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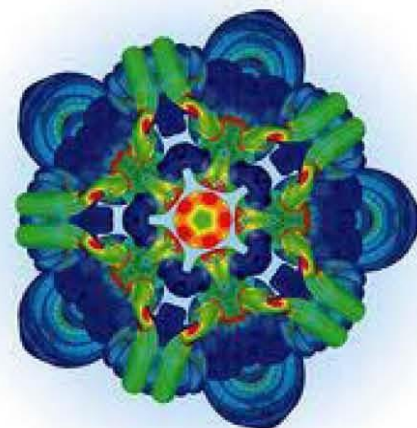
National Conference on Current & Emerging Process Technologies, (CONCEPT-2019), January 25, 2019

Organised by:

Indian Institute of Chemical Engineers KEC Student Chapter, Department of Chemical Engineering, Kongu Engineering College, Perundurai, Erode, Tamil Nadu, INDIA

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Extraction of Ascorbic Acid and Carotenoids from *Passiflora edulis*

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Abstract. Researches carried out over the years have demonstrated the growing interest in recovering phytochemicals from vegetal matrices. The main goal of this work is to recover carotenoid and ascorbic acid from *passiflora edulis* (passion fruit). About 7 to 9% of Carotenoid and 34 to 36% ascorbic acid can be obtained from 100gms of seed and peel extract of *passiflora edulis*. Previous studies demonstrate that high dosage of vitamin C can improve the quality of life of cancer patients and carotenoid decrease the risk of breast cancer, ovarian cancer in women and also prevent pregnancy related complications. The reason for selecting *passiflora edulis* is due to abundant availability of the fruit in the southern India and also rich in vitamin A, Riboflavin, Niacin. Carotenoids are the major phytochemicals which has the biological activity to inhibit oxidation and can be used as anticancer supplements. The motivation of this theme is based on complete extraction of carotenoid and ascorbic acid from seed and peel. The recovery of carotenoid can be done by the Eco-friendly solvent extraction techniques

Keywords: Carotenoid, Ascorbic acid, *Passiflora edulis*, Solid- Liquid extraction.

I. Introduction

The recent studies have demonstrated the growing interest in recovering phytochemicals from vegetal matrices. Products derived from plants can control the microbial growth in diverse and in specific case of disease treatment [1]. The main objective of this recovery is to obtain compounds such as carotenoids and ascorbic acid from a fruit, such as *Passiflora edulis*. These compounds have the antioxidant activity [2], which restricts the production of free radicals and prevents chronic diseases such as cancer. Most of the countries use antioxidants which are derived from vegetal matrices.

Passiflora edulis is commonly known as passion fruit, belonging to the family passifloraceae. which. which. which is abundant in Brazil as well as southern India. Brazil is the largest producer of *passiflora edulis* [1]. Passion fruit stands for its exotic and unique flavor, aroma and its amazing nutritional and medicinal properties. There are two types of *Passiflora edulis* are grown commercially, the purple form (*Passiflora edulis* sims) and a yellow form (*Passiflora edulis* var. *flavicarpa*). The compounds such as alkaloids, flavonoids, niacin, *Tocopherols chrysin*, phenols, carotenoids and ascorbic acids are present in *Passiflora edulis* [3]. All these compounds have several biological activities and high nutritional value, which are related to many health benefits. It is estimated that the fruit mass of *Passiflora edulis* contain 36% of ascorbic acid and 7-9% of carotenoids.

The separation process of one or more components from a complex mixture is a requirement to several unit operations in food and chemical industries. The separation process can be classified according to the nature of the material submitted to separation, based on unit operations or classified by the type of phases in contact, such as solid-liquid, liquid-liquid, among others. Basically, the separation of substances from vegetable matrices is classified as solid-liquid extraction and can be carried out through conventional or non-conventional methods.

The present study was conducted to obtain the complete recovery of carotenoids and ascorbic acid from *Passiflora edulis* by hot continuous extraction method. Solvents such as ethanol, hexane, water and sodium benzoate are used, and which is performed with edible parts of the fruit such as seed and peel. The carotenoids and ascorbic acid have antioxidant properties [4,5], which help in repairing the cell damage and also act against the metagenesis tumor cells.

Conventional extraction methods are the classical techniques based on the extraction capacity of different solvents. Soxhlet extraction and maceration are the techniques used for the extraction. These techniques can be considered as “Green” or environmentally friendly methods.

II. Materials and Methodology

A. Materials

UV spectrophotometer is employed for the spectrometric analysis (Research and Development Center, Akay Flavors and Aromatics Pvt Ltd, Kerala) and HPLC is employed for quantitative and qualitative analysis of the extract (Research and Development Center, Akay Flavors and Aromatics Pvt Ltd, Kerala). *Passiflora edulis* is collected from a local plantation in Malappuram, Kerala and all the chemicals and solvents used are of analytical grade.

B. Collection and processing of *passiflora edulis*

Fresh *Passiflora edulis* are collected from the plantation and identified, which is then rinsed using fresh water and dried either using rotary drum dryer or air drying. The dried seed and peel are then pulverized using mixer grinder and then stored under room temperature.

C. Rotary drum drying

The rinsed seed and peel is stored and then it is processed and applied to the rotary drum dryer, the seed and peel is separately processed, and the temperature and rpm of the dryer is set to 85° C and the rpm is set to about 10-15 respectively.

D. Extraction by Maceration

50 grams of pulverized seed and peel is weighed using electronic weighing balance and then it is soaked in 400 ml of organic solvent (Hexane, water and sodium benzoate) contained in a conical flask. The mixture is kept on a rotary shaker for 24hrs and then mixture is filtered using filter paper and then it is subjected to Liquid-Liquid extraction in the drug/solvent ratio of 1:8 and the fruit extract is taken in beaker and stored at the room temperature.

E. Extraction by Hot Continuous Extraction

50 grams of pulverized seed and peel is weighed using electronic weighing balance and then it is charged to the extraction chamber of Soxhlet extractor and then 500 ml solvent is added to the round bottom flask and suitable temperature is applied According to the type of solvent used for the extraction, the extraction is carried out in the drug/solvent ratio of 1:12 and the fruit extract is taken in beaker and stored at the room temperature.

F. Recovery of Solvent

The solvent is recovered by either using vacuum evaporation or steam distillation. Then the solvent is recycled and used for further extraction purposes.

G. Analysis of extract

Qualitative Analysis of phytochemicals from the aqueous extract will be performed for checking the presence of carotenoid, ascorbic acids, saponin, steroid, cardiac glycosides, amino acids, terpenoids, alkaloids, reducing sugars and tannins in the sample. Each sample must be undergone UV spectroscopy for the confirmation of the presence of carotenoids and ascorbic acid and molecular structures can be identified by NMR Spectroscopy. The carotenoids and ascorbic acid can be separated by HPLC, GC-MS analysis. HPLC is preferred for the separation of these bioactive compounds because of high separation power and sensitive detection.

III. Result and Discussion

Extraction is a key step involved in obtaining Carotenoids and ascorbic acid from *passiflora edulis*. Hot continuous extraction procedure has been employed to extract the compounds from *passiflora edulis*. Different solvents were analyzed to identify the best solvent which will gives the maximum extract.

In the present study, two extraction methods, namely maceration and Soxhlet along with two drug/solvent ratios (1:8, and 1:12) have been used to see their efficiency on extraction of chemical constituents

and antioxidant activities in *P. edulis*. Among the different extraction and solvent method, Soxhlet extraction in 1:12 of drug/solvent ratio provided the maximum extract.

Figure 1 Effect of Temperature on Extraction

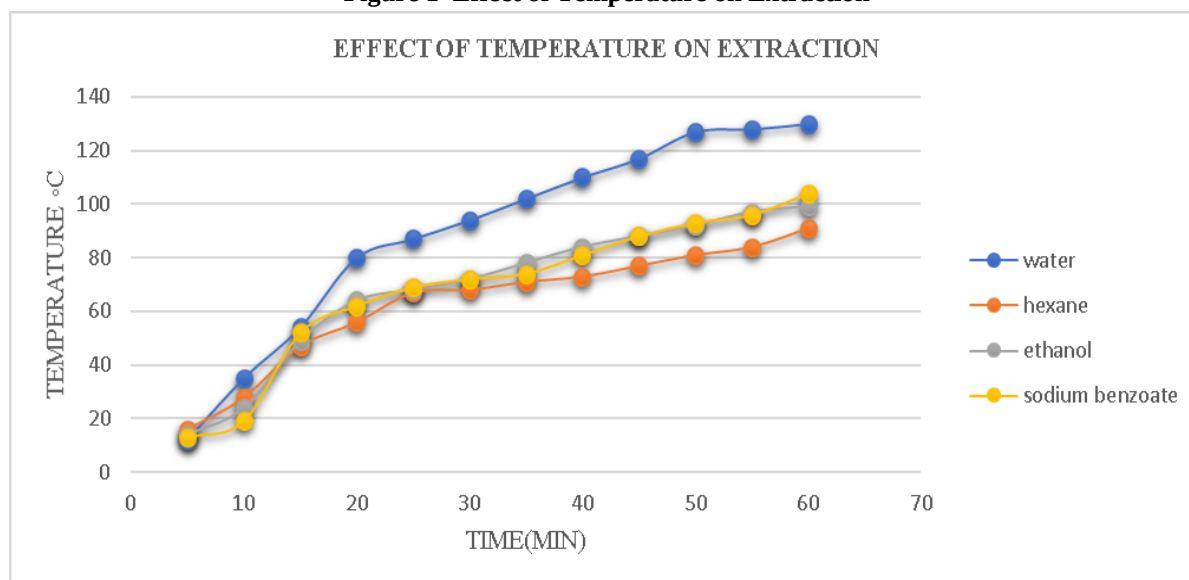


Fig.1 shows the effect of temperature on extraction, from the observations the Water gives highest extraction percentage when compared to other three solvents, the temperature increases up to 130°C and the extraction also increases with the increase in temperature. From the observation water, ethanol and sodium benzoate are the suitable solvents for the extraction phytochemicals from *passiflora edulis*

IV. Conclusion

The study of the chemical composition of *Passiflora edulis* shows the fruit is rich in carotenoids and ascorbic acid which are relevant tool in contributing antioxidant supplements to the pharmaceutical industries. With regard to the extraction method the best results were obtained with Soxhlet extraction at drug/solvent ratio of 1:12. Here, we used UV and NMR spectroscopy for identification of the presence of carotenoids and ascorbic acid. HPLC and MS-GS are used to separate carotenoids and ascorbic acid. The study revealed the presence of several flavones in extract of *P. edulis* with moderate antioxidant activity, which shows that *P. edulis* may serve as an additional natural source of bioactive compounds. In conclusion, we suggest that *P. edulis* could be considered as one of the natural antioxidant sources and dietary nutritional supplements to prevent oxidation-related diseases.

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Influence of temperature, pH, incubation time, metal ions on amylases production from *Bacillus* species for Bio-Desizing

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Abstract: In Textile Processing the Enzymatic removal of starch sizes from woven fabrics has been in use for most of this century and the fermentation vat is probably the oldest known dyeing process. Bioprocessing also offers the potential for new industrial processes that require less energy and are based on renewable raw materials. Various applications which entail enzyme and colors broadly included fading of denim and non-denim, bio-scouring, bio-polishing, silk degumming, carbonizing of wool, peroxide removal, washing of reactive dyes, etc. Incidentally enzymes were consumed to the tune of about 70 percentages in detergents than in textile industry. Enzymes are large protein molecules made up of long chain amino acids which are produced by living cells in plants, animals and microorganism. Enzymes are secretions of living organisms, which catalyze biochemical reactions. Enzymes are biocatalysts without which no life in plant or animal kingdom can be sustained. Today enzymes have become an integral part of the textile processing. Amylases are hydrolase class of enzymes, which hydrolyse amylose and amylopectin of starch to convert them into soluble dextrins. Amylase production from *Bacillus* species are of great industrial importance in the production of corn syrup or dextrose. The present study is aimed to determine the influence of temperature, pH, incubation time, metal ions on stability of α -amylase from *Bacillus* species. This present study is expected to give the outcome that enzyme may more stable at pH 6.0 than other pH values (7.0 and 8.0). The bacterium could grow satisfactory at all temperatures tested but the maximal amylase activity in the growth medium was achieved at 37°C. The maximum amylase production may be observed at an incubation period of 24 hrs for *Bacillus* species. The presence of calcium chloride may in the nutrient medium induce amylase production followed by CuSO_4 and MgSO_4 . All α -amylases are metallo enzymes containing at least one Ca^{2+} ion per enzyme molecule which is essential for activity.

Keywords: Enzyme, Amylase, *Bacillus* species, Bio Textiles

I. Introduction

Textile processing is a growing industry that traditionally has used a lot of water, energy and harsh chemicals starting from pesticides for cotton growing to high amount of wash waters that result in waste streams causing environmental burdens. The awareness of environmental impacts of chemical processing of textiles, combined with increased strict legislation on industrial effluent and consumer interest to use ecofriendly products has led to the advanced, non polluting chemical process for textile fibrous material treatments, particularly in wet processing.

Modern society expects biotechnology to be the answer for many worldwide problems like depletion of ozone layer, global warming, selfish resource exploitation, pollution of water and air, scarcity of landfills and waste management. Industrial use of Biotechnology is bringing about new products and processes at the renewable resources, as well as the application of green technologies with low energy consumption and environmentally healthy practices. It is rapidly gaining importance due to the various advantages it offers over conventional polluting chemical process. It is defined as the application of living organisms and their components to industrial products and processes. It is not an industry in itself, but an important technology that will have a large impact on many different industrial sectors in the future report [1].

World over textile processing is undergoing a sea change, and traditional, time consuming and often polluting processes are being replaced with efficient quick and green technology. Recently it is observed that enzyme is safe to use, easy to control and biodegradable Enzyme and enzyme technology are widely touted as the way of the future for many processing industries. This technology is one way to attain leadership in traditional wet processing area, by both protecting the environment and reducing energy and chemical needs [2].

Enzymes are highly efficient catalyst from biological sources, which catalyse synthetic and degradative reaction of living organisms. Enzymes are used industrially because of their high catalytic power, specific mode of action, stereospecificity, eco-friendly nature and reduce energy requirements. The beauty of enzymes is that they are specific. The scalpel of enzyme can be used instead of sledge hammer of chemicals [3].

Enzymes can be safely used in a wide selection of textile processes such as desizing, scouring, bleaching, dyeing and finishing. There are five known sources of enzymes. They are fungi, bacteria, ruminants, marine organisms and plants [4]. Bacterial enzymes are produced by growing culture of certain microorganisms. Microorganisms have now become one of the major sources for the production of industrial scale of enzymes. Amylase enzyme is one of the most important industrial enzymes which hold the supreme market share of enzyme sales with major applications in starch industry, baking, analytical chemistry, detergents, textile desizing, and medicine, pulp and paper industries [5]. These amylase enzymes originate from different sources like plants, animals and microorganisms; among them, microbial amylases are the most produced and used in industries due to their high productivity and thermostability [6]. Because of the industrial importance of amylase, there is ongoing interest in the isolation of new bacterial strains producing amylase that suit-able for new industrial applications [7]. Studies on bacterial amylase in developing countries are con-centrating mainly on *Bacillus* sp. probably because of simple nature and cheaper nutritional requirements of these organisms [8]. “How-ever, *Bacillus* sp. produces a large variety of extracellular enzymes such as amylases, proteases, and lipases which have significant industrial importance [9]. The amylases produced by different *Bacillus* species vary not only in their types but also in the varying range of pH and temperature [10]. The bacterial source of the enzyme is usually either from *Bacillus amy-loliquefaciens* or *Bacillus licheniformis*, the latter now being of greater industrial importance [11]. The optimal production of a microbial enzyme and its growth depends on the nature of strain involved as well as various environmental parameters such as dissolved oxygen, agitation, temperature, pH, substrate and nutrients. Although production of amylase has been implemented on agricultural and industrial wastes and its co-products such as starch materials to solve pollution problems and obtain a low cost medium [12].

Various types of enzymes like amylase, cellulase, laccase, and catalase are used in textile process. Amylases are used for removal of starch, cellulases are used for biopolishing and biostoning, catalase degrades excess peroxide in bleaching process and laccase is used to bleach fabrics. Amylase is one of the most important enzymes applied at early pre-treatment stages, making a strong foundation for the successful finishing of fabrics. Amylase selectively hydrolyses starch to desize the fabric completely. Amylase can be divided in two categories, endo amylases and exoamylases. Endo amylases catalyse hydrolysis in a random manner in the interior of the starch molecule producing linear and branched oligosaccharides of various chain lengths. Exoamylases act from the non-reducing end successively resulting in short end products. Amylase application has evidenced in many other fields, such as clinical, medicinal, analytical chemistries and application in starch saccharification in the textile, food, fermentation, paper, brewing and distilling industries. Desizing is the first wet treatment given in the processing of the textile materials, which involves the removal of starch and ingredients used. It is generally believed that efficient desizing is of crucial importance to the scouring, bleaching and dyeing also.

Desizing using amylase enzymes has been well established for many years. The most outstanding features of the enzyme desizing are the specific nature of enzyme action. The enzyme hydrolyses starch but does not tender cellulose. Therefore, enzyme desizing is safer than conventional desizing. Enzyme desizing is eco – friendly.

Currently, a great deal of attention is being paid on the biotechnological potential of agro industrial residues such as oil cakes, wheat bran, rice bran etc. for their use as raw materials in the production of value added products such as enzymes, organic acids, single cell protein etc.

Agro residues attempt to reduce the production cost by promoting the use of agro residues as source material and also avoiding or reducing costly supplement such as yeast extract. Application of these agro industrial residues in bioprocesses also solves pollution problems. Amylase production from *Bacillus* species are of great industrial importance in the production of corn syrup or dextrose. The present study was determined about the influence of temperature, pH, incubation time, metal ions on stability of α -amylase from *Bacillus* species. Hence the present study is planned to isolate amylase producing bacteria from spoiled foods, Influence of temperature, pH, incubation time, metal ions on amylases production from *Bacillus* species for Bio-Desizing.

II. Primary and Secondary Screening Methods

A. Selection of the source

Amylases are important enzymes, particularly in the process involving starch hydrolysis. Though they originate from different sources (plants, animals and microorganisms) in industry, they are mainly produced from the microbes, due to their higher yield and thermostability. The first important step is to isolate and identify amylolytic microorganisms. Habitats that contain this substrate are the best sources, in which to find these microorganisms.

Hence spoiled banana, spoiled apple, spoiled vegetables like potato, tomato and spoiled food which are rich in starch were selected for the isolation of amylolytic bacteria.

B. Collection of the sample

Decayed fruits and other vegetables were collected locally and stored in a clean polythene bag and kept at 4° C until analysis was done

C. Isolation of amylolytic Bacteria

The fruits and vegetables were washed and ground with sterile water. 10 grams of each ground sample was weighed into 90 ml of sterile distilled water separately. From this dilution was made up to 10⁻⁸ dilutions. 1ml of sample from each dilution was poured into sterilized nutrient agar medium (Beef extract-0.3g, NaCl-0.5g, Peptone-0.5g, Agar-2g, Distilled water-100ml) (Plate 1) and incubated at 37°C for 24 hrs. Well grown colonies were picked and streaked in starch agar plates and the plates were incubated for 24 hrs. The zone formed on starch agar plates were visualized by flooding the plates with iodine solution. The isolates which showed zone of clearance greater than 3 were selected for the study.

D. Screening of Amylase activity

Amylase activity was determined by DNS method (Sadhashivan and Manickam, 1997). One unit of enzyme activity is defined as the amount of enzyme required for releasing 1 mg of reducing sugar, equivalent to maltose, per min under the optimum conditions of assay.

E. Selection of amylolytic bacteria

The selected strains were inoculated (2% V/V) in nutrient broth and kept at 24 hrs for 37° C in shaker incubator (Plate -2). After incubation, the culture was centrifuged at 5000 rpm for 20 minutes at 4° C in a refrigerated centrifuge (Plate - 3). Amylase activity was determined in the cell free supernatant. The isolate which produced maximum activity was selected and maintained on nutrient agar slant at 4° C and sub cultured after every 15 days.

III. Optimization of the cultural conditions for amylase production

A. Influence of pH on amylase production

The optimum pH for amylase production was determined at different pH such as 3, 4, 5, 6, 7, 8 and 9 by keeping the temperature as constant at 37°C. The pH of the nutrient medium was adjusted using 1N HCl or 1N NaOH. 2% overnight grown culture was inoculated into the medium with different pH and kept for incubation at 37°C for 24 hrs at 4° C in a refrigerated centrifuge. The amylase activity and cell mass was determined using nano UV-VIS spectrophotometer.

B. Influence of temperature on amylase production

Two percent overnight grown culture was inoculated in nutrient medium at pH 6. The broth was incubated at different temperatures ranging from 20° C - 60° C at 10° C interval for 24 hrs. After the incubation period, the culture was centrifuged at 5000 rpm for 20 minutes at 4° C in a refrigerated centrifuge. The amylase activity was determined from the cell free supernatant.

C. Influence of incubation time on amylase production

To optimize the incubation time for the cell growth and amylase production, the inoculated culture was incubated at 37° C at different time intervals such as 24 hrs, 36 hrs, 48hrs, 60hrs and 72hrs. After each incubation period, cell mass and amylase activity was determined.

D. Influence of metal ions for amylase production

Impact of metal ions on amylase production was determined by incubating 0.1% of various metal ions such as CaCl₂, KCl, MgSO₄, FeSO₄, CuSO₄, Pb(NO₃) and HgCl₂. Amylase activity was determined after 24 hrs at 37° C.

IV. Results and discussion

The optimization of growth parameters such as incubation time, temperature, pH, and metal ions for amylase production was analyzed using ANOVA (Analysis of variance technique) one way classification and conclusion was drawn on the basis of analysis of variance technique.

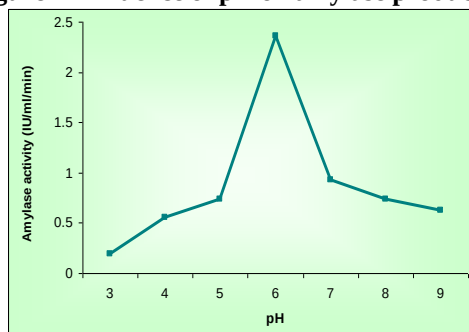
A. Influence of pH on amylase production

The effect of pH on growth and enzyme production by *Bacillus* sp is depicted in Table I and Fig. 1. From the table the optimum pH was found to be at pH 6. After pH 6 a continuous decrease in amylase activity was observed. There was a decrease in amylase activity as the pH increases.

Table I Influence of pH on amylase production

pH	Amylase Activity IU/ml/min	Cell mass OD at 600 nm	Specific Activity (mg/ml)
3	0.19	0.0151	3.16
4	0.55	0.025	4.75
5	0.74	0.093	5.20
6	2.36	1.456	7.23
7	0.925	0.128	6.11
8	0.74	0.123	5.20
9	0.63	0.094	3.14

Figure 1 Influence of pH on amylase production



From the above table it can be inferred that the optimum pH for amylase activity ranges from 6 to 7 and also there is a decline in the enzyme activity below and above the optimum pH range. Amylases are generally stable in pH range 6 – 9.0 but exceptions exist on both sides of the pH scale, mainly in the enzymes of microbial origin. Among the physicochemical parameters, the pH of the growth medium plays an important role by inducing the morphological changes in the organisms and in the enzyme secretion. The production of amylase was very sensitive to initial pH of the fermentation medium. Based on the obtained results; the initial pH value of the medium was adjusted to 6.0 for maximum production of amylase.

B. Influence of temperature on amylase production

Temperature is directly related to the metabolic activities of the microorganism and it affects the product formation by the organism. Every organism has its own optimal temperature at which it grows maximum and produces the desired product. *Bacillus* species showed best amylase synthesis when incubated at 37°C.

Table II Influence of temperature on amylase production

Temperature (°C)	Amylase Activity IU/ml/min	Cell mass OD at 600 nm	Specific Activity (mg/ml)
27° C	1.90	0.140	5.83
37° C	2.58	0.195	7.64
50° C	0.925	0.120	6.01
60° C	0.74	0.050	5.35
90° C	0.62	0.045	4.27

Figure 2 Influence of temperature on amylase production

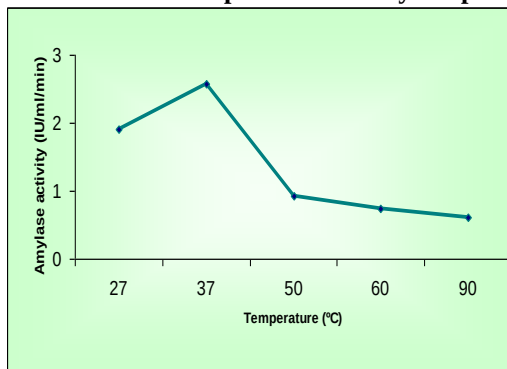


Table II and Figure II describes the effect of temperature on the growth and enzyme production by *Bacillus* sp. It is observed from the table that temperature of 37°C favours the maximum growth of *Bacillus* sp. and the yield of amylase. As the temperature increases, the activity decreases due to denaturation of protein. The bacterium could grow satisfactory at all temperatures tested but the maximal amylase activity in the growth

medium was achieved at 37°C. A wide range of temperature (35-80°C) has been reported for optimum growth and α -amylase production in bacteria.

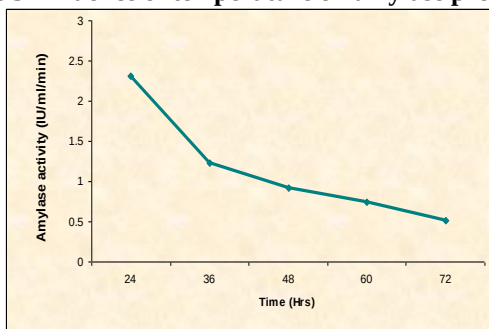
C. Influence of incubation time on amylase production

To determine optimum incubation time for cell growth and amylase production, the inoculated medium was kept at 37° C for 24 hrs to 72 hrs at different time intervals. The amylase activity was determined after each incubation time. The maximum amylase production was observed at an incubation period of 24 hrs for Bacillus sp which is depicted in Table III and Figure III.

Table III Influence of temperature on amylase production

Time (Hrs)	Amylase Activity IU/ml/min	Cell mass OD at 600 nm	Specific Activity (Mg/ml)
24 hrs	2.31	0.136	7.46
36 hrs	1.235	0.067	6.98
48 hrs	0.924	0.017	6.20
60 hrs	0.74	0.045	6.02
72 hrs	0.510	0.036	5.25

Figure 3 Influence of temperature on amylase production



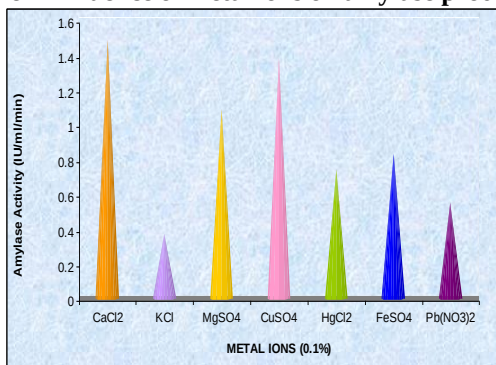
D. Influence of metal ions on amylase production

From the table, it is clear that presence of calcium chloride in the nutrient medium induces amylase production followed by CuSO₄ and MgSO₄. All α -amylases are metallo enzymes containing at least one Ca²⁺ ion per enzyme molecule which is essential for activity and affinity of Ca²⁺ is much stronger than that of other ions. In Bacillus subtilis, α -amylases was activated by 2mM Ca²⁺ but inhibited by all other metal ions to a variable extent. Metal ions like HgCl₂ and FeSO₄ inhibits amylase activity.

Table IV Influence of metal ions on amylase production

Metal ions	Amylase Activity IU/ml/min	Cell mass OD at 600 nm	Specific Activity (mg/ml)
CaCl ₂	1.480	0.128	7.28
KCl	0.37	0.036	6.03
MgSO ₄	1.09	0.140	6.23
CuSO ₄	1.38	0.125	5.20
HgCl ₂	0.74	0.060	2.25
FeSO ₄	0.832	0.068	3.04
Pb(NO ₃) ₂	0.55	0.046	4.33

Figure 4 Influence of metal ions on amylase production



V. Summary and Conclusion

The success of the textile industry is based on the production of good quality of textiles, matching the demands of the consumer. Today's textile production is characterized by high quality requirements, high productivity and high flexibility to meet the basic requirements of the markets.

Eco friendliness is the basic need in textile wet processing. This can be achieved by means of green 'chemistry' in other words, non-toxic enzymatic treatment. A good way to start the process is to begin naturally with bio-desizing. Optimization of growth conditions for amylase production by *Bacillus* species. The effects of various parameters such as pH, temperature, incubation time and metal ions use of agro waste as substrate on amylase production were determined.

The optimum growth conditions for amylase production by *Bacillus* sp. was found as follows.

- The optimum pH for amylase production was found to be at pH 6.
- The optimum temperature for amylase production was found is at 37° C.
- An incubation time of 24 hrs resulted in maximum production of amylase.
- Amylase production was enhanced by the supplementation of maltose and peptone.
- CaCl_2 at 0.1% acts as an activator for the production of amylase.
- The agro waste wheat bran was used as substrate for the production of amylase. But the production was not comparable with that of submerged fermentation.

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Aqueous solubility enhancement of naringenin a bioactive compound using an eco-friendly hydrotropic phenomenon

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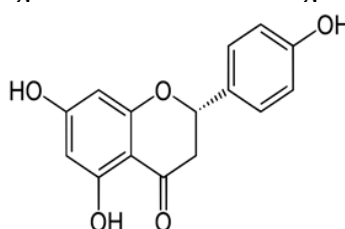
Abstract: Natural products from plant sources are widely used in medicinal fields. Naringenin is a flavonone derived from citrus fruit and grape fruit, has many biological effects such as antioxidant, anti-inflammatory, anticancer, antifibrogenic, antiandrogenic and free radical scavenger. On other hand naringenin is poorly soluble in water. Since it is poorly soluble in water it is not efficiently consumed. Hence, the aim of this study is to enhance the solubility of naringenin using hydrotropes such as nicotinamide & potassium acetate and to find the thermodynamic parameters such as gibbs free energy, enthalpy and entropy. Solubility enhancement is confirmed by UV-Vis spectrophotometer and it is found that the aqueous solubility is enhanced by several folds when using nicotinamide as hydrotrope. The obtained thermodynamic parameters proved that, the hydrotropic aggregation is favored entropically.

Keywords: Naringenin, Hydrotropes, Aqueous solubility, Thermodynamic parameters

I. Introduction

Plants have been used by human being since antiquity for diverse purposes such as food and medicine. Many of the currently available drugs have been derived from natural sources. More than 25% of the drugs prescribed worldwide are derived from plants, and 121 such active phytoconstituents are used for different disorders. The term flavonoid is derived from the Latin word "flavus", meaning yellow [1]. Flavonoids, rich in fruits, teas, vegetables, and medicinal plants, have received great attention and been studied extensively, since they have many curative effects such as antibacterial, antioxidant, antiviral, analgesic activities, etc [2]. Naringenin (4', 5, 7-trihydroxyflavanone) (NRG) is one of the major citrus flavanone commonly found in citrus fruits such as grapes and oranges. Naringenin has a bioactive effect on human health such as antioxidant, anti-inflammatory, anticancer, antifibrogenic, antiandrogenic and free radical scavenger [3]. Therapeutic effectiveness of a drug depends upon the bioavailability and ultimately upon the solubility of drug molecules. Naringenin shows slow dissolution from oral dosage forms, thereby restricting its use in therapy. Naringenin is poorly soluble in water and showed poor bioavailability when administered orally. Therefore, it is important to develop new methods for enhancing the solubility of naringenin [4]. Various techniques have been employed to enhance the solubility of drugs that are sparingly soluble in water. Hydrotropy is a unique and unprecedented solubilisation technique which is used to solubilize various sparingly soluble organic compounds, drugs and petro products. Hydrotropy is a technique that uses hydrotropes which are used as food preservatives or medicinal uses to enhance the solubility of drugs [5]. Hydrotropes are class of chemical compounds used to effect a several fold increase in aqueous solubility of certain solutes. This increase in solubility in water is probably due to the formation of organized assemblies of hydrotrope molecules at critical concentrations [6]. Various organic solvents like methanol, chloroform, alcohol, dimethyl formamide, and benzene have been employed for the solubilisation of poor water soluble drugs for their analysis. But due to high consumption of solvent, toxicity and post purification methods it is not effectively utilized [7].

Figure 1 Structure of Naringenin



The present study aims to apply hydrotropes such as Nicotinamide and Potassium acetate as a solubilizing agent to enhance solubility of naringenin and to substantiate the hydrotropic aggregation behaviour.

Thermodynamic properties such as Gibb's free energy and Entropy and Enthalpy of the system were studied with the knowledge of solubility data.

II. Experimental Procedure

A. Solubility Enhancement

The experimental methodology for solubility is same as stated [5], which consist of water bath shaker, thermostatic bath and separating funnel. Naringenin along with known concentration of hydrotrope solution are taken in a conical flask and it is vigorously shaken for 2 hours in a water bath shaker and transferred in to a separating funnel. The separating funnel is sealed to avoid the evaporation of the solvent at higher temperatures. The separation funnel was immersed in a constant-temperature bath fitted with a temperature controller. The setup was kept overnight to attain equilibration. Then the solution from the separating funnel is filtered which is analysed using UV spectrophotometer for naringenin content.

B. Thermodynamic Parameters

The thermodynamic parameters of the complexation reaction such as Gibbs free energy change, Enthalpy change and Entropy change are determined as cited [8].

Gibbs free energy change (ΔG°) can be calculated using the equation

$$\Delta G^\circ = RT \ln X_{MHC}$$

(R – gas constant, T – temperature, X_{MHC} – solubility at minimum hydrotrope concentration.)

It indicates the transfer of naringenin from water into the hydrotrope. It also provides data regarding favourable or unfavourable condition concerning the solubility of naringenin in hydrotropic solution. By calculating the Enthalpy change (ΔH°) and Entropy change (ΔS°), information about the strength of the interaction between naringenin and hydrotrope can be obtained.

The Enthalpy change is determined from the equation.

$$\Delta H^\circ = -RT^2 (\partial \ln X_{MHC} / \partial T)$$

The Entropy change of the complexation reaction is determined using the equation

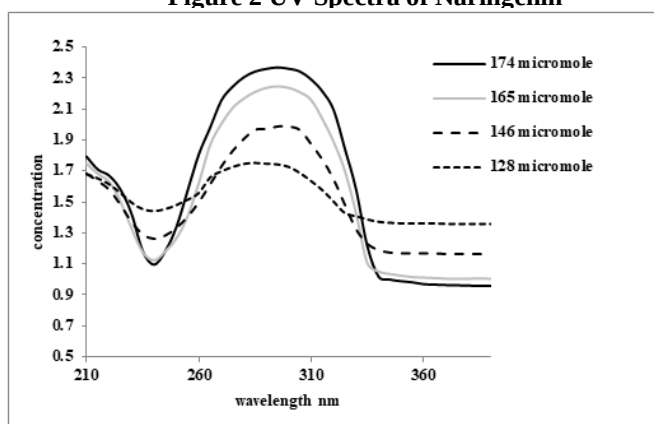
$$\Delta S^\circ = (\Delta H^\circ - \Delta G^\circ) / T.$$

III. Result and Discussion

A. Standardization of Naringenin

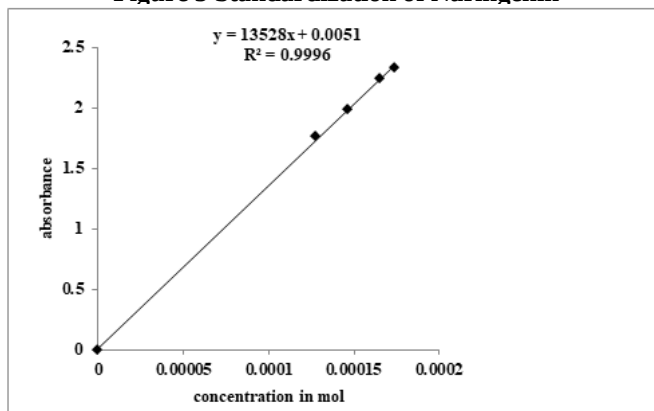
The molar extinction coefficient is obtained by standardization of naringenin. UV- spectrometer analysis is done for various concentrations of naringenin at a wavelength of $\lambda_{max} = 298\text{nm}$. Absorbance value is obtained from UV- spectrometer analysis shown in fig.1. A graph is plotted between absorbance vs concentration of naringenin which describes the standardization of naringenin as shown in the fig.2, from which the molar extinction coefficient is determined.

Figure 2 UV Spectra of Naringenin



UV- spectrometer analysis is done to identify the solubility of naringenin. Peak value is taken as the absorbance value from the curves in fig.1. From the absorbance value and concentration of naringenin molar extinction coefficient is determined. From fig.2 the molar extinction value is determined which is found to be $13528 \text{ mol}^{-1} \text{ cm}^{-1}$ and it is in compliance with values obtained in [9].

Figure 3 Standardization of Naringenin



B. Solubility Enhancement

From fig.3, fig.4 & fig.5 it has been concluded that, at Minimum Hydrotrope concentration (MHC) there is no increase in the solubility. The solubility increases only above the MHC. This increase in solubility is maintained only up to certain concentration of hydrotrope, beyond which there is no appreciable increase in the solubility. This concentration is referred to us Maximum Hydrotrope Concentration (C_{max}). It is also noted that there is an increase in solubility with increase in temperature and concentration of the hydrotrope.

Figure 4 Solubility Enhancement Using Nicotinamide

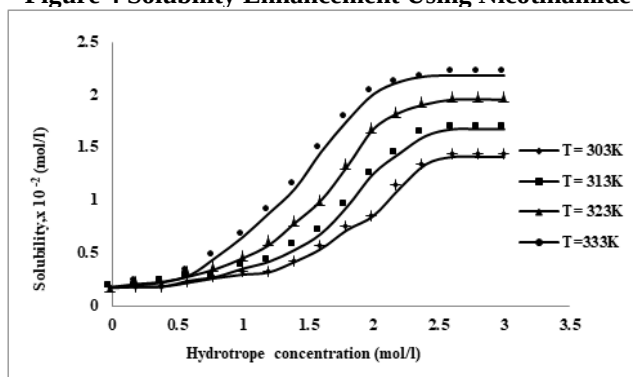
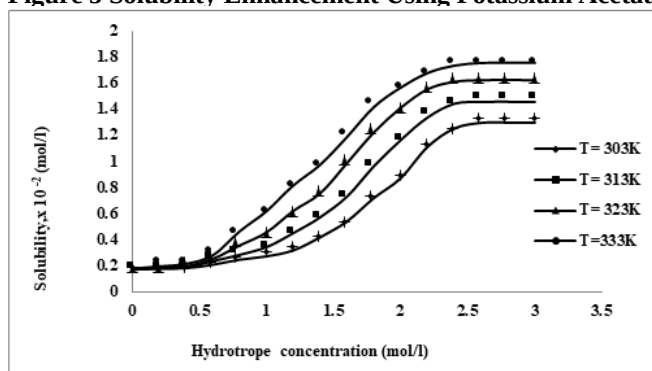


Figure 5 Solubility Enhancement Using Potassium Acetate



C. Maximum Enhancement Factor

Maximum enhancement factor is the ratio of maximum solubility using hydrotropes and solubility without hydrotropes. From table 1 it has been observed that the solubility of naringenin increased by 12.2 folds when using nicotinamide as hydrotrope.

Table I Maximum Enhancement Factor

Maximum Enhancement Factor (ϕ)				
Hydrotropes	T = 303 K	T = 313 K	T = 323 K	T = 333 K
Nicotinamide	8.12	9.46	10.93	12.2
Potassium acetate	7.46	8.23	9.01	9.7

D. Thermodynamic Parameters

The thermodynamic parameters of the complexation reaction such as Gibbs free energy change, Enthalpy change and Entropy change are determined as cited [8].

Gibbs free energy change (ΔG°) can be calculated using the equation

$$\Delta G^\circ = RT \ln X_{MHC}$$

(R – gas constant, T – temperature, X_{MHC} – solubility at minimum hydrotrope concentration.)

Where, R = 8.314

It indicates the transfer of naringenin from water into the hydrotrope. It also provides data regarding favorable or unfavorable condition concerning the solubility of naringenin in hydrotropic solution. By calculating the Enthalpy change (ΔH°) and Entropy change (ΔS°), information about the strength of the interaction between naringenin and hydrotrope can be obtained. The Enthalpy change is determined from the equation

$$\Delta H^\circ = -RT^2 (\partial \ln X_{MHC} / \partial T)$$

(R – gas constant, T – temperature, $(\partial \ln X_{MHC} / \partial T)$ = slope value at Minimum Hydrotropic Concentration and temperature)

R = 8.314

The Entropy change of the complexation reaction is determined using the equation

$$\Delta S^\circ = (\Delta H^\circ - \Delta G^\circ) / T$$

T – temperature.

Figure 6 Solubility at $\ln X_{MHC}$ vs Temperature (Nicotinamide)

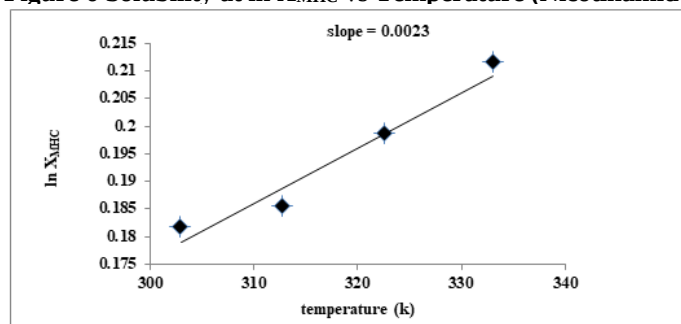


Table II Thermodynamic Parameters (Nicotinamide)

Temperature (K)	ΔG° (KJ/mol)	ΔH° (KJ/mol)	ΔS° (KJ/molK)
303	-4.292	-1.755	0.0084
313	-4.391	-1.873	0.0080
323	-4.349	-1.995	0.0073
333	-4.308	-2.120	0.0066

Figure 7 Solubility at $\ln X_{MHC}$ vs Temperature (Potassium Acetate)

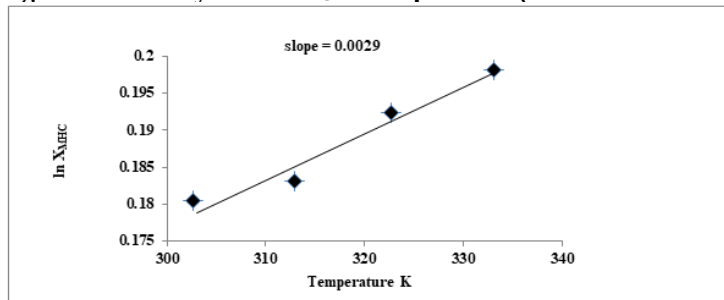


Table III Thermodynamic Parameters for Potassium Acetate

Temperature (K)	ΔG° (KJ/mol)	ΔH° (KJ/mol)	ΔS° (KJ/molK)
303	-4.320	-2.214	0.0070
313	-4.419	-2.362	0.0066
323	-4.432	-2.515	0.0059
333	-4.484	-2.674	0.0054

The negative value of Gibbs free energy change (ΔG°) indicates the favorable condition for the solubilization of naringenin in the presence of hydrotrope. If the values of (ΔG°) are decreasing with increase in the hydrotrope concentration and temperature of the process, the reaction becomes more favorable with the increase of hydrotrope concentration and temperature (10).

The values of thermodynamic parameters confirmed that the inclusion of naringenin into hydrotrope is an exothermic process since the Enthalpy change (ΔH°) values are negative. It takes place spontaneously at the chosen temperature [8].

Moreover, the transfer of naringenin from aqueous medium into the hydrotropes is realized by hydrophobic interactions due to the positive values of Entropy change (ΔS°).

IV. Conclusion

Since naringenin is poorly soluble water, hydrotropes such as nicotinamide and potassium acetate are used to enhance the solubility of naringenin. These hydrotropes enhanced the solubility of naringenin, in which the solubility of naringenin is increased when compared with the solubility of free naringenin in distilled water. The solubility enhancement techniques were conducted at various temperatures (303K, 313K, 323K & 333K) and for various concentrations of hydrotropes from 0 to 3 moles. There is an increase in the solubility with increase in the temperature and concentration of hydrotropes. The solubility of naringenin is increased by 12.2 folds when using nicotinamide as hydrotrope.

The thermodynamic parameters show that, the negative values of Gibbs free energy change indicate the favorable condition for the solubility of naringenin in the presence of hydrotropes. The negative values of Enthalpy change indicate that, inclusion of naringenin into hydrotropes is an exothermic process. Moreover, the transfer of naringenin from aqueous medium into the hydrotropes is realized by hydrophobic interaction due to the positive value of Entropy change.

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Flocculation of Dairy Effluent using Seed Coat of Hyacinth Beans and Utilization of Sludge as a Fertilizer

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Abstract: Dairy plant which requires huge amount of fresh water converts 90% of fresh water into wastewater demonstrating high risk of pollution. The quantity of water used in the milk processing plant depends upon the size of the treatment plant which is expressed in the terms of maximum weight of milk handled per day and the process involved. The operations which uses the water for rinsing and cleaning the equipment need not be proportional to the amount of product formed. The raw dairy effluent is collected from local dairy plant near ERODE. The characteristics such as, COD, BOD, TDS, Turbidity, pH are found out. Effluent which consists of impurities is coagulated by using the natural coagulants such as, bentonite clay and seed coat of hyacinth beans. The results such as colour removal, turbidity removal, COD, BOD removal will be noted down for various coagulant dosages and the optimum coagulant dosage level is found out. The coagulants are compared for the best. Batch clarifier for the treatment of dairy effluent is designed for different solid concentrations. The removal of sludge is the major issue in present days and it can be reduced by using it as fertilizer. In the present study, the sludge obtained is treated as Bio-fertilizer.

Keywords: Coagulation; Flocculation; Dairy effluent; Bentonite clay; Hyacinth beans; Bio-fertilizer.

I. Introduction

Effluents, especially surface waters, contain both dissolved and suspended particles. Coagulation and flocculation processes are used to separate the suspended solids portion from the water. Correct application of coagulation and flocculation processes and selection of the coagulants depend upon understanding the interaction between suspended solids and water. The small particles are stabilized (kept in suspension) by the action of physical forces on the particles themselves. One of the forces playing a dominant role in stabilization results from the surface charge present on the particles. Most solids suspended in water possess a negative charge and, since they have the same type of surface charge, repel each other when they come close together. The slightly larger particles formed through this process is called microflocs which are not visible to the naked eye. Here in this study natural coagulants such as bentonite clay and seed coat of hyacinth beans are being used. Bentonite is an absorbent, aluminium phyllosilicate, impure clay consisting mostly of montmorillonite. Bentonite usually forms from weathering of volcanic ash, most often in the presence of water. Hyacinth bean (*dolichos hyacinth l.*) is an Asia origin crop and was probably domesticated in India as a cultivated grain legume which contains an average of 17% protein with in vitro protein digestibility of 80%. Dairy is one of the major agriculture industries and dairy wastewater problem is larger in developing countries because all milk is processed industrially and environmental impact of the factory can be very high, especially due to the discharge of very large wastewater with high content of organic matter and nutrients (nitrogen and phosphate).

II. Materials and Methods

Dairy effluent is collected from the local dairy industry near erode. The study is carried out by the Jar test standard method using a 100 ml wastewater with beakers and measuring flask in laboratory scale. To evaluate the results, pH is measured using pH meter; water clarity is measured by using the turbidimetric method; COD by using Titration method; TDS by TDS meter; and TSS by filtration and drying method.

100 mL of raw effluent is taken and agitator is immersed in the beaker. The approximate dosage level is presumed (as per in the article done by Salam J. Bash Al Malik) and added to the coagulant solution as rapidly as possible.



Fig 1 Settling of effluent after treatment

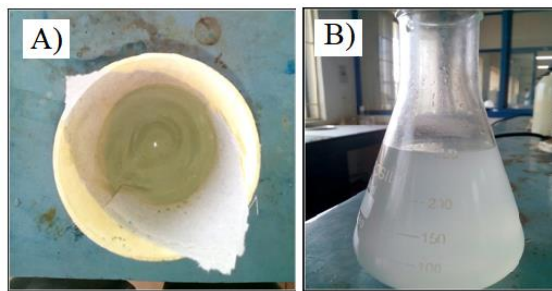


Fig 2 A) Wet sludge obtained B) Filtrate obtained

The agitator is operated at the maximum speed for 30 seconds. The stirring speed is reduced to half for up to 20 min. The agitator is now stopped and the interface height is noted down with respect to time in mL, which is later converted into m. The coagulant dosage which has the best flocculation time and the most floc settled out is determined. This is the optimal coagulant dosage. Thus, the same is carried out for both the coagulants and compared.

The design of batch clarifier is proposed for the effluent taken with different concentration levels. There are only two methods for designing clarifier and they are Talmage and Fitch procedure and Batch Flux method. As this study is done by batch process, design of clarifier is carried out by using Batch flux method. According to this method, Zone Settling Velocity (ZSV) is found out for the effluent with different solid concentrations. This can be found out using graph plotted between interface height and time noted down for different solid concentrations. The values of ZSV for different concentrations are noted down separately and another graph is plotted between Zone Settling Velocity and its corresponding solid concentrations and the equation of the line was found as,

$$\log V = mx + b$$

From the above equation V is found out and from that settling flux is found out, which is given by the following equation.

$$G_i = V_i X_i$$

This equation is the basis of calculation of area of clarifier, which is the most important parameter for the clarifier design. The sludge obtained after the coagulation of dairy waste water, is filtered and dried. The dried sludge is then weighed to find out TSS, which is obtained after separating the weight of coagulants and the filter paper, i.e the weight of only impurities in the effluent. It is separated in weight basis such as 10 – 50 grams in the interval of 10. It is then applied to the soil taken in the tray which is equally weighed. The soil characteristics and the characteristics of sludge obtained are listed in the table 1 and 2 respectively.

Table I shows the soil characteristics

PARAMETER	VALUE	UNIT
pH	7.52	-
Electric conductivity	0.44	dS/m
Available nitrogen	263	Kg/ha
Available phosphorous	21.2	Kg/ha
Available potassium	795	Kg/ha

Table II shows the sludge characteristics

PARAMETER	VALUES (%)
Total nitrogen	14.3%
Total phosphorous	9.6%
Total potassium	9.2%

As per the soil results obtained, the plant species such as *Trigonella foenum – graecum* and *Vigna radiata* are the species that can be easily grown in the soil. 25 g of exactly weighed plant species is planted in the tray containing the soil weighing 5 kg. The same must be done for five more trays for each plant species and the plantation is done with the applied sludge as fertilizer. The details of each tray are given below.

- T1 – controlled plant growth
- T2 – Natural fertilizer (cow dung) 50 g
- T3 – sludge weighed 10 g
- T4 – sludge weighed 20 g
- T5 – sludge weighed 30 g
- T6 – sludge weighed 40 g

The growth rate of the plant is measured in terms of shoot length, root length and leaf area. The yield of *Trigonella foenum – graecum* was found out by planting them weighing 50 g in six different rows each which has 0 to 40 g of sludge fertilizer and the last row is imparted with natural cow dung as fertilizer.

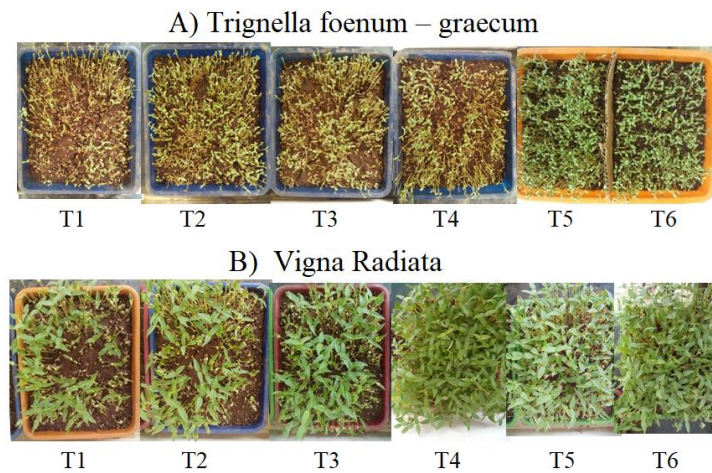


Fig 3 Plants grown in Trays (T1-T6) A) *Trigonella foenum – graecum* B) *Vigna radiata*

III. Result and Discussion

The dairy effluent before treatment is analysed and the various characteristics are tabulated below.

Table III shows the characteristics of raw effluent

S.NO	PARAMETERS	VALUES
1	pH	6.67
2	Concentration (kg/m ³)	2.63
3	BOD (g/L)	1972
4	COD (g/L)	3816
5	Turbidity (NTU)	712
6	Total Dissolved Solids (ppm)	5283

The above-mentioned characteristics such as BOD, COD, TDS and Turbidity are measured for the raw effluent and also for the treated water. Those are recorded and depicted down as follows.

The removal of COD, BOD, Turbidity and TDS by treating with two different natural coagulants by varying the dosage from 0 to 2 in the interval of 0.2 is depicted below in figure 4 to 7 respectively.

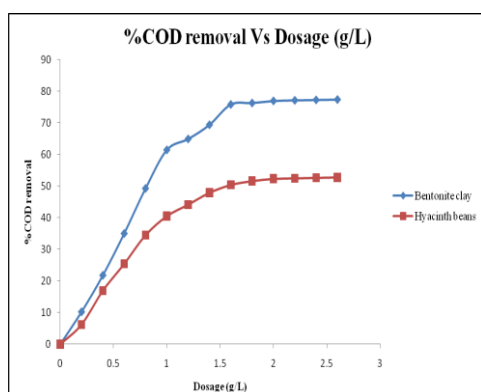


Fig 4 Percentage COD removal

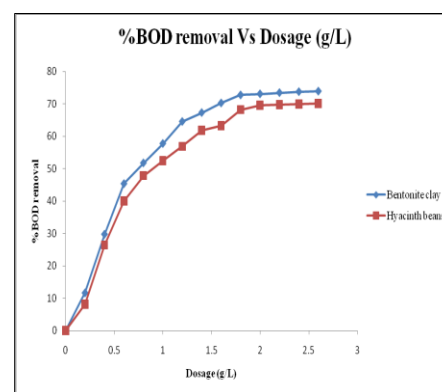


Fig 5 Percentage BOD removal

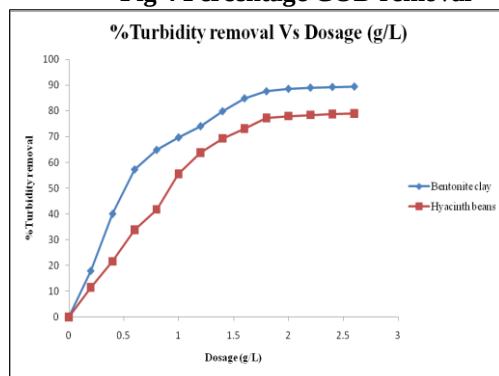


Fig 6 Percentage Turbidity removal

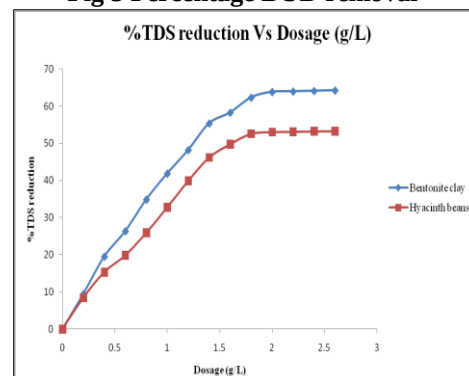


Fig 7 Percentage TDS removal

The optimum coagulant dosage is decided as 1.8g in 100 ml of effluent, as the values of characteristics became constant. From the graph obtained above, it may be concluded that using bentonite clay as natural coagulant is more successful than the usage of hyacinth beans due to the acquisition of good results.

By doing the clarification studies in the batch sedimentation jar, interface height was measured for the effluents having different solid concentrations and graphs are plotted between those values for six different solid concentration level. Zone Settling Velocity (ZSV) was found out from those graphs and was shown in the table 4.

Table IV shows the settling velocities for different solid concentrations

Effluent %	TSS (kg/m ³)	Ln ZSV (m/hr)
0	2	0.45
5	1.83	0.653
10	1.59	0.732
15	1.38	0.833
20	1.21	0.91
25	0.94	0.973

The graph is plotted between Ln ZSV and TSS from the above values and is given below and the velocity for different solid concentrations is found out from the equation obtained from the graph.

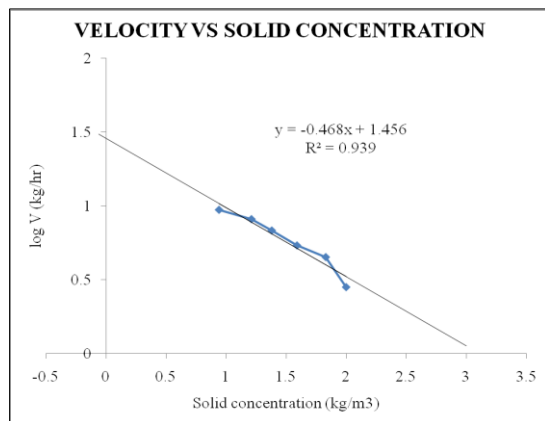


Fig 8 Settling velocity for different solid concentrations

Equation obtained from the graph is

$$\ln V = -0.468 X_i + 1.456$$

where X_i = solid concentration. From the above equation settling velocity for different solid concentrations is found out. Solid flux for the corresponding solid concentration is found out from the following equation,

$$G_i = V_i X_i$$

where G_i is solid flux, V_i is the settling velocity and X_i is the corresponding solid concentration. In order to find out G_L , C_L and C_U which is total flux, its corresponding concentration and outlet concentration, with its initial concentration C_O as 2.9 kg/m³, a plot between solid flux and its corresponding solid concentration is drawn.

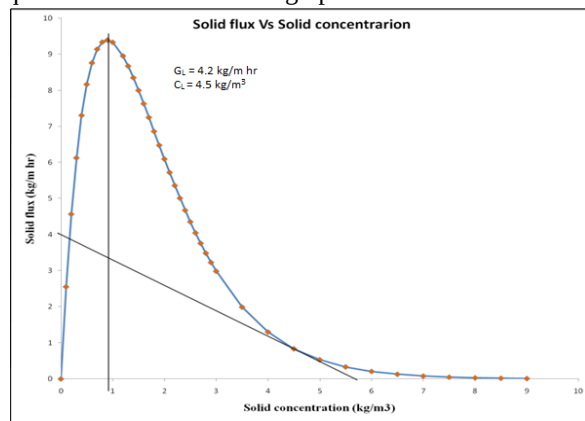


Fig 9 Batch Flux Curve

From the graph, G_L , C_L , C_U and C_O is founded that, 4.2 kg/m.hr, 4.5 kg/m³, 5.6 kg/m³ and 0.9 kg/m³ respectively. The maximum area required for the thickener with 10 m³/hr volumetric flow rate is found out from the formula

$$A = Q_O C_O / G_L$$

and it is founded that 6.19 m². Therefore, for the dairy effluent having 2.6 kg/m³ concentration and 10 m³/hr volumetric flow rate can be clarified in the clarifier having 6.19 m² areas.

The wet sludge obtained after was imparted to the soil as per the above listings. Plant growth was tested by measuring shoot length, root length and leaf area for both *Trigonella foenum-graecum* (TFG) and *Vigna radiata* (VR) and they were shown in the figures 10 to 12 and figures 13 to 15 respectively.

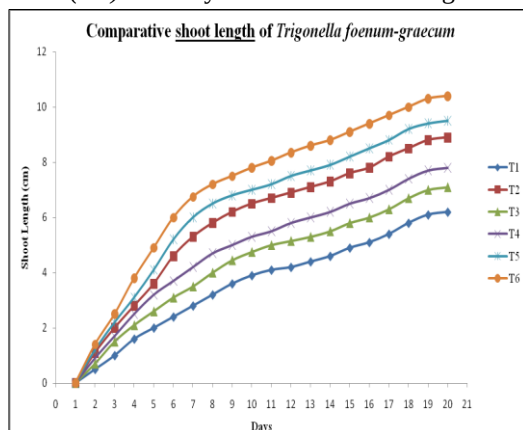


Fig 10 Shoot length of TFG

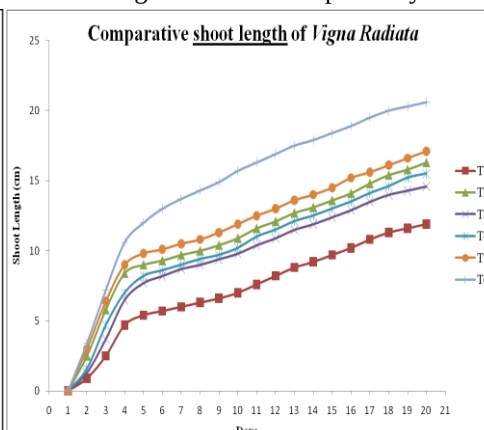


Fig 11 Shoot length of VR

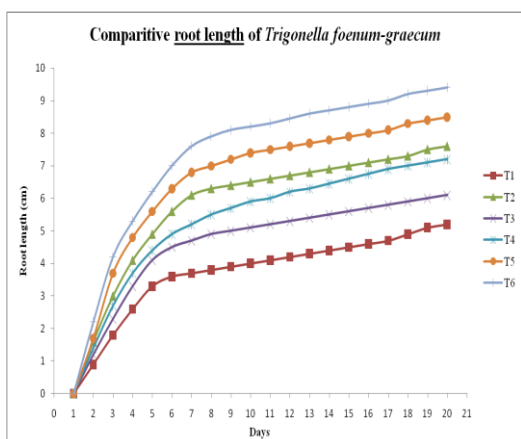


Fig 12 Root length of TFG

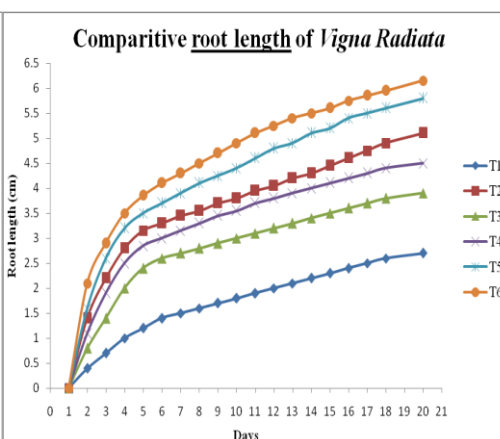


Fig 13 Root length of VR

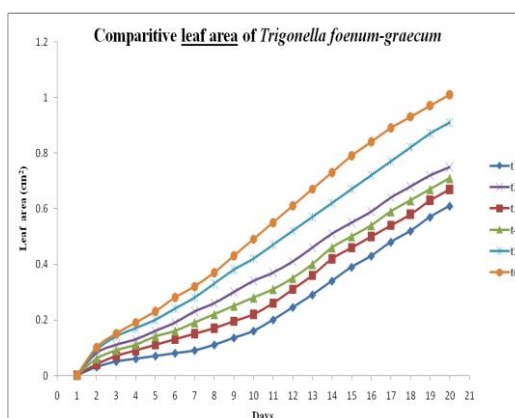


Fig 14 Leaf area of TFG

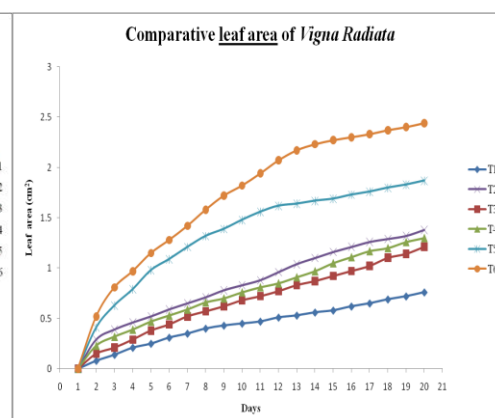


Fig 15 Leaf area of VR

In case of *Trigonella foenum-graecum*, it comes to yield within 35 – 40 days. Therefore, the yield of *Trigonella foenum-graecum*'s seeds are measured and its details are shown in Table V.

Table V shows the Yield of seeds in *Trigonella foenum-graecum*

Rows (fertilizer in g)	1 (0 g)	2 (10 g)	3 (20 g)	4 (30 g)	5 (40 g)	6 (cow dung – 50 g)
Yield (g)	50	90	168	232	275	206

The clarifier sludge as biofertilizer for *Trigonella foenum-graecum* had a higher yield percentage of 88.79 % more compared to that of normal cow dung.

IV. Conclusion

Dairy effluent in real contains a lot of organic impurities that can be minimised by coagulation process. It was done by batch process using two different natural coagulants such as Bentonite clay and seed coat of hyacinth beans. The optimum coagulant dosage for both was determined as 1.8 g per litre. The coagulation activity for the both natural coagulants was compared and the best was found to be Bentonite clay. The coagulated effluent is indulged in settling studies. The parameters measured are used to find out the maximum clarification area of a continuous clarifier, and it was found to be 6.23 m² with the Batch Flux Method by assuming the inlet volumetric flow rate as 10 m³/hr. The clarified sludge was dried; applied as fertilizer and compared with natural fertilizer like cow dung for the species namely, *Trigonella foenum-graecum* and *Vigna radiata*. The results obtained prove that there is a significant increase in Shoot length, Root length and Leaf area for both the species by imparting sludge as fertilizer than that of natural fertilizer. Hence, from the results the clarified dairy sludge can be imparted as fertilizer.

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Alkali Leaching of Cu from Electroplating Sludge: Studies and Kinetic Aspects

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Abstract: Recently, great interest has been shown for treating industrial sludge by alkaline leaching for selective recovery of copper (Cu). This novel approach overcomes the different environmental risks when compare to traditional acid leaching method. In the present study, waste sludge (ES) obtained from Bishoftu Automotive Engineering Industry, Ethiopia has looked at for selective leaching of Cu and its leaching kinetics using the alkali reagent, ammonium nitrate (AN). The effect of important parameters such as concentration of AN solution (1, 2, 3, 4 and 5 M) and temperature (288, 298, 308, 318, and 328 K) on Cu leaching was examined. The experiment results were subjected to pseudo-first order kinetics and shrinking core model (SCM) for determining the rate of leaching and rate controlling step, respectively. The results explicated that the leaching increases with increasing concentration of the reagent solution and temperature. The values of leaching rate were calculated to be 0.0012, 0.0019, 0.0038, 0.0053, and 0.0058 min⁻¹ for the experiment conducted at the temperatures 288, 298, 308, 318, and 328 K, respectively. The kinetic analysis revealed that leaching rate increases with increasing concentration of reagent solution and also identified that the chemical reaction controls rate of leaching. Using the Arrhenius equation, the activation energy for the Cu leaching from the ES reaction was calculated to be 31.85 kJ/mol.

Keywords: Electroplating sludge, ammonium nitrate, copper, leaching, rate kinetics, shrinking core model.

I. INTRODUCTION

There are many machinery parts and accessories are coated with another material for protecting against corrosion, improving some properties, and beautifying objects. Metal coating is the common technique used for coating various parts. Using the electrical field, one metal is deposited uniformly on the surface of another metal is known as "electroplating" or electro-coating [1, 2]. The efficiency of the coating decreases because of repeated recirculation of the bath liquids. Further, the baths are required to change with a fresh high metal concentrated solution. Thus, huge amounts of liquid waste are generated as wastewater after coating process. This wastewater contains harmful toxic heavy metals [3]. Wastewater treatment generates a large amount of sludge that consist significant quantity of heavy metals such as Cu, Cr, Zn, Ni, and Fe. There are many traditional techniques adopted extensively for recovery of heavy metals from this kind of heavy metal bearing sludge such as leaching, solvent extraction, electrolysis, membrane separation, ion exchange, and biological separations. Nevertheless, there is some drawback for using traditional methods like the dissolution of other metals with the copper and also causes environmental impact due to impurities because of high consumption of strong acid. On other hand, leaching with ammoniacal solutions, colloquially, alkaline leaching over comes the difficulties associated with copper leaching from the sludge [4–8]. NH₄NO₃ solution (AN) consists of strong acid (HNO₃) and weak base (NH₃). The composition shows salt character. At the aqueous medium, NH₄⁺ and NO₃⁻ ions are formed by the ionization reaction. Further, the hydrolysis reaction of ammonium generates NH₃ and H₃O⁺. NH₄⁺ ions provide protons as H₃O⁺ which requires for the dissolution. Since the presence of copper in the sludge is in the form of CuO, copper amine complex [Cu(NH₃)₂²⁺] forms with NH₃ during the leaching reaction. Thus, instead of precipitating, the copper ions are leached into the reagent solution [9–12]. However, study has to be carried out for delineating the suitable conditions for copper leachability from sludge with AN solution. In the present work, the effect of important parameters such as concentration of AN solution (1, 2, 3, 4, and 5 M) and temperature (288, 298, 308, 318, and 328 K) on Cu leaching from the electroplating sludge were examined. Further, the

experiment results were subjected to pseudo-first order kinetics and shrinking core model (SCM) for determining the rate of leaching and rate controlling step, respectively.

II. MATERIALS AND METHODS

A. Sludge Characterization

Electroplating sludge was obtained from Bishoftu Automotive Engineering Industry, Ethiopia. It was collected from different depths (20–50 cm) along the sludge bed in the effluent treatment plant. Further, the sludge was then air-dried overnight at room temperature. The total Cu present in the sludge was determined by digesting the sludge with $\text{HNO}_3/\text{HOCl}/\text{H}_2\text{SO}_4$ at the ratio of 8:1:1. Dissolved Cu was estimated by atomic absorption spectrometry (AA200 model; PerkinElmer). The ion activity was analyzed using dry sludge/water extract (10:25) through a calibrated pH meter (Eutech Instruments, Singapore). The organic substance in the sludge was estimated using standard 1 N $\text{K}_2\text{Cr}_2\text{O}_7$ and Ferroin indicator as described by Walkely–Black technique [13]. Micro–Kjeldahl distillation apparatus was used to analyze the total nitrogen content in the sludge. Micro-vanadate-molybdate method was adopted for total available phosphorus content in the sludge. Other metals, Ca, Mg, and K were analyzed using flame photometry (CL378 model; Elico) after extracting the sludge with ammonium acetate. These procedures for sludge characterization were followed as outlined in the American Public Health Association (APHA) standard [14]. Three replicates were used for sludge characterization and the mean values were taken for consideration.

B. Sludge Sample preparation

The sludge sample was dried about 24 h in an oven at 150 °C for removing water. Dried sludge was sieved using standard ASTM sieves to get 125+63 μm of average particle size. This selected size particles were considered for further leaching experiments.

C. Leaching Experiments

In this study, leaching experiments were performed in 250mL glass beakers, each beaker contained 100mL working volume along with 5% (w/v) of sludge loading. A mechanical stirrer and a heater respectively, were used to maintain desired agitation speed and temperature. Constant agitation speed, 200 rpm, was maintained throughout the leaching experiments. To elucidate the effect of concentration of AN solution different concentrations of AN solutions such as 1, 2, 3, 4 and 5 M were used. To investigate the influence of temperature on leaching, the experiments were carried out at different predetermined temperatures ranging 288 to 328 K. The leaching experiments were carried out for 50 min. At every 5-min intervals, the samples (5 mL) were periodically collected from the beaker and were centrifuged at 2000 rpm for 15 minutes. The supernatants were collected from the centrifuge and the dissolved Cu concentration was determined by atomic absorption spectrometry (AA200 model; PerkinElmer). The volume losses due to the collection of sample and evaporation were compensated by adding the fresh AN solution.

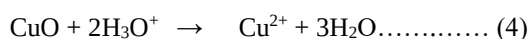
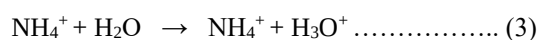
Leaching efficiency of Cu, denoted by $\mathcal{E}_{\text{Cu}}$ (%), was calculated as the ratio between the solubilized Cu and the total Cu present in the original sludge as given in the following equation:

$$\mathcal{E}_{\text{Cu}} (\%) = [(P_{\text{sol}}^t) \times 100] / (P_{\text{T}}) \dots \dots \dots (1)$$

Where, P_{sol}^t is the solubilized Cu concentration at time t during the experiment and P_{T} is the total Cu concentration present in the original sludge.

D. Leaching Reaction

NH_4NO_3 (AN) solution consists of strong acid (HNO_3) and weak base (NH_3). The composition shows salt character. In the aqueous medium, NH_4^+ and NO_3^- ions are formed by the ionization reaction (Eq.2) of NH_4NO_3 and further hydrolysis of ammonium liberates NH_3 and H_3O^+ (Eq.3). These hydrolysis reactions play a vital role in leaching because NH_4^+ ions provide required protons as H_3O^+ for the dissolution of Cu. Since the Cu presence in sludge in the form of CuO, the reaction occurs according to equation. 4. Also the soluble copper amine complexes forms with NH_3 during the reaction as described in equation 5 [15].



The overall reaction can be written as follows (Eq.6)



E. Kinetic procedures

The pseudo-first-order kinetic model can be applied to measure the rate of solubilization of Cu. In the present study, the rate of Cu solubilization can be deduced from pseudo-first-order kinetic model (Eq.7).

$$\text{Leaching rate of Cu} = \frac{dM}{dt} = k(P - P_t) \dots\dots\dots (7)$$

Where (dM/dt) is the rate of Cu leaching and k is defined as the rate constant of solubilization which refers the speed of the leaching reaction. By integrating equation (7) between respective limits of Cu concentration (at t = 0, P_t = 0 and t = t min, P_t = P_t) the following equation can be obtained:

$$\ln\left(\frac{P}{P - P_t}\right) = kt \dots\dots\dots (8)$$

Where P and P_t are the total available Cu concentration in the original sludge and solubilized Cu concentration in aqueous phase at time t during leaching, respectively. Using the equation (8) reaction rate constant can be determined from the slope obtained plotting ln[P/(P - P_t)] versus time. The rate-controlling step was identified by the kinetic studies based on the SCM of fluid-particle reaction [16]. According to SCM, the rate controlling step may be either ash layer diffusion step or chemical reaction step. The developed model of equations for the above mentioned rate-controlling steps are $1 + 2(1 - Y) - 3(1 - Y)^{2/3} = X_0 t$ and $1 - (1 - Y)^{1/3} = X_0 t$, respectively, where Y is the fraction of leached Cu present in the aqueous phase at time t and X₀ is the observed kinetic constant applicable to the respective model. From the best fit of the linear regression correlation of the plots, $[1 + 2(1 - Y) - 3(1 - Y)^{2/3}]$ versus time and $[1 - (1 - Y)^{1/3}]$ versus time, the rate-controlling step was identified.

F. Activation Energy

The activation energy is the minimum amount of energy required to promote the reaction. The Arrhenius equation [Eq. 9], which relates the rate constant and activation energy can be used to calculate activation energy [17]:

$$\ln k = \ln F - \frac{E}{R} \left(\frac{1}{T} \right) \dots\dots\dots (9)$$

Where E is the activation energy (cal/mol), F is the frequency factor, k is the rate constant for leaching reaction, R denotes the gas constant (J/mol K), and T is the absolute temperature (K). Using the equation (9), an Arrhenius plot [lnk versus (1/T)] was prepared and activation energy was calculated from the slope [18].

III. RESULTS AND DISCUSSION

A. Sludge Characteristics

The selective physicochemical properties of collected electroplating sludge sample were determined and are listed in Table 1. The sludge characterization revealed that the sludge was in alkali condition (pH 8.6). The sludge contained 1805 and 1520 mg kg⁻¹ of total available Kjeldahl nitrogen and phosphorus, respectively. It contained moderate level of potassium (346 mg kg⁻¹). Magnesium and calcium contents were also found to be 24,610 and 7610 mg kg⁻¹, respectively. Organic carbon present in the sludge was observed to be quite low (0.85 mg kg⁻¹). The Cu analysis showed that Cu was retained in the sludge and it was found to be 3540 mg kg⁻¹. It indicated that the Cu content in the sludge is high and may pose a serious hazard to the environment when it disposed on land without proper treatment.

B. Effect of Reagent Concentration and Temperature

The experiments were carried out using different concentrations of AN solution ranging from 1 to 5 M of AN solution at room temperature (288 K) and 200 rpm speed of agitation. The solid loading was kept as 5% (w/v) for each experiment. The solubilization profile for Cu with time for different solution concentrations are shown in Fig. 1. At the end of the 50th min, in the treatments with 1, 2, 3, 4, and 5 M AN solution, the solubilization of Cu reached to 65.76%, 77.46%, 84.64%, 90.99% and 92.81%, respectively. From the study, it is apparent that the solubilization efficiencies of Cu metal increased by increasing the reagent concentration. Fig. 2 shows the efficiency of Cu solubilization with time at different temperatures. Same solid loading and rpm were maintained. Nevertheless, experiments with different temperatures were carried out with 0.5 M concentration of AN solution. At the end of 50 min, the efficiencies of Cu solubilization were found to be 40.39%, 57.51%, 86.01%, 92.73% and 94.67%, in the experiments at 288 K, 298 K, 308 K, 318 K, and 328 K, respectively. Though the solubilization of Cu from electroplating sludge ranging 80%–100% is reported elsewhere, that depends on the sludge type, solid concentration, and method of solubilization used in the process.

Figure 1 Leaching efficiency of Cu at different reagent concentrations.

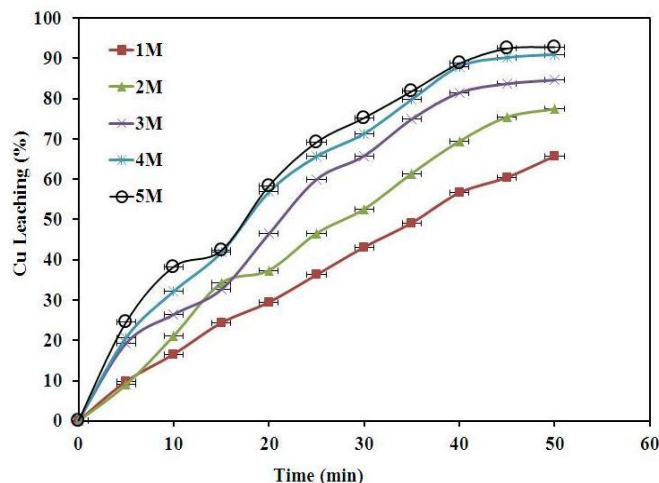
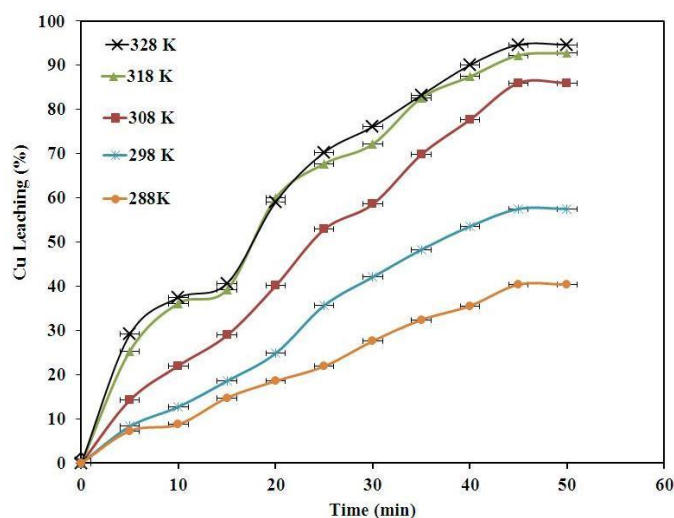


Figure 2 Leaching efficiency of Cu at different temperatures.



C. Rate Kinetics, Rate-Controlling Step and Activation Energy

The pseudo-first-order empirical equation [Eq.7] was used to determine the rate of Cu solubilization. Fig. 3 depicts a plot using leaching data based on equation (7). The linear regression analysis revealed that the pseudo-first-order rate kinetic model is well fitted to the experimental data. The kinetic analysis disclosed that the rate constant value increases with temperature. The rate constant value of Cu solubilization at 288 K was calculated to be 0.0012 min^{-1} . With further increase in temperature, the values of rate constant increased to 0.0019, 0.0038, 0.0053, and 0.0058 min^{-1} , respectively for 298, 308, 318, and 328 K. The rate-controlling step was determined using the SCM. Fig. 4a and Fig. 4b show the graphical fitting to examine the significance of mathematical linear equation of controlling steps. The correlation coefficient obtained from the graphs gives the evidence that solubilization data fit better to the model of chemical reaction control step. It is clear that the rate-controlling step is a chemical reaction between reagent and metal components present in the sludge as explained in the reactions. Furthermore, it was observed that there was no effect of temperature on the rate-controlling step on Cu solubilization. Arrhenius equation, as given in equation 9, the activation energy was determined for the leaching reaction. Following this equation (9), an Arrhenius plot of $\ln k$ versus $(1/T)$ was prepared and same has been given in Fig. 5. From the slope, the activation energy was calculated to be 31.85 kJ/mol.

Figure 3 Pseudo-first-order kinetic plot for rate constant.

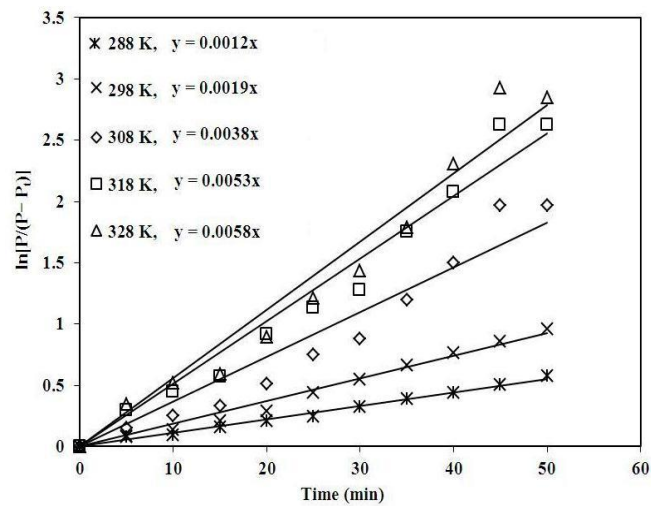


Figure 4 Fitting of Zn leaching data to (a) ash layer diffusion control and (b) chemical reaction control model.

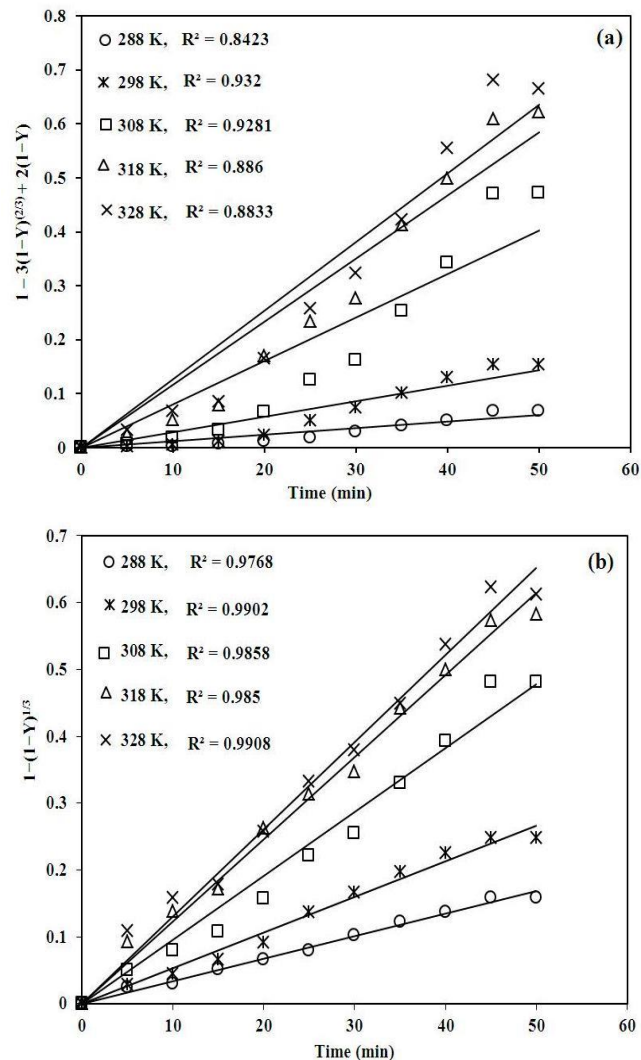
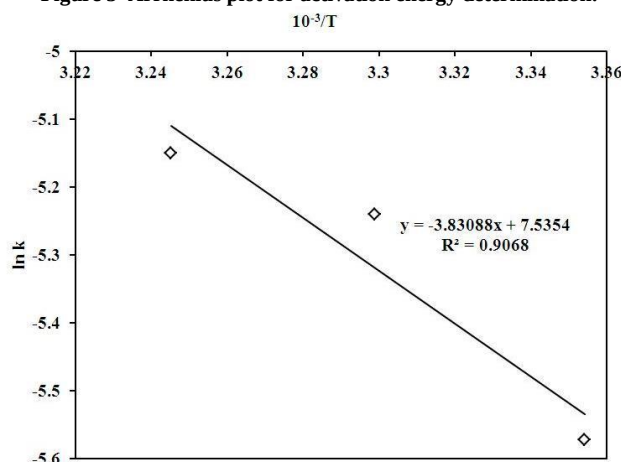


Figure 5 Arrhenius plot for activation energy determination.



IV. CONCLUSION

A study on the removal of Cu from the electroplating industrial sludge with due importance for understanding the influence of reagent concentration and temperature was carried out. The experiments were performed in 250 mL beakers. The experimental conditions were 100 mL of working volume, 5% (w/v) of sludge loading, and temperature range of 288–328 K. The results from the experiments proved that the solubilization efficiencies of Cu metal increased by increasing the reagent concentration and reaction temperature. The kinetic study revealed that the solubilization rate constant is considerably influenced by temperature. It was observed that the maximized value of rate constant, 0.0058 min^{-1} , was obtained at 328 K. Using SCM analysis, the rate-controlling step was identified as chemical reaction. From the Arrhenius equation, activation energy was calculated to be 31.85 kJ/mol. Such a study will be much helpful for understanding and designing the detoxification process with due significance of removal of heavy metal from the harmful sludge before disposal.

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Experimental Investigation on the Performance and Emission Characteristics of Lemon Grass Oil Methyl Ester and Its Blends in Single Cylinder Diesel Engine

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Abstract: The Sustainable development of a country depends on its own resources in meeting their energy need. The increase in environmental pollution caused by the use of conventional petroleum fossil fuel has led to search of environment friendly and easily renewable fuels. This experimental work investigates the performance and emission characteristics of lime grass oil (LGOME) and its blends under different loading conditions from no load to full load in the incremental of 20% and the engine speed is maintained constant as 1500 rpm for all the fuel and its blends. The lemon grass oil is derived from the lemon grass by the steam distillation process and is then esterified. From the result it is observed that the lemon grass oil methyl ester (LGOME) resulted in better brake specific fuel consumption at increasing load conditions, lower exhaust gas temperature with lower rate of nitrous oxide emission at all the load conditions than the diesel fuel.

Keywords: performance and emission characteristics, steam distillation, esterification and lemon grass oil methyl ester (LGOME).

I. Introduction

The increase in the industrialization and motorization of the world has led to step rise for the demand of petroleum based fossil fuels and for the search of suitable alternative source, since the Petroleum based fuels are obtained from the limited reserves [7]. Besides the economy and development, on the other hand the petroleum fossil fuels fossil fuel leads to environmental associated problems like global warming and sudden climatic change due to the emission of harmful gases like carbon monoxide (CO), oxides of nitrogen (NO_x), and carbon dioxide (CO₂) [8]. Technologically advanced countries are making effective efforts in order to develop environmentally friendly vehicle engines and fuels for the improvement of combustion [1].

II. Literature Review

A. Solubility Enhancement

In the recent days the renewable energy source such as biodiesel has become the subjects of great attention and interest. The Biodiesel in general helps in enhancing the rural economy as they are mainly developed using the local available raw material such as plant seeds and other decomposed biological material. The Indonesia government started its effort of biodiesel development since over ten years ago. Since from May 20th 2006, Indonesia has formally started selling a B5 blend of biodiesel, with the trade name of BIOSOLAR, at a price equal to the subsidized automotive diesel oil. Even the higher price of biodiesel can be accepted if its characteristics are superior to the petroleum die [21]. In India the resources of fossil fuels are found very less and limited, the production and use of biodiesel from vegetable oils and fats may be a effective feasible solution for facing the ever growing demand of diesel in the country [14]. Nearly more than 350 oil bearing crops that have been identified, among which only sunflower, soyabean, cottonseed, rapeseed and peanut oils are considered as potential alternative fuels for diesel engines[3]. These fuels contribute to the reduction of dependence on fossil fuels import from other countries [8]. It is found from the results of several researches that the biodiesel gives less pollution than petroleum fuels and can be re-used without any engine modification [36]. The major challenges of biodiesel are its production cost and its limited availability of oil resources. The cost of biodiesel raw materials accounts for 60 to 75% of the total cost of biodiesel fuel. However the cost of the biodiesel production can be minimized by the recovery of methanol used in deriving it. Biodiesel is a suitable substitute for conventional petroleum based diesel fuel due to its superior advantages such as improved lubricity, higher cetane number, cleaner emissions (except NO_x), reduced global warming, and enhanced rural development [5].

III. Production of lemon grass oil

The lemon grasses are collected from the waste and farm lands. The collected lemon grasses are washed well with water and shade dried for 3 days. The dried lemon grasses are chopped to equal lengths and employed for steam distillation process to produce lemon grass oil.

IV. Steam Distillation

Steam distillation is the simplest process. The components used in this investigation for deriving lemon grass oil from the lemon grass are pressure cooker, copper tube wound spirally and a plastic bowl containing ice. The photographic view of the experimental setup is shown in the Figure 1.

Figure 1 Steam distillation experimental setup



The lemon grasses are placed inside the pressure cooker containing water. The one side of the copper tube is fixed rigidly with the lid of pressure cooker, the spirally wound portion of the copper tube is rested inside the plastic bowl containing ice and the other end of the copper projects outwards on the sidewall of plastic container. As the heating is initiated, the lemon grasses along with water are heated and once after reaching the boiling point of water, steam is formed containing the traces of lemon grass oil. The steam is made to pass through the copper tube and once when the steam passes in the spiral portion of copper tube immersed in ice cubes, the steam is condensed and the lemon grass oil as droplets is collected on the outward projection of copper tube on the sidewall of plastic container. The Table I shows the physicochemical properties of lemon grass oil.

Table I Physicochemical properties of lemon grass oil

PROPERTY	LGOME
Oil content	2-3% on dry basis
Specific gravity	0.973
Density	908 Kg/m ³
Flash point	530C
Fire point	640C
Calorific value	36,179 Kj/Kg
Kinematic viscosity	3.59 mm ² /s
Refractive index	1.447
Free fatty acid content	0.63%

V. Transesterification

Transesterification is the most widely used chemical process. In this investigation the oil to methanol ratio is maintained at a rate of 1:6 to get better yield in presence of a catalyst. The weighed NaOH catalyst (3% by weight of LGO) is made to dissolve in the methanol to form methoxide solution. The sodium methoxide solution thus prepared is then slowly mixed with the crude lemon grass oil placed in the batch reactor under constant heating and stirring of 600C and 100 rpm respectively. The process of heating and stirring is continued for 2 hours. The mixture after stirring is then allowed to cool and transferred to a clean container and kept under observation for 24 hours. Two distinct layers lemon grass oil methyl ester (LGOME) at the top layer and glycerol at the bottom layer are formed. The glycerol thus produced as a byproduct is separated from the lemon grass oil methyl ester by gravity separation method.

VI. Washing and drying

The esterified lemon grass oil methyl ester (LGOME) may contain small traces of unreacted catalyst and methanol which can be eliminated by washing with distilled water until the color of distilled water remains neutral. Followed by washing, the lemon grass oil methyl ester (LGOME) is heated to the boiling point of water (100°C) to remove the traces of water particles.

VII. Fuel preparation

Before conducting the performance and emission test the following fuel samples were prepared: Lemon grass oil methyl ester (LGOME) and its blends in varying proportions namely B25 (25% of LGOME and 75% diesel), B50 (50% of LGOME and 50% diesel) and B75 (75% of LGOME and 25% diesel).

VIII. Experimental methodology and procedure

The experimental investigation is carried on a single cylinder water cooled diesel engine (Kirloskar TV-I) equipped with electrical dynamometer, data acquisition system, AVL digas444 gas analyzer and smoke meter.

- Before conducting the test check the flow of water for circulation, engine fuel level and the level of lubrication oil in the engine oil sump
- Initially at no load condition, using neat diesel as fuel note down the time taken for 10 cc of fuel supply using stop watch, inlet and outlet the temperatures of circulating water and air, pressure difference readings using manometer, maximum pressure and heat release value using data acquisition system, emission values from gas analyzer and smoke density from the smoke meter.
- Repeat the step 2 for the same fuel under variable load conditions from no load to full load in the incremental of 20% and note down the readings
- Repeat the step 2 and 3 for lemon grass oil and its blends B25, B50 and B75. The readings recorded are noted down and the optimum is suggested.

IX. Result and discussion

The performance and emission characteristics of diesel engine fuelled with lemon grass methyl ester (LGOME) and its blends are measured by maintaining the engine speed constant at 1500 rpm by adjusting the governor. Since the speed of engine is maintained constant, then the values of parameters such as brake power (BP=6.28NT/60) and engine torque ($T=W \times R$) is found similar for all the fuel blends.

X. Performance and emission characteristics

Figure 2.Variation of BSFC with load

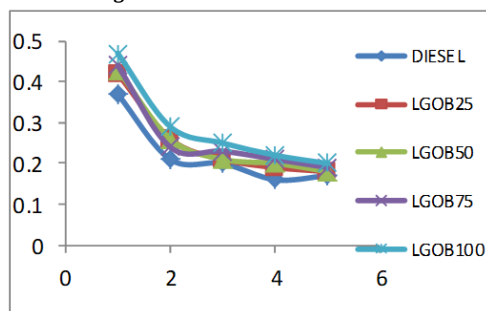


Figure 3.Variation of BTHE with load

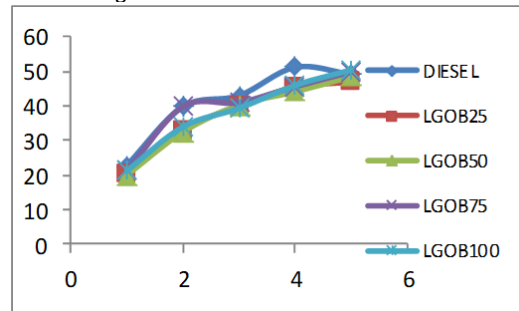


Figure 4.Variation of EGT with load

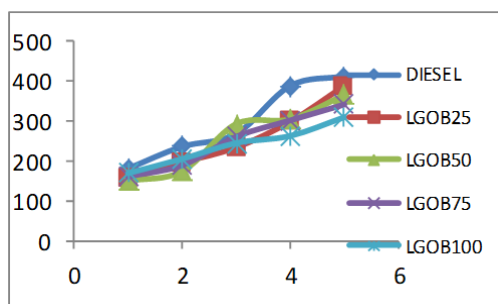


Figure 5.Variation of CO emission with load

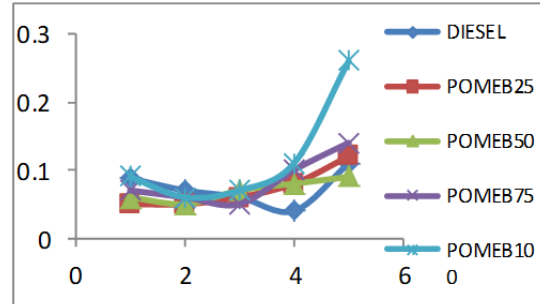


Figure 6.Variation of HC emission with load

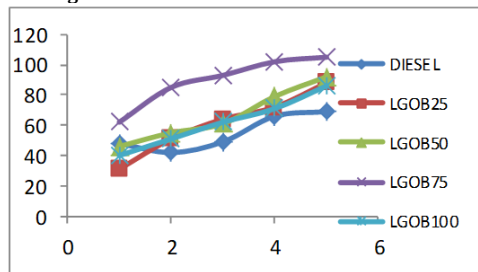
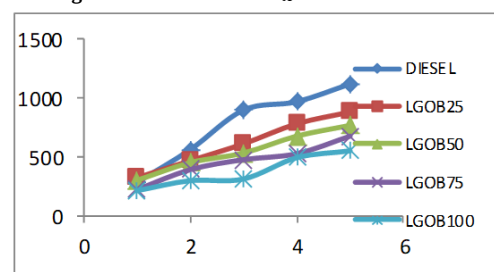


Figure 7.Variation of NO_x emission with load



The results revealed that the brake specific fuel consumption value is closer for the diesel, blends of lemon grass oil methyl ester (LGOME) and neat lemon grass oil methyl ester at full load condition. The value of brake specific fuel consumption is found decreasing with increase in load. The brake thermal efficiency is recorded maximum at full load condition, especially for the blend B77 and neat LGOME. The blends B25 and B50 of LGOME recorded same brake thermal efficiency at 20%, 40% and 60% load condition. The exhaust gas temperature increased with increase in load. The exhaust gas temperature is found low the blends B25 and B50 at 20% load and it is found maximum for the diesel fuel at full load condition. At all the load condition the neat LGOME and its blends recorded less exhaust gas temperature when compared with diesel except the blend B75 at 60% load. The emission of carbon monoxide is recorded maximum for the neat LGOME at full load condition. The emission of carbon monoxide is found minimum for the blends B25 and B50 at 40% load. The emission of carbon monoxide is found similar for diesel and neat LGOME at 20% load. The emission of

hydrocarbon is found minimum for the blend B25 and maximum for the blend B75 at full load condition. At all the load condition the blend B75 recorded high level of hydrocarbon emission then the diesel and other blends of LGOME. The rate of hydrocarbon and nitrous oxide emission is found increased with increase in load. The emission of nitrous oxide is found minimum for the blend B75 and neat LGOME at 20% load. The emission of nitrous oxide is recorded less for LGOME and its blends at all load levels, except the blends B25 and B50 at 20% load. Even at full load condition with higher operating temperature, the emission of nitrous oxide started decreasing with the increase in blending proportions.

XI. Conclusion

Production of biodiesel from lemon grass involves less cost and simpler deriving technique when compared with the production of other biodiesels. Except the blend B75 of LGOME, all other blends showed satisfactory performance and emission characteristics than diesel. The LGOME and its blends produced less nitrous oxide emission than the conventional diesel fuel in all the load conditions. At full load condition the LGOME and its blends recorded similar brake specific fuel consumption as that of diesel.

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Self-Ingesting Cooler for Non-Volatile Liquids

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Abstract: It was intended to minimize the energy consumption in cooling of non-volatile liquids and to study the characteristics of pneumatic cooling using air-inducing impellers. The conventional methods of cooling use heat exchangers, fin-type air coolers and cooling towers etc. The principle of the proposed method is to cool the non-volatile liquids using the air drawn by the centrifugal force created by the impeller action. An attempt was made to study the cooling characteristics of the air induced and distributed by the action of air-inducing impeller in an agitated vessel. In order to eliminate the use of coolant, a tube-set (6 SS tubes each bent to form L-shape and welded firmly to three hub rings) was used as the requirement of the process is only the suction and distribution of air and not the mixing of liquid. The advantage of the proposed cooling method is that it does not require a separate supply and/or circulation of the cooling medium which, in turn, would reduce the operating cost of the process.

Keywords: Non-volatile Liquids; Pneumatic Cooling; Heat Transfer Rate; Air-inducing Impeller; Mixing

I. Introduction

Cooling is the removal of thermal energy from a substance, usually a process fluid, via thermal radiation, heat conduction or convection. It is one of the important transfer process to study [1]. Almost all the industrial processes involve the transfer of heat energy [2]. Heat may be added, removed or moved from one process stream to another. The enhancement of heating or cooling in an industrial process will result in energy saving, increased equipment life time, reduction in process time, raise in thermal rating etc., [3]. There are wide applications of cooling in process industries. In food industry, fresh items such as fruit and vegetables are respiring, transpiring, and drying all at the same time. Therefore reducing the temperature of such items from 10°C to 5°C approximately doubles shelf life [4, 5]. The primary use of cooling in process industries like power plants, petroleum refineries, petrochemical plants, natural gas processing plants, food processing plants, semiconductor plants etc., is to remove the heat produced in various equipment during the process run time [6]. The two most commonly used method for cooling is air cooling and water cooling [7-9]. The air cooling was divided into the nature air cooling and the forced air cooling [10, 11]. The forced air cooling system had been widely used for numerous applications. Pneumatic cooling is a method of dissipating heat. It works by expanding the surface area of or increasing the flow of air over the object to be cooled, or both [12]. The principle of pneumatic cooling is being applied in the operation of heat exchangers such as shell and tube heat exchanger, plate and frame heat exchanger, double pipe heat exchanger, etc., [13, 14]. Cooling of liquids using such heat exchangers requires another liquid, namely, the service liquids like water, brine solution, refrigerants, etc. The service liquid is made to flow through jackets or coils for the purpose.

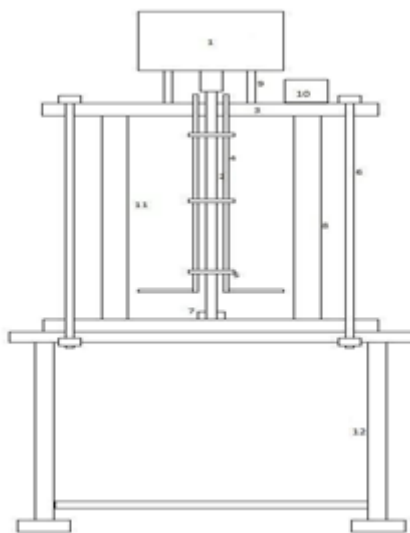
The main objective of our project is to cool non-volatile liquids using atmospheric air with the help of gas-inducing impellers. The non-volatile liquids may include water, oil, etc. The fall in temperature of the non-volatile liquids is determined from the changes in physicochemical properties. This method has an advantage of cooling without the aid of heat exchangers or any kind of cold utility [15, 16]. The impellers used for gas induction in earlier times were complex. More effort was required to fabricate, implement and apply. They had a separate shaft, hub and large blades. The blades were drilled to create many holes for the passage of air. Such impellers could not be used directly in systems. Modifications of those systems became quite essential for their implementation and its usage in various fields was reduced. Hence, there was no ease of application [17]. This is overcome by the usage of simple stainless steel tubes. The tubes are simply bent by an angle of 90 degrees to be transformed into impellers. They can be attached without any change being made in the system. Therefore, retrofitting type of modification is done which is an added advantage of the proposed system. Several authors have come up with many innovative ideas for cooling. They required the need of compressors or blowers,

pumps and spargers. These made the fabrication tedious. The present work eliminates such difficulties. Atmospheric air is directly used for cooling without special equipment for compression and distribution.

II. Experimental Set-Up

The setup consists of an acrylic cylindrical vessel enclosed by flat lids on both sides. A motor is connected to the shaft. A tube set, fabricated using six stainless steel tubes bent at an angle of 90 degree is used as impellers. The impeller is fixed to the shaft by three hub ring and is driven by the motor. The top end of the vertical portion of the stainless tubes is purposely made to project outside the vessel in order to draw the atmospheric air for cooling the liquid. Baffles are fitted to enhance turbulence and to avoid the formation of vortex. Several holes are drilled on the upper lid to allow the circulated air to escape. Thermocouples are inserted at different points to measure the temperatures of the liquid at regular intervals. The whole apparatus is placed on a stand.

Figure 1: Schematic view of the pneumatic cooler



- | | |
|--------------------|---------------------------|
| 1. Motor | 7. Shaft holder |
| 2. Shaft | 8. Reactor |
| 3. Acrylic lid | 9. Motor support |
| 4. Impeller | 10. Temperature indicator |
| 5. Impeller holder | 11. Baffle |
| 6. Support | 12. Stand |

Specifications	Dimension
Vessel diameter	30 cm
Vessel height	60 cm
Vessel thickness	0.8 cm
Baffle width	3 cm
Baffle thickness	0.2 cm
Shaft thickness	0.9 cm
Outer diameter of the impeller	0.3 cm
Number of tubes in tube set	6 cm

III. Experimental Procedure

The acrylic vessel was first filled with water upto a specified level. The effects of cooling in the fluid were studied for different impeller speeds (450, 550, 650 and 750 rpm) and levels (25, 30 and 35cm) for various initial temperatures of 50, 60, 70 and 80°C. Thermocouples were used to measure the temperatures at three different points in the acrylic vessel. The temperature measurement was made at regular intervals of 10 minutes. The average temperature was calculated for every time interval and was plotted against time. The heat transfer rate was calculated and plotted against time.

IV. Results and Discussion

Figure 2: Temperature Vs time at 25cm liquid level

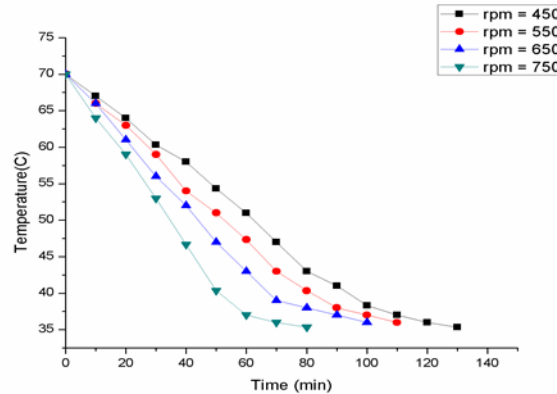


Figure 3: Temperature Vs time at 30 cm liquid level

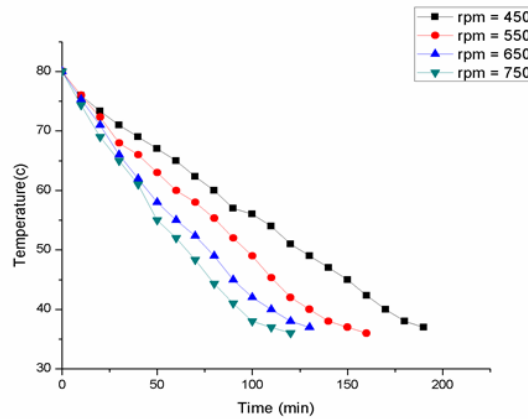


Figure 4: Temperature Vs time at 35 cm liquid level

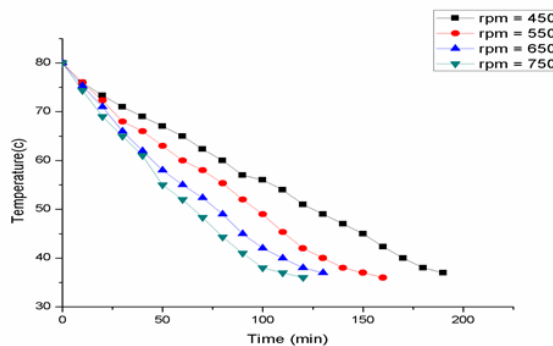


Fig. 2 through Fig. 4 represent the variations in temperature with time for liquid levels of 25, 30 and 35 cm, respectively. It was observed that the temperature of the fluid decreases with the time. It was also noticed that the increased in impeller speed reduces the time required for bringing the temperature of the liquid equal to that of the atmosphere. This clearly indicates that the rate of heat removal increases with increase in speed of the impeller. This behavior is attributed to the fact when the impeller is increased, the rate of induced air flow into the vessel is also increased which, in turn, increases the circulation rate of atmospheric air through the liquid. Hence, the increase in impeller speed lowers the temperature of the liquid at a faster rate. This behavior was

found to be common for all the three liquid levels studied. It could also be noticed that the time required for reducing the temperature of the liquid equal to that of the atmospheric air increased with increase in liquid level in the tank. This effect is because of the fact that the heat load or heat duty increases with increases with increase in quantity of the liquid to be cooled which is proportional to the liquid level in the tank.

The rate of heat transfer was plotted against the time for 25, 30 and 35 cm liquid levels and the results are presented in Fig. 5 through Fig. 6, respectively. The results showed that the heat transfer rate increased with increase in speed of the impeller but decreased with time. The increase in rate of heat transfer with increase in impeller is due the fact that the circulation rate of atmospheric air into the liquid increased with impeller speed. The decrease in rate of heat transfer with time is attributed to the fact that as the cooling proceeds, the average temperature of the liquid and hence the temperature difference between the liquid and the induced atmospheric air decrease. This is because the rate of heat transfer is directly proportional to the temperature difference.

Figure 5: Heat transfer rate Vs time at 25 cm liquid

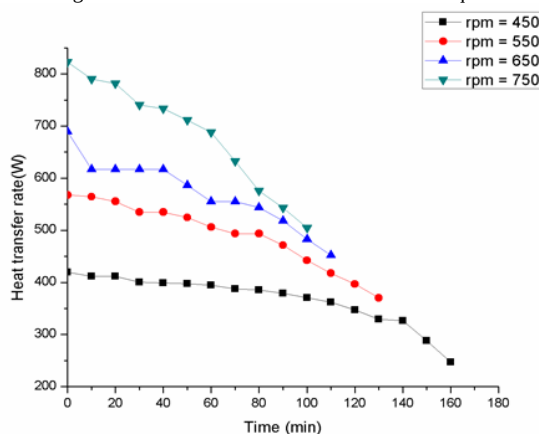


Figure 6: Heat transfer rate Vs time at 30 cm liquid height

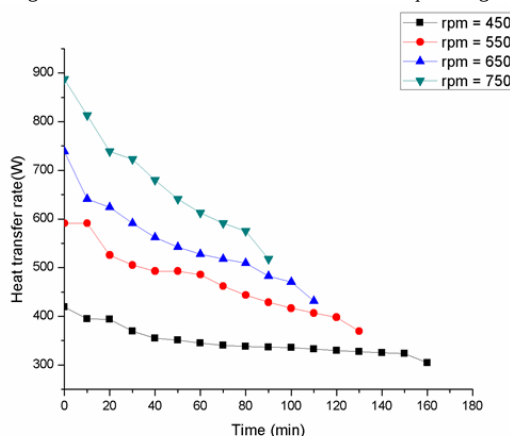
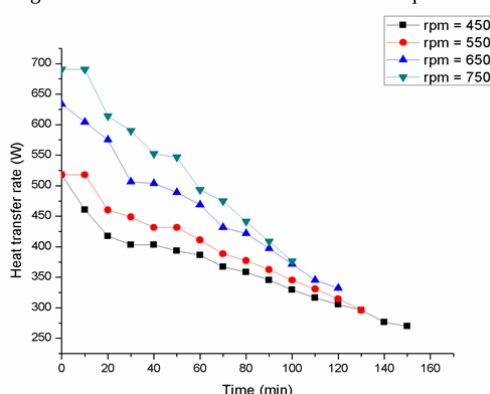
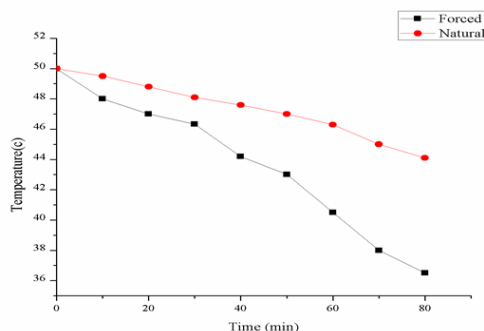


Figure7: Heat transfer rate Vs time at 35 cm liquid level



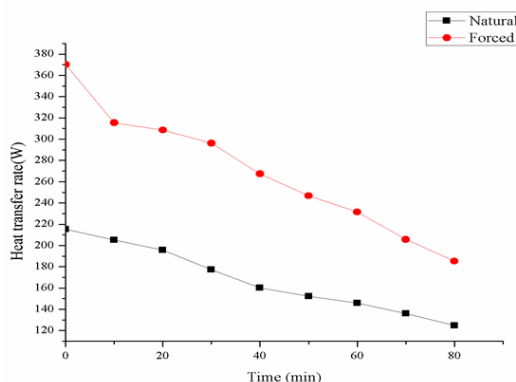
V. Comparative Study

Figure 8: Temperature Vs time for forced and natural heat transfer



It is clear from the Fig. 8 that time required for reducing the temperature of the liquid equal to that of atmospheric air was less for the air induced cooling system when compared with that of normal cooling without the circulation of air. It was also noticed that for given cooling time, the temperature attained by the liquid cooled by induced air was less than that of liquid cooled by still air.

Figure 9: Heat transfer rate Vs time for forced and natural heat transfer



The variation in rate of heat transfer was plotted against the cooling time and the results are presented in Fig. 9. It is clear that the rate of heat transfer was higher for forced circulation of air when compared with that for cooling with still ambient air. This result is attributed to the fact that the rate of heat transfer increases with increase in heat transfer area which is increased by increasing the rate of circulation of atmospheric air into the liquid.

VI. Conclusion

In order to study the suitability of the air inducing impeller for cooling the non-volatile liquids by eliminating the use of cold utilities, an air-inducing tube set was fabricated and attached to the impeller shaft of a conventional mechanically agitated vessel. The experiments were carried out by measuring the variations in temperature of the liquid with time by varying the initial temperature of the liquid, rotational speed of the impeller and the liquid level in the tank. The temperature of the liquid was found to decrease with increase in impeller speed and heat transfer rate were found to decrease with time. For a given initial temperature and level of the liquid, the heat transfer rate was found to increase with increase in rotational speed of the impeller. The decrease in temperature was found to be quicker when the impeller speed was high. More heat transfer rate was observed in high rotational speeds and also it increased with the raise in the liquid level. Though higher rotational speeds were required for the quick decrease in temperature, the air-inducing impeller is found to be more suitable for the economic, effective and efficient aeration of the liquid in the vessel as the suction and distribution of air was more satisfactory and interesting. The proposed method of aeration works effectively and is expected to be more effective in vessels with larger diameter which could be an alternative for cooling in industries.

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Mass Transfer Studies in Stirred Fluidized Bed

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Abstract: Fluidized Beds are used for different purpose in the chemical industry because of a considerable advantage like uniform particle mixing, uniform temperature gradients and ability to operate under continuous state. It also enhances high heat and mass transfer. Some of the applications of fluidized bed are catalyst cracking, solid separation. This present study is focused to study the effects of air flow rate, liquid height and stirrer speed on volumetric mass transfer coefficient. It was observed that the volumetric mass transfer coefficient was high in stirred bed than in unstirred bed condition.

Keywords: Stirred fluidized bed, mass transfer studies, air flow rate, liquid height, stirrer speed

I. Introduction

Fluidization is a unit operation which occurs when fluid is passed through the granular material. Fluidized bed is a gas-solids and liquid-solids system in which the solid phase is subjected to behave more or less like a fluid by the upwelling current of gas or liquid stream moving through the bed containing solid particles. In the fluidized bed, the fluid vigorously agitates the solid passing through bed and there will be practically no temperature gradient in the bed even with chemical reactions because of efficient mixing. For cracking and hydrocarbon reform this type of beds was used. The bed is formed where the solid/fluids mixture uniformly to behave as a fluid, the fixed mass of solid particulate is situated in appropriate condition. Classification of fluidized bed is based on the flow behavior. Some of them are stationary or bubbling bed, circulating fluidized bed, vibrating fluidized bed etc. Fluidized bed has lots of advantages like efficient heat transfer and mass transfer rate, good contact between solid and fluid phase [4,5]. Fluidized bed finds applications in polymer synthesis, adsorption, chemical conversion, drying and other processes [1-3]. Due to fine particles, the agglomeration [6] and channeling occurs in the fluidized bed and it is difficult to maintain the smooth fluidization. For effective fluidization can be ensured by the aeration of the bed. But too much of aeration can cause bubble formation and slugging. By implementation of mechanical stirring the fluidization efficiency can be improved.

In a biological treatment of wastewater, the inverse fluidized bed plays an important role in the control of film thickness. By using Response Surface Methodology and experimental method [7]. Haribabu et al studied that mass transfer coefficient is determined by the effect of liquid, gas velocity, solid loading and concentration of xanthum gum. He also studied in mass transfer, superficial liquid velocity had a weaker effect whereas the mass transfer positively affected by gas flow rate for a non-Newtonian fluid. The behavior of phase holdups and the volumetric gas-liquid are examined[8]relative to a great range of gas and liquid superficial velocity in the presence of a surfactant. The bed fails to expand fully due to it reduced gas velocity by an increase in liquid velocity and solid loading and primarily by the presence of a surfactant. Ca-alginate gels act as a solid phase in three-phase fluidized bed bioreactor. This study [9] shows that for lesser gel diameter the mass transfer coefficient value decreased with increase in particle concentration. They also conferred a dimensionless correlation for mass transfer coefficient and gas phase holdup. The size and density of the three-phase fluidized bioreactor [10] to investigate gas-liquid mass-transfer coefficients. The mass transfer coefficient is adversely affected by the presence of the high and low-density particle. For low-density particle mass transfer coefficient value decrease with increase in concentration.

The recent work is centralized to mass transfer studies in the stirred fluidized bed using air- water system. In this two-phase fluidized bed, there is good contact between the gas and liquid phase and it possess advantages like excellent heat and mass transfer rate, uniform mixing and uniform temperature gradient [11].

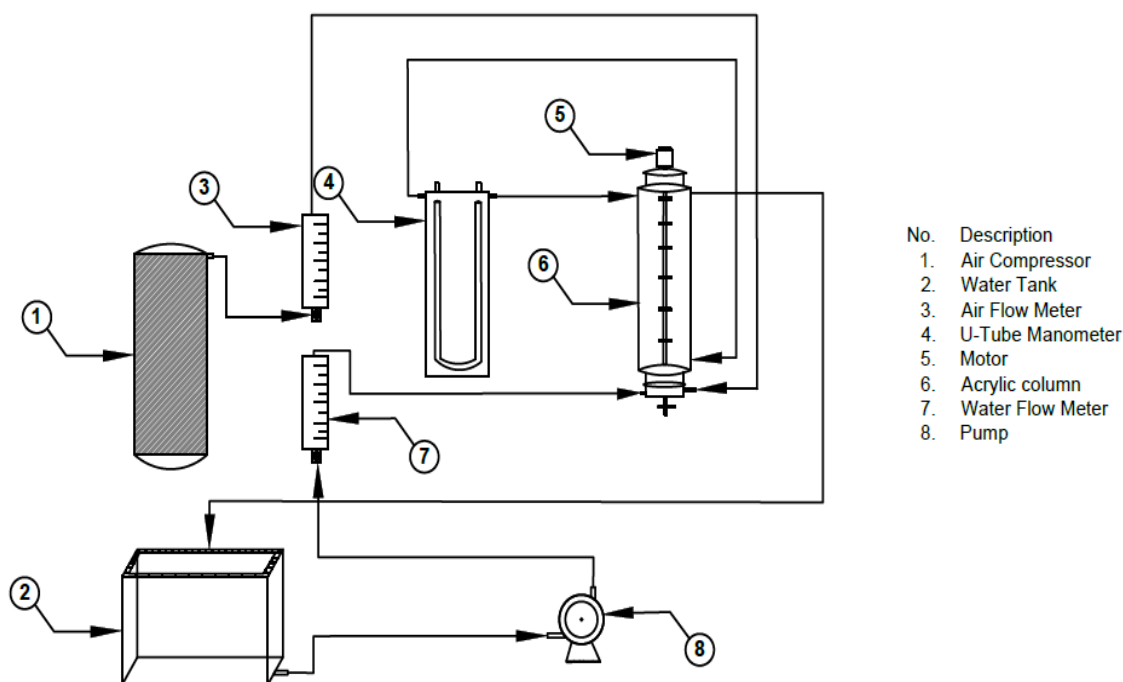
Two phase fluidized bed find application in hydrocarbon cracking, wastewater treatment [12] etc. Stirring increases the efficiency of the system. This work includes the investigation of effect of bed height, air flow rate and mechanical stirring on dissolved oxygen content and mass transfer coefficient.

II. Materials and Methods

The experimental setup is shown in Figure 1. The set up consist of a transparent acrylic column of inside diameter 50mm and outer diameter 60mm. The column is 1000 mm high. A stirrer is employed for enhancing the mixing. The stirrer is made up of stainless steel which consist of 6 impeller blades of 7 mm diameter. Impellers employed are roustion turbine -1 number, pitched blade down 45°- 4 number pitched up flow – 1 number. For measuring liquid flow rate and air flow rate, pre-calibrated rotameter is enabled such that 0-5 LPM for liquid and 0-10 LPM for air. Across the column, a U tube differential manometer is fixed for measuring the pressure drop. The compressor is equipped to supply the compressed air into the system.

Water is pumped in to the bed at constant flow rate of 2 LPM. Air is pumped from the bottom of the bed at different flow rates. The pressure drop was catch up by the manometer. The digital tachometer is employed for measuring the impeller speed. The dissolved oxygen content is measured from the system by using dissolved oxygen meter. The dissolved oxygen content is found out for bed height of 50 cm, 60 cm and 70cm by the with and without usage of stirrer. The air flow rate varied as 2 LPM, 6 LPM and 8 LPM. The stirrer speed is turned at 600 rpm, 800 rpm and 1000 rpm.

Figure 1 Stirred Fluidized Bed



III. Results and Discussion

The effect of air flow rate on volumetric mass transfer co-efficient for different bed height is shown in Figure 2. It is observed from the graph that the volumetric mass transfer coefficient decreases with increase in bed height. The reason behind the decrease in the mass transfer coefficient is due to the reduced oxygen distribution in the column. Figure 3 shows the change in volumetric mass transfer coefficient in relation with the air flow rate and impeller speed at liquid height of 50 cm. The study is carried out for stirred condition for different impeller speed, air flow velocity and unstirred condition for different air flow velocity. The mass transfer coefficient increases with increase in air flow velocity for both stirred and unstirred condition. The higher mass transfer coefficient is reached for stirred condition for higher impeller speed and higher air flow velocity. The unstirred bed has low mass transfer coefficient proving that the mass transfer is enhanced when stirring and velocity is higher in the column.

Figure 2 Effect of air flow rate on volumetric mass transfer coefficient at unstirred condition for different liquid height

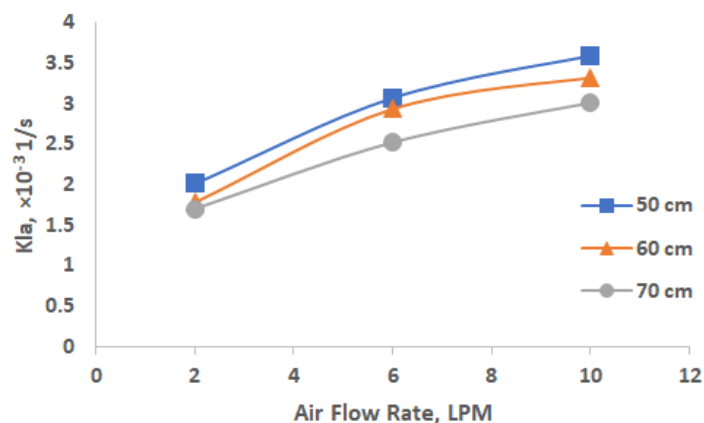
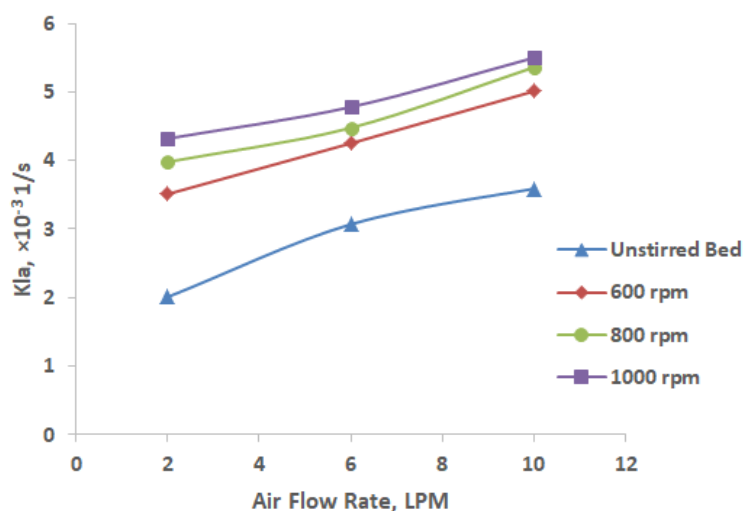


Figure 3 Effect of air flow rate on volumetric mass transfer coefficient at the liquid bed height 50 cm for stirred and unstirred condition



The variation in mass transfer coefficient with a constant liquid bed height of 60 cm is shown in Figure 4. The variables taken into account is the impeller speed and air flow velocity for both stirred and unstirred conditions. The mass transfer coefficient increases with increase in impeller speed due to increased turbulence of the bed with is one of the mass transfer influencing parameters. The value of mass transfer coefficient is little lower than that for the liquid bed height of 50 cm. This is due to the increased liquid bed height which causes a reduction in oxygen distribution in the column. The maximum value of mass transfer coefficient is reached at stirred condition for higher impeller speed and higher air flow velocity.

Figure 5 shows the influence of the air flow velocity and impeller speed on the mass transfer coefficient with constant liquid bed height of 70 cm. The mass transfer coefficient increases for increase in the impeller speed and air flow velocity and is higher for an impeller speed of 1000 rpm and air flow velocity of 10 LPM. The mass transfer coefficient is lower for unstirred bed due to the fact that low turbulence because of the absence of impeller motion. The mass transfer coefficient as compared to the precious liquid bed height shows that better mass transfer is achieved at minimum bed height. The effect of stirrer speed on volumetric mass transfer coefficient for various liquid heights is shown in Figure 6. This stirrer speed increases the oxygen distribution while increase in stirrer speed. It was observed that the mass transfer coefficient increases with the increase in stirrer speed.

Figure 4 Effect of air flow rate on volumetric mass transfer coefficient at the liquid bed height 60 cm for stirred and unstirred condition

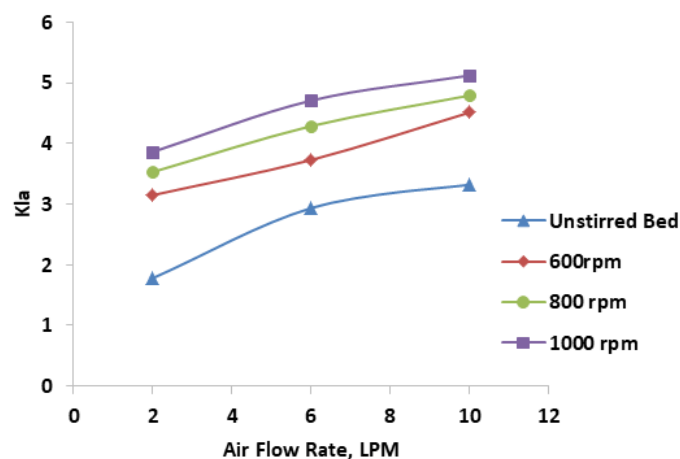


Figure 5 Effect of air flow rate on volumetric mass transfer coefficient at the liquid bed height 70 cm for stirred and unstirred condition

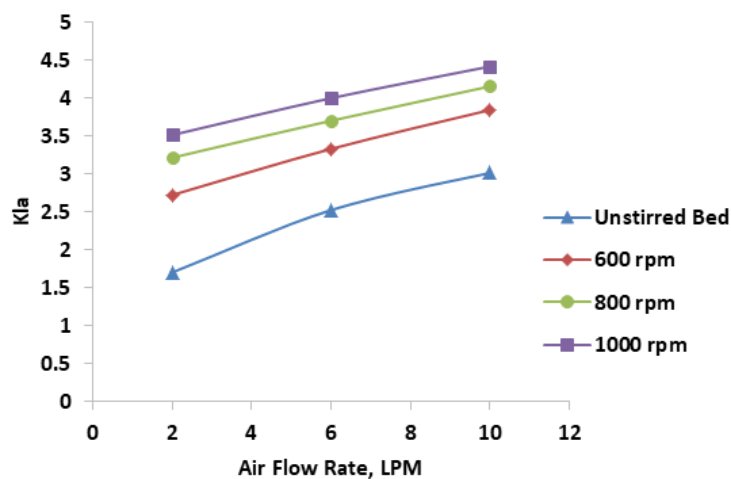
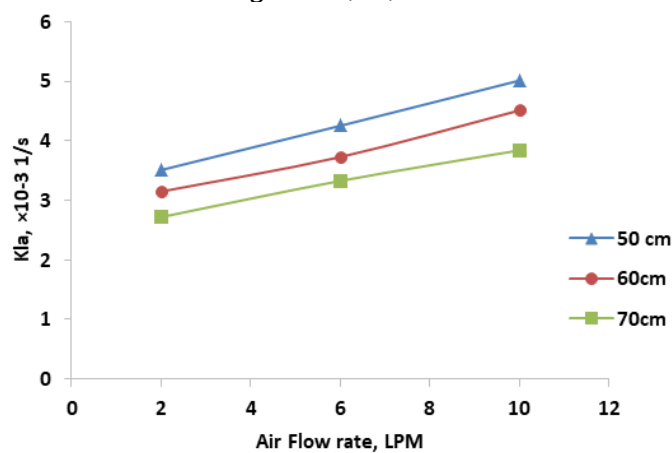


Figure 6 Effect of air flow rate on volumetric mass transfer coefficient at the 600 rpm for liquid bed height of 60, 70, 80 cm



Conclusion

The mass transfer coefficient studies were carried out in a stirred fluidized bed column. It is observed from the results that the mass transfer coefficient is high in stirred bed than in unstirred bed. The mass transfer coefficient increases with increase in the impeller speed and air flow velocity. The height of the liquid bed has a significant increase in the mass transfer coefficient. So, it is suggested to have a minimum height of liquid bed for a higher mass transfer coefficient.

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Hydrodynamics Study on Packed Bed with Wood Particles

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Abstract: Hydrodynamics of air as moving fluids inside a packed column of wood particles is carried out in the current study. Here basic shapes of wood particles in the form of cube and cuboid structures were taken. The hydrodynamic characteristics such as pressure drop, friction factor, sphericity, porosity have been determined. The column was filled with packing of wood particles and maintained at three different heights (58cm, 68cm, and 78cm). Cube wood particles with the sphericity 0.806 and cuboid particles with the sphericity 0.7185 when filled at various heights was studied for pressure drop at different flow rates of air with respect to manometric difference of 1 cm to 25 cm. The theoretical and experimental pressure drop value were compared between the two particles and hence found that the pressure drop for cubic particles is low when compared to cuboids packing.

Keywords: Hydrodynamics; Cube; Cuboid; Wood; Friction factor; Pressure drop

I. Introduction

A packed bed is a hollow tube, pipe, or other vessel that is filled with a packing material. The packing can be randomly filled with small objects like Raschig rings or else it can be a specifically designed structured packing. Packed beds may also contain catalyst particles or adsorbents such as zeolite pellets, granular activated carbon, etc.

The purpose of a packed bed is typically to improve contact between two phases in a chemical or similar process. Packed beds can be used in a chemical reactor, a distillation process, or a scrubber, but packed beds have also been used to store heat in chemical plants.

The column can be filled with random dumped packing (creating a random packed column) or with structured packing sections, which are arranged or stacked (creating a stacked packed column). In the column, liquids tend to wet the surface of the packing and the vapors pass across this wetted surface, where mass transfer takes place. Packing material can be used instead of trays to improve separation in distillation columns. Packing offers the advantage of a lower pressure drop across the column (when compared to plates or trays), which is beneficial while operating under vacuum. Differently shaped packing materials have different surface areas and void space between the packing. Both of these factors affect packing performance.

A. Hydrodynamics Study in Packed Bed

Hydrodynamics is the study of motion of fluids. A hydrodynamic model is a tool to describe or represent in some way the motion of fluids. Before the advent of widely available computer systems, a hydrodynamic model could in fact be a physical model built to scale. However, virtually all hydrodynamic models in use today are computational numerical models. Here hydrodynamic characteristics such as pressure drop, friction factor, sphericity, porosity have been determined.

B. Wood Particles in Packed Bed

Worldwide targets are set to cut the anthropogenic greenhouse gas (GHG) emissions in order to limit global warming. Recently, the European Commission put forth an integrated proposal for Climate Action with a time horizon till 2020 (new emission reduction targets, targets for the share of renewable energy, facilitation of carbon capture and storage, and energy efficiency and savings) since the reduction of GHG emissions is not happening fast enough and the dependence on oil and gas is growing. Therefore, the European Commission needs to find new energy alternatives and to produce more energy on its own as efficiently as possible. To this end the European Commission has proposed a new Directive named (COM (2008) 19) on the promotion of energy from renewable sources, among others. The European Commission target is a share of 20% renewable energy in 2020 (compared to a share of 8.5% today).

Bioenergy is the largest renewable energy contributor to global primary energy today and has the highest potential of all renewable energy sources. Within this bioenergy category wood plays an important role worldwide. In residential heating systems wood is used as boards or pellets in stoves. In developing countries wood is still the major fuel for cooking purposes. For electricity generation wood is used either in centralized coal

fired power plants (co-combustion as wood dust or wood pellets) or in decentralized combined heat and power Stirling engines or steam turbines.

The knowledge of the pressure drop across a packed bed of irregular shaped wood particles is of great importance for achieving optimal control and maximum efficiency in many applications, such as wood drying, pyrolysis, gasification and combustion. In this work the effect of porosity, average particle size and particle orientation on the pressure drop in a packed bed is investigated.

The Ergun equation requires an average equivalent particle diameter that is derived from the measured particle size distribution. This equivalent diameter and the corresponding bed porosity are used in the well-known Ergun equation.

II. Materials and Apparatus

The glass column of about 1m height is taken with wood particles as packing material and air as fluid. The air velocity is measured using anemometer. The pressure drop is measured using manometer and its difference is measured as manometric difference.

A. Pressure Drop Determination

The pressure drop is determined theoretically using Ergun equation. The Ergun equation can be given by $(\Delta p/L)_{\text{theoretical}} = [150\mu(1-\varepsilon^2)v_0] / [\Phi_s D_p^2 \varepsilon^3] + [1.75\rho^*(1-\varepsilon)]/[\Phi_s D_p \varepsilon^3] * v_0^2$

Kozeny Carmen equation valid for laminar flow = $[150\mu(1-\varepsilon^2)v_0]/[\Phi_s D_p^2 \varepsilon^3]$

Bruke Plummer equation valid for turbulent flow = $[1.75\rho^*(1-\varepsilon)]/[\Phi_s D_p \varepsilon^3] * v_0^2$

Where,

μ = Viscosity of flowing fluid(kg/ms)

ε = Porosity = Volume of voids / Volume of bed

v_0 = velocity of fluid(m/s)

Φ_s = Sphericity= $\pi^{1/3}(6V_p)^{2/3} / D_p$

D_p = Diameter of particles (m)

ρ = Density of fluid(kg/m³)

The friction factor can be given by $f = (\Delta p/L)_{\text{theoretical}} * g / 2\rho v^2$

The experimental pressure drop can be determined experimentally by $(\Delta p/L)_{\text{experimental}} = R_m * (\rho_m - \rho_f) * g$

Where,

R_m – manometric difference (m)

ρ_m – density of manometric fluid (kg/m³)

ρ_f – density of flowing fluid (kg/m³)

B. Porosity Determination

A bed of irregularly shaped wood particles, however, gives rise to non-uniformly distributed bed porosities. The assumption of a uniform distributed porosity and the neglect of the wall effect is justified in the case of a packed bed of wood chips when the tube diameter and height are relatively large compared to the particle diameter.

- Porosity = (volume of voids / volume of bed)
- Volume of bed = $V = \pi r^2 h$

The volume of voids can be determined by closing the outlet of packing and filling the column with fluid. The volume of water collected inside the packing will be equal to volume of voids. Porosity can be obtained by taking ratio of volume of void and volume of bed.

C. Sphericity Determination

Sphericity is a measure of how spherical (round) an object is. As such, it is a specific example of a compactness measure of a shape. The sphericity of cube and cuboid shaped particles can be determined by the formula.

$$\Psi = \frac{\pi^{1/3}(6V_p)^{2/3}}{A_p}$$

III. Experimental Procedure

The column filled with packing of wood particles is maintained at three different heights (58cm, 68cm, and 78cm). The air is passed as fluid from top of the column, before passing the air inlet velocity is determined using anemometer. Then the air is passed through packing and its outlet velocity is determined. The manometric difference can be obtained using manometer and the experimental pressure drop is determined. The same procedure is repeated for different velocity, different height and shape.

Fig 1. Schematic Diagram of Packed Bed of Wood Particles



IV. Results and Discussion

D. Hydrodynamics Study for cube shaped particles

The column filled with cube shaped packing of wood particles of sphericity 0.806 is maintained at height 58cm, porosity 0.4697 and the hydrodynamic studies were done and the manometric readings were taken. Similarly the same cube particles were tested for height 68cm, porosity as 0.4697 and 78 cm, 0.4309 respectively and the results were tabulated as below in Table I, II and III.

Table I Cube Particles for Packing Height 58cm

S.No	Rm(m)	f	Nre	Nrem	Vo(m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.008	0.0094	676.551	1275.79	0.8	94.5504	78.3787
2	0.023	0.0035	1775.95	3348.95	2.1	248.1950	225.3389
3	0.032	0.0026	2452.5	4624.73	2.9	342.7455	313.5150
4	0.036	0.0023	2790.77	5262.63	3.3	390.0207	352.7044
5	0.052	0.0017	3721.03	7016.84	4.4	520.0277	509.4619

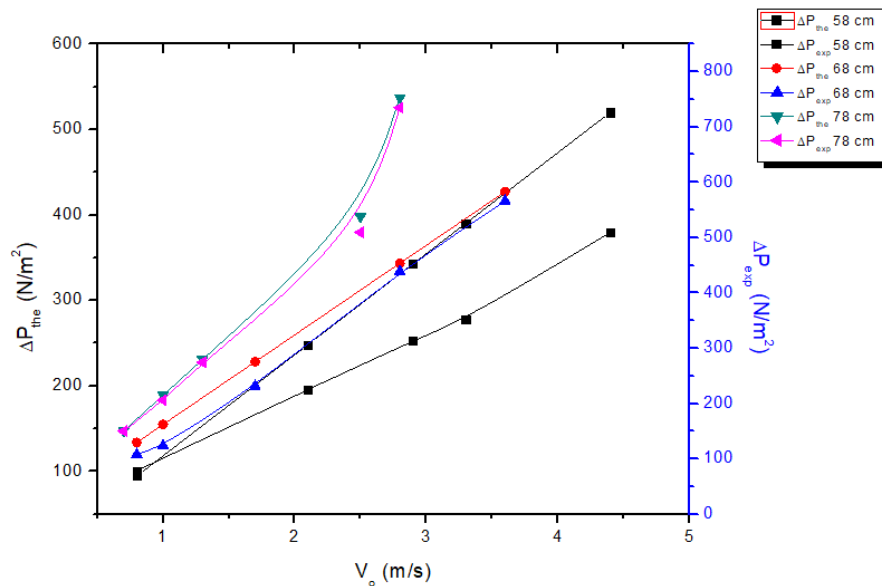
Table II Cube Particles for Packing Height 68cm

S. No	Rm(m)	f	Nre	Nrem	Vo(m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.011	0.01291	644.559	1170.65	0.8	129.5929	107.7707
2	0.0126	0.01033	805.698	1463.31	1.0	161.9911	123.4465
3	0.0236	0.00608	1369.69	2487.63	1.7	275.3849	231.2173
4	0.0448	0.00369	2255.96	4097.27	2.8	453.5752	438.9210
5	0.0578	0.00287	2900.51	5267.92	3.6	583.1682	566.2865

Table III Cube Particles for Packing Height 78cm

S.No	Rm(m)	f	Nre	Nrem	Vo(m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.0153	0.01959	563.989	991.019	0.7	150.5629	149.8993
2	0.021	0.01372	805.698	1415.74	1	215.0899	205.7442
3	0.028	0.01055	1047.41	1840.46	1.3	279.6169	274.3256
4	0.052	0.00549	2014.25	3539.35	2.5	537.7249	509.4619
5	0.075	0.00612	2255.96	3964.08	2.8	752.8149	734.8008

Fig .2 Pressure Drop (ΔP) v/s V_o Cube Particles for Packing Height 58cm, 68 cm, 78 cm



From the above table and graph, The experiment conducted by varying the heights of packed bed and the velocity of fluid used and the graph plotted between pressure drop and velocity shows the parabolic relation $x^2 = y$. The parabolic curve is achieved at packed height of 78 cm of cubic particles.

E. Hydrodynamics Study for cuboid shaped particles

The column filled with cuboid shaped packing of wood particles of sphericity 0.7185 is maintained at height 58cm, porosity 0.4742 and the hydrodynamic studies were done and the manometric readings were taken. Similarly the same cube particles were tested for height 68cm, porosity as 0.4419 and 78 cm, 0.4179 respectively and the results were tabulated as below in Table IV, V and VI.

Table IV Cuboid Particles for Packing Height 58cm

S..No	Rm(m)	f	Nre	Nrem	V_o (m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.014	0.01324	557.791	1060.84	0.9	218.6368	137.1628
2	0.029	0.00993	743.722	1414.46	1.2	291.5157	284.1230
3	0.068	0.00426	1735.35	3300.4	2.8	680.2033	666.2195
4	0.079	0.00331	2231.16	4243.37	3.6	874.5472	773.9903
5	0.11	0.00243	3036.86	5775.7	4.9	1190.3559	1077.7079

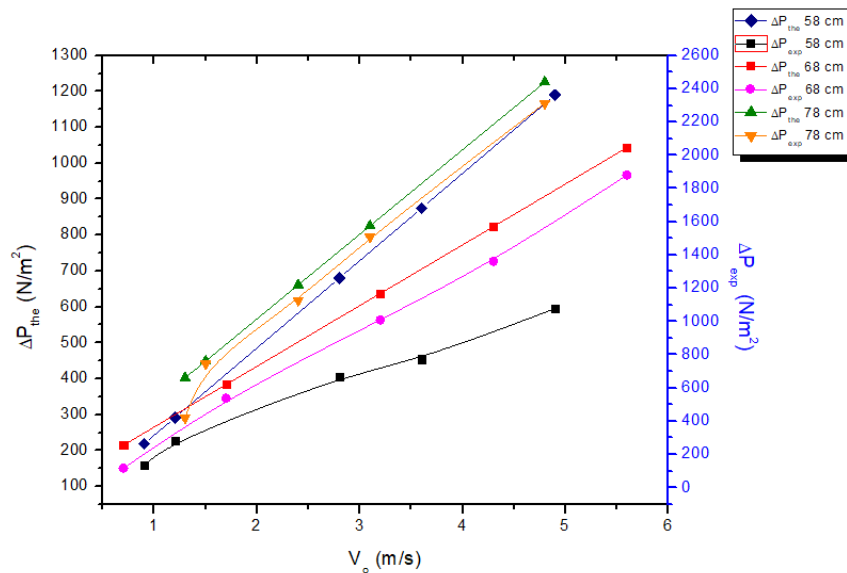
Table V Cuboid Particles for Packing Height 68cm

S.No	Rm(m)	f	Nre	Nrem	V_o (m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.012	0.0256	433.838	777.347	0.7	255.7658	117.5681
2	0.055	0.0105	1053.61	1887.84	1.7	621.1456	538.8539
3	0.103	0.0056	1983.26	3553.59	3.2	1169.2152	1009.1265
4	0.139	0.0042	2665	4775.13	4.3	1571.1330	1361.8309
5	0.192	0.0032	3470.7	6218.78	5.6	2046.1267	1881.0902

Table VI Cuboid Particles for Packing Height 78cm

S.No	Rm(m)	f	Nre	Nrem	V_o (m/s)	(ΔP)the (N/m ²)	(ΔP)exp (N/m ²)
1	0.043	0.01918	805.698	1443.65	1.3	660.7306	421.2858
2	0.076	0.01662	929.652	1665.74	1.5	762.3816	744.5982
3	0.115	0.01039	1487.44	2665.19	2.4	1219.8104	1126.6946
4	0.154	0.00804	1921.28	3442.54	3.1	1575.5885	1508.7911
5	0.236	0.00519	2974.89	5330.38	4.8	2439.6209	2312.1734

Fig .3 Pressure Drop (ΔP) v/s V_o Cuboid Particles for Packing Height 58cm, 68 cm, 78 cm



The graph is plotted which is linear with high pressure drop for maximum height and the deviation between graphical value and trend line is negligible. On comparing the experimental and theoretical data for cube and cuboid shaped particles the pressure drop for cube is lower than that of the cuboid particles.

V. Conclusion

It is clearly known from the experimental data and graphs plotted that the cubic particles have the parabolic curve for maximum height of the packed bed (78 cm). The pressure drop for cubic particles is low when compared to cuboids packing. From the above discussions it is concluded that the cubic particles are suitable for chemical process industries which is supposed to have low pressure drop with maximum height of packing. Hence hydrodynamics studies hold well for wooden cubic packing material of side 1.3 cm and packing height of 78 cm which can be employed in pyrolysis process for effective gasification of packed bed.

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Influence of anticorrosive behavior of ZnO nanotetra-pods on AZ91-grade Mg alloy

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Abstract: Highly cross linked zinc oxide (ZnO) with the nanorod morphology of tetra-pods was successfully prepared using the microwave irradiation technique. In comparison with the available conventional techniques, the microwave irradiation technique has the advantage of producing different morphological structures with high purity and in a shorter reaction time. These tetra-pods consist of a ZnO core in the zinc blende from which four ZnO arms emerge in the wurtzite structure. The growth mechanism during the production of ZnO nanorods was identified. The structural, morphological and optical properties of ZnO nanorods were investigated by field emission scanning electron microscopy, X-ray diffraction and energy-dispersive spectroscopy. The electrochemical corrosion behaviors of an AZ91-grade Mg alloy and a ZnO nanotetra-pods-coated Mg alloy were investigated. The tafel plot revealed that the corrosion of Mg drastically decreased on coating with a thin layer of ZnO nanotetra-pods (Mg/ZnO) compared to Mg in a KOH electrolyte.

Keywords: Microwave irradiation; ZnO nanotetra-pods; Structural properties; Optical properties; corrosion studies.

I. Introduction

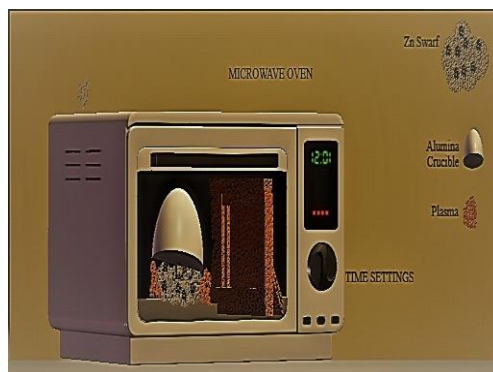
In recent years, semiconductors with one-dimensional (1D) nanostructures such as rods, wires, belts and tubes have received attention due to their distinctive properties for applications in life-sciences and electronics [1]. It is known that 1D nanostructure is useful for investigations of electrical, thermal and mechanical properties, dimensionality and quantum confinement. They play a significant role as both functional and structural units in the manufacture of microelectronic, electronic and electrochemical devices [2]. Recently, metal oxide nano particles with morphology at a nano scale less than 100 nm have become important [3]. One of these is zinc oxide (ZnO), an N-type semiconductor that has an extensive band gap of 3.37 eV and a large excitation binding energy of 60 meV at room temperature. ZnO is of research interest due to its unique properties [4]. ZnO nanotetra-pods were synthesized in this work using the microwave irradiation (MWI) technique. MWI is a type of heating method that has a number of applications in chemistry. Compared to conventional methods such as [5], microwave (MW) synthesis has the advantage of producing smaller particle sizes with high purity owing to a short reaction time [6]. In the MWI technique, heat is generating internally within the material itself, instead of from an external source. Another benefit of the MWI technique is that there is no need for a post-annealing process [6]. These radiations have unique properties such as homogeneous volumetric heating, which causes the heat to be directed directly into the sample, which in turn leads to a high reaction rate, selectivity and increased product yield.

II. Experimental Procedure

A Zn ingot was bought from the automobile industry and made into Zn wool or Zn swarf by drilling. A Zn ingot with a weight of 7.8 kg was supplied by M/s. Arrkay Engg Works, Chennai, India. A domestic MW oven (M/s. Samsung ME711K), aluminium crucibles, a sample container and ethanol were used as received, without further purification and changes. The synthesis of ZnO nanotetra-pods by the MWI method was carried out as shown in Figure 1. Initially, 3 g of Zn swarf was added to an alumina substrate and placed in an MW oven. The substrate was then covered with an inverted aluminium crucible and MW radiations were passed through the crucible. The swarf gets heated up as plasma and ejects the Zn atoms. The Zn atom oxidized and accumulated in the aluminium crucible. The time durations for exposure of MW radiation is 60. The standard principle of this MWI method is that the MW radiations induce an internal potential, which generates a very high field at the sharp peaks and edges of a metallic component (aluminium foil) [7]. At these sharp peaks, electrons can excite and

form a plasma arc. Hence, a sharp edge was needed to initiate ignition from the MW. This also explains why plasma can be ignited by irradiating a sharp swarf using MW. During the passage of MW radiation, air plasma sputtered Zn atoms out of the swarf. Consequently, Zn atoms were oxidized and accumulated in the aluminium crucible. The major compositions of air plasma are nitrogen and oxygen gases. The high-energy plasma is generally composed of ionized nitrogen atoms and ionized oxygen atoms, which can sputter Zn atoms out of the swarf. The products obtained from the MW air plasma were Zn vapors (deposition and floating fume), ZnO nanorods with the structure of tetra-pods, ozone and nitrogen oxide. Nitrogen oxide and ozone were exhausted out of the hood, but deposited ZnO nano particles were collected inside the aluminium crucible. Therefore, aluminium was chosen because it has a high homogeneity of deposition compared with other substrates such as glass and paper [8].

Figure 1 Pictorial Representation of preparation of ZnO nanotetra-pods



A) Material Characterization

The morphological structures of the synthesized nano particles at different time durations were studied through FESEM using a Hitachi SU8010 microscope. The microstructure was analyzed by the XRD pattern using a RigakuXtaLAB mini II, a benchtop X-ray crystallography system with a monochromatic $\text{CuK}\alpha_1$ wavelength (λ) of $1.5406 \text{ \AA}$. The average crystalline size (d) was determined using Scherrer's formula: $d = k\lambda / \beta \cos\theta$, where k is a grain shape-dependent constant (~ 0.9), θ is the Bragg reflection angle and β is the full-width at half-maximum of the main diffraction peak. The elemental composition of the ZnO was analyzed using FESEM coupled with an energy-dispersive X-ray analysis (EDX; AMETEK, Z2E).

B) Electrochemical corrosion studies: Sample Preparation

An AZ91 magnesium metal plate was used for the present study. Table 1 shows the chemical composition (wt %) of the AZ91 magnesium alloy used for the present study. The metal plate was cut into a small round specimen (1 cm^2) and then subsequently polished with $9 \mu\text{m}$, $3 \mu\text{m}$ and $1 \mu\text{m}$ silicon carbide grid papers and cleaned after each step with acetone. The synthesized Zinc oxide nanotetra-pods were mixed with PVDF and N-Methyl-2-pyrrolidone in an 80:15:5 weight ratio to prepare slurry. The Mg specimen was coated again with the prepared slurry using the doctor blade technique [9, 10]. The coating was repeated three times to achieve a uniform thickness of $\sim 1 \mu\text{m}$ of ZnO nanotetra-pods on the Mg metal surface. The coated Mg metal was dried in a hot-air oven at 353 K for 1 hour and then used for corrosion studies. Hereafter, the coated sample will be referred to as Mg/ZnO.

Table I Shows Chemical composition (weight %) of AZ91 magnesium alloy

Alloy	Mg	Al	Zn	Mn	Si	Cu	Ni	Fe
AZ91	90.012	9.0	0.7	0.24	0.04	0.005	<0.001	0.002

C) Electrochemical measurements

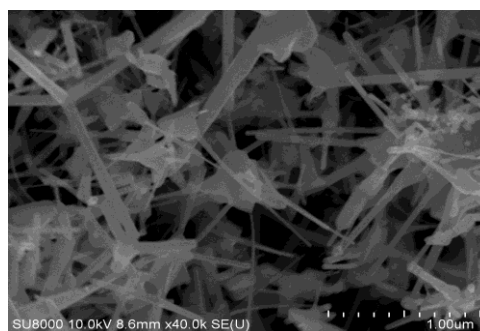
The examination of corrosion characteristics behavior in an Mg metal was performed using a three-electrode-cell set-up. In this cell set-up, an Mg metal was used as a working electrode, while platinum and saturated calomel were used as counter and reference electrodes, respectively. Electrochemical corrosion studies were carried out (until the concurrent value was obtained) for both Mg and Mg/ZnO in different electrolytes (1 M KOH, 1 M HCl and 1 M NaCl) using the auto lab PGSTAT302N equipment (MetrohmAutolab, the

Netherlands). The applied potential window for corrosion studies was 1.8 V to 1 V at a scan rate of 5 mVs⁻¹. Corrosion potential (V_{corr}) and corrosion current (i_{corr}) were determined from the extrapolated data of the cathodic and anodic parts of the potentiodynamic polarization test or a tafel plot. All these electrochemical measurements were performed three times to confirm the reproducibility of the results.

III. Results and Discussion

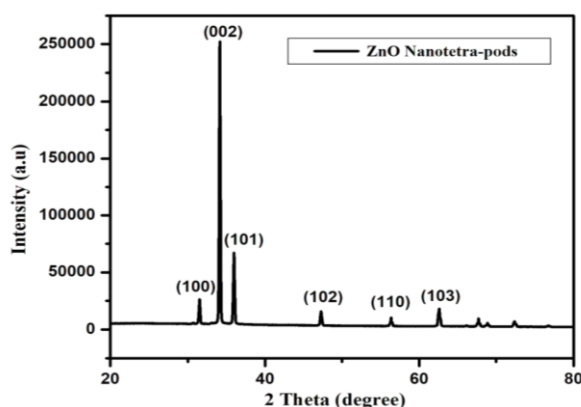
The morphological characteristics of ZnO nanotetra-pods with synthesis time of 60s are shown in Figure 2. These tetra-pods comprised a core ZnO in the blende Zn from which four ZnO arms emerged in the wurtzite structure [11]. From Figure 2, it is clear that each arm is well faceted with a hexagonal cross section and is non uniform in length and diameter. Generally, the growth of the cylindrical supports proceeds with the nucleation of a core assembly. By varying the growth parameters such as the O₂ content and the MWI time duration, the morphology and the size of nanotetra-pods can be manipulated. One key advantage of tetra-pods over other nanocrystalline geometries is that they actively orientate with one arm directed normal to the plane of the Al substrate [11].

Figure 2 FESEM image of synthesized ZnO nanotetra-pods at 60s



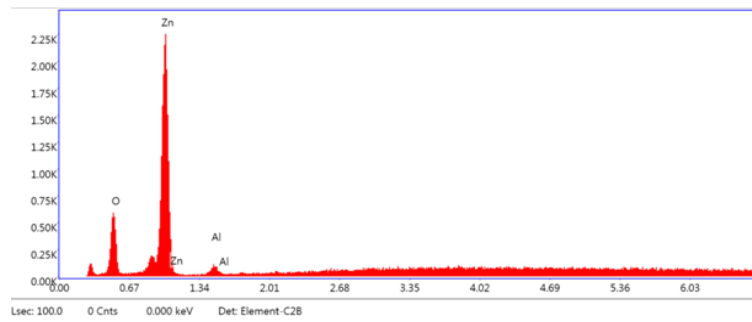
The XRD pattern of ZnO shown in Figure 3 confirms the proper phase formation and the crystalline nature of the prepared ZnO nanotetra-pods at 90s. The highest (002) intensity peak with other smaller intensity (100), (101), (102), (110) and (103) peaks of ZnO were observed in the XRD pattern. The crystallite size of ZnO nanotetra-pods was found to be 58.60 nm, which was calculated using Scherrer's formula from the XRD pattern. In Figure 3 the indexed diffraction planes represent the wurtzite phase of ZnO with the lattice parameters $a = 3.2492 \text{ \AA}$, $c = 5.2042 \text{ \AA}$ and c/a ratio = 1.612, which are agreement with the values reported in the literature ($a = 3.250 \text{ \AA}$, $c = 5.206 \text{ \AA}$, JCPDS No. 36-1451).

Figure 3 XRD pattern for ZnO nanotetra-pods prepared at 60s.



The EDX spectrum of the ZnO nanotetra-pods at 90s is shown in Figure 4, which confirms the presence of Zn, O and Al in the prepared sample. The presence of a small amount of Al contamination from the aluminium substrate (as expected) was observed along with the predominant Zn and O peaks. The EDX spectrum shows that the percentage of error for Zn is very low, which confirms the occurrence of Zn and O in the sample. The atomic percent ratio of O and Zn in the dried sample was, respectively, 31.26 and 65.09, which indicates that there were very few O₂ vacancy defects on the surface of the sample. Thus, the purity of the prepared ZnO was confirmed.

Figure 4 Elemental Composition of the synthesised ZnO sample by EDX prepared at 60s.



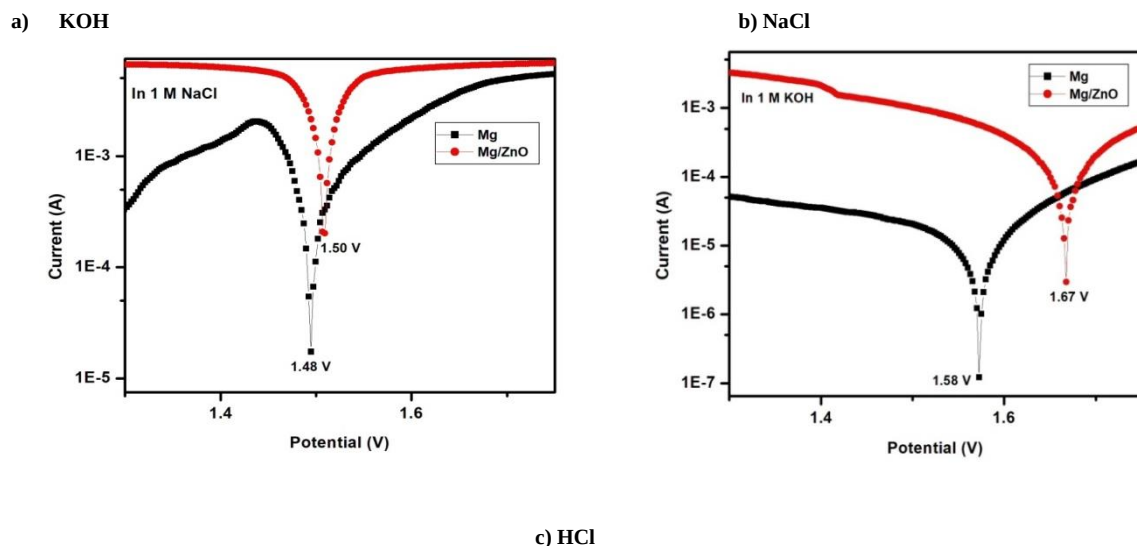
eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
O K	10.30	31.26	33.12	8.95	0.0680	1.3304	0.4957	1.0000
ZnL	87.67	65.09	160.66	3.14	0.8116	0.9584	0.9659	1.0000
AlK	2.03	3.65	4.84	21.57	0.0122	1.1717	0.5140	1.0004

Comparative corrosion characteristics were studied for both the Mg alloy (Mg) and the zinc oxide nanotetra-pods-coated Mg alloy (Mg/ZnO) samples in KOH, HCl and NaCl electrolytes. First, the potential was applied at 1.8 V and the corrosion was initiated at the Mg anode. Further, the potential tended to trace towards 1 V with an interval of $\sim 5 \text{ mVs}^{-1}$. Figure 5a shows the potentiodynamic polarization curves or tafel plots for Mg and Mg/ZnO samples in 1 M of KOH electrolyte solution. It is clear from Figure 5a that the corrosion potential of the Mg/ZnO sample is moved towards more positive (1.67 V) (anodic region) compared to Mg (1.58 V). The calculated corrosion current (i_{corr}), tabulated in Table 2, was found to be $\sim 5.36 \times 10^{-4} \text{ Acm}^{-2}$ and $\sim 3.24 \times 10^{-4} \text{ Acm}^{-2}$ for Mg and Mg/ZnO samples, respectively. The above results confirmed that a low rate of corrosion and high electrochemical corrosion resistance were achieved by a thin-layer coating of ZnO nanotetra-pods over the Mg anode surface. Figure 5b shows the corrosion curves for Mg and Mg/ZnO in 1 M of NaCl electrolyte. A similar corrosion trend was observed. The corrosion current (i_{corr}) of Mg/ZnO ($\sim 1.46 \times 10^{-4} \text{ Acm}^{-2}$) had a lower value than Mg ($\sim 1.58 \times 10^{-4} \text{ Acm}^{-2}$). It is clear from Figure 5b that the corrosion potential of the Mg/ZnO sample is shifted towards more positive, (1.50 V) (anodic region) value compared to Mg (1.48 V).

The corrosion curve for Mg and Mg/ZnO samples in 1 M of HCl electrolyte is plotted in Figure 7c. It was also obvious that the Mg/ZnO sample had lower corrosion current compared to the Mg alloy sample, which suggests that improved corrosion resistance was achieved with the coating of ZnO nanotetra-pods over the Mg surface. The Tafel slope was observed to be at a low potential for Mg compared to Mg/ZnO, which also suggests a high corrosion rate for Mg. The calculated corrosion current (i_{corr}) of the Mg and the Mg/ZnO sample was mapped from the extrapolated lines of the tafel curve, Table 2, and was ($\sim 6.18 \times 10^{-4} \text{ Acm}^{-2}$) and ($\sim 5.84 \times 10^{-4} \text{ Acm}^{-2}$), respectively. It is clear from Figure 5c that the corrosion potential of the Mg/ZnO sample is moved towards more positive, (1.57 V) (anodic region) value compared to Mg (1.52 V). The above experimental evidence confirmed that the ZnO thin-layer coating over the Mg surface could improve corrosion resistance in aqueous electrolytes.

Figure 5 Potentiodynamic polarisation curves for Mg and Mg/ZnO in three different electrolytes.



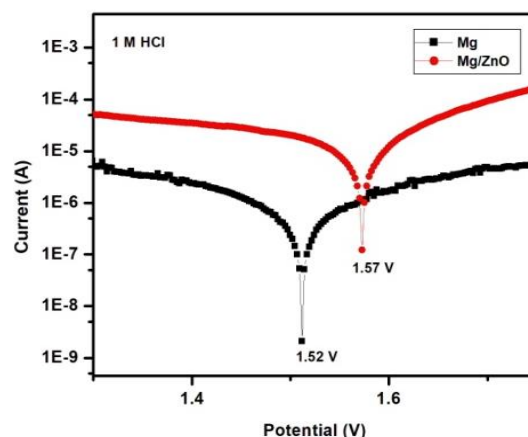
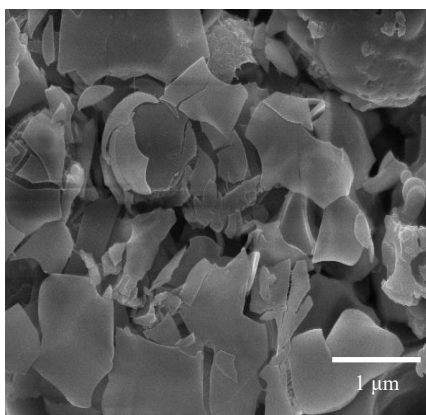


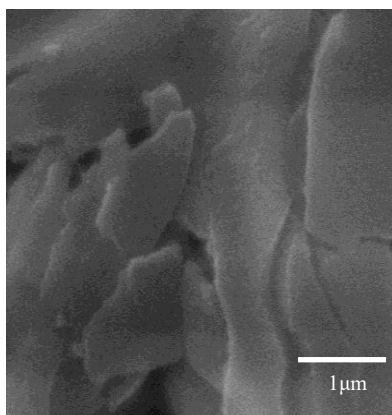
Figure 6 a, b, c reveals that the entire surface of Mg alloy sample is degraded due to uniform surface corrosion after exposure to positive potential in the electrolytes, while the Mg/ZnO samples Figure 7 a, b, c surface remain intact except degradation at few isolated area, and leaving major part of the sample surface unharmed. It is evident from the post-corrosion SEM study that ZnO nanotetra-pods does not corrode on the potential window used in our study. The above observation once again indicates that ZnO nanotetra-pods coated Mg (Mg/ZnO) samples exhibit high corrosion resistance.

Figure 6 SEM image Mg samples in three different electrolytes after corrosion studies.

a) KOH



b) NaCl



c) HCl

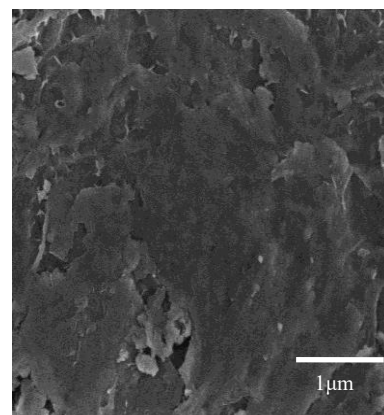
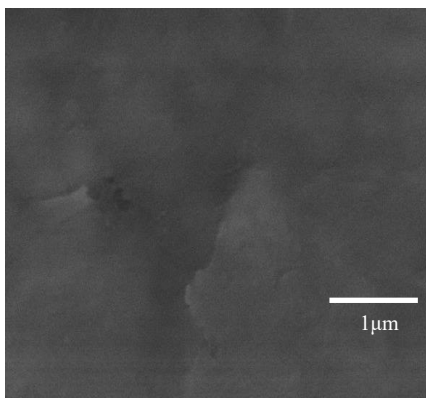
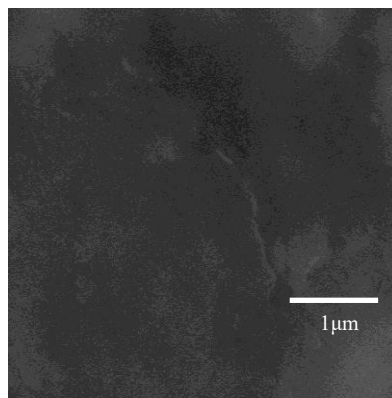


Figure 7 SEM image Mg/ZnO samples in three different electrolytes after corrosion studies.

a) KOH



b) NaCl



c) HCl

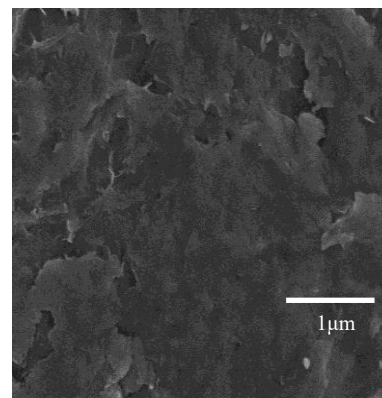


Table 2 Corrosion potential (V_{corr}) and corrosion current (i_{corr}) determined from Tafel curves of 1 M KOH, 1 M NaCl and 1 M HCl

Electrolyte	Sample	Corrosion Potential (vs. S.C.R.E.) V^{-1}	Corrosion Current (A_{cm^2}) $\times 10^4$
1 M KOH	Mg	1.58	5.36
	Mg/ZnO	1.67	3.24
1 M NaCl	Mg	1.48	1.58
	Mg/ZnO	1.50	1.46
1M HCl	Mg	1.52	6.18
	Mg/ZnO	1.57	5.84

IV. Conclusion

In summary, ZnO synthesized by energy efficient, rapid and cost effective microwave irradiation technique is applied as a thin layer coating over Mg alloy surface in order to prevent corrosion in aqueous electrolytes. Electrochemical measurements in three different aqueous electrolytes of KOH, NaCl and HCl show a sharp decrease in corrosion rate. The excellent corrosion resistance in aqueous electrolytes suggests that the Mg/ZnO has the potential to be used as an anode material for primary Mg battery system.

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Intelligent Refrigeration and Food Management System using Biomachine learning Refrigerator

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Abstract: The paper focuses on the application of standardized notation and labeling of food items to store them in a refrigerator. The standardized database can be accessed by the user that would thus help the refrigerator to understand the lifespan and condition of the food item. The refrigerator thus allows us to have control over the shelf life of the food item and also to determine the expiry time of the same. The data and the information of the food product are obtained with the help of camera and texture is analyzed to understand the condition of the food items then analyzed by the system to generate visual patterns and light outputs on the storage compartment accordingly. The compartments are fitted with sensors to detect the presence of the object and show the output. The food spectrum generated can help us to analyze the food shelf life and also to determine how long food can stay fresh. The data acquired is stored in a logger and is also sent to a web server. The data acquisition and storage system can be used for the understanding of food life and impact of refrigeration on it.

Keywords: Smart Refrigerator; biosensor; machine learning

I. INTRODUCTION

In our day to day life, with health being a major concern for everyone, the storage of the food items attracts a lot of attention of the user. Different types of refrigeration system and storage compartments are available for the purpose of storing the food items over a longer period of time. With the increase in the amount of preservatives and our hectic schedule it is very difficult to monitor the general aspects of these food items. We still use many traditional methods for the purpose of storage of food items. The modern approach has not reached so far as to achieve something capable enough to take a step forward in the domain of food preservation and storage. The allowance of a smart refrigerator with fitted sensors to allow and improve the biological health of food item will allow us to have a futuristic approach towards better health. The process covers the standardization of the food items, the interface to allow the machine to understand the features of the food item and then finally allowing the user to see the status of the item. The data acquired can also be used to further analyze the food shelf life spectrum and create a database.

The major issue with the present lifestyle of human being is that we are too careless regarding our food requirements and it's intake. Generally, we don't have time to think about the condition of the food item and also the shelf life of the food. This problem can cause a lot of medical and biological problems in our life. This kind of problem may even lead to hereditary medical problems. The storage of the food items being the major loophole where the food item may get damaged and may turn into poisonous substances. Regular use of non-hygienic food items may lead to genetically made problems also.

The Solution to these problems is the use of biomedical sensors to analyze the scenario of the food item and display it to the user via the use of some graphical method and then broadcasting the information to the user's local device (cellphones and laptops). The major component in this whole process is the analysis of different types of food items and allocation of those food items in the refrigerator. The display for the user will allow the user to improve the health of the food item by controlling the amount of different artificial atmospheric factors generated by the machine or to know that the product's expiry date has arrived. The main idea is to allow the user to have complete control over the food items present in the refrigerator and allow to use the technological factors to preserve the food items.

II. RELEVANT WORK

H. Bai explained how generally we use the alcohol sensor for the purpose of sensing the presence of an alcoholic environment in a vehicle and use it as a detection measure for drunk people. The alcohol sensor is successful in detection of alcohol content and benzene.[1]

C. Savulescu explained how he used the sensor to monitor the athlete health in real time. The major setback to this problem is the lack of accuracy and exactness of the data for the purpose of monitoring. This shows that sensor is not only meant for the purpose of monitoring the alcohol content but also it can be used to measure the exactness or accuracy of the health parameter of the person.[2]

Xuandeng Xue in his paper studies the trade-off between energy consumption and food quality loss, at varying ambient conditions, in supermarket refrigeration systems. Compared with the traditional operation with pressure control, a large potential for energy savings without extra loss of food quality was demonstrated.[3]

III. DESIGN OF THE SYSTEM

IV. MECHANICAL DESIGN

The designed the prototype on Solidwork with all the basic requirements of a refrigerator . The components column on the refrigerator are sensors and LED strips that have the basic functionality of displaying the output . Further a LCD panel is fitted in the front of the refrigerator.

V. DESIGNING

The 2D Sketch of the required layers is designed initially. This 2D sketch is then extruded to build the 3D parts. The required holes are mirrored and generated using the Extrude-Cut option. To build a stacked up design the parts are then imported on a new Assembly file and assembled accordingly. Variation of heights between layers can be easily adjusted in the design. The final design is rendered using PhotoView 360.



Figure 1: Demonstration Refrigerator

A. Practical implementation of the sensors and mechanisms.

The sensors are fitted inside the compartment area of the refrigerator and are allowed to sense the food items with the help of different parameters .The gas sensor uses Neutral Gas to check for the quality [4]of the food. Similarly other sensors are also fitted to allow the refrigerator understand the condition of the food item .

B. Classifying Food Items

For the given setup we are using MQ-3 Sensor which is an alcohol sensor. The sensor is designed to sense Alcohol and Benzene. Looking forward for the properties of a closed container we are using the sensor to sense for the air quality .The sensor can be easily interfaced with an arduino microcontroller which allows for the data to be read and analysed[5].

1) Dairy

We use a Chocolate bar for testing the decay of the food item by using the Alcohol sensor MQ-3. The sample was kept under observation in a closed container for a span of 30 minutes over which we obtain the graph given below.

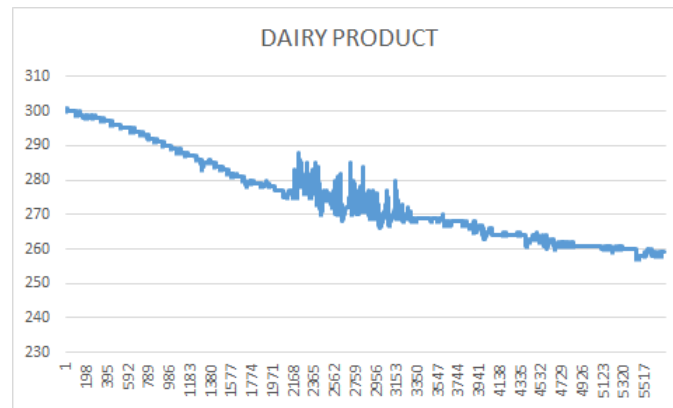


Figure 2: Dairy product Analysed

The graph obtained is decreasing, but it can be clearly seen that the graph is divided in three phases. In the initial phase, due to temperature change and contamination, gases are released from the sample into the closed surrounding changing the composition of the air.

During the middle section saturation point approaches as the released from the sample fills the air surrounding it as observed by the rapid variation in the graph.

During the last phase, after a certain point of time the saturation becomes stable. It can be seen that the variation stops and the values obtained become uniform again.

Note: The nodemcu should always be connected to a network so it can be a Wi-Fi network or a hotspot.

2) Beverage

Beverages tend to have longer shelf space. This may include fresh juices, sodas, cold drinks or alcohols. We are aware of the fact that packed juices stay fresh longer than fresh juice because of preservatives, but this fact can be changed by specifically changing the refrigeration conditions in the specific compartment.

C. The Output Of The System

The system is giving the output in the form of RGB Led the led show the quality of the food which is overlaying it. This also helps us to know the shelf life.

1) The gas sensor

During the testing of the machine we used general purpose gas sensor to understand the impact of gases on the food items. We experimented the gas sensor with an arduino to read the sensor values. For the purpose of getting the data for a longer duration we are using a SD card data logger to keep the data. The experimented data is saved in the SD card in .xlsx format. This data can be analyzed with the help of either MATLAB or Microsoft excel tools .

2) Sum Up of the Electronics

The core electronics which are being used in this system include a camera, raspberry pi, gas sensor, Arduino and RGB Neo spectrum lights. The setup takes place in two phases , the testing phase and the implementation phase . The output data is displayed on an LCD which is fitted on the front of the refrigerator .

VI. DATA ANALYSIS SYSTEM

The data generated from the gas sensor is initially read from an Arduino and further analyzed. The spectrum of the data which we are considering takes longer duration to have small variation so for that purpose we used an SD card logger. A raspberry pi setup is introduced after the system has finally been calibrated to have a mathematical function to reproduce the same data as we require.

VII. APPLICATION

- Capable of sensing and monitoring its contents and the refrigerator is also able to remotely notify the user about scarce products via android application.
- It also facilitates the purchase of scarce items by providing a link of the online vendor of that particular item.
- Provides users with extra information about their products, their nutritional facts and consumption history.
- Refrigerator can be designed to allow users to order groceries over the Internet.

VIII. CONCLUSION

This concept helps us in adding additional functionality to the commonly used refrigerator, and also this allows the food to be monitored more responsibly. This additional set of features can be pre built inside the present refrigerator or it can be added externally to the old machines via mounts and attachments. In all this concept of generalizing food analysis technology will help us in understanding food behavior and life span of food in different areas and this also helps in understanding the human food consumption and give personalized feedbacks over food habits

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A Comprehensive Study on Face Detection and Recognition Techniques

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Abstract: In recent trend, Face detection and recognition has become extensively used security based access control mechanism. It has acquired great deal of research in image processing and computer vision based facial endorsement domains. Face detection is the process of capturing and perceiving the digital image of an individual through a well framed camera and it can be progressed towards automatic face recognition that performs an unequivocal analysis with patterns of the face against trained facial attributes available in the database to obtain an accurate match of facial characteristics. In addition to rendering a unique identity of an individual, these technologies can be used as an alternative for biometric based authentication systems and forensics. In this paper we have presented a comprehensive survey of different methodologies and applications of this field. The discussion predominantly focus on prevalent techniques like (i) Principal Component Analysis(PCA) using EigenFaces, an unsupervised learning techniques that reduces the dimensionality of the data by stripping out unnecessary data and necessary data to find the accurate facial patterns. The training data images called 'EigenFaces' are extracted from large set of different human face images by applying PCA and then analysed against test image. (ii) Linear discriminant Analysis (LDA) which is a supervised learning techniques for pattern recognition in the facial features. (iii) Machine learning approaches like Viola - Jones Haar cascade classifiers with the trained number of positives and negative images, analogous elements are extracted using Raspberry pi. Finally, we identified opportunities for future enhancements in this realm.

Keywords: Eigenvector; Haar classifier; Eigenfaces; Raspberry pi; Putty client

I. INTRODUCTION

Biometrics has become an emerging technology for recognizing individuals using their biological features. Now, biometrics is becoming part of day to day life, in which a person is recognized by his/her personal biological characteristics. Face recognition is one of the types of biometric identification system in which it does not need any physical contact with the person of whom the face was going to recognize. The main segments of facial perception are face detection and face recognition. The distinction between face detection (identification) and recognition (acknowledgement) is that detection is to detect a face in a video or an image and locate the face whereas face recognition is to find and provide unique identity of an individual.

Among other biometrics, facial recognition may not be more reliable than other biometrics like fingerprints etc., but it offers several advantages over others. Well-designed system in malls or other public places can detect specific persons from the crowd of people whereas biometrics need physical presence of the person.

Many different algorithms exist to perform face detection and recognition, each have its pros and cons. In this paper we discussed about some of the algorithms that are more likely used for face detection and recognition. Some of the algorithms which are used for face detection are Eigen face, Local Binary Pattern Histogram algorithm, Principle Component Analysis, Neural Networks etc. Each algorithm is having its own way to detect the face features, analysing the features and giving the result.

Raspberry pi (a small card sized computer) and some other peripherals can be used for face recognition because of its features it makes the system more efficient with all the basic requirements embedded on its motherboard, running a dedicated version of Linux which can be plugged into TV and a keyboard. In other words it is a capable little computer which can be used in electronic devices and for much functionality that a desktop computer can perform which is available with low price

OpenCV is one of the modules in python which was mainly used for face recognition. It is imbued with three approaches for face recognition like Eigen faces, Fisher faces and Local binary pattern histograms. In Eigen faces, it looks at all the training images of the people as a whole and tries to extract the components which

are relevant and useful and discards the rest. These important features are called principal components. Fisher faces recognizer algorithm extracts principal components that differentiate one person from the others. In that sense, an individual's components do not dominate over the others.

Objective

To pin down the range of techniques in use for facial detection and recognition as well as to determine the effectiveness and correlation of each approaches.

Road Map

This paper is organized as follows: Section II discusses the review and analysis about existing techniques and applications. Section III delineates the illustrations of intrinsic technologies and finally, we conclude this study with brief note on its future applications.

II. RELATED WORK

Referring [2] analysed and furnished an accurate response rate of variegated face detection and recognition methods for video surveillance. The authors has used AdaBoost classifier algorithm with Haar - like features for evaluating large set of features in a new image and Support Vector Machine (SVM) classifier with Histogram of Oriented Gradients[HOG] is employed to label the pixels of an image for meticulous face detection from face rich databases. Among these all, the authors has mentioned that the AdaBoost classifier with Haar features gives 96.70% accurate results whereas SVM with HOG provides 90.88% result. For face recognition linear discriminant analysis is done on the pixel values of the faces from five datasets which has been used to validate the quality with reduced false face identification. Rahul Sharma *et al.* (2013), deals with Minutia Score Matching method which examine image at the boundary to find the minutia points, ridges and does ridges bifurcation to overcome security and identification issues. They also suggested that the wavelet packet correlation technique can be used to match the character strings which is in low contrast with combined minutia and wavelet features. The major disadvantage of the approach is if the user gets injury in their faces/fingers it cannot be recognized properly and accuracy may change.

Ashutosh Chandra Bhensle *et al.* (2014), suggested the statistical technique of effective recognition of face (frontal view) from various sources like static images and dynamic images (live stream or pre-recorded videos) using Principal Component Analysis (PCA) and Euclidean distance for extricating and training the facial features. PCA enumerate eigen vectors(eigen faces) and discover unique facial features with reduced dimension by performing conversion of 2D image vector into the 1D vector form and then it reckons the average image vector from the images which is taken as a training dataset. The authors has explained the Viola-Jones algorithm and Euclidean Distance Classifier that finds the minimum distance between the training image and testing image in the database. If the distance is low then the testing image and the training image in the database are similar else the testing image is truncated.

Vanlalhruaia *et al.* (2015), suggested the technique of Principal Component Analysis [PCA]. This method has used the principles of Eigenface based Dimension Reduction algorithm in which face images are fragmented into Eigen faces and then weights (eigenvectors) are assigned. To find the similar patterns of the face features amidst the group images Elastic Bunch Graph matching algorithm has been used, which measures the similarities of the derived graphs from which the face has been recognized. Association of Hidden Markov model has been applied to separate the regions of the faces like nose, eyes, mouth, etc. to identify the best match against sampled images.

Smriti Tikoo *et al.* (2016), imparted Viola Jones algorithm for face detection and proposed a kind of supervised learning modus operandi called Back Propagation Neural Network (BPNN) implemented in Matlab 8.2 (to train and test the face image) for face recognition. In this framework, Viola Jones algorithm works in four phases to detect the face viz., (i) Haar Feature Selection (using OpenCV) which take the all common features of the human faces. (ii) Creation of an integral image using rectangular features of the image which determine sum of the pixel coordinates (iii) Ada Boost training algorithm has been applied to train the classifiers by cascading with previously sampled weak classifiers. After detecting the face, the images will be converted from RGB to grayscale / binary image so that segmentation will be take place by using BPNN tool (i.e. it train, test and validate each individual segmented part by utilizing curve fitting tool of Matlab which gives approximately 85% accurate performance results).

Jianzheng Liu *et al.* (2016), proposed the system to extract the facial features using Motion History Image (MHI). The MHI will be generated by the sequence of images in lieu of single face image. By detecting the sequence of face images, Region Of Interest (ROI) of the tested image is generated and then ROI images are converted into gray-scale image thereby used to get the MHI's (pre-processing). Then the MHI will be resized into vectors, normalized and fused together as features (into 7-layer deep learning neural network). The results obtained are 100% face identification accuracy amidst behavioural characteristics (facial expressions).The

authors says that the fusion features in their work deal with large quantity of facial expressions which have yielded supercilious state - of - art performance results. Tathe et al. (2016), presented the system for multiple human visual face detection and recognition in digital videos using Haar classifier technique (based on wavelet transform of time - frequency representation which interpret the facial image in terms of its coefficients) to detect the faces. The authors has employed EigenFace to identify the face in videos (by categorizing known and unknown individual face images) and Gabor filter are applied for texture representation and discrimination (i.e., useful features are extracted directly from gray-level images). The following shows result of the processing time for detection and recognition process with regard to this approach.

The below Table.1 shows the comparison of Eigen and Gabor filter based recognition time, true recognition and false recognition rate. The Eigen takes less time when comparing with Gabor filter method. It also explains that Eigen recognizes more face when comparing with Gabor filter technique and in Eigen method, false recognition is less.

VIDEOS TAKEN	NO.OF FRAMES	FACE DETECT	RECOGNITION TIME		TRUE RECOGNITION		FALSE RECOGNITION	
			EIGEN	GABOR	EIGEN	GABOR	EIGEN	GABOR
1	237	71	0.2303	28.517	47	37	24	34
2	329	99	0.3002	40.035	97	31	2	68
3	257	223	0.6475	88.746	52	98	171	125
4	339	225	0.6601	90.225	65	18	160	87
5	448	305	0.8934	122.02	225	7	80	298

Table.1. Comparison of Eigen and Gabor Filter Method (Tathe et al. (2016))

Fontaine et al. (2017), explained face recognition in real world images in which the authors has used the novel alignment process with sparse representation technique for classification. The authors has manoeuvred Robust Sparse Coding(RSC) algorithm with some modifications which requires only a minimum number of training images and all images should be in the same size, equally aligned and all images should be captured as frontal images. The basic prerequisite of this method is that face images should be aligned properly before applying RSC algorithm on the image database. Such novel approach has yielded 95% recognition rate of the real world images. Umme Aiman et al. (2017), deals with advanced deep learning based face recognition from a compact dataset. It follows Convolutional Neural Network (CNN) where the data augmentation technique has been used to increase the number of training data sets and it enhances the generalization power of network. And the authors suggest that such system will manage the problem of poor recognition rate on smaller datasets in deep learning based face recognition technique. The augmented datasets (training) holds an extra images which is produced by applying Poisson and Gaussian noise on the actual training data sets. Then the training datasets has been given to the CNN training model. The author specifies that face recognition rate has been increased from 79% to 95% when applying augmented data on CNN model.

Table.2. Age Recognition Rate[in percentage] Using Different Approaches (Umme Aiman et al. (2017))

Training approaches	Number of images per subject for training							
	1	2	3	4	5	6	7	8
CNN without noise	41.75	61.34	78.57	79.29	86.30	88.56	89.92	90.88
CNN with Gaussian noise	59.72	87.75	92.71	94.39	99.60	99.81	98.42	95.88
CNN with poisson noise	60.47	88.41	86.50	95.21	99.92	99.94	99.58	99.96

The above Table.2 explains the age recognition rate in percentage for the each set of training images which is stored in database by applying the approach CNN(Convolutional Neural Network) with noise(Gaussian noise and Poisson noise) and without noise.

Kruti Goyal et al. (2017), has proposed the system for face detection and tracking using OpenCV to identify the faces in images and videos which will be helpful for video surveillance and police departments to

track the faces of the person. The authors applied many forms in the face detection techniques like determining faces using motion like features (i.e., by blinking the face) color, limited area of pixels, and applying Camshaft algorithm with Haar cascades. Camshaft algorithm follows the steps to detect the faces (i.e., it first get the target image, create the histogram and then generate the face portions that has to be searched first). Correspondingly each portion of the face is detected by limited area of pixels using edge detection orientation.

Table.3. Summary of Literature Survey check form

ALGORITHM/ METHODOLOGY USED	WHO, WHEN	ADVANTAGES
AdaBoost classifier algorithm with Haar - like features, Support Vector Machine (SVM) classifier with Histogram of Oriented Gradients[HOG]	Faizan Ahmad, Aaima Najam and Zeeshan Ahmed (2012)	Deep learning can be used even to train small datasets which can be applied in schools and offices for attendance purpose
Minutia Score Matching method	Rahul Sharma, Nidhi Mishra, Sanjeev Kumar Yadav (2013)	Preserves the quality of the image. It can be used in banking sectors.
PCA, Euclidean Distance Classifier	Ashutosh Chandra Bhensle, Rohit Raja, (2014)	it is a powerful tool that can analyze data. It can be used where there should need to analyze large amount of data.
PCA with Eigen face, Elastic Bunch Graph matching algorithm	Vanlalhruiia, R. Chawngsanpuii And Yumnam Kirani Singh (2015)	Elastic Bunch Graph Matching make use of Gabor features which helps for better accuracy. It can be used to identify the thief's.
Viola - Jones algorithm Back Propagation Neural Network	Smriti Tikoo And Nitin Malik, (2016)	Works and gives the result fastly – can be used in shopping malls or in crowd areas.
Convolutional neural networks Histogram of Oriented gradients (HOG) and Support Vector Machines	Jianzheng Liu, Chunlin Fang, and ChaoWu (2016)	More robust when compared with other models. It can be used in shopping malls and home security surveillance.
Haar features, Eigen and Gabor filter	Tathe S V , Narote A S, & Narote S P, (2016)	It is one the most preferable way for face recognition. It can be used in home surveillance.
Robust Sparse Coding, Novel alignment	Fontaine X, Achanta R, & Susstrunk S, (2017)	Works more effectively in face occlusion, corruption, lighting and expression changes, etc. can be used in shopping malls near signals.
Deep Learning Based face recognition System	Umme Aiman, Virendra P. Vishwakarma, (2017)	Deep learning neural network to learn face representation from a smaller dataset – which can be used in schools and offices for attendance purpose
Camshaft algorithm Haar cascades using openCV	Kruti Goyal, Karthikey Agarwal and Rishi Kumar (2017)	Performs better and gives more accurate results. It can be used in banking sectors where then accuracy is more important

III. INTRINSIC TECHNOLOGY

Various process modules are involved implementing the idea of Face detection and recognition using Raspberry pi. In this paper have focused on the following:

- Powering up and Connecting the RaspberryPi with Monitor and Camera (Charu Bhartiya et al. (2015))
- Capturing and Detection (Charu Bhartiya et al. (2015) & Ayman A. Wazwaz et al. (2018))
- Local Binary Pattern Histogram (LBPH) based Recognition of faces (Charu Bhartiya et al. (2015))

(i) Powering up and connecting the RaspberryPi with Monitor and Camera

In this module, the Raspberry pi (an embedded low cost single board computer with multicore processor) is powered up by connecting USB Type B plug to it. Interfacing with camera and display monitor can be done by connecting HDMI cable to VGA convertor or via Ethernet cable. Then from the pre-trained samples (positive images i.e. object of the image and negative images i.e. only background present in the image collected either manually or can be downloaded from internet resource (Charu Bhartiya et al. (2015) will create an xml file using Haar classifiers which compares the frames of images or live video images (which mandatory facial features that assists in identifying and describing for faces within the picture).

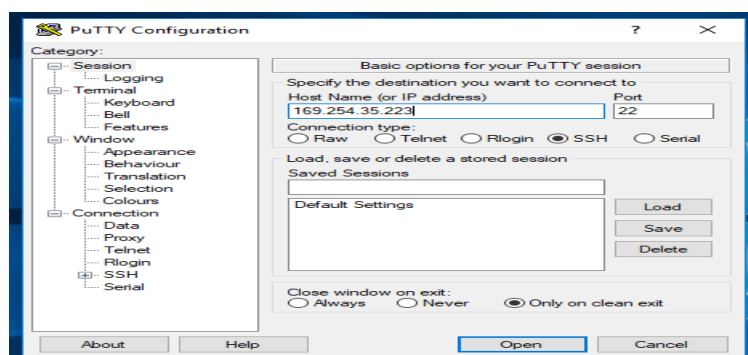


Fig.1 Accessing the RaspberryPi through SSH client (Ayman A. Wazwaz et al. (2018))

The above Fig.1 shows the interconnection of raspberry pi with external peripherals (e.g. display monitor or laptop) through its IP (via IP scanner) and acquiring the transmission conveyance through Putty SSH Client.

(ii) Capturing and Detection

For capturing process, detection of face will be performed in view of the fact that in an image or a video there may be several background influences (Jiri Prinosil et al. (2007)) however only the face needs to be captured, so to the great extent we will train the system to capture only the precise face region without recording the backgrounds. For this purpose Viola Jones in 2001 proposed object detection based Haar Cascade classifiers algorithm which is designed by OpenCV to detect the frontal face (Charu Bhartiya et al. (2015)) can be used which let the system i.e., USB camera connected to raspberry pi to capture maximum of 20 to 30 pictures continuously when face was detected. The image capture count can be increased to get an unequivocal results. After capturing, the images are saved in a local storage with username as extension which further used for recognizing the face.

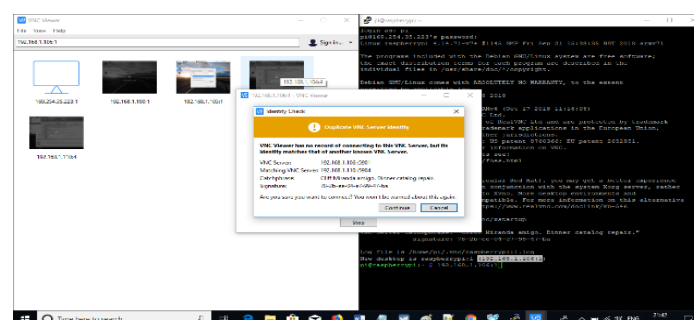


Fig.2 Access the GUI of RaspberryPi using the ip in Vnc Viewer (Ayman A. Wazwaz et al. (2018))



Fig.3. Sample Captured images (Ayman A. Wazwaz et al. (2018))

The above Fig.2 & Fig.3. Shows remote direct communication of raspberry pi established via. VNC Viewer and face image captured.

(iii) Local Binary Pattern Histogram (LBPH) based Recognition of faces

In this module, computer vision based LBPH algorithm (Charu Bhartiya et al. (2015)) will be applied on all the images (which labels the pixels of an image by thresholding the neighbourhood of each pixel with the center pixel) were stored in the memory to produce the LBPH values. After training, when the image was detected in the live video, the system will capture it and converted in to grey scale image and LBPH value will be generated and the generated value will be compared with previous LBPH values and gives the result.



Fig.4. Recognition of face using previously trained images (Ayman A. Wazwaz et al. (2018))

The above Fig.4. Shows the example of Local Binary Pattern (LBP) classification and detection and recognition of face with trained samples from cascade trainer (Jiri Prinostil et al. (2007) & Ayman A. Wazwaz et al. (2018)) via. LBP conversion process which compare the grey scale value with its neighbouring 8 pixels and will be given 0's if the values less than the centre pixel value, 1's if the value is greater than the centre pixel value and will generate an 8 digit binary number which will converted in to decimal for finding the matching.

IV. CONCLUSION

Face recognition has become one of the research topic from the past years. Today, most of the systems are being automated to identify the persons for surveillance and privacy tasks, and for controlling access to homes, mobiles and offices. These recognition algorithms works to gain high recognition accuracy. However, in the coming few years, this face recognition systems are going to be used widely suited for smart environments. To achieve this we have to make the system more reliable with optimized algorithms which work flawlessly to give the accurate results.

V. AUTHOR DETAILS

Bhaskaruni.V.M. Sai dileep received the B.Sc degree in Computer Science from Acharya Nagarjuna University in 2017 and pursuing M.Sc in Computer Science from Central University of Tamilnadu. Now he is working on face detection and recognition using raspberry pi and his area of interests are Machine Learning, Artificial Intelligence and Network Security.

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Implementation of Medium Frequency High Power Supply for Traction Application

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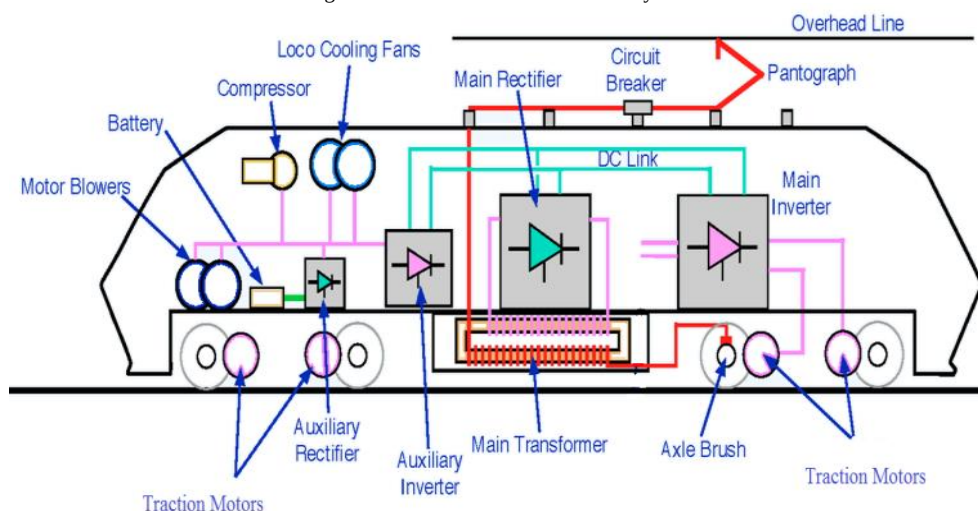
Abstract: The evolution of power electronics is ushering to an improved industrial revolution. Power electronics is the state of art for traction systems. Incorporating modern high power semiconductors in the traction systems opens up the opportunity to replace low frequency transformers with a new medium frequency power supply structures. Double stage power architecture is proposed, which converts DC/DC/AC voltages. A boost converter is designed with 20 kHz switching frequency converting 100V DC to 600V DC. The Pulse Width Modulation (PWM) is utilized in single phase inverter to achieve high conversion efficiency. The boosted voltage is inverted to 600V AC. Conventionally used MOSFET switches are replaced by Insulated Gate Bipolar Transistors (IGBT) as it is more preferred for medium voltage applications with a breakdown voltage of 600V to 750V. Medium frequency power conversion can effectively reduce the volume of passive components and lead to higher power density design for high voltage power supply. The system design is simulated using MATLAB Simulink.

Keywords: Medium frequency; Traction system; Pulse Width Modulation (PWM); Insulated Gate Bipolar Transistor (IGBT).

I. INTRODUCTION

The evolution of power electronics has resulted in the rapid growth of technology. Power electronics is the state of art for traction applications. Incorporating modern high power semiconductors in the traction systems opens up the opportunity to replace low frequency transformers with a new medium frequency conversion structure [1], [2].

Figure 1 Detailed structure of traction system



In specific, to improve the conversion efficiency with reliability and cost reduction, the proposed system addresses the use of double stage power architecture where the first stage is the boost converter and the second stage is accomplished by means of single phase inverter [3].

Conventionally in both the stages MOSFET switches are employed. MOSFETs are preferred for low voltage applications with a breakdown voltage of 250V [4]. MOSFET has the merits of higher commutation speed and improved efficiency during operation at low voltages. MOSFETs are connected in parallel to switch a high power load. But paralleling of MOSFET faces several potential problems. The issue is faced at the gate bleeder resistor. In the construction of MOSFET, a very thin dielectric insulator is placed between gate and source. This creates considerable capacitance which leads to thermal instability. To overcome these issues, IGBT shall be employed in the place of MOSFET. IGBTs are most preferable for medium voltage applications with a breakdown voltage of 600V to 750V and switching frequencies in the range of 20 kHz to 40 kHz. IGBTs are voltage driven forced commutating devices [5] – [8].

The detailed structure of the traction system is shown in Figure 1. The systems which are powered by electrical power for traction systems are called electrical traction. The track electrification deals with the type of supply system which is used to power the traction system. Here the main focus is on double stage power conversion of DC/DC/AC [9]-[12]. This conversion is attained by controlled turn on and turn off of semiconductor devices.

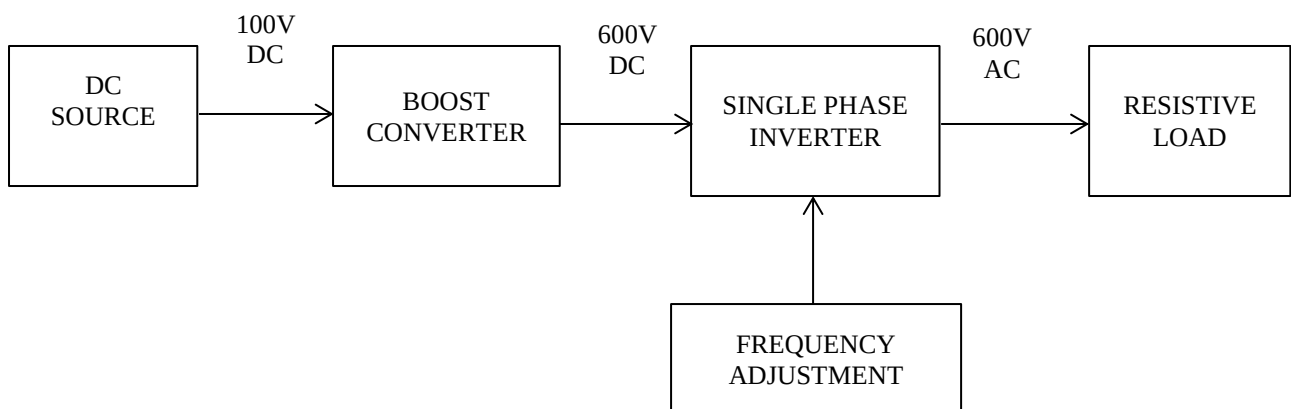
II. TOPOLOGY

The block diagram of the proposed double stage power architecture is shown in Figure. 2. In recent years, DC-DC converters are mainly used in switched mode power supplies. These are used to either step up or step down unregulated DC input voltage. There are four basic topologies of DC/DC converters like the buck, boost, buck-boost and Cuk converters.

The first conversion stage is achieved by means of DC/DC boost converter. Here the 100 V DC is converted to 600 V DC with 20 kHz switching frequency. The PWM technology is utilized so that high conversion efficiency can be achieved in all the operating conditions. In the second stage of conversion, the boosted DC voltage is converted to 600V AC by means of single phase inverter. Depending on the application, the conversion can be achieved either by controlled turn on and turn off of devices or by forces commutated thyristors. The voltage waveform of a practical inverter is, however non-sinusoidal. Medium frequency application requires square wave or quasi square waveform.

PWM is used in the inverter to get a steady output voltage. The inverter based on PWM is superior to conventional inverters. By changing the width of the switching frequency, the PWM corrects the output voltage according to the required the load.

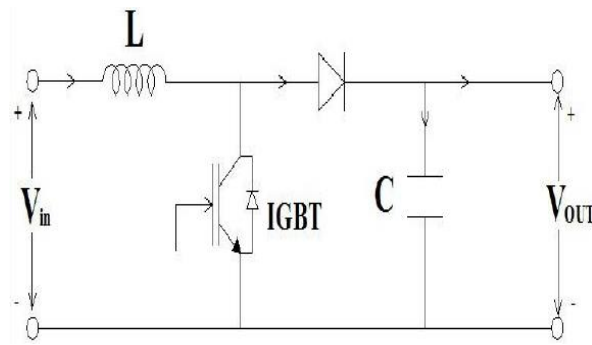
Figure 2 Block diagram of medium frequency double stage power supply



III. MEDIUM FREQUENCY INVERTER WITH VOLTAGE BOOST FUNCTION

A boost converter is a switched mode DC/DC converter with output voltage greater than input voltage. The schematic of boost converter is shown in figure 3. A medium switching frequency allows making use of small inductor and capacitor. This leads to decrease in current ripple.

Figure 3 Schematic of boost converter



The parameters which are necessary to design a boost converter are as follows:

1. Input Voltage Range: $V_{in(min)}$ and $V_{in(max)}$
2. Nominal Output Voltage: V_{out}
3. Maximum Output Current: $I_{out(max)}$

The relationship of voltage and current for an inductor is:

$$i = \frac{1}{L} \int_0^t V dt + i_o$$

$$V = L \frac{di}{dt}$$

When the transistor is switched on,

$$i_{pk} = \frac{(V_{in} - V_{Trans})T_{on}}{L} + i_o$$

$$\Delta i = \frac{(V_{in} - V_{Trans})T_{on}}{L}$$

and when the transistor switches off,

$$i_o = i_{pk} - \frac{(V_{out} - V_{in} + V_D)T_{off}}{L}$$

$$\Delta i = \frac{(V_{out} - V_{in} + V_D)T_{off}}{L}$$

Where V_D is the voltage drop across the diode and V_{Trans} is the voltage drop across the transistor. The continuous/discontinuous boundary occurs when i_o is zero. By equating through Δi ,

$$\frac{(V_{in} - V_{Trans})T_{on}}{L} = \frac{(V_{out} - V_{in} + V_D)T_{off}}{L}$$

$$V_{in}T_{on} - V_{Trans}T_{on} = V_{out}T_{off} - V_{in}T_{off} + V_D T_{off}$$

$$V_{in} - V_{Trans}D = (V_{out} + V_D)(1 - D)$$

$$V_{out} = \frac{V_{in} - V_{Trans}D}{(1 - D)} - V_D$$

Solving for the duty cycle ,

$$DV_{out} + DV_D - V_{Trans}D = V_{out} - V_{in} + V_D$$

$$D = \frac{V_{out} - V_{in} + V_D}{V_{out} + V_D - V_{Trans}}$$

Neglecting the voltage drops across the transistor and diode then:

$$V_{out} = \frac{V_{in}}{D}$$

So it is clear that the output voltage is directly related to the duty cycle of the pulses.

Therefore, duty cycle can be expressed as;

$$D = 1 - \left[\frac{V_{in} * \eta}{V_{out}} \right]$$

Where,

$V_{in(min)}$ = minimum input voltage

V_{out} = desired output voltage

η = efficiency of the converter, e.g. estimated 80%

This calculation of duty cycle with efficiency factor gives a more realistic duty cycle.

For the selection of inductor, inductor ripple current is to be determined.

$$\Delta I_L = \frac{V_{in(min)} * D}{f_s * L}$$

Where, f_s = minimum switching frequency of the converter

L = selected inductor value

Therefore, Inductor value

$$L = \frac{V_{in} * (V_{out} - V_{in})}{\Delta I_L * f_s * V_{out}}$$

Where,

f_s = minimum switching frequency of the converter

With unknown inductor value the ΔI_L can be determined by estimating ΔI_L as 20% to 40% of the output current

$$\text{i.e., } \Delta I_L = (0.2 \text{ to } 0.4) * I_{out(max)} * \frac{V_{out}}{V_{in}}$$

For the selection of capacitor, output voltage ripple is to be determined.

$$\Delta V_{out} = ESR * \left(\frac{I_{out}}{(1-D)} + \frac{\Delta I_L}{2} \right)$$

ESR is the equivalent series resistance of the used output capacitor

Therefore, Capacitor value

$$C = \frac{(I_{out} * D)}{f_s * \Delta V_{out}}$$

IV. SOFTWARE IMPLEMENTATION AND EXPERIMENTAL RESULTS

The proposed double stage medium frequency with voltage boost function is implemented and simulated using MATLAB Simulink 9.1.

Figure 4 Schematic diagram of software implementation

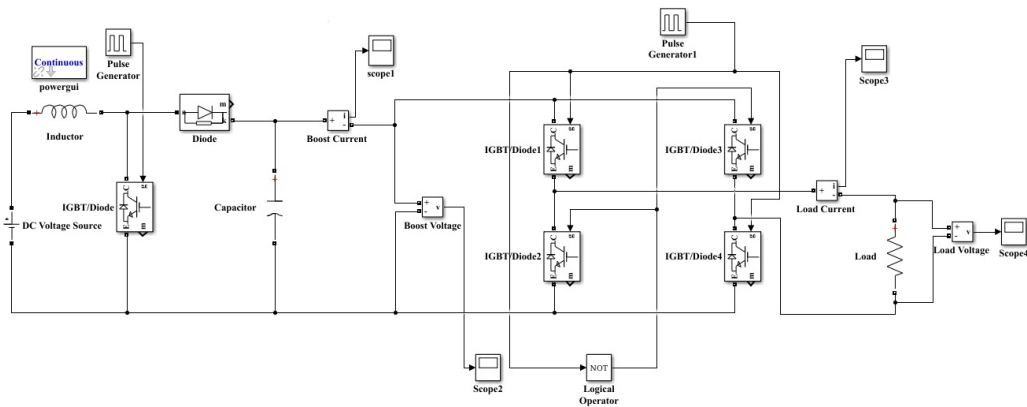


Figure 4 shows the schematic diagram of software implementation. The single phase inverter has four IGBT switches and it is fed by boost voltage. The IGBTs are switched alternatively in each half of controlled PWM period.

Figure 5 and 6 shows the output waveform of boost voltage and boost current respectively with 20 kHz switching frequency. The DC input voltage of 100V is boosted to between 600 to 700V with an average output current of 73A.

Figure 5 Waveform of boost voltage

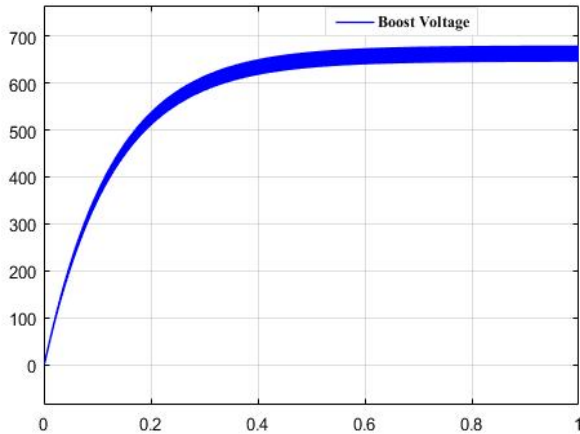
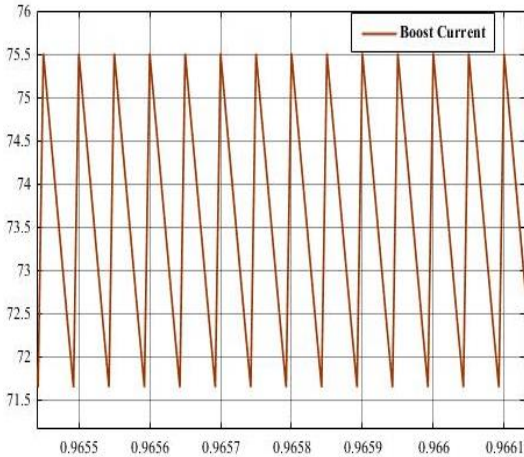


Figure 6 Waveform of boost current



The boost up voltage is then given to single phase inverter to convert DC voltage to AC voltage, since the traction supply source is of AC type. The system is connected to a load of 40 KW. The simulated output voltage and current is depicted in figure 7 and 8 respectively.

Figure 7 Waveform of load voltage

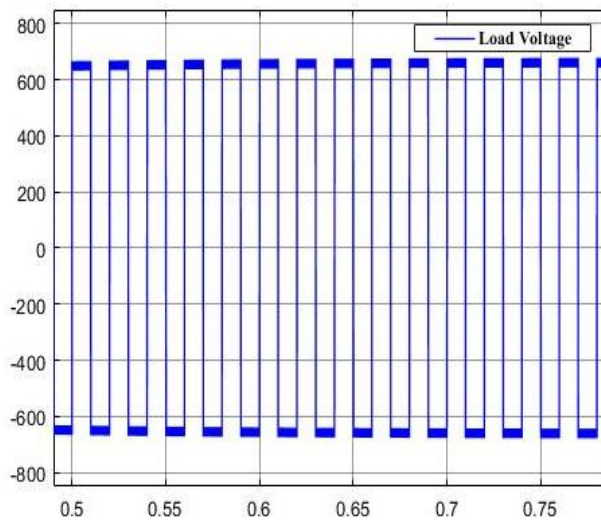
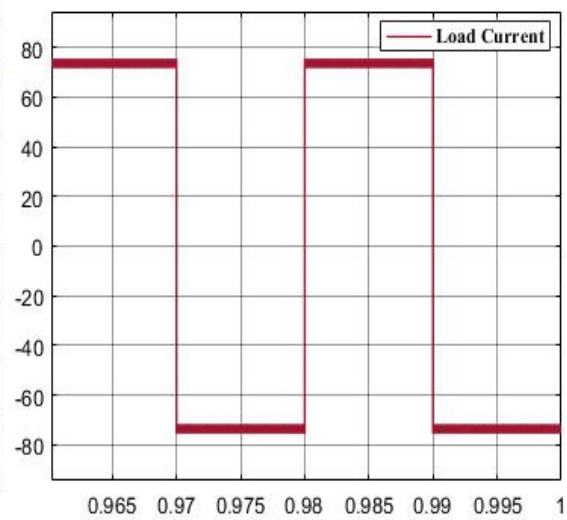


Figure 8 Waveform of load current



V. CONCLUSION

The proposed system of medium frequency high power supply is simulated by deploying IGBTs in the converter circuit. One basic advantage of MF-dc/dc-converter technology is increased efficiency when compared to conventional traction power supply. The boost converter is been designed to get an output voltage of 600V DC from 100V DC. For reason of reliability, component count and cost of the overall supply circuit, 600V IGBT power devices are favorable for use in the primary dc-links. The use of modified IGBT promises an increase in the possible switching frequency at a given power to be transferred. The proposed circuit design is implemented using MATLAB Simulink which is a high-level design tool that allows simulation, implementation and verification within MATLAB/Simulink environment.

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Recent View Regarding Cloud Computing

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Abstract: Cloud Computing is one of the most emerging trends in the IT industries and business to safeguard the stored data. It makes use of the smart grid computing and virtualization technique by replacing the maintenance and infrastructure costs of the computer. In cloud computing, a program code or a file can run in parallel without affecting the applications in the system on which it runs. Though this technology has more flexibility, but it faces data loss and data thefts. The user's personal data can be lost permanently by vulnerability attacks and data breaches. Cloud computing provides multitenancy in which users can share a lot of resources. To reduce the penetration by unauthorized access to the cloud and recover data from backups, fueling to high security and privacy norms. In this paper, we will discuss about the disadvantages of cloud computing and how to overcome them by secure cloud architecture.

Keywords: Cloud Computing, Smart Grid Computing, Threats, Data Breaches, Vulnerable Attacks, Flexibility, Cloud Sandbox.

I. Introduction

Cloud Computing is one of the blooming technology which is going to held the future needs. A large proportion of business, IT sectors and multinationals are shifting to cloud due to its numerous advantages, starting from effective manner of resource management to privacy concerns. Cloud environment is composed of highly extensive infrastructure in which multiple data resources can be shared as a pool, and that can be accessed using a "pay-for-use model" where only the actual usage of the cloud for effective means is billable. So, this substitutes the use of any hardware and complex software where if a user is in need of a data, they can place in the cloud and can access easily whenever, wherever they want, in a fraction of second. It brings the user access to data, applications and storage that are not stored on their remote computer. Cloud computing is built for the purpose of efficient and secure cloud architecture. The data, storage and applications in cloud computing leads the business to upper hand edge thus offering reduced cost. The cloud accomplishes increased computing abilities having to provide a new infrastructure. Cloud computing involves the technology innovations from cluster, grid computing to modern virtualization technique.

Virtualization is the concept of cloud computing where a layer of virtualization software allows physical IT sectors to provide multiple data resources as a pool that can be shared by multiple users. We access the cloud by cloud service providers, where a legal contract is made between a cloud provider and cloud consumer in the form of service-level agreement. But an unreliable cloud provider may not maintain the guarantees made in the SLA. So, the risks in management of cloud computing and their security issues is a major challenge.

In this paper, we will deliberate about the needs of cloud computing, the risks and challenges faced by cloud computing, and how to build a secure cloud architecture.

II. Understanding cloud computing

Cloud computing involves certain roles and boundaries defining how they interact with the cloud and it's hosted IT resources.

❖ Role of Cloud Consumers and Cloud Providers:

Cloud computing, in all its various forms is shifting the dynamic between providers and consumers of technology services and solutions. They don't have a clear idea who may be a "provider" and a "consumer."

1. Cloud Providers:

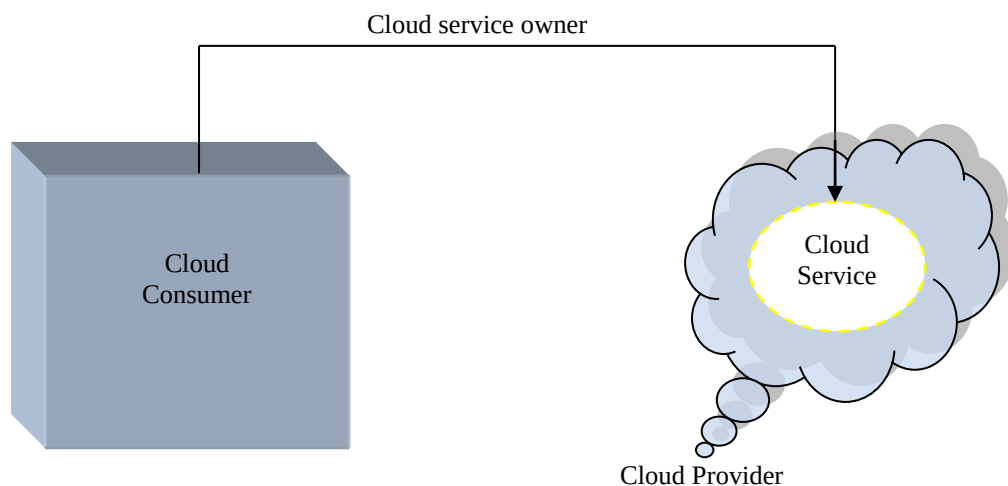
Cloud Providers are the organization that provides cloud based IT resources for the cloud consumers. When considering the job of cloud providers, the firm is responsible for making the cloud services available to cloud consumers as per Service Level Agreement (SLA) guarantees. Cloud Providers is further exercised with any required management and administrative chores to ensure the on-going operation of the overall cloud infrastructure. Cloud Providers ordinarily own the IT resources that are made available rental agreement by cloud consumers nevertheless, some cloud providers also “resell” IT resources lease from other cloud providers.

2. Cloud Consumers:

A cloud consumer is a firm or user that has authorized legal contract with a cloud provider to make use of IT resources made available by cloud providers. Specifically, the cloud consumer further uses a cloud service consumer to access a cloud service.

In simple, the organization or a user remotely access the cloud-based IT resources are considered as cloud consumers.

The cloud consumer can also be a cloud service owner, when it deploys its own service in a cloud. The cloud provider becomes a cloud service owner if it deploys its own cloud service, consistently for other cloud consumers to use.



❖ Cloud characteristics:

The effective usage of cloud depends upon the cloud characteristics to enable remote allocation of scalable and measured IT resources in an effective manner. Cloud Consumers and Cloud Providers make use of these characteristics to measure the value offered by the cloud platform.

1. Remotely Hosted:

The service of the cloud is not only hosted in one location most of the times to replicate the content, to make use of the content reliable, secure, it is hosted in multiple locations. So the services are hosted remotely that is wherever you are, you will be able to access to the cloud.

2. Ubiquitous Access:

It represents the ability for wide usage of cloud service. It can require support for a range of devices, transport protocols, interfaces and security technologies and switching to ubiquitous access the architecture of the cloud be tailored to particular needs of different cloud service consumers.

3. Multitenancy (and Resource Pooling):

A multitenancy is a software program which allows a single instance of software running into different servers, so that multiple tenants can share computing resources in a public or private cloud. Each tenant's data is private and not shared by other tenants, so every tenant data is unique and safe. It permits resource pooling to pool large-scale IT resources to serve multiple cloud consumers that frequently rely on the use of virtualization technologies.

4. on Demand Usage:

A cloud consumer has unilateral access to the cloud giving them full legal rights to self-provision the IT resources. Once configured, the usage of the self-provisioned data resources can be automated. A user can himself provision computing capabilities without requiring interactions by the cloud consumer or cloud provider. This results in on-demand usage environment.

5. Resiliency:

Resiliency is a form of holding multiple mirror copies of different data in different data centers. It is very important characteristics of cloud. Due to some geographical disasters, the data may be affected or lost. To prevent such loss, cloud providers conventionally mirrors solution to multiple data centers to minimize downtime in the event of disaster.

6. Elasticity:

Elasticity is the ability to adapt to workload changes which can able to balance the ups and downs of the infrastructure resources dynamically. It permits automatic switching, that is, moving from one cloud to another depending upon the requirements of the cloud user. Thus an elasticity characteristic represents the capability of a cloud to transparently and automatically scale IT resources out or in. Cloud providers can offer a wide range of elasticity with available IT resources. The main advantage of elasticity is associated with the reduced investment and proportional costs benefits.

❖ Cloud Delivery Models:

There are three basic cloud delivery models that are being widely used and formalized:

1. Infrastructure-as-a-Service (IaaS):

The most advanced environment which uses the hardware components operating systems networks connectivity and other 'raw' machine resources in the cloud. This environment is based on the requirement of the cloud consumers plan to design their own cloud-based environment. The main advantage of this cloud model is that they are generally not pre-configured, providing with high level of control and administrative responsibility directly to the cloud consumer. So, the cloud consumer needs not to be depending upon the cloud provider because they can configure their own cloud environment.

2. Software-as-a-Service (SaaS):

The SaaS-based service put together the utility of the software program, applications, and developed codes for the use of the product. So this service is generally offered by the cloud providers allowing limited administrative control rather than IaaS. If an organization or a cloud consumer use this SaaS model then they can share this model to another cloud consumer because of the reusable cloud service feature. Therefore, a cloud consumer can also act as a cloud provider using their own service and also leasing their service for different purposes.

3. Platform-as-a-Service(PaaS):

This type of service is a "ready to use model", independent of the machine and the program language on what users' work, because the cloud service will automatically manage the device, no matter which language is. The PaaS service reduces the burden of the consumers eliminating the complexity of building, configuring and maintain the infrastructure. A consumer can set their own platform where a set of services are decided to run. The advantage of PaaS is that consumers can implement SaaS environment and can also work with the PaaS environment collectively.

Other service delivery models include Storage-as-a-Service, Security-as-a-Service, Process-as-a-Service, Database-as-a-Service, etc...

❖ Cloud Deployment models:

According to the group of members who owns and access the cloud service, they can divided into four Common deployment models:

1. Public Cloud:

The public cloud (sharable storage) is owned by the ordinary people as a whole. In general, the public consumers make use of the cloud service owned by the third-party cloud providers. The whole maintenance of the cloud environment is carried out by unknown cloud providers. Example: Google drive

2. Private Cloud:

The private cloud (dedicated storage) is owned for the use of one particular group of people having no public concern. It is deployed for the privacy use where the consumers have a contract from their cloud providers legally.

3. Community Cloud:

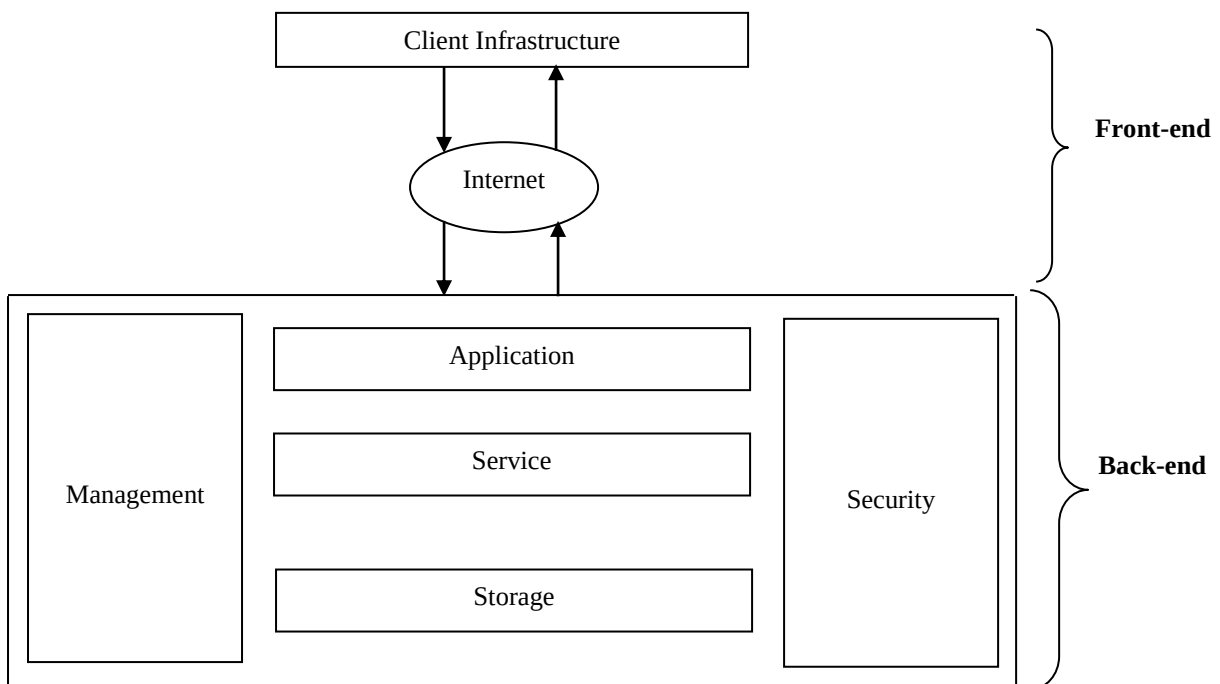
The community cloud is shared by a certain people showing some common interests. This can be owned by an organization or jointly owned by the members of the organization limiting the use for other type of organization.

4. Hybrid Cloud:

The hybrid cloud is enabled by combining two or more different cloud deployment models. For example, combining the work of the public and the private cloud or community cloud.

III. Cloud Computing Architecture

The components and sub-components required for cloud computing is referred to as cloud computing architecture. These components which are loosely connected, generally consists of a front end (fat client, thin clients, mobile device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combination of these make up a cloud architecture. The cloud infrastructure is closely related to its architecture.



Cloud Computing architecture is divided into two sections, they are:

- Front-end.
- Back-end.

The front-end and backend connect to each other through network usually the internet. The front-end is the site of computer user or client sees. The front-end includes the client's computer or computer network and application required to access the cloud computing system. Not all cloud computing systems have the same user interface. The interaction is done through middleware or via web-browser or virtual sessions. Other systems have unique applications to the clients.

The back-end is the cloud section of the system. On the back-end of the system have the various computers, servers and data storing systems between the clouds of computing services. It is the responsibility of the back-end to provide the security of the data for cloud users along with the traffic control mechanism. The server also provides the middleware which helps to connect devices and communicate with each other.

IV. Risk and Challenges Faced by Cloud Computing

There are many advantages in cloud computing but also a lot of drawbacks in adopting the cloud computing because of the security threats and security risks. They are explained as follows:

❖ Increased Security Vulnerabilities:

In Cloud Computing, the data can be stored at multiple locations so that, even if attack occurs in one place then we can back up the data in another server location. But the shared data leads to the overlapping of trust boundaries. For example, imagine a scenario whereby two different organizations have access to the same cloud service. So that it can be challenging for the cloud providers to offer security mechanisms to both consumers. Because an unreliable cloud provider may interrupt the security and can cause major threats.

❖ Lack of Governance:

A cloud consumer must keep track of the actual service offered by the cloud provider. They should monitor the reliable conditions and check other guarantees offered by them, to ensure the quality of data is being maintained at high security rate. As different cloud providers offer various degrees of operational control, there can be unreliable network connection in between the cloud service provider and cloud service consumer, which creates further threats. Another drawback is that longer geographic distance between the cloud consumer and cloud provider, where there can be fluctuations and would require additional networks to fetch the data.

❖ Limited Portability:

The need for the cloud consumer varies from one to another with custom-built solutions with dependencies, so there may be a chance of switching to another cloud, it can be challenging for the consumers to move from one cloud provider to other. Portability is a measure used to determine the impact of moving cloud consumer data between the clouds, due to the lack of established industrial standards within the cloud computing.

V. Cloud Attacks

❖ Threat Agents:

A threat agent is a thing that takes an active role in a specific cloud attack. It is either carried out by an active or a passive agent, that is, it is being spread by a human or a software program. These threat agents further cause vulnerabilities, threats, risks, and also break the security policies established by the cloud. Some of the threat agents are discussed below:

1. A) Malicious Service Agent:

The malicious service agent can deny the participation of the host functionality in which it is able to interrupt and forward the network traffic within a cloud. So the service agent would misuse the hosts' resources and their services. This malicious threat is carried by unknown service agent posing a threat to other agents in multiple manners.

B) Malicious Insider:

A malicious insider can directly attack the network of the cloud gaining authorized system access because they are very much familiar with the cloud architecture. After gaining access these insiders steal the sensitive data to inject viruses in the cloud. This type of attack can cause system crashes and have an immense damage potential, as the insider have the administrative privileges to intercept the cloud consumers.

C) Malicious Intermediary:

The malicious intermediary is a human who acts as a mediator carrying unwanted messages between the cloud provider and cloud consumer, by inserting harmful data into the message before reaching the destination of the cloud consumer. This intermediary is further appointed by the malicious service agents who can gain access to the cloud.

2. Anonymous Attacker:

These types of attackers are the non-trusted cloud service consumers without having legal permission to access the cloud. They attack the cloud by a software program that specifically attacks the virtual cloud servers via the public network. An anonymous attacker has a limited knowledge about the security norms and they attack the cloud by either stealing or hacking the user's account. They do not have much mastery about the cloud defense infrastructure. If proper protection is made, they can restore their data before second attack.

3. Trusted Attacker:

In this type of attack, the trusted attacker is already a cloud user of a particular service infrastructure of the cloud. They have a better understanding of the inner functions of the cloud and could attack the services provided by the cloud providers overriding the Service Level Agreements (SLA). The trusted attackers are the trusted consumers of the cloud service, where anonymous attacker is an unknown non-trusted public cloud consumer or provider. As comparing to the anonymous attacker, a trusted attacker can be more dangerous because they know well about the cloud infrastructure and can exploit the IT resources with a wide range of techniques like hacking, establishing weak authentication process, breaking of encryption, denying of services, e-mail spamming, loss of stored data, and some common attacks.

4. Traffic Eavesdropping:

Traffic Eavesdropping is setting network traffic between the cloud communications that is while transferring any information between the clouds. By enabling a very poor connection between two cloud users, the attackers can loot the data of the user by switching to attackers' network without the user's awareness. Traffic Eavesdropping are very hard to detect because it can run into the network very normally and can sustain over a long period of time.

5. Virtualization Attack:

As many computers, mobiles and devices are connected to the virtual servers so that one cannot easily identify the attack in the virtual environment. Once the data is lost, it is lost permanently so further we need to provide high level securities and secure infrastructure, multiple firewall protections, etc...The authentication process should be monitored properly before any suspect in the network.

6. Overlapping Trust Boundaries:

As the cloud provider have more than one cloud consumers, so that they should provide privacy for more than one cloud consumer and maintain their data securely. An unreliable cloud provider will exploit the reliable customers' data and sell their data illegally to other customers, mainly business related data for further competition. This leads to the overlapping of trust boundaries between the cloud consumers.

So, it is important to provide security for the cloud environment because once if the data is theft it can be exploited illegally and cause further black mark to any individual or any organization. The number of theft attacks in the cloud may lead to the loss of administrative control because the user cannot maintain their theft attack and it causes a lot of crime actions. In this scenario, the need for security mechanisms has to be increased for a better cloud secure environment.

VI. How to overcome the Cloud Attacks

To overcome the problems faced by cloud computing that is attacks on cloud.

1. Encryption:

Encryption is the process of encoding the information or a message so that only authorized parties can access it and those who are unauthorized cannot access it. In this, the data is coded in a readable format called plaintext. When this data is transmitted over a network, plaintext is vulnerable to unauthorized and potentially malicious access. Encryption technology usually follows an algorithm called a cipher to transform original plaintext data into encrypted data; it is referred as cipher text. The encrypted plain text data is called as cipher text. Cipher text does not reveal the original data, apart from some metadata which include message length and creation date. When plain text is processed by encryption, the data is paired with a string of characters called an encryption key. Encryption key is a secret text or message that is created by and shared among authorized parties. The encryption key is used in order to get back the original plain text format from cipher text by decryption.

This type of encryption technology makes the transmitted message confidential and the malicious service agent is unable to retrieve data from an encrypted messages. There are two common forms of encryption;

- Symmetric encryption.
- Asymmetric encryption.

❖ Symmetric Encryption:

Symmetric encryption uses the same key for both encryption and decryption. These both encryption and decryption are performed by authorized parties that use the one shared one key. It is also known as *secret key cryptography*. If the messages are encrypted with one key, then it is decrypted with the help of same key. Parties that decrypt the data are provided with the evidence to identify whether parties which performed original

encryption possess the key. It is clear that authorized parties which own the key can create messages. This make sure the maintenance and verification of the data confidentiality.

❖ **Asymmetric Encryption:**

Asymmetric encryption uses two different keys, namely a private key and a public key. It is also known as *public key cryptography*. The private key is known only to the owner while the public key is generally available. If the message was encrypted with a private key, then it can only be correctly decrypted with the corresponding public key. Similarly the message or document that was encrypted with public key can only be decrypted using its private key. This shows two different key being used instead of one key. But asymmetric encryption is almost computationally slower than symmetric encryption.

2. Hashing:

When there is need of one-way or non-reversible form of data protection is required hashing mechanism is brought in use. Once this hashing is put in application to a message, it is locked and no key is provided for the message to be unlocked. Storage of passwords is the wide application of this mechanism.

Hashing technology is mostly used to derive a hashing code or message digest from a message, which is frequently of fixed length and smaller than the original message. The same hash function can be applied by the recipients to the message to crosscheck that the produced message digest is identical or same to the one accompanied the message. If any alteration is done to the original data, it results in entirely different message digest and distinctly indicates that tampering has occurred.

Before the message is forwarded, hashing function is applied to protect the integrity of a message that is intercepted and altered by a malicious service agent. The firewall is configured in order to identify whether the message has been altered, thereby enabling it to reject the message before it can protect to the cloud service.

3. Digital Signature:

The digital signature means providing data authenticity and integrity through authentication and assurance. A message is provided with digital signature before transmission, which is then given invalid if the message undergone any subsequent, unauthorized modifications. A digital signature supplies evidences that the message received is the same as the one generated by specified sender. In the creation of digital signature, it involves both hashing and asymmetric encryption, which necessarily exists as a message digest that was encrypted by a private key and joins to the original message. The receiver verifies the digital signature validity and uses the corresponding public key to decrypt the digital signature that produces message digest. Exact results from the two different processes indicate that the message maintained its honesty. Whenever a cloud consumer performs a management action that are related with IT resources, the cloud service consumer program must include a digital signature in the message request to provide the legitimacy of its user.

4. Public Key Infrastructure(PKI):

Public key infrastructure mechanism exist as a system of protocols, data formats, rules, and practices that enable large-scale systems to securely use public key cryptography. This system is used to couple public keys with their agreed owners (called as public key identification) while allowing the verification of key validity. PKIs works on the use of digital certificates, which are digitally signed data structures that combine public keys to certificate the owner identities, as well as related information, such as validity periods. Digital certificate are generally digitally signed by a third-party certificate authority (CA).

5. Identity and Access Management (IAM):

The IAM mechanism encloses the policy controls, which are needed to keep track of the users' identities to access to the cloud IT resources and cloud environment. The group of functions which are carried out under the IAM mechanisms is called the IAM cloud. These clouds are mainly involved for providing security in the process of authorization, authentication, and verification of the identity of the cloud user. The major challenge faced by the cloud computing today is that managing identities of the cloud user to avoid any suspects.

6. Authentication:

Authentication is the action of verifying the identity of a user. When users try to interact with the cloud they should undergo many steps before they request to access the cloud. So this may ensure the CSP (cloud service provider) to permit the service only for the authorized cloud consumer. If the cloud consumer has stored their information in multiple clouds then this will lead to multiple authentication processes, because they had stored their passwords in multiple cloud locations. Now, this creates a further demand in security issues between the cloud consumer and cloud service provider. This problem can be rectified by setting protocols, logic algorithms, audit logs, by setting OTP passwords and data encryption. Some of the authentication algorithms are RSA

(Rivest-Shamir-Adleman) algorithm, AES (Advanced Encryption Standard) & MD5 (Message Digest 5) hashing algorithm, Rijndael algorithm, etc...

7. Single Sign-On(SSO):

Single Sign-On services uses protocols for user authentication purposes. When a user wants to access the information in the cloud, the cloud service provider will confirm the identity of a user by sending a request to the user for run time authentication. The cloud user must provide all their login data to the security broker. And the security broker would store their type of login data in the cloud database and with a single click authentication the cloud security broker service enables the different types of login details provided by the cloud user to click on before signing on to the cloud. So the user do not need to remember long passwords (Password Fatigue) and can also save the time to re-enter the password every time, because with a single login credentials SSO mechanisms will be able to secure data. Once the run-time authentication is done with one single step, then the cloud user can use the multiple applications, it can avoid phishing and the data streams are centralized and complied together.

8. Cloud Based Security Groups:

In cloud based security groups, the multiple security functions are adopted and partitioned across different groups to provide privacy and security. Resources are segmented based on the individual requirement of cloud security policies. By segmenting into different cloud security groups the maintenance of the physical and virtual servers can be easily identified and can avoid from any security risks. If the work is being divided, then the data and resources stored in the cloud would be preserved for a long time. And if one illegal third party member tries to control one cloud service, then there will be multiple security groups that would eliminate their control and produce multiple copies of firewall protection. So the attacks can be avoided collectively if the cloud service is being divided into different cloud based security groups.

VII. Conclusion

With the introduction of new technologies which replace the existing technology, from physical storage to storing the data in the virtual servers, cloud computing is one of the ultimate emerging technique in this contemporary world. Whatever drawbacks it holds, there is a necessary need to overcome these negative aspects and create productive, secure cloud environment. A lot of security practices need to be addressed for the confidentiality, integrity and availability of the cloud services. In this paper, it concludes the clear view regarding the risks and challenges of cloud computing and how to overcome them by established security norms.

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Detection of Noise for Discrimination of False Arrhythmia Alarm in ICU using ECG Signals

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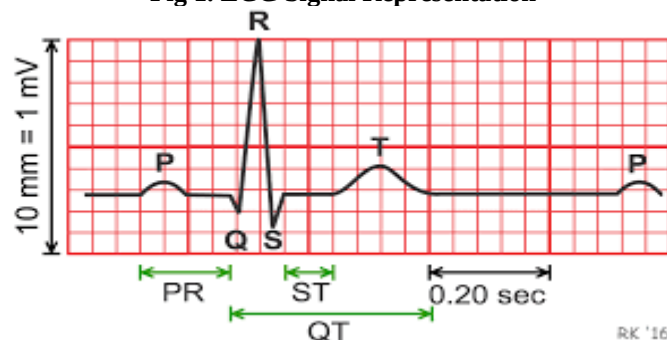
Abstract: The False Arrhythmia alarm is the insignificant alarm caused by the monitoring systems. The large number of false alarms in intensive care is a severe issue. The alarms caused by noise peaks can be high and in a noisy environment nurses can experience stress and fatigue. In addition, patient safety is compromised because reaction time of the caregivers to true alarms is reduced. The problem of false arrhythmia alarm reduction has been approached with various strategies. These approaches can be roughly divided into filtering methods, signal quality assessment, multi-parametric analysis, machine learning approaches, or combinations of the previous methods. Accurate signal quality measures during arrhythmia are difficult to develop and may not always work as desired. The purpose of this project is to develop algorithms to lower the incidence of false arrhythmia alarms in the ICU using information from independent source, electrocardiogram (ECG).

Keywords: False Arrhythmia alarm, monitoring systems, signal quality assessment.

I. Introduction

False arrhythmia alarm is the insignificant alarm caused by the existing monitoring instruments that are with an algorithm that sets off alarms in high decibel sounds. This paper proposes an algorithm that is capable of distinguishing arrhythmia into true and false alarm events accurately. The Electrocardiogram signals is preprocessed to remove the common noise like baseline wander, trends and the pacemaker spiking. The feature extraction process is by different types of entropies such as Shannon entropy and Log energy entropy. The peaks of the ECG signal R wave is detected by using the Pan Tompkins algorithm. This paper uses various methods to reduce the occurrence of false alarms in emergency unit using the ECG Signals. The purpose of this project is to develop algorithms to lower the incidence of false arrhythmia alarms in the ICU using information from independent sources, namely electrocardiogram (ECG), arterial blood pressure (ABP) and photoplethysmogram (PPG). This approach relies on robust adaptive signal processing techniques in order to extract accurate heart rate (HR) values from the different waveforms. Based on the quality of available signals, heart rate was either estimated from pulsatile waveforms using an adaptive frequency tracking algorithm or computed from ECGs using an adaptive mathematical morphology approach.

Fig 1. ECG Signal Representation



1.1 Background of Study

The false arrhythmia alarm in the ICU is the major life-threatening problem for several years. Over the past two decades false alarm rates have been increased and yet an unresolved concern in ICU. False arrhythmia alarm are commonly due to the single channel ECG artifacts and low voltage signals and therefore the false alarm rates may be reduced if the information is from different independent signals is used to form more robust hypothesis

of alarm etiology. There was an open challenge presented by an organization known as Physionet in 2015 which insists the researchers on participating to focus on the discrimination of false arrhythmia alarm in ICU. Several papers have been published relating this challenge in a journal named Physio net Measurement. All the papers published had attained successful algorithms. The context was reviewed and explained concisely with summarisation. This is composed of overview of several journals to have better view of the method been used.

1.2 Problem Statement

The main problem is stated as the false alarm rate in ICU always gets a constant attention. The unnecessary alarm noise that are being exposed by the monitors capable of causing excitation of nervous system leads to intense cardiac work causing difficulties on muscle function. Not only this is the major cause these noises from frequently occurring false alarms had also led to the conditions such as increase in cortisol hormone levels due to repeated number of alarms, sleep deprivation, impaired wound healing and mental distress of the patients. The target is to develop an algorithm to lower the incidence of false arrhythmia alarms in the ICU using information from independent sources. Our algorithm uses pulsatile waveforms and simultaneous ECG in order to detect and enhance the determination of the life-threatening arrhythmia alarms. Eventually leading to the establishment of better algorithm that can be implemented into hardware in future.

1.3 Objective

- To develop and describe a robust false arrhythmia alarm reduction system for use in the ICU.
- To analyze several signal quality assessments to remove and identify the noise and others artifacts.
- To identify suitable segmentation methods to extract the part of ECG signals
- To carry out feature extraction process to get proper feature to be analysed and used in classification process.

II. Literature review

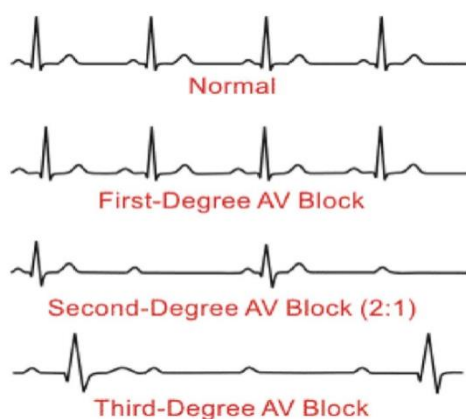
Electrocardiography is a well-established method to monitor and record heart activity. The ECG is obtained by measuring the difference in potential between two point on the body surface. However, the surface measurements include various types of noise. The challenge of ECG pre-processing is to filter and minimize these components, therefore making it easier diagnoses various heart disorders. The most important noise sources are baseline wandering, frequency noise, muscle noise and interference. To evaluate each method, the signal to the noise ratios of original and filter signal are to be calculated. And the so-called morphological filtering works best for baseline wander and impulsive noise whereas band stop filtering leads to good results when dealing with narrowband frequency noise.

2.1 Arrhythmia

An arrhythmia is abnormal heart rhythm. It may feel like fluttering or a brief pause. it may be so brief that it doesn't change your overall heart rate to be too slow or too fast. some arrhythmias don't cause any symptoms. others can make you feel lightheaded or dizzy. there are two basis kind of arrhythmia.

1. Bradycardia is when the heart rate is too slow- less than 60 beats per minute.
2. Tachycardia is when the heat rate is too fast - more than 100 beats per minute.

Fig 2 Arrhythmia signals of abnormal heart rate



2.2 Detection and Removal of Noise

Heart disease is one of the significant reasons of death worldwide, the effective ways to diagnose heart disease is the electrocardiogram (ECG). The electrical functioning of the heart is translated into a waveform is utilized to find the condition of the heart. This paper deals with the ECG noise removal and its analysis in MATLAB

environment. This work includes ECG analysis consisting of three main basic steps. The first step is collecting the sample ECG signals. The sample ECG signal has various kinds of noise such as power line interference, baseline drift, patient electrode motion. The second step is elimination of these noises from the signal. The third step is development of algorithm for finding various peaks and detection of intervals between those peaks in MATLAB environment.

2.3 Pre-Processing in ECG Signal

Pre-processing is the crucial stage of this paper as most of the false arrhythmia alarms was claimed as due to the presences of artifacts and power line inferences. The noises in the signal is the primary focus as the same signal source to be used in this paper, therefore the algorithm to be developed should have the best signal that has to processed

2.3.1. Baseline Wandering

Baseline wanderings actually the effect where the base axis (X-axis) of any signal viewed on a screen appears to be 'wander' or move up and down rather than be straight. This causes the entire signal to shift from its normal base and it is caused due to improper electrodes (like rusted, or broken). It is very prominent while taking the ECG (Electro Cardio Gram) signal of the heart as they may cause incorrect results, so they take extra precautions in the machine to eliminate the baseline wander by using different techniques.

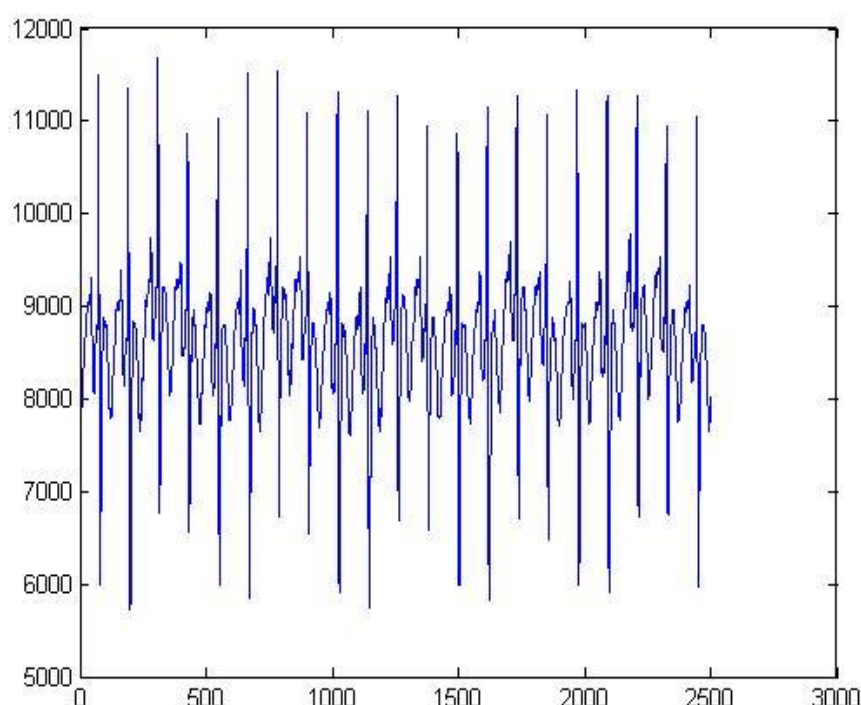
2.3.2. Flat Line Artifacts

For flat line artifacts as in the paper by kalithas et al., there exist two types of flat line namely DC values flat lines and zigzag flat line. The signals with zigzag flat line are identified by scanning for the segments of the signals having alternating positive and negative slopes between samples identified by the second where local variance of the signal less than specified threshold.

III. Result

The Simulation result for the pacemaker spikes is obtained using MATLAB and shown in Fig.3.

Fig 3 ECG sample signals



	1	2	3	4	5	6	7	8	9	10
1	-171	-263	-456	-670	-685	-450	-228	-235	-342	-3
2	9127	10341	9045	8298	8963	9553	9574	9130	9456	97
3	6042	6821	5932	5549	5943	6167	5894	5708	5345	59
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IV. Conclusion and Scope(s)

Thus, the pre-processing step is completed by detection and removal of noise in the sample ECG signal. The scope of the paper is that the methodology been developed using ECG data obtained from physionet database. Training records of ECG signal is contaminated with artefacts is identified manually, which is done by three human annotators. These recordings could then be used to train a classifier which identifies to make an accurate decision. MATLAB Tool is been used throughout the project to develop the algorithm.

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Advanced load sharing for effective energy using virtual machines scheduling in cloud analysis software defined network

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Abstract: In this Paper, knowledge centers intelligent considering the position of virtual machines on the servers in the data center. The problem has been developed as Associate in Nursing whole number programming problem, prove that it's NP-hard, and so explore two greedy algorithms, minimum energy virtual machine (VM) programming algorithmic rule (MINES) and stripped-down communication virtual machine programming rule (MINCS) within the performance of the tenant's service-level agreements. Our projected mechanism doesn't need researching and redirection routing for the lost Bigdata server through link loss info during a content map update and also the location of the queried knowledge to be sent to the content of the map. Peers communicate with different peers mistreatment messages transmitted over the network. If two peers are able to send and receive the message directly. Otherwise, negotiate peer needed to transmitted messages, and there is an indirect connection between these two peers. In this case, the agents act as routers. We prove the convergence of the Markov Decision Process (MDP) based dynamic VM management and analyze the boundary of its approximation error. The rule maintains and updates a virtual (shadow) queuing system, and therefore the routing supported the state of the system

Keywords: Greedy Algorithms, Energy Virtual Machine Scheduling Algorithm, Big data Service Providers, Markov Decision Process, Virtual (shadow) Queuing System

I. Introduction

A. General

The huge knowledge Computing has emerged as a replacement consumption and virtualization model for the high price computing infrastructures and net based mostly IT solutions. huge knowledge provides appropriate, on-demand service, elasticity, broad network access, resource pooling and measured service in extremely customizable manner with minimal management effort. The appliance of affordable computing devices, superior network resources, large storage capability, linguistics net technology, SOA (Service destined Architecture), usage of API (Application Programming Interfaces), etc., have helped within the swift growth of massive knowledge technology. Huge knowledge applications are deployed in remote knowledge centers (DCs) wherever high capability servers and storage systems are situated. a quick growth of demand for large knowledge based mostly services results into institution of huge knowledge centers intense high quantity of electric power. Energy economical model is needed for complete infrastructure to scale back useful prices whereas maintaining very important Quality of Service. Energy optimization will be achieved by combining resources as per this utilization, economical virtual network topologies and thermal standing of computing hardware's and nodes.

B. Markov Decision Process (MDP) Based Dynamic VM Management

One recent technology that permits energy saving is cooperative transmission. In cooperative transmission, multiple nodes at the same time receive, decode, and conduct knowledge packets. During this paper, as opposition previous works, we have a tendency to use a cooperative communication model with multiple nodes on each ends of a hop and with every knowledge packet being transmitted one time per hop. In our model of cooperative transmission, each node on the trail from the supply node to the destination node becomes a cluster head, with the task of recruiting alternative nodes in its neighborhood and coordinative their transmissions. Consequently, the classical route from a supply node to a sink node is replaced with a multi-hop cooperative path, and also the classical point-to-point communication is replaced with many-to-many cooperative communication. The trail will then be represented as "having a dimension," wherever the "width" of a path at a selected hop is set by the quantity of nodes on every finish of a hop. Within the overlay, every peer

maintains temporary information info to be retrieved by routing and looking. Peers are human action with alternative peers victimization message transmitted over the network. There can be an immediate association or associate degree indirect association between 2 peers. If 2 peers are able to send and receive messages directly, there's an immediate association between them. Otherwise, negotiator peers are needed to forward transmit messages, and thus there's associate degree indirect association between these 2 peers and multiple voltages which operate different CPU frequencies.

Comprehensive simulations supported 2 real work traces show that MDP-based dynamic VM management achieves important performance gains against 2 existing baseline approaches to energy consumption, resource shortage, and also the variety of VM migrations. The additional the resource necessities fluctuate, the additional MDP-based dynamic VM management surpasses

II. Related Works

A. *Worldwide Electricity used in Data Centers*

J. G. Koomey, within the year of 2008. The direct electricity utilized by information centers has become a very important issue in recent years as demands for brand spanking new web services (such as search, music downloads, video-on-demand, social networking, and telephony) became a lot of widespread. This study estimates historical electricity utilized by information centers worldwide and regionally on the idea of a lot of elaborate information than were accessible for previous assessments, electricity utilized by servers and different web infrastructure has become a very important issue in recent years. This study estimates total electricity utilized by information centers within the world by combining IDC information on the put in base of servers with measured information and estimates of power utilized by the foremost widespread servers still as estimates of electricity utilized by information center communications and storage instrumentation. These estimates square measure supported a lot of elaborate information than previous assessments, and that they ought to facilitate policy manufacturers and businesses trying to create sense of recent trends during this trade

B. *The Cost of a Big Data: Research Problems in Data Center Networks*

A. Greenberg, J. Hamilton, D. A. Maltz, and P. Patel within the year of 2008. We tend to describe knowledge the info the information} centers wont to produce huge data services represent a significant investment in capital outlay and in progress prices. Consequently, service supplier area unit building out geo-distributed networks of knowledge centers. Geo-diversity lowers latency to users. huge knowledge analysis applications (e.g., computing the net search index) area unit a natural acceptable a mega knowledge center, wherever some issues need Brobdingnagian amounts of quick RAM, others need huge numbers of central processor cycles, and still others need huge disk I/O information measure. These issues generally involve intensive communication between servers that the speed of the computation would drop because the propagation delay between servers will increase. Further, the dollar value of communication would go up if the servers were opened up across multiple knowledge centers separated by long distance links, because the value for these so much exceeds the price of intra-building links.

C. *Efficient Server Provisioning and Off-Loading Policies For Internet Datacenters With Dynamic Load-Demand*

D. Xu, B. Fan, and X. Liu within the year of 2007. In datacenters, traffic demand varies in each giant and tiny time scales. A datacenter with dynamic traffic usually has to over-provision active servers to fulfill the height demand that incurs vital energy value. During this paper, our goal is to cut back energy value of a collection of distributed net datacenters (IDCs) whereas maintaining the standard of service of the dynamic traffic. Specially, we tend to contemplate the outage likelihood because the QoS metric, wherever outage is outlined as service demand extraordinary the capability. We tend to need the outage likelihood at every IDC to be smaller than a predefined threshold. Our goal is therefore to attenuate total energy value over all IDCs, subject to the outage likelihood constraint. We tend to accomplish the goal by dynamically adjusting server capability and playacting load shifting in several time scales. We tend to propose 3 totally different completely different} load-shifting.

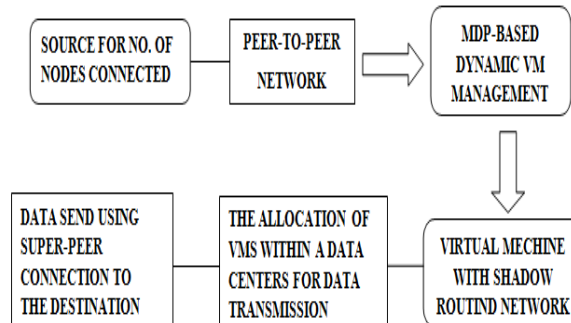
D. *Towards Energy-Aware Scheduling In Data Centers Using Machine Learning*

J. L. Berral, I. Goiri, R. Nou, F. Juli a, J. Guitart, R. Gavald, and J. Torres within the year of 2010. As energy-related prices became a significant economical issue situation, employing a simulation with representative heterogeneous workloads, and that we live the standard of the results in line with a collection of metrics targeted toward our goals, besides ancient policies. Less hardware is needed, less electrical consumption {is needed is needed} for server power and cooling and fewer physical house is required. Showing intelligence turning off of spare servers that don't seem to be getting used is an evident thanks to cut back each power and cooling prices whereas maintaining smart performance levels.

III. System Design

The system style delineated on top of that of the energy consumption supported the utilization of multiple routing methods. The utilization of multiple path variants of MDP-based dynamic VM management and a virtual management plane (shadow) queuing system allocating methods for knowledge transmission to the destination with overlay prediction methodology

Figure 1: System Design



IV. Proposed System

In this article, a haul of excessive energy consumption in very massive information by the present traditional operational ways once link loss happens in massive information servers. We have a tendency to propose a mechanism to unravel excessive energy consumption of knowledge centers. In our planned mechanism doesn't need re-searching and redirecting routing for the lost massive information server by change affiliation loss info in a very content map and causation the situation of queried information keep within the content map. Within the overlay, every peer maintains temporary information info to be retrieved by routing and looking out. Peers square measure human action with different peer's victimization message transmitted over the network. There may be an on the spot affiliation or Associate in Nursing indirect affiliation between 2 peers. If 2 peers square measure able to send and receive messages directly, there's an on the spot affiliation between them. Otherwise, mediator peers square measure needed to forward transmitted messages, and so there's Associate in Nursing indirect affiliation between these 2 peers.. The formula maintains and updates a virtual management plane (shadow) queuing system, and also the routing supported the state of the system. as an example, there square measure solely 2 peers every with an on the spot link to an excellent peer. All different colleagues have indirect connections to the super peer. A peer sends queries for every information services and receives the results from different peers with direct or indirect links. The overlay is self-organizing and permits peers to attach or leave the overlay.

V. Methods

A. System Construction

We think about a giant information-assisted wireless sensing element network in 5G that's designed to support transmission and data services running on mobile devices. The network consists of giant information and WSNs. the massive information is created by interconnected information servers. The WNS could be a dynamic set of mobile devices (computers, good phones, sensors, etc.) that communicate with one another over wireless links. The benefits of the mobile huge information network (e.g. support for richer applications, saving on mobile device energy consumption) for transmission services are studied in. During this work, we tend to investigate aspects of energy potency once mistreatment huge information-assisted ad-hoc networks for data services. In reality, information looking out (or looking out, for short) is most significant in additional storage of WSNs for transmission and information services. Therefore, we tend to specialize in developing the new mechanisms of 2 transactions.

B. Cooperative transmission protocol

Cooperation may be induced in observe in some ways, and every approach could need a distinct compromise of power, bandwidth, processing, and economic resources. so as to style sensible networks that derive most performance gains from the collaboration, it's necessary to grasp the similarities and variations between the user and relay cooperative models. Routing Phase: The initial path between the supply and also the sink nodes is discovered "one-node-thick" path. Recruiting-and-transmitting: The initial path becomes cluster heads that recruit further.

C. Load-Balancing Scheme

Interflow packet order is natively preserved besetting slicing threshold to the delay edge at. Any 2 packets within the same flow slice can't be disordered as they're sent to an equivalent switch path wherever process is guaranteed; and 2 packets within the same flow however totally different flow slices are going to be so as at departure, because the earlier packet can have depart from before the latter packet arrives. thanks to the less variety of active flow slices, the sole further overhead in, the hash table, may be unbroken rather little, , and placed on-chip to supply ultrafast access speed.

D. Multi path switch System

Through lay-aside Buffer Management module, all packets are nearly queued at the output in keeping with the flow cluster and also the priority category in an exceedingly hierarchal manner. The output computer hardware fetches packets to the output line mistreatment data provided by. Packets within the same flow are going to be nearly buffered within the same queue and scheduled in discipline. Hence, intra flow packet departure orders hold as their inward orders at the electronic device. Central-stage parallel switches adopt associate output-queued model. By Theorem, we tend to derive packet delay sure initially stage. we tend to then study delay at second-stage switches. Outline native packet delay at stage m of associate be delay experienced at stage m on the condition.

E. Peer-to-Peer network overlay prediction

Within the overlay, every peer maintains a tentative information containing data to be retrieved by routing and looking out. Peers communicate with different peers mistreatment messages transmitted over the ad-hoc wireless network. There may be an instantaneous link or associate indirect link between any 2 peers. If 2 peers are ready to send and receive messages directly, then there's an instantaneous link between them. Otherwise, inter mediator peers are needed to forward transmitted messages, associated thus there's an indirect link between these 2 peers. During this case the inter mediator peers act as routers. As an example, There are solely 2 peers with every having one direct link to a super-peer. All different peers have indirect links to the super-peer. A peer sends queries for information services and receives the result from different peers mistreatment direct or indirect links.

F. Energy consumption analysis

We tend to analyze the one-hop energy consumption of the transmissions. Information packets between 2 cooperative clusters of nodes Distances of causing and also the receiving clusters is high its will increase the energy consumption. We tend to North American nation integers rather than specific energy measure units like header associated prediction as a result of the permit us to higher illustrate our plan at an abstract level. We tend to assume that looking out energy consumption is unambiguously one altogether of the massive information servers. We tend to assume more that routing energy consumption of a link is associate whole number between 1&5.

VI. Experiment Results

A. MDP-Based Dynamic VM Management Algorithms

We tend to propose associate optimum MDP-based algorithmic rule to resolve the dynamic VM management downside because it has simply been developed. We tend to prove the convergence of MadVM and analyze the boundaries of its approximation error. Additionally, MadVM may be enforced in an exceedingly distributed system that meets the wants of real information centers. Intensive simulations supported 2 real employment traces show that MadVM considerably improves performance compared to 2 existing baseline ideas of power consumption, resource bottlenecks, and also the variety of VM migrations. of VMs. we tend to propose associate approximate MDP-based dynamic VM management algorithmic rule referred to as MadVM

B. Optimum VM Management Algorithmic Rule

Since we tend to specialize in minimizing the typical value over time, we tend to formulate the dynamic VM management in downside one as associate infinite horizon average MDP. The optimum answer may be achieved by finding the equivalent Bellman's equation

$$\beta + V(S_i) = \min_{\gamma \in \mathcal{A}(S_i)} \left[g(S_i) + \sum_{S_j \in \mathcal{S}} Pr[S_j|S_i, \gamma] V(S_j) \right] \quad (1)$$

Where $g(S_i)$ is the instantaneous cost under the system state S_i , then β is the optimal average cost:

$$\beta = \min_{\Omega} \bar{g}(\Omega). \quad (2)$$

We can capture the temporal correlation of a VM's resource demands by estimating $\phi_{i,j,l}$ as defined. Denote the estimated $\phi_{i,j}$ and $\phi_{i,j,l}$ as $\hat{\phi}_{i,j}$ and $\hat{\phi}_{i,j,l}$, respectively. We can learn $\hat{\phi}_{i,j,l}$ as follows:

$$\hat{\phi}_{i,j,l}(t) = \frac{\sum_{t'=t-T_w+1}^t \mathbf{1}[R_l(t'-1) = r_i]}{\sum_{t'=t-T_w+1}^t \mathbf{1}[R_l(t'-1) = r_i | R_l(t') = r_j]} \quad (3)$$

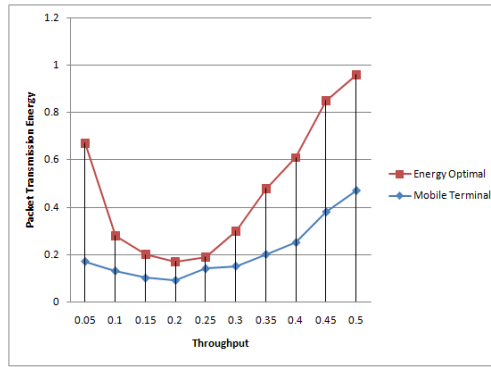
Where T_w is the length of the sliding window and $r_{i,l}$ is the demand level of ml in state η_i .

The key states for the VM m_l at timeslot t , denoted as S_K^l , are defined as following,

$$S_K^l = \{i_{l,r,y}(t) | r = r_0, \dots, r_{\Lambda-1}; y = s_1, \dots, s_{|V_s|}\} \quad (4)$$

It is NP-hard to solve the Bellman equation [4]. The algorithm goes through all states in S and takes exponential time and space to calculate the utility function. We propose an efficient approximate algorithm in the following subsections

Figure 2: total energy and throughput for mobile relay link.



The simulation can draw from the mobility results in Figure 6.1 that relay mobility can help reduce packet transmission energy. To substantiate our claim, we will compare our obtained throughput energy curves for different mobility speeds with those for the stationary relay

VII. Conclusion

In this paper, we have a tendency to examine the necessity for power consumption and energy potency within the huge knowledge computing model. Peers communicate with different peers employing a message transmitted over the network. There can be an on the spot affiliation or AN indirect affiliation between 2 peers. during this case, the agents act as routers. We have a tendency to demonstrate the convergence of MDP-based dynamic VM management and analyze the boundary of its approximation error. Additionally, it are often enforced in a very distributed system that's tailored to the necessities of real knowledge centers. Comprehensive simulations supported 2 real employment traces show that MDP-based dynamic VM management achieves vital performance gains against 2 existing baseline approaches for energy consumption, resource shortages, and VM migrations. A peer sends requests for all knowledge services and receives the results of different peers with direct or indirect connections to the info security over the energy consumption.

VIII. Future Work

There square measure totally different applications, like good grid, that may get pleasure from the benefits of cluster-based algorithms. Good grid is an electrical power-grid infrastructure wont to offer effective communications, observance and automation. during this future work are to more measure physiological state Routing victimization packet-level simulations and example implementation that may capture the results of transport layer congestion management. a bunch of good meters will kind a vicinity space Network (NAN) that may be established employing a WSN as a result of the low price, flexibility and intelligence of WSNs. during this manner, power disturbances and outages may be avoided by observance the facility conditions and providing the specified medical specialty and protection. This will additionally facilitate within the issue of skyrocketing electricity demand and network congestion

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Investigation of User Satisfaction in Residential Building with Demand Side Load Management Using Fuzzy System

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Abstract: In current years energy demand in the consumer side (load side) is increasing day by day. The more different technologies are used to encounter the power demand with a high quality of power and reliable system. Recently, energy consumption is reduced by giving priority to a load of residential buildings. In this paper presents the demand side load management by controlling the loads within the residential limits by using the fuzzy system. The system considers input as, the rating of an electrical device, time of power usage, satisfaction to the consumer and output as a cost of energy utilization. The priority level of load has an output as minimization of user cost and maximize user comfort (satisfaction) level. The predefined budget applied the fuzzy inference system to reduce user cost, by creating fuzzy membership function and fuzzy rules. The result reveals that the proposed system suggest the crisp value of reduction of user power consumption cost and maximization of user satisfaction.

Keywords demand-side load management, fuzzy inference system, membership function, fuzzy rules, satisfaction maximized.

I. Introduction

In the past decade of years, demand-side load management has different topology to reduce the power demand in the market. The concept of this paper to encourage the user to change their power utilization pattern to provide priority to the load during a nonpeak period [1, 2]. Definitely, in this situation, both the side demand and supply side have different power. The main goal of demand-side load management (DSM) is encouraging the consumer to preschedule the electrical appliances in their home to minimize the energy cost. Proposed system in [3] is using load scheduling pattern under the construction of linear programming algorithm, but it could not flexible in the smart grid system. According to paper [4], different techniques to be implemented for demand-side load management to make a building smarter peak loads are to be reduced by various authors. It may be achieved by reducing the usage of energy time and power consumption of the user. The user side prediction of real-time pricing is done by including the price predictor filter in [5]. DSM have various method to reduce power consumption some of them are load shifting, peak-valley filling, end-use equipment control, peak clipping [6]. These techniques are very easy to implement and giving the required result. The non-optimization problem and non-linear problems are solved by using genetic algorithm [7], this algorithm provides an increased efficiency, flexibility and improved iteration speed. The simplified model of Building Energy Management System is managing household energy and to reduce the electricity bill [8]. This ability to optimize a compromise between user comfort and energy cost, simulator is a SIMBAD taken into MATLAB Simulink. Mixed integer linear programming is an application [9] in solving optimization problem majorly in demand-side planning, monitoring and implementing side scheduling problems. It will boost the user to change their energy level and schedule the priority. [10] The different window models are designed to investigate power saving lighting and residential comfort level, the window located in the centre of the room gives less illuminance comparing back of the room and the size of the window does not relate energy saving.

II. Energy Management

Demand side management system is one of the energy management systems to reduce power consumption in the demand side. It triggers the user to use less amount of energy during peak load time. Peak demand management does not necessarily decrease total energy consumption but could be expected to reduce the need for investments in networks and/or power plants for meeting peak demands. An example is the use of energy storage units to store energy during off-peak hours and discharge them during peak hours. A newer application for DSM is to aid grid operators in balancing intermittent generation from wind and solar units, particularly when the timing and magnitude of energy demand do not coincide with the renewable generation. The DSM perform different techniques are follows:

- 1) Peak clipping
- 2) Valley filling, Load shifting
- 3) Strategic conservation
- 4) Strategic load growth
- 5) Flexible modeling

1) Peak clipping:

Peak clipping or reduction of the system loads embodies one of the classical forms of load management. Generally, the extra loads are cut from the supply during peak house. For example, direct control of consumer's appliances by utilities at the time of peak load. The best example of this direct control is air conditioning units. This is mostly used DSM technique in a recent day.

2) Valley filling:

This technique is used to fill load which area has a low level of loads, these added loads are from the supply. This process is done during the building load in the off-peak period, strategy to improve the power factor. The results reveal that low cost and high efficiency of operation because of improved power factor. Some heavy appliances (irrigation pump, water heater etc) switched off during peak hours and switched on during off-peak hours.

3) Load shifting:

The third technique of load shape change is load shifting which moves peak loads to off-peak time periods without necessarily changing overall consumption. Load shifting combines the benefits of peak clipping and valley filling by moving existing loads from on-peak hours to off-peak hours. This is the basic principle of load shifting.

4) Strategic conversion:

The conversion decreases the seasonal consumption of energy, primarily by the reduction of energy wastage, to increase the efficiency of energy consumption. Various incentives, mainly for the technological change, are included in the program.

5) Flexible modeling:

It consists of actions, following an integrated plan between the consumer and concessionaire, according to the need of the moment. Through the installation of the load-limiting devices, it limits the energy use of a consumer during certain moments, without affecting the actual, security conditions

III. Concept of Satisfication

User fulfillment is a measure or indicator of how many consumers of an association's devices or administrations are satisfied with those products or services. It is a correlation between the client's desires versus his impression of the experience. The satisfaction to be represented as ' σ '. Satisfaction, σ is quantifiable for example σ can be assessed numerically. Satisfaction, σ is fuzzy instead of crisp. Satisfaction doesn't exist just in the conditions of 'finish detachment' (for example $\sigma = 0$) Furthermore, 'totally satisfaction' (for example $\sigma = 1$). Or maybe, σ exists on the whole values in the middle of the conditions of 'finish lack of interest' and 'totally fulfilled'. Fulfillment is similar and relative. Two dimensions of relativity are characterized for σ : time sensitive relativity and devices-based relativity. By time sensitive relativity it is inferred that on the off chance that there exists an electrical apparatus #A, the fulfillment it gives at time t_1 ($\sigma A(t_1)$) is relative and can be thought about to the fulfillment it gives at time t_2 ($\sigma A(t_2)$).

Load/cost table

The load/cost table is derived from what are all the appliances used by a user, wattage of each appliance per hour and energy cost. The main goal of the paper is to plan a design for demand-side load management during peak hours. Let a house with two rooms, a corridor and a kitchen and with other fundamental places is considered for the case of an investigation. Every one of the loads referenced in table.1 is considered in a middle-class family in India. According to the utilization and everyday utilization of electric power in peak hours (morning 1 am to midnight at 12 am) the loads are assigned. Presently, by applying the load priority pattern in this case, the utilization amid the peak hours is constrained by cutting a few loads off and hence there will be an appropriate use of energy to the high uninterruptable power supply.

Table 1 Load data

Appliances	Power consumption (kW)	Number of loads
Lighting	0.04	1
Television	0.15	1
Refrigerator	0.15	1
Fan	0.06	1
Water heater	4	1

IV. Fuzzy Controller

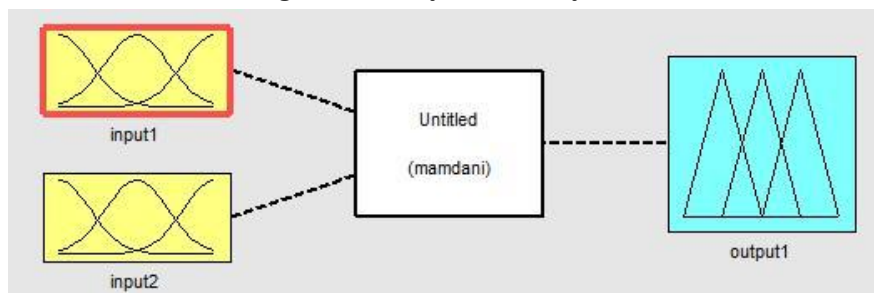
Fuzzy logic is a good decision process for user requirement, it deals very difficult problems and used to mapping the point. The Fuzzy Inference System is used here to multi-input and multi-output system. The FIS reveals equalization of energy in both generation and demand side, the controller is designed to predict the load during peak hours considering load priority pattern, off-peak hours controller releases the load to the consumer. The fuzzy logic system designed to meet the user required power and constraint, the following requirements are necessary,

- a) Fuzzy inference system
- b) Fuzzy membership function
- c) Fuzzy rules
- d) Defuzzification

a) Fuzzy inference system

The fuzzy inference system is shown in the figure.1, two inputs and one output multi-input single output Mamdani inference system, it deals human understanding problem in the very effective manner. The inputs are power consumption and satisfaction of the user, the output is the cost function of energy utilization. These variables are declared in FIS and put the name in Mamdani system.

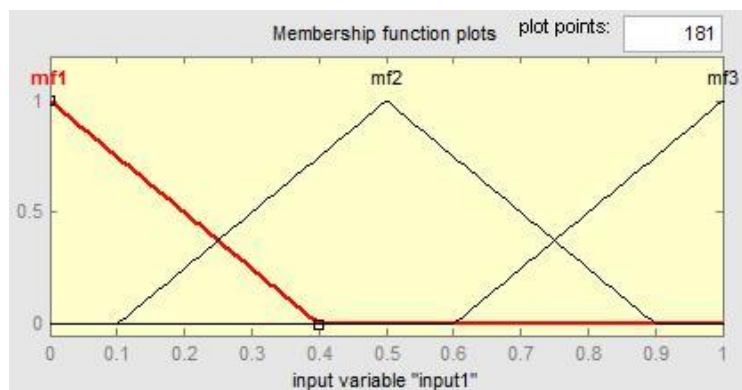
Figure 1 A fuzzy inference system



b) Fuzzy membership function

Fuzzy membership functions are used for all input and output variable in order to define fuzzy rules. The MF having ranges as low, medium and high, its ranges having values according to user utilization and satisfaction. All the membership functions are represented in the triangular function, so the definition of each rule is very simple and easy. Initially, the crisp value is converted to a fuzzy value, then the following steps to be performed.

Figure 2 A fuzzy membership function



c) Fuzzy rules

Fuzzy rules are created by using the fuzzy membership function. The proposed system model requires 9 fuzzy rules to have a required result. All of these nine rules one rule has the best result for the proposed model.

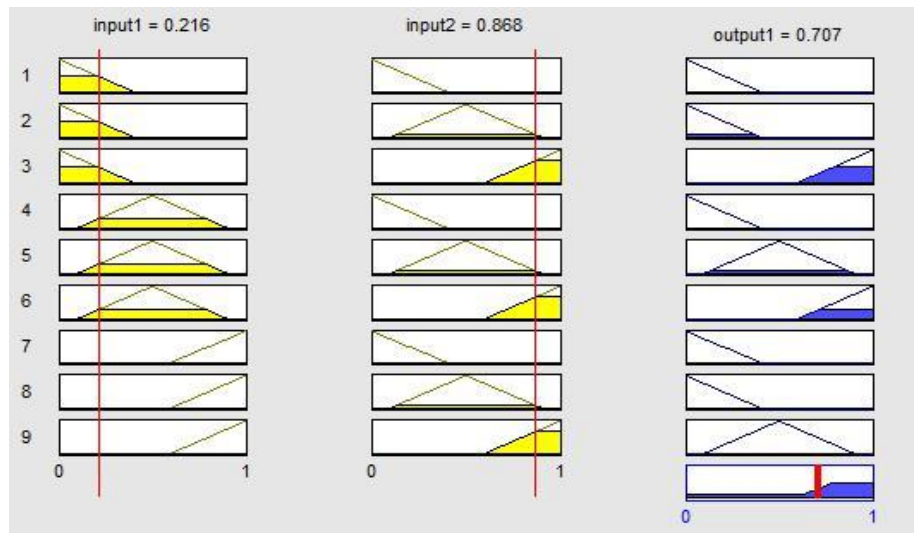
Figure 3 A Fuzzy rule

1. If (input1 is low) and (input2 is low) then (output1 is low) (1)
2. If (input1 is low) and (input2 is medium) then (output1 is low) (1)
3. If (input1 is low) and (input2 is high) then (output1 is high) (1)
4. If (input1 is medium) and (input2 is low) then (output1 is low) (1)
5. If (input1 is medium) and (input2 is medium) then (output1 is medium) (1)
6. If (input1 is medium) and (input2 is high) then (output1 is high) (1)
7. If (input1 is high) and (input2 is low) then (output1 is low) (1)
8. If (input1 is high) and (input2 is medium) then (output1 is low) (1)
9. If (input1 is high) and (input2 is high) then (output1 is medium) (1)

d) Defuzzification

In our proposal, defuzzification is used to convert fuzzy value to crisp (numerical) value. Defuzzification needs a formula of Center of Area to calculate a crisp value. The output is noted as

Figure 4 defuzzified output waveform



Total time and user satisfaction parameters are calculating an output value. The required formula for defuzzification is,

$$Z_{COA} = \frac{\sum_{i=1}^n t_i \sigma(t_i)}{\sum_{i=1}^n \sigma(t_i)}$$

The following diagram shows the fuzzy output waveform, by adjusting the two input corresponding output will be displayed. The power consumption is limited during peak hours and the loads are released in off-peak hours using the priority level of the fuzzy inference system.

V. Conclusion

In this paper, demand-side load management system that enhances the user satisfaction during peak hours. Using a fuzzy inference system and fuzzy rules required result was evaluated. The user rescheduling energy pattern can improve the reduced form of energy utilization cost, this pattern is created according to the user power consumption. The result reveals that the proposed fuzzy system offered a maximum user satisfaction at minimum cost.

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Decision Tree based Global Solar Radiation Prediction

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Abstract: Solar radiation is the radiation energy emitted by the sun which in turn converted into electricity. The heat energy produced by solar is more but it is not utilized properly since the data's and records of the solar radiation is not available and also the maintenance of the instrument is also quite difficult. In this paper the global solar radiation data are analyzed and predicted by using decision tree algorithm. Decision tree is one of the machine learning algorithms which is used for both the classification and regression problems. Its structure look like a tree with branches and leaves. Classification means it will handle only binary values as 0 or 1 while regression means it handle real or decimal numbers. In this article data of solar radiation are real numbers so regression method is used for prediction of solar radiation. The solar radiation data of year 2017 is chosen in this work. With the predicted output of solar radiation, future application of solar energy can be properly designed. The results are simulated in the MATLAB software R2017a.

Keywords: Decision tree, solar radiation, regression, classification, standard deviation, standard deviation reduction

I. Introduction

One of the major problems in our ecosystem is production of electricity. For the production of electricity, renewable and nonrenewable energy resource is preferred. The renewable energy of wind, solar and tidal energy is used. Among these energy resources solar energy is one of the most commonly used energy resources for the production of electricity. The amount of electricity produced by solar energy is more than the other energies. Since the solar energy production depends upon the sunlight rating. In case of summer season, the sunlight rating is very high, in such a period the outcome of heat radiation from sun is high, which results production of electricity in huge manner. In India most of the electricity applications are carried out by solar energy.

In solar energy, solar radiation is the prime factor, since the electricity production depends upon the radiation reaching the surface. The radiation reaching the surface is divided into three regions as visible, infrared and ultraviolet region. The radiation in the ultraviolet region is not used for production of electricity. The radiation under the region of visible and infrared is considered for the electricity production. The energy outcome of solar is high but in some cases, it is not properly benefited by the end application. Because there is no appropriate recording of the solar radiation data. The instrument such as pyranometer and pyrheliometer are used to measure the solar radiation data while the maintenance of the instrument is difficult. So in this work solar radiation data is predicted by the decision tree algorithm. For the prediction of solar radiation, the data of 365 sample is taken from the website open government of India. The data set of year 2017 is chosen. With the help of decision tree, the solar radiation data is properly designed and make it efficient for the end application of electricity.

II. Decision tree in machine learning

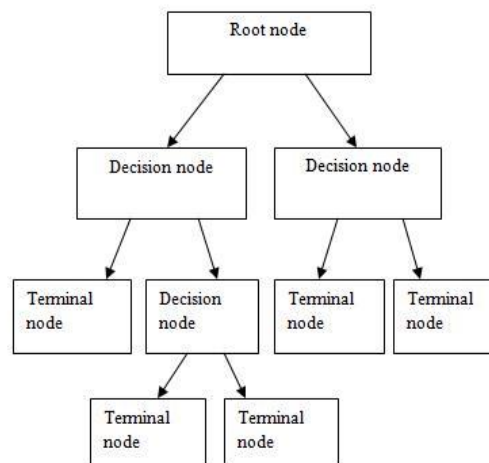
In case of inductive inference, decision tree is one of the commonly used practical periods. Decision tree provide good hypothesis for the model and it is a method for approximating discrete valued target functions. The decision tree follows ID3(Iterative Dichotomiser) algorithm for the prediction of solar radiation. Decision tree handle both classification and regression models. The classification model means it carry only binary values as 0 or 1, while in case of regression it handles real number. In this paper the dataset chosen is completely real number so the regression model is considered for this model.

A. Decision tree representation

A decision tree is a type of supervised learning algorithm that is mostly used in classification problems. It works for both categorical and continuous input and output variables. It is a structure that includes root node, branches and leaf nodes. Each internal node denotes a test on an attribute, each branch denotes the outcome of a test and each leaf node holds a class label.

The topmost node in the tree is the root node. Root node it represents entire sample or population and this further gets divided into two or more homogeneous sets. Splitting is a process of dividing a node into two or more sub nodes. Decision node is a sub-node splits into further sub-nodes, then it is called decision node. Leaf/terminal node it is the nodes do not split is called leaf or terminal node. Pruning process of removing sub-nodes of a decision node, this process is called pruning. Branch/sub-tree it is a sub section of entire tree is called branch or sub-tree. Parent and child node is a node, which is divided into sub-nodes is called parent node of sub-nodes whereas sub-nodes are the child of parent node.

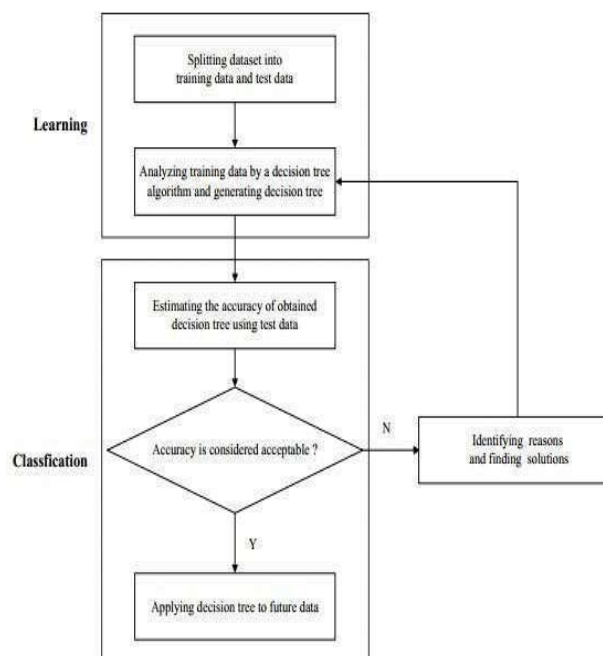
Figure1 Decision tree structure



B. Architecture of decision tree

Decision tree flow diagram is drawn. The first step is the splitting dataset into training and testing dataset. The second step is the analyzing training data by decision tree algorithm. Then the model is created based on the training data. Now the testing data is given to the model. It will test the data with the training dataset. If the value is same as the training data there is no error. If there is any difference between training and testing dataset an error is created

Figure2 Architecture of decision tree



III. Solar Radiation Prediction

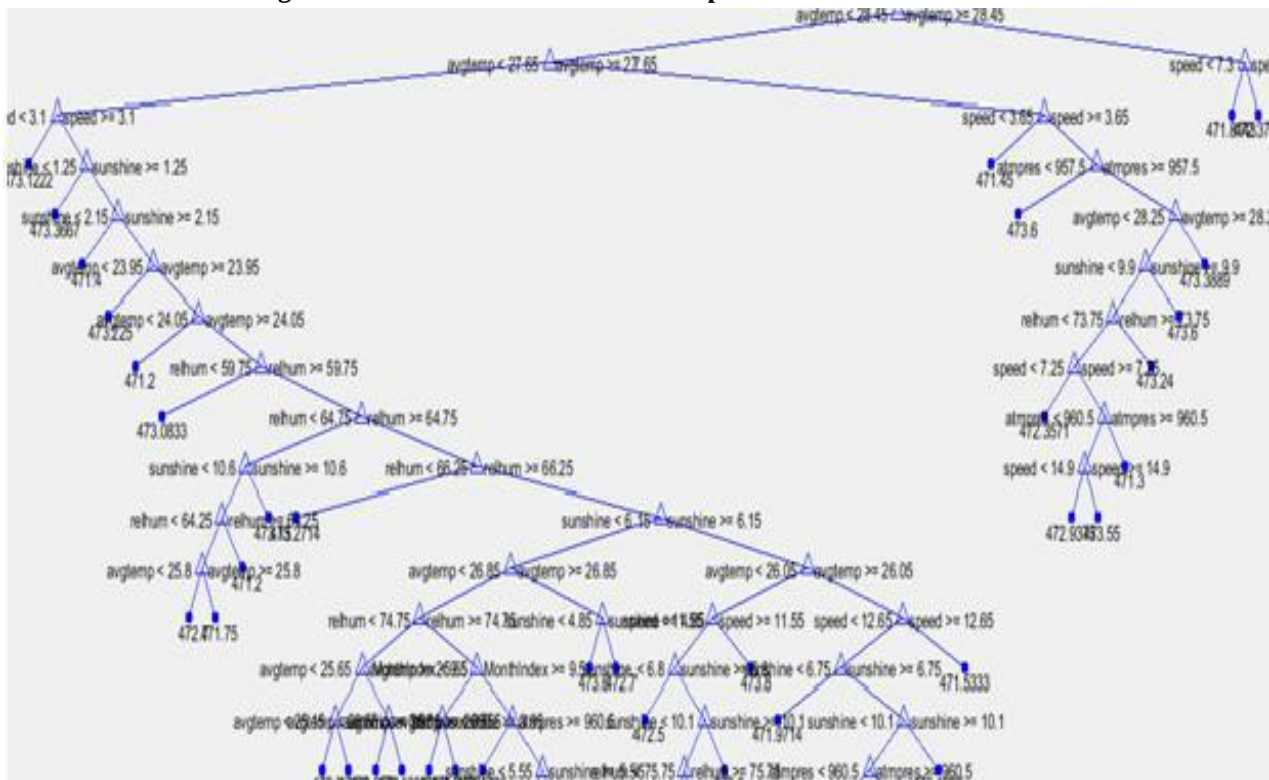
For the prediction of solar radiation, the input attributes chosen are the atmospheric pressure, average temperature, humidity and wind speed. Decision tree is created by considering the training and test data set. Training dataset is some percent of data is taken from full length of data set to build the model. While the remaining percentage of data is given for testing the model. The outcome of the model is the predicted value of the dataset.

A. splitting of dataset

In this paper the ratio of 40:60 is chosen that is forty percent of data is given for training the model while the remaining sixty percentage is given for testing the model. The input attribute with highest standard deviation reduction act as the root node. Then the further splitting of decision tree depends upon the value of standard deviation. The process continues until the predicted value is obtained.

The termination process of decision tree ends at the predicted solar radiation value is reached. The branch with non-leaf node stops computing the model.

Figure3 Decision tree of solar radiation prediction of 60% test data



B. decision tree structure of solar radiation

For the target variable the standard deviation is calculated, here the target variable is global solar radiation. The inputs atmospheric pressure, average temperature, wind speed, sunshine hours, humidity and solar radiation is given as input to the model while the output is the predicted global solar radiation. Now the standard deviation is calculated for every input attribute. The standard deviation reduction is the difference between standard deviation of each input attribute and the actual mean value of the corresponding input attribute.

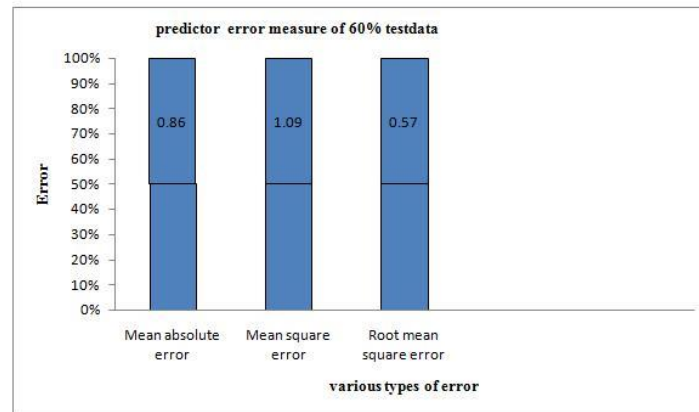
The decision tree is created for the data set. In most of the cases the model is predicted as same as input in some cases there occurs error between the actual and predicted solar radiation. The three types of error is calculated mean absolute error, mean square error and root mean square error.

Table 1 Error value of 60% test data

S.NO	Types of error	Error value
1	Mean absolute error	0.86
2	Mean square error	1.09
3	Root mean square error	0.57

The graph shows the error value of solar radiation prediction.

Figure 4 Error value graph of 60% test data



From the graph it is clear that the value of absolute mean error and root mean square error is minimum, so the accuracy of solar radiation prediction by decision tree is more appropriate.

IV. Conclusion

In this work solar radiation prediction is carried out by decision tree algorithm as it provides high accuracy. Since the absolute error and the root mean square error is very low. The solar radiation is predicted in more efficient manner. The test data of sixty percentage is taken and the training data of 40% is chosen. The efficient prediction of solar radiation results in better production of electricity and the application of various devices can be properly designed. The maintenance of solar radiation records is not necessary. Decision tree algorithm performs the prediction.

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Non-Technical Loss Detection in Electric Power Distribution Networks by using Random Forest Fed Support Vector Machines

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Abstract: Non-technical losses, particularly due to electricity theft have been a major concern in power system for a long time. Large consumption of electricity in a fraudulent manner may imbalance the demand supply gap to great extent. Non-technical loss detection is done in two levels of data processing and analysis scheme. This paper presents prediction for expected electricity consumption of distribution level consumers by using suitable machine learning algorithms namely decision tree and random forest based SVM. Random forest is most popular algorithm for solving classification and regression problem and it is based on the Decision tree algorithm. This study compares the classification performance of DT and RF which was generated using 100 trees. MATLAB is used for analysis of electricity consumption data for electricity prediction using data samples. In this paper the prediction accuracy of decision tree and random forest based SVM was used for performance comparison.

Keywords: Non-technical loss, Random forest, SVM, Fraudulent consumers, Decision tree algorithm, Classification.

I. Introduction

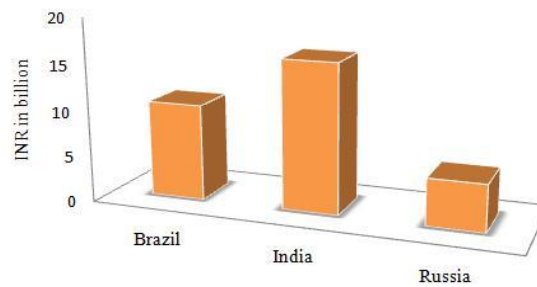
The losses in electrical energy transmission and distribution network are one of the major problems in electrical utilities and can be classified into two categories. One is the technical loss due to electrical energy dissipated in form of heat like core loss, iron loss between energy supply and distribution point of consumers. Another one is non-technical loss, such as energy theft at distribution level, metering error and errors in the billing process [1]. In many developing countries, NTL are serious concerns for utility companies as they are about 10 to 40% of their total generation capacity. NTLs faced by electric utility companies in the United States were estimated between 0.5% and 3.5% of gross annual revenue, which is relatively low when compared to losses faced by electric utilities in developing countries such as Bangladesh, India, and Pakistan. The theft of the electrical energy is criminal practice and it should be punishable one. The high amount of non-technical loss happening in India. The world loses US I.N.R 89.3 billion annually to electricity theft. The highest losses were in India (INR 16.2 billion), followed by Brazil (INR 10.5 billion) and Russia (INR 5.1 billion) [2]. President of Northeast Group Ben Gardner stated, "India loses more money to theft than any other country in the world as shown in fig.1. The state of Maharashtra—which includes Mumbai—alone loses I.N.R 2.8 billion per year, more than all but eight countries in the world. Nationally, total transmission and distribution losses approach 23% and some states' losses exceed 50% [3].

There are various types of electrical power theft, including Tapping a line or bypassing the energy meter. According to a study, 80% of worldwide theft occurs in private dwellings and 20% on commercial and industrial premises.

The various types of electrical power theft include:

1. Direct Hooking from line
2. Bypassing the energy meter
3. Injecting foreign element into the energy meter
4. Physical obstruction
5. ESD attack on electronic meter

Figure 1 Overall money losses due to Non-technical loss



The above theft is detecting by two approaches. The predominant direction is research and development are employing artificial intelligence and in particular machine learning methods to detect customers that steal electricity. this paper proposes a framework to identification of non-technical losses in consumers level and abnormalities in electrical power consumption activities shows fraudulent consumers. Then, SVMs are trained from the developed dataset and tested on a different dataset to find irregularities or deviations in the customer energy consumption profile. This training dataset represent all possible forms of irregularities of illegal consumers. In addition, this paper proposes a framework for training and testing the dataset in order to separate and group the illegal consumers. The rest of the paper is organized in the following way, section II illustrates the existing system which contains the working of decision tree and SVM, section III discusses about the MATLAB simulation output for decision tree fed SVM classifier, section IV details the proposed system of random forest working, section V discusses the simulation output for random forest based SVM. Section VI concludes the paper and details the future work of the authors.

A. Contributions:

The fundamental contribution of this paper is to detect the non-technical loss in distribution level of power system. This entail that framework of detecting the non-technical loss in transmission, distribution and consumer level. The main contribution of this paper is using the Random Forest based Support Vector Machine classifier to identify the fraudulent consumers which is advanced of Decision Tree based Support vector Machine. The proposal needs the data set from historical power usage. This frame work collects the parameter data set for classification purpose from the real-world historical data.

II. Existing Scheme

The existing system consists of non-technical loss detection by using decision tree fed support vector machine. The decision tree with 100 trees leads the There are many developing techniques are available to detect the electrical energy theft. The researchers have extensively explored different type of technique for theft detection. Supervised machine learning algorithm is the most common tool for data analysis modeling and data mining. it uses features in the data to create a predictive model. Machine learning for data analytics solution allow firms to discover, optimize, and deploy predictive model by analyzing data sources to improve business outcomes data analytics has key challenges. Random forest and decision trees [3] are come under the supervised machine learning algorithm uses the tree concept. These trees are arranged with two types of nodes namely terminal node and decision node. In [4] decision tree has Interactive Dichotomiser 3 (ID3) a technique for develop decision tree. C4.5 is a distinct algorithm for constructing decision tree from Interactive Dichotomiser 3 algorithm. Both ID3 and C4.5 is extremely prominent algorithm in machine learning. The major difference between Interactive Dichotomizer3 [5] and C4.5 [6], [7] employs for multi feature and Interactive Dichotomiser 3 employs for binary split. When the target variable is continuous regression tree models are recommended. The output of the decision tree is classifying into two class labels, by using these class label and predictor value SVM trained, which detect the non-technical loss with respect to training samples.

A. Decision Tree for Regression

A classification scheme which generates a tree and a set of rules from given data set. The set of records available for developing classification methods is divided into two disjoint subsets –

- A Training Set
- A Test Set.

The attributes of the records are categorized into two types:

- (i) Attributes whose domain is numerical are called numerical attributes.
- (ii) Attributes whose domain is not numerical are called the categorical attributes.

The decision tree classified as classification tree, which used only data samples are numerical value and regression tree, which used for classification when data samples are continues value. Both of the tree algorithm varies important in decision tree. There are many specific decision tree algorithms. Notable ones included,

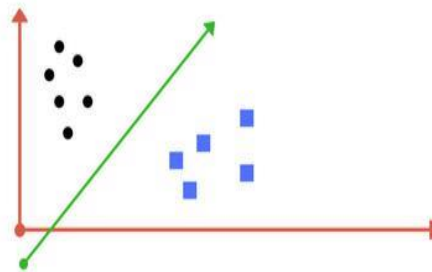
- ID3 (Iterative Dichotomiser 3)

- C4.5 (successor of ID3)
- CART (Classification and Regression Tree)
- CHAID (Chi-squared Automatic Interaction Detector). Performs multi-level splits when computing classification trees.
- MARS: extends decision trees to handle numerical data better.

B. Support Vector machine for classification

“Support Vector Machine” (SVM) is a supervised machine learning algorithm which can be used for both classification and regression problems. This algorithm is a discriminative classifier formally defined by a separating hyper plane. In two-dimensional space this hyper plane is a line dividing a plane in two parts where in each class lay in either side as shown in fig.2.

Figure 2 Separation of two classes by using hyper plane



s Image B: Sample cut to divide into two classes.

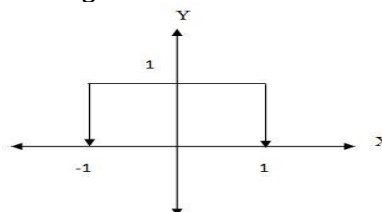
The tuning parameter of the SVM is very important for proper operation of hyper plane. There are many tuning parameters available in SVM such as, Kernel, Regularization, Gamma and Margin. Among the four-tuning parameter in this paper uses the kernel parameter because, kernel only for nonlinear classification rest of them for linear classification. SVM algorithms use a set of mathematical functions that are defined as the kernel. The function of kernel is to take data as input and transform it into the required form.

Different SVM algorithms use different types of kernel functions. These functions can be different types. For example, **linear, nonlinear, polynomial, radial basis function (RBF), and sigmoid**. Introduce Kernel functions for sequence data, graphs, text, images, as well as vectors. The most used type of kernel function is **RBF** as in [8]. Because it has localized and finite response along the entire x-axis. The kernel functions return the inner product between two points in a suitable feature space. Thus, by defining a notion of similarity, with little computational cost even in very high-dimensional spaces. The kernel rules defined as Eqn. (1),

$$K(x) = \begin{cases} 1 & \text{if } x \leq 1 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

This value of this function is 1 inside the closed ball of radius 1 centered at the origin, and 0 otherwise. As shown in the fig.3.

Figure 3 Kernel function



C. Methodology

Step 1: Calculation of standard deviation for target attribute.

Step 2: By using standard deviation, all data samples are divided on the distinct attributes

Step 3: For each branch standard deviation is calculated.

Step 4: To find the class label from step 3. There are two classes namely “0” and “1”.

Step 5: Based on the value of elected attribute the data samples are partitioned.

Step 6: Fed the input attributes and output from the DT to SVM classifier.

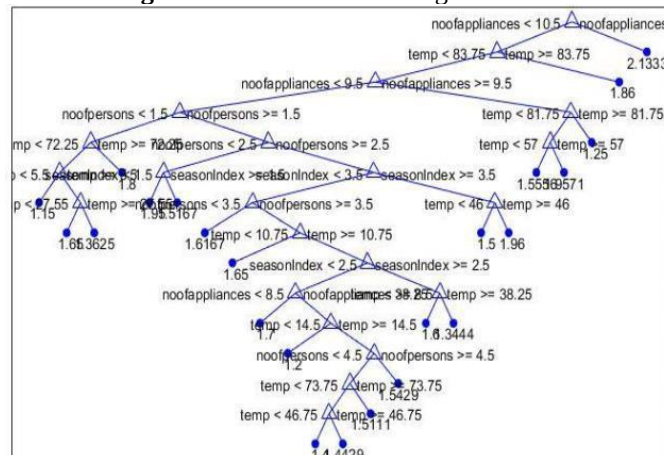
Step 7: Calculate the False Positive and True Negative rate from the Confusion matrix.

For illustration, the above procedure that is step by step procedure is applied to our sample database. The attributes used to find non-technical loss are: number of appliances, number of persons, temperature, season, and actual electricity consumption.

III. Simulation Output for DT fed SVM

A. Simulation output for Decision Tree

Figure 4 Decision Tree for regression



B. Confusion Matrix for Decision Tree fed SVM

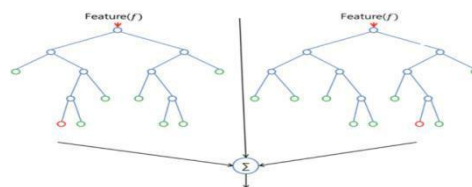
Table I Shows the Confusion Matrix Output

T. N	F. P
202	13
15	8
F. N	T. P

IV. Proposed Scheme

The proposed system has same working functionality like Decision tree fed SVM classifier but here Random Forest regression techniques used instead of Decision tree. Random forest is an ensemble learning based classification and regression techniques. It is one of the commonly used predictive modelling and machine learning techniques. A random forest is making a bunch of decision tree and consulting all of them at once to make your decision. Where as in random forest as a name suggest, it has many trees (decision trees) that means forest of trees so it is called as forest, these forests of trees are constructed in a randomized manner that's why these are called random forest. A data frame (sample dataset) has two dimensions rows (observations, records) and columns (variables, attributes, predictors) for building the decision tree, samples of data samples are selected with replacement along with selecting a subset of variables for each of the decision tree. Both sampling of data frame and selection of the variables are done randomly so it is called random. To say it in simple words: Random forest builds multiple decision trees and merges them together to get a more accurate as shown in fig.5.

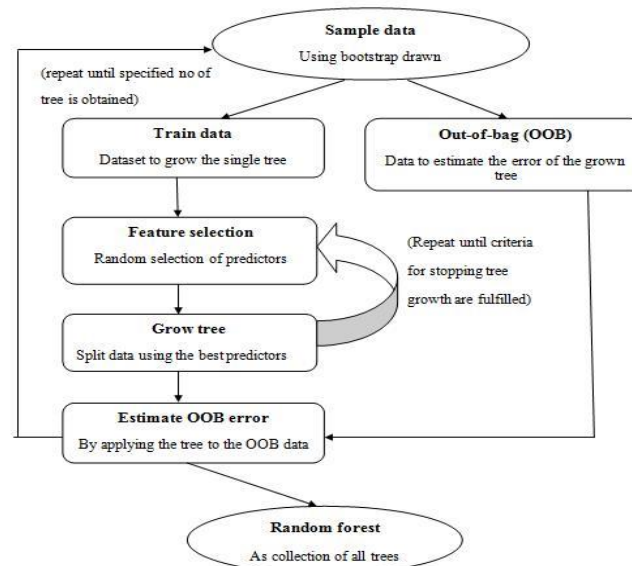
Figure 5 Working of Random Forest from Decision Tree for regression



A. Working methodology of Random Forest

When the training set for the current tree is drawn by sampling with replacement, about one-third of the cases are left out of the sample. This OOB (out-of-bag) data is used to get a running unbiased estimate of the classification error as trees are added to the forest. It is also used to get estimates of variable importance. After each tree is built, all of the data are run down the tree, and proximities are computed for each pair of cases as in [9]. If two cases occupy the same terminal node, their proximity is increased by one. At the end of the run, the proximities are normalized by dividing by the number of trees. Proximities are used in replacing missing data, locating outliers, and producing illuminating low-dimensional views of the data. Working methodology for random forest depicted as flow model in fig.6.

Figure 6 Working methodology of Random Forest



B. Advantages of Random Forest

1. RF algorithm can solve both the classification and regression type of problems.
2. It produces highly accurate classifier.
3. No need for pruning trees
4. Over fitting not, a problem
5. Capable to handle thousands of input variables without variable deletion.
6. Random forest is capable to handle dataset that may have error and large missing values.
7. OOB error estimation.
8. Runs efficiently on large datasets

C. Disadvantages of Random Forest

9. Random forest has been observed to over fit for some datasets with noisy classification/regression tasks.
10. Extreme values are not predicted accurately.

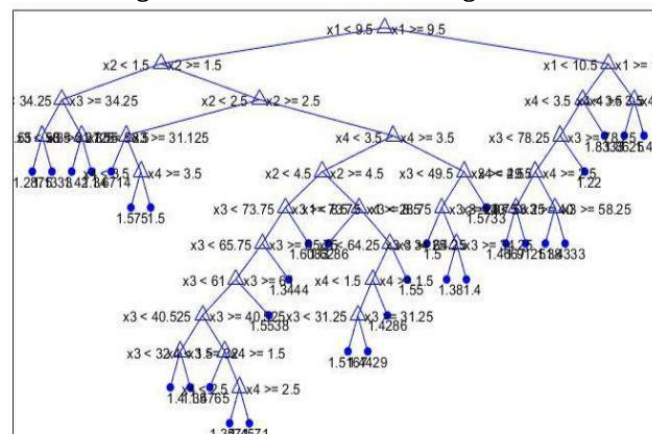
D. Similarities of Between DT and RFT

1. Data type is not a constraint because decision tree and random forest can handle numerical and categorical variable.
2. Both algorithms are capable to handle classification and prediction techniques
3. DT and RF use standard deviation and standard deviation reduction to find the best attributes for partition.
4. Decision tree and random forest are capable to handle dataset that may have error and missing values.

V. Simulation Output for RF fed SVM

A. Simulation output for Random Forest

Figure 7 Random Forest for regression



The tree structure of random forest is shown the fig.7. It has the x1,x2,x3,x4 as input attributes namely x1 denoted as the number of appliances,x2 denoted as number of persons,x3 denoted as temperature and x4 denoted as season.

B. Confusion Matrix for Random Forest fed SVM

Table III Shows the Confusion Matrix Output

T. N	F. P
185	32
5	16
F. N	T. P

The confusion matrix of SVM shown in tabulation I and II. From this the accuracy of the Decision tree based SVM and Random Forest based SVM is calculated by using the Sensitivity and Selectivity. The SVM classifies the consumers as Normal or Fraudulent. To calculate the accuracy of classified SVM performance measures selectivity and sensitivity can be used.

C. Performance comparison of Random Forest fed SVM and Decision Tree fed SVM

Table IV Shows performance of DT fed SVM and RF fed SVM from Confusion Matrix Output

Predicted Condition	DT fed SVM	RF fed SVM
condition	0.9395	0.8525
Sensitivity	0.347	0.7619
Loss Rate	0.7135	0.4235
Accuracy Rate	88.5	84.4

The tree construction of random forest high while compare to the decision tree and loss level is low in random forest compare to decision tree. The performance comparison of Decision tree fed SVM and Random Forest fed SVM is shown in Table III. That clearly shows the loss is less but accuracy of RF fed SVM low because the random forest has less generalization capability because of it has a greater number of trees than Decision tree. For this reason, this paper moves on the next level classifier called Extreme Learning Machine.

D. Normal and Fraudulent Consumers

Figure 7 Normal Consumers
Predicted & Actual Consumers

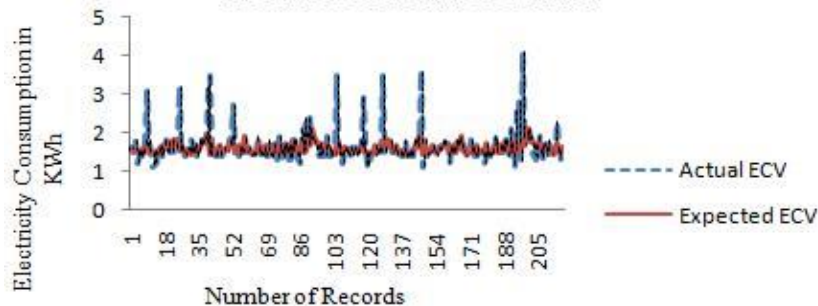
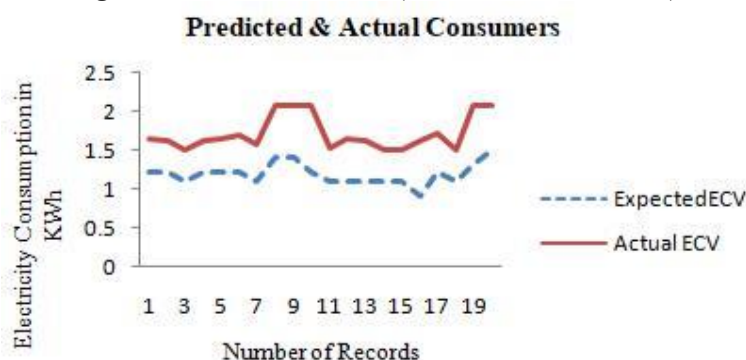


Figure 8 Non-Technical loss (Fraudulent Consumers)
Predicted & Actual Consumers



To provide more clarity the normal electricity consumption consumers and fraudulent electricity consumers are differentiated separately in fig.7,8 the expected value determined from the random forest. Where there is a significant different between actual electricity and predictor electricity consumption those are observed as fraudulent electricity consumers. From the above analysis it can be concluded that the predicted electricity plays a significant role in differentiating the malicious consumers.

VI. Conclusion

Decision tree and Random forest are most popular machine learning algorithms for solving classification and regression problem. The goal is to predict accurately the class to which the data samples belong to. A Random forest is ensemble of decision trees so it helps in predicting data accurately. A random forest model is typically made up of tens or hundreds of decision trees. The above algorithm was compared and analysis was performed using the tool MATLAB, by considering 238 data samples of electricity consumption data. Prediction accuracy of RF and DT based SVM are 84.4%, 88.52% respectively. But time taken by random forest to execute the dataset is more compared to decision trees. As a result of the study Random Forest [Number of trees=100] SVM yields less classification accuracy compared with Random Forest based ELM algorithm due SVM has less generalization capability with RF compared to decision tree based SVM. To overcome it the advanced classification Extreme Machine Learning classification is used for classification, this is non-technical loss detection (detect whether the customer is normal or malicious).

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CBU (College Bus Ubicacter)

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Abstract: CBU (College Bus Ubicacter) proposes a Real-Time College Bus Tracking Application for Sri Sairam Engineering College that is developed for Android smart phones as an mobile android application. This kind of implementation of mobile application will enable the students or users from outside college for finding out the location of the college bus so that they will not get delay to catch the bus. The main purpose of this CBU Mobile application is to provide exact location of the student's route buses in Google Maps with providing information like college bus route details along with CBU driver details, stops, routes, expected time and distance to reach the particular stop. This application may be widely used by the Sri Sairam Engineering college students and if needed outside participants (users) also can make use of this app if they want to reach the college venue. Mobile and Android smart phones are common and it can be affordable for all. It is a real time college bus tracking system as the current location of the CBU bus is updated every moment in the form of latitude and longitude position which is received by the students or users through their CBU application on Google maps. CBU application is using client-server technology. CBU consists of two separate applications of "CBU user app" and "CBU driver app". Whenever a request is raised from the CBU user app for finding the current location of the bus along with expected time and distance, the current location of the college bus with expected time and distance is updated to the user from CBU driver app with the help of the Firebase Database. The ultimate aim of developing this application is to track the vehicles, particularly for College Buses at Chennai city. As far as now, there is no proper application is developed using android application for real time tracking system at free of cost and also there is an increased rate of traffic jamming during week days, college students find difficulties at those moments. To overcome this issue, this application is being proposed. The route details used in this application are from "Sri Sairam Engineering College" route bus details.

Keywords: CBU driver application, CBU User application, Firebase Database, CBU admin

I. Introduction

This kind of vehicle tracking project has been implemented in many states of India. But most of them are paid android apps and some of the application shows only the locations of data type value of double of latitude and longitude positions which is very difficult for a user to understand. Also, the expected time and distance is not showed in any of the apps. Many school bus applications for Real Time Tracking of the Vehicle have been developed with use of GPS, hardware modules. But, this application for real time tracking of college buses "CBU-College Bus Ubicacter" is developed as an android application using Android studio 3.2.1 and as well as an web application which is developed using NodeJS with express framework. So it is easy for an user to make use of any one form of the application. Thus, it is cost efficient too. There is a chat bot and emergency call features is also included in the CBU application in which during emergency situations user or driver can make a call or send alert messages to the authority for help. The data collected from user during sign up, route details, college bus driver login details, current location details are updated and stored in a real time database called "Firebase Database". There is a CBU Administration Authority who is responsible for monitoring and managing the data of the two applications. He is the one who gives access to the college bus driver's login through the CBU web page created.

II. Literature Survey

Real-time college bus tracking system has been implemented for tracking system using GPS modules. Existing system involves the GPS tracking system that will allow users for transportation companies for exchanging their products and goods and it also prevents from theft and accidental situations. After some years, the tracking system has been taken into another level by introducing google maps in android phone display.

Using Google maps, the user can able to track and share the location to the other person. Most of the online shopping applications like Uber cabs, Uber Eats, Ola cabs, Swiggy, Zomato, Flipkart, Amazon online shopping applications also makes use of this Google Maps application for tracking the user's product to their respective locations. The google maps are displayed in mobile applications by means of google api key. This api key is provided by google console for developers for free for one year. After the retention period of api key got over, the user has upgraded his/her google api account to a premium one.

III. Proposed Solution

CBU is very efficient and cost effective as it was implemented as mobile applications. This CBU is particularly developed for Sri Sairam Engineering College Bus tracking. This application uses Android studio 3.2.1 IDE for android development and NodeJS for CBU admin web page development. This is a tracking application which works more alike as Ola and Uber applications as the concept of implementation is likely to be similar. Also, this application stores data with real time database called "Firebase Database". So, retrieval of data and showing the required details to the user will be done in a fraction of seconds. It is implemented for around 120 routes of Chennai. So, the implementation of CBU applications is completely feasible. Most of the mobile vehicle tracking applications does not display the distance and time of the vehicle to reach the stop. But this application will show the estimated time and distance to reach the stop. Also this application will be extended with the feature of chat bots and an alert notification to the admin if a driver violates the traffic rules and indulged in some mal practices like speed limit violation, automatic penalty providence.

IV. Architecture of CBU



Fig 1. Architecture of CBU

A. CBU Administrator

Admin is the one who has the centralized access control, monitoring and management of the two applications. He is responsible for entering new route details and also can select the route from the list of routes and then the corresponding sub routes are displayed. He will add or remove a route & modify or remove a stop from the route. Enter new student details, driver login credentials and can view the list of students and college bus drivers who are all logged into the application, add or remove a student details and driver details. The admin is responsible for overall application monitoring for efficient working.

B. CBU User Application

User has to enter the login credentials to login into the application. They will provide with the access to search for a bus in the search bar. Then the corresponding location will be displayed in the map.

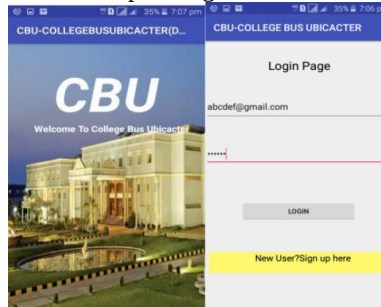


FIG 2. Screenshot of CBU User Application-Login Screen

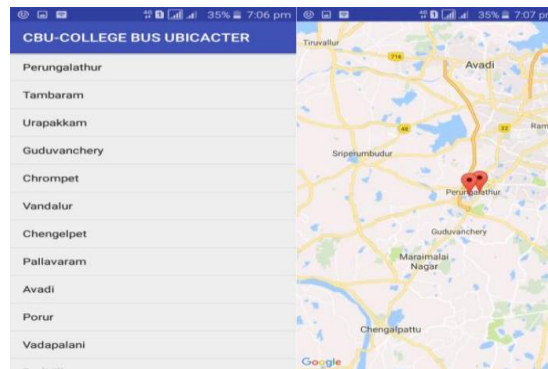


Fig 3. Screenshot of CBU User Application-Route details with map display

C. Firebase

Firebase is involved in client-module interaction which is used for data update, deletion and modification like route details, student details and driver details. It is generally done by the administrator and it deals with server side (database activities). When student or user needs the Bus Information, the data for their request will be fetched from the firebase database and delivered to user or student through server. This is one of the real time database so the details will be fetched with less number of time generally less than a minute. In technical aspect the lines of code required to make connection and create tables in this database is very less and also this database can able to store large amount of data as it can able to store unstructured data more like a NoSQL database in a JSON format.

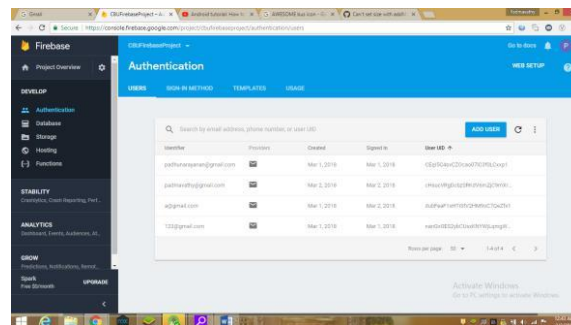


Fig 4. Screenshot of Firebase-Logged in User Details

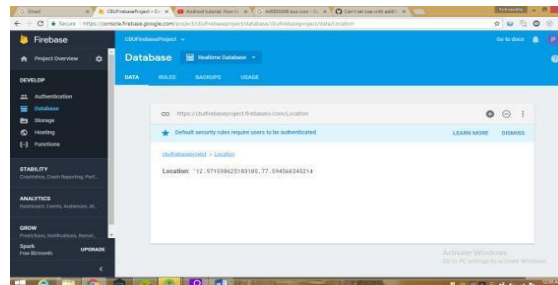


Fig 5. Screenshot of Firebase-Location details in Latitude and longitude

D. CBU Driver's Application

Driver has to enter the login credentials to login into the CBU driver application. After that, the driver's location is automatically updated in firebase and is shared with the user's application for college bus tracking.

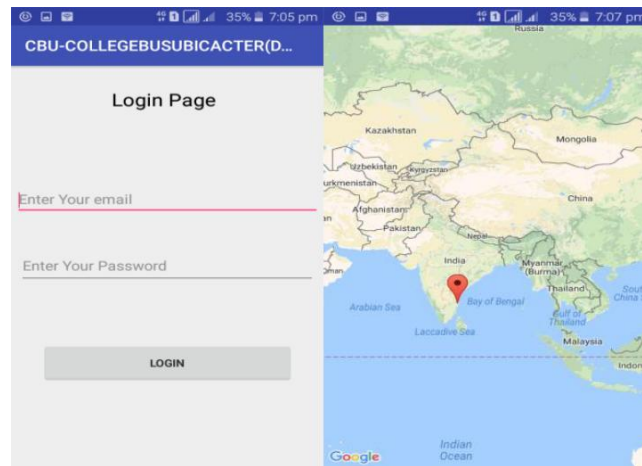


Fig 6. Screenshot of CBU Driver Application

V. Future Enhancements

In the modern world there is an increased number of population and increased number of vehicles are being constrained and it spoils the smooth flow of the traffic resulting in traffic jams. This kind of activity will create inconvenience among the vehicle users who are travelling daily basis. So along with the implementation of vehicle tracking application, automatic penalty system for violation of traffic rules, driver's expired license and PUC number expiration date can be validated and if it detects it is out of date then automatic penalty renewal system will be implemented by make use of IoT concepts and mobile application.

VI. Conclusion

In this paper it has been proposed a college bus tracking system which can be used to track a Sri Sairam Engineering College bus with the proposed two CBU mobile applications. In future, other related devices in college bus such as sensors may be integrated and embedded. An own server can be created and maintained for storage and retrieval of data for the purpose of seeing the college bus route and other data related to college bus in a physical device. Thus, these kind of android mobile tracking applications for college buses will form an intelligent tracking system which will be useful for the students as well as for outside participants (users) who wants to utilize this kind of tracking application.

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Real-time Monitoring System of Industrial machines With Node MCU using IoT

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Abstract: Internet of Things (IoT) is an imaginative way to deal with interface different gadgets through the web and utilize such an interconnection to actualize profoundly valuable capacities. In this paper, an IoT-based framework has been proposed for the ongoing checking on industrial machines through remote sensor networks. In the mechanical divisions the machines runs consistently all through the year, so there is higher possibility for execution of the machines to get reduced. In request to screen the execution of the machines at each moment of time and remotely through remote sensor systems with node MCU controller and thing speak cloud. Node MCU's fundamental capacities are to process information from sensors with the machines, tell client about framework disappointment, and send data to the server. The acquired outcomes are assessed utilizing thing speak open information IoT stage with information investigation. A noteworthy preferred standpoint of the proposed framework is its cost viability. This model would examine the information and report it to the clients.

Keywords: Node MCU, Thing Speak, Internet of Things, Sensors, Cloud.

I. Introduction

The development of innovation is inescapable. Each advancement was made to have positive effect in human life [1]. A standout amongst the most created innovations today is Internet of Things (IoT) where the things can be found, followed, observed and controlled consequently. The quick advancement of data innovation (IT) has brought a hyper associated society forward where objects are associated with cell phones and the Internet, speaking with each other [2]. In this task the ceaselessly observing machines with the assistance of sensor systems to check the execution of the mechanical machines by examining the different parameters like voltage, current, temperature, humidity and vibration of the machines. By investigating the above parameters, it will send the information consistently to the cloud with the assistance of Node MCU controller [3]. The reasons Node MCU is utilized as a controller are its shoddy value, it has inserted Wi-Fi module which disentangle correspondence among controller and server, it has 11 GPIOs and an ADC stick, and its abilities which surpass what this framework require. It incorporates firmware which keeps running on the ESP8266 Wi-Fi SoC and equipment which depends on the ESP-12 module. In all the IoT based applications, information examination will assume a noteworthy job to take the dynamic choices for better execution. Inserted gadgets, for example, sensors, actuators, and advanced cells, give an extraordinary business potential towards the new time of IoT, in which every one of the gadgets can interconnect and speak with one another utilizing Internet [4]. The examined figures from the different has been sent to the cloud. Thing Speak empowers the formation of sensor logging applications, area following applications, and an informal community of things with status updates. So, with the assistance of information examination clients can screen the machine execution. This model would analyze the data and report it to the customers.

II. Literature survey

The growth of technology is inevitable. Every innovation was created to have positive impact in human life. The real-time monitoring has been important to inventors in the development of the most recent decades. The study on IOT based machines has explored and divided into broad range of applications. According to the literature the appliances can monitor from remote areas using different communication networks. Numerous organizations are making efforts to make automated machines industry and laboratory hence convenient for the people. Amazon proposed an "Elastic Compute Cloud", EC2 benefit in 2006 which opened the cloud administration time [5]. Ashton asserted that IoT can possibly change the world generally as Internet [6]. He expressed that the majority of the information accessible on the Internet these days were initially made or captured by people. "Pachube" was procured by a main supplier of cloud-based integration solutions called

“LogMeIn” in July 2011, and thus renamed to “Cosm” in May 2012 [7]. The work [6] has presented internet of things-based system. They present Bluetooth technology for the connectivity of system and use different equipment for implementation of wireless home automation as per literature survey presently there is no system at lower rates. Numerous systems are very difficult to install, maintain and use. Existing systems are generally closed and protective, functions of system are not exact customizable by the end user. Investigating different devices of various vendors there is needed to develop cost effective system

III. Hardware description

A. DTH11 Temperature and Humidity sensor

DHT11 has advanced flag yield with the temperature and mugginess sensor capacity. It quantifies the temperature and dampness of the machine and it is extremely useful to keep the unfortunate warming and short out deficiencies inside the machine. In this undertaking this sensor assumes a crucial job to detect the temperature from the specific machine which need to under checking

B. Current Sensor (ACS712)

A current sensor which distinguishes and changes over current to an effectively estimated yield voltage, which is corresponding to the current through the deliberate way. It depends on the standard of Hall-impact .When current is connected through the copper conveyor, an attractive field is created which is detected by the inherent Hall component.

C. Vibration Sensor Module Vibration switch (SW420)

The Vibration Sensor Module Vibration Switch SW-420 distinguishes if there is any vibration that past the limit. The edge can be balanced by the on-board potentiometer. At the point when this no vibration, this module yield rationale LOW the flag demonstrates LED light and the other way around when there is a vibration this module yield rationale will be HIGH the flag show LED light

D. Voltage Sensor Module (ZMPT101B)

A voltage sensor will be ready to decide and even screen and measure the voltage supply. It has high precision for voltage and power estimation. It can make the grade regarding 250V AC. It is easy to utilize and accompanies a multi turn trim potentiometer for changing the ADC yield.

E. Thing Speak™ Cloud

Thing Speak™ is an IoT investigation stage benefit that enables you to total, envision, and break down live information streams in the cloud. It is one of the clouds which is utilized to send all the sensor information into the cloud. The Node MCU controller which gathers the different information from the sensor modules what's more, send it the cloud for observing.

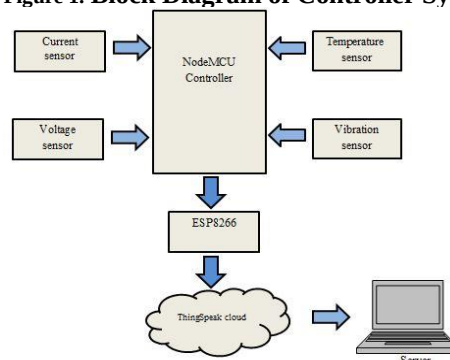
F. Node MCU

Node MCU is an open source firmware and it can modify utilizing Arduino IDE. It can customize utilizing c dialect simple to program and it detects the information from the different sensors interfaced with it. It is furnished with work in ESP8266 module for sending the information acquired from the sensors to the cloud.

IV. System Design

In this block section the Node MCU controller is interfaced with various sensors from various parameters like current, voltage, temperature and humidity and the vibration were obtained. The sensor are interfaced with the corresponding machines to collect the parameters from the machines and obtained using controller along with mathematical calculations. All sensors interfaced with the controller is taken as input to the controller, whereas it gives analog data to controller with the help of the Node MCU the analog data are converted into the digital data with the help of ADC. With the use of ESP8266 module it is connected with Wi-Fi and data are send to the cloud by using Thing Speak™ application. The block diagram is shown in Fig. 1.

Figure 1. Block Diagram of Controller System



V. Result Analysis

The separate sensors are interfaced with the relating machine. The parameters referenced above are assembled from the sensors interfaced with the machines. The Node MCU module is customized with the assistance of arduino Ide. It is coded with the general c programming. The temperature and mugginess of the machines, both can be gotten in the single sensor module is DHT11. Similarly, the voltage, current, vibration can be modified alongside the scientific calculation. Thing Speak library is included the Arduino Ide to effortlessly cloud the information acquired from the machines. In the Thing Speak site the channel should be made and to be named, finally we can break down the information from the machines over the Internet. At long last idea of IoT is accomplished with the assistance of Node MCU controller. The data obtained from the machine over Thing Speak is shown in the Fig. 2.

Figure 2. Thing Speak Data



VI. Conclusion

In this paper, an IoT-based framework has been proposed to screen the modern machines to keep up the execution of machine in great state. Utilizing diverse sensors associated with a Node MCU, parameters like voltage, current, temperature, humidity and vibration are watched and recorded at regular intervals. The broke down information is then answered to the clients to keep them educated and reliably screen them if there should be an occurrence of any issue that requires consideration. Along these lines, this framework would empower the earth in which it is introduced to be checked constantly and gives the precise information to evade execution decrease. Its savvy and adaptable nature likewise makes it simple to install. So embracing such an IoT-based methodology would be a compelling answer for screen and resolve issues that the machines may experience.

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A Comparative Analysis of Conventional PI controller with Fuzzy Controller for a Non-Interacting System

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Abstract: In present paper, an SISO model of non-interacting liquid level system has been taken for the analysis and the different controller designing methods are applied to the mathematical model and performance characteristics is compared with the fuzzy based PI controller. Initially transfer function for the model is derived, and various control (Conventional Controllers) algorithm are used to design PI controller. The error and change in error is used as fuzzy variables and membership functions are defined in order to obtain the suitable PI controller. The effectiveness is demonstrated both in simulation and real time environment using Simulink software. Also, the closed loop performance indices are tabulated and compared with another conventional controller.

Keywords Non-Interacting system, SISO Process, PI Controller, Fuzzy Controller

I. Introduction

The basic problem in process industries is control of liquid level in multiple tanks and flow of liquid between the tanks. Level process is one of the most common processes employed in chemical industries. The level of the process liquid must be maintained at a certain level inspite of the disturbances [1]. Level process may consist of single tank which is very simple to analyse and control, or it may consist of two or more tanks which are complex and difficult to control. Many controllers used in the industries are conventional PID controller. For controlling any process, initially a mathematical model is identified, controller is designed and simulated to get the expected process behaviour.

II. System Description and Mathematical Modelling

Resistance and capacitance are the two terms used in a two-tank system. Resistance is defined as change in level difference between the two tanks which causes a unit change in flow rate. Capacitance is defined as change in quantity to stored liquid to cause a unit change in potential head [2]. Consider the two tank system as shown in **Fig.1**, the inlet flow rate is given as q_i , the outlet flow rate is given as q_1, q_2 for tank 1 and tank 2 respectively, the level and area of the tank1 and tank 2 are h_1, a_1 and h_2, a_2 respectively. Based on the mentioned assumptions, the mathematical model can be obtained as

For Tank 1

$$A_1 \frac{dh_1}{dt} = q_{in} - q_1 \quad (1)$$

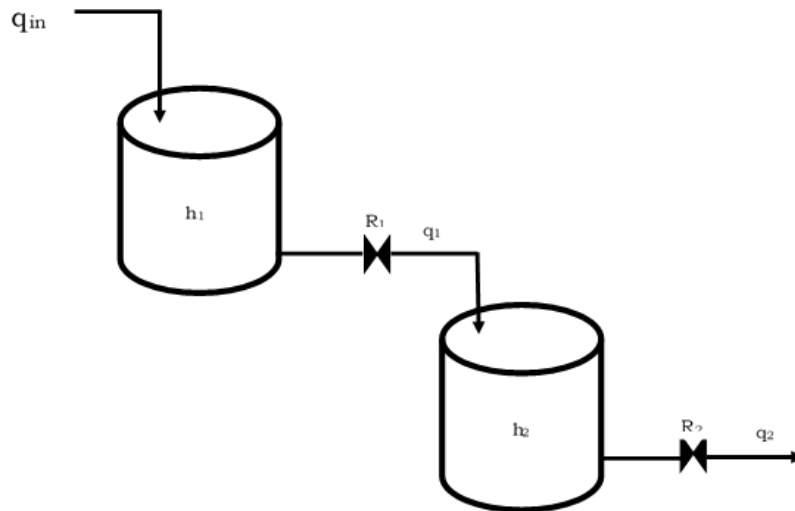
$$q_1 = \frac{h_1}{R_1} \quad (2)$$

$$A_1 \frac{dh_1}{dt} = q_{in} - \frac{h_1}{R_1} \quad (3)$$

Taking Laplace Transform

$$\frac{H_1(s)}{Q_{in}(s)} = \frac{R_1}{A_1 R_1 s + 1} \quad (4)$$

Fig.1: Non-Interacting Two Tank System



For Tank 2

$$A_2 \frac{dh_2}{dt} = q_1 - q_2 \quad (5)$$

$$q_1 = \frac{h_1}{R_1} \quad (6)$$

$$q_2 = \frac{h_2}{R_2} \quad (7)$$

Taking Laplace Transform

$$\frac{H_1(s)}{Q_{in}(s)} = \frac{R_1}{A_1 R_1 s + 1} \quad (8)$$

$$A_2 \frac{dh_2}{dt} = \frac{h_1}{R_1} - \frac{h_2}{R_2} \quad (9)$$

Taking Laplace Transform

$$A_2 s H_2(s) = \frac{H_1(s)}{R_1} - \frac{H_2(s)}{R_2} \quad (10)$$

Substituting (4) in (6)

$$\frac{H_2(s)}{Q_{in}(s)} = \frac{R_2}{(1 + A_1 R_1 s)(1 + A_2 R_2 s)} \quad (11)$$

By considering the following design parameters specified in Table 1, the transfer function of the non-interacting liquid level system is obtained as

$$\frac{H_2(s)}{Q_{in}(s)} = \frac{0.01}{6.25s^2 + 7.5s + 1} \quad (12)$$

Table 1. Technical Specification

Capacity of the Process Tank	2 liters
Total Height of the Process Tank	300 mm
Level Transmitter	Dual RF capacitance
Level Transmitter Input Range	0-300mm
Level Transmitter Output Range	4-20mA

III. Fuzzy Logic Controller

Fuzzy controllers are simple in concept. They possess three stages of process viz., Input stage, a processing stage and an output stage. In the initial input stage, the sensor or other input devices gets mapped to the corresponding membership function and values. During the processing stage rule based combines the result of the appropriate rules for the particular input combination. The final stage is the output stage with converts the combined result back into a specific control output value. The following are the design parameters for a Fuzzy Logic Controller.

1. Fuzzification strategies and Fuzzification operator
2. Selection of membership function and definition of fuzzy set.
3. Sources and derivation of fuzzy control rules
4. Defuzzification strategies and Defuzzification operator.

Error (E) and Change in Error (CE) is considered as input variables, to determine proportional gain (Kp), integral gain (Ki) as output variables, that is used to tune the PI controller.

A. Fuzzy Inference System (FIS) Editor

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The process of fuzzy inference involves membership functions, logical operation and If-Then rules.

B. Membership Function

Membership function describes the information in fuzzy set, whether the elements are discrete or continuous. It can be defined as a technique to solve practical problems, these are represented by graphical forms the following are the list of membership functions of one dimension.

1. Triangular MF: A triangular MF is specified by three parameters (a, b, c) as follows

$$\text{triangle}(x; a, b, c) = \begin{cases} 0 & x \leq a \\ \frac{x-a}{b-a} & a \leq x \leq b \\ \frac{c-x}{c-b} & b \leq x \leq c \\ 0 & c \leq x \end{cases} \quad (13)$$

2. Trapezoidal MF: A trapezoidal MF is specified by four parameters (a, b, c, d) as follows

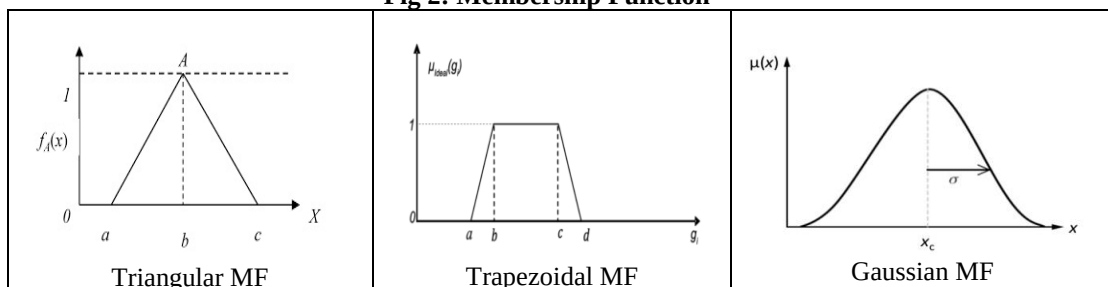
$$\text{trapezoidal}(x; a, b, c, d) = \begin{cases} 0 & x \leq a \\ \frac{x-a}{b-a} & a \leq x \leq b \\ 1 & b \leq x \leq c \\ \frac{d-x}{d-c} & c \leq x \leq d \\ 0 & d \leq x \end{cases} \quad (14)$$

3. Gaussian MF: A Gaussian MF is specified by two parameters

$$\text{gaussian}(x; c, \sigma) = e^{-\frac{1}{2}\left(\frac{x-c}{\sigma}\right)^2} \quad (15)$$

Where C represents the MF center and σ determines the MF width

Fig 2: Membership Function



C. Rule Base

Rules associate ideas and relate one event to another. Fuzzy rules also operate using a series of if-then statements. For instance, if X then A, if Y then B, where A and B are all sets of X and Y. Fuzzy rules define fuzzy patches, which is the key idea in fuzzy logic. These rules are set based on the knowledge and experience with proportional, integral and derivative controllers.

IV. Controller Design Methodology

A. Internal Model Controller

Internal model controller PI provides a transparent framework for control system design and tuning. The IMC approach has main advantage, it explicitly takes into account model and uncertainty [5]. The main feature of internal model controller is that the process model is in parallel with the actual process [8].

$$K_p = \frac{2T_m + \tau_m}{2 * k_m * (\tau_m + \beta)} \quad (16)$$

$$T_i = \frac{1}{K_m * (\tau_m + \beta)} \quad (17)$$

B. Fruehauf method

This tuning method is applicable to integrating processes and uses IMC structure to obtain the tuning parameters [7]. The expressions for a PI controller in this tuning method are:

$$K_p = \frac{5T_m}{9K_m\tau_m} \quad (18)$$

$$T_i = 5\tau_m \quad (19)$$

C. Ziegler Nichols Method

The steps involved in tuning a process using this ZN method also called as process curve method is stated below [4].

1. Make an open loop step test of process transfer function.
2. From the curve determine the dead time τ_{dead} , time constant and ultimate value that the response reaches at steady state
3. Obtain the PI tuning parameters

$$K_p = 0.9 * K_u \text{ and } T_i = 3.3\tau_{dead} \quad (20)$$

The following are the steps involved in tuning based on closed loop control system

1. Determine the characteristic equation of the closed loop system
2. Substitute $s=jw$ and determine the ultimate gain K_u and ultimate period T_u
3. Obtain the PI tuning parameters

$$K_p = 0.45 * K_u \text{ and } T_i = T_u/12 \quad (21)$$

D. Fuzzy PI Method

In fuzzy based PI controller design Error (E) and Change in Error (CE) is considered as two input variable and fuzzy produces a controller output (U). The triangular membership function is considered as membership function for inputs and output [6].

Table.2. Rules for Fuzzy based PI

	NB	NM	NS	Z	PS	PM	PB
Change In Error	NB	NB	NM	NS	NS	NS	NS
	NM	NB	NB	NM	NS	NS	NS
	NS	NB	NM	NS	Z	PS	PS
	Z	NB	NM	NS	Z	PS	PB
	PS	NS	NS	Z	PS	PM	PB
	PM	NS	NS	Z	PS	PM	PB
	PB	PS	PS	PM	PM	PB	PB

V. Simulation and Results

The simulation of two tank non-interacting system is carried out and Fig.3. and Fig.4 shows the servo and regulatory response. The simulation results show that the suggested Fuzzy PI controller show good setpoint tracking. Table.1 shows value of the tuning parameters of various PI controller.

Table I PI Tuning Parameters

Method	Parameters of PI	
	K_p	T_i
IMC PI	296.6244	7.030
Fruehauf method	149.5222	3.705
Ziegler Nichols Method	396.7391	4.600
Fuzzy PI Method	422.1583	7.13

Fig 3: Servo Response of Level Process when input R=1

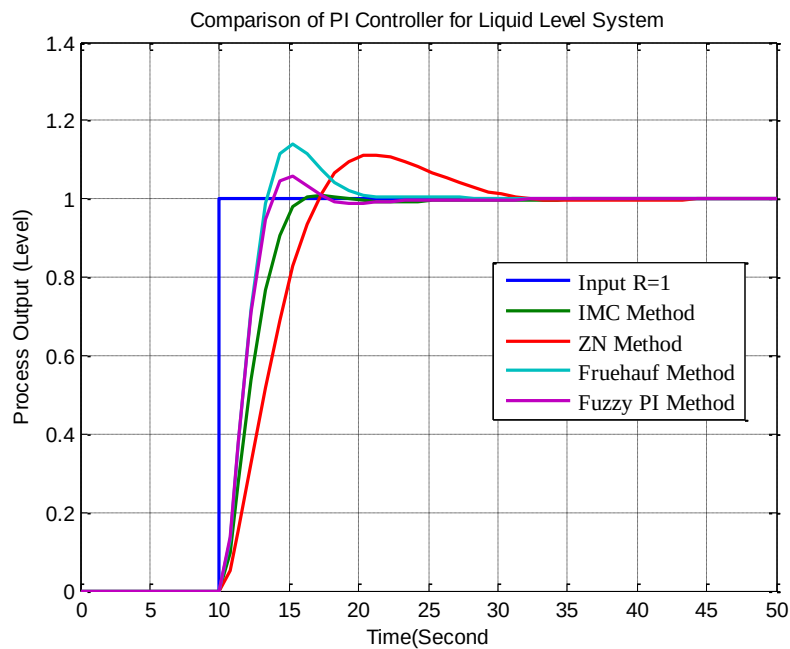
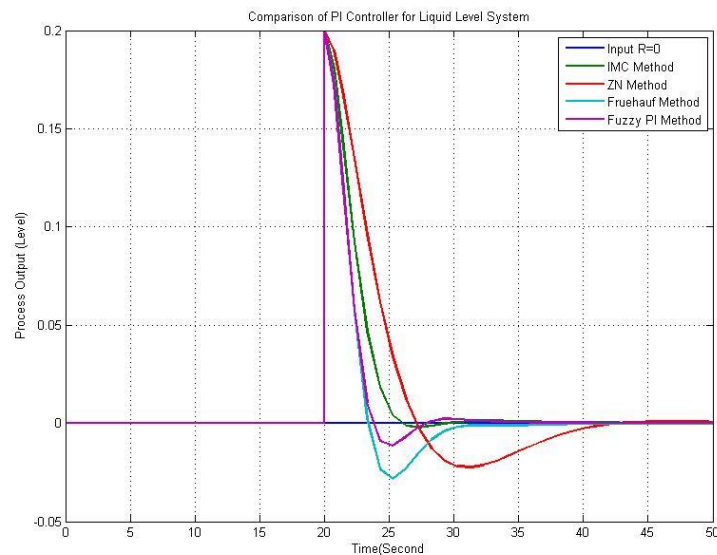


Fig 3: Regulatory Response of Level Process when input R=0 and disturbance d at 20 secs



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VII. Acknowledgments

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Dynamic Simulation of Heat Transfer through Cooling Tower Using MATLAB Simulink

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Abstract: This paper deals with the control dynamics of transient simulation of heat transfer through cooling tower using simulation tool. The main objective of this research is to find an effective tuning method for controlling a cooling tower using controller. Cooling tower is one of the important systems with wide diversity of applications in oil refineries, petrochemical plants and other chemical plants, thermal Power stations. The transfer function is taken as First Order System Plus Dead Time (FOPDT). The effect of step change in the temperature is observed and analysed at steady state. Transient simulation response of heat transfer through cooling tower is generated using Matlab Simulink. The simulation results for the inlet step change in heat transfer through cooling tower are discussed.

Keywords: FOPDT; step change; steady state; cooling tower; simulation

I. Introduction

The cooling tower is one special type of heat exchanger that transfers waste heat to the atmosphere through the cooling down the process stream using the atmospheric air. It uses the evaporation of water to remove process heat and cool the working fluid to near the wet bulb air temperature. Here, Markel's theory is used which is based on enthalpy potential difference as driving force. The behavior of the cooling tower should be predicted for transient operating condition and steady-state operating condition to reduce future possible failure and loss in maintenance costs. Two factors are mainly to be considered in the design of the cooling tower-feasibility and controllability. Feasibility refers to the flexibility at a given operation mode and controllability refers to the transition between different operation modes. Entrainment is an important condition where the liquid is carried away by the gas stream due to its higher velocity. This may be due to high rate of air flow which should be avoided to get better performance. Some of the key application of cooling tower in process operation are lowering the temperature of circulating water at oil refineries, thermal power plants, HVAC the buildings, etc. The classification is based on the type of air induction into the tower: the main types of cooling towers are Natural draft and mechanical draft (induced and forced) cooling towers. The hyperboloid structures which are as large as 660ft are associated with nuclear power plants. A model was formulated for forced draft cooling tower which has been taken into account for variation of outlet temperatures with respect to time interval and flow rates. To know the stability of the cooling tower the experiment was carried out and the transfer function was derived for different step changes in the cooling tower, simulations were done using a Proportional Integral Derivative (PID).

II. PID Controller

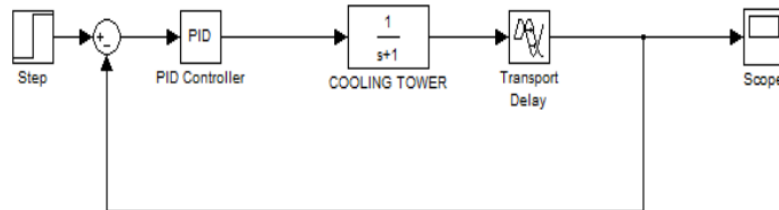
PID controllers have the ability of Proportional, Integral and Derivative control modes as they are used. These controllers are widely used in all automatic process control industries to minimize the manual errors. PID controllers will be accustomed regulate flow, temperature, pressure, level, and lots of different process variables. A PID controller has a set point that the operator can set to the desired temperature. The controller's output indicates the controller position. And the temperature measurement, called the Process Variable gives the controller its much-needed feedback. The process variable and controller output is frequently transmitted via 4–20 mA signals, or via digital commands on a Fieldbus.

While processing the PID controller compares the PV with SP and gives the difference between the variables as errors (E). The generated error signal is sent to the controller, on which the controller tunes the constants and positions the controller in such a way that the PV approaches the setpoint. According to the error the controller may move its piston position from open to close or vice versa. If the controlled variable should rise above its set point, the controller will reduce the valve position and vice versa. Since PID is the combination

of proportional, derivative and integral, a proportional controller (K_p) has the ability to reduce the rising time but never eliminates the steady-state errors. Whereas in the integral controller (K_i) the drawback of proportional controller is overcome by eliminating the steady state errors yet the transient response is poor. Derivative controller (K_d) has the facility in increasing the stability of system, improving the transient response, reducing overshoot, etc. For all design specifications, 100% desired conditions can be reached with the PID controller. Control tuning loop is the adjustment of its control parameters to the optimum values for the desired response. The parameters are proportional band/gain, integral gain/reset, derivative gain/rate.

PID tuning is a difficult problem, even though there are only three parameters and in principle is simple to describe, because it must satisfy complex criteria within the limitations of PID control. Designing and tuning a PID controller is an conceptually intuitive and hard process, if multiple objectives such as short transient and high stability are to be achieved. PID controllers often provide acceptable control over the system by default, but performance can be improved by careful tuning, and with poor tuning performance may result in unacceptable results. Usually, initial designs need to be adjusted repeatedly through computer simulations until the closed-loop system performs or compromises as desired. Some processes have a degree of nonlinearity and so parameters that work well at full-load conditions don't work when the process is starting up from no-load; this can be corrected by gain scheduling (using different parameters in different operating regions).

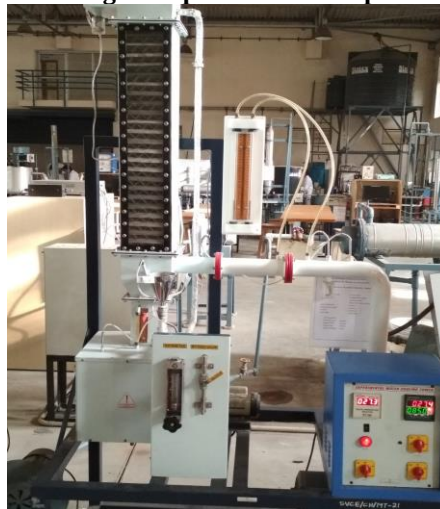
Fig.1: MATLAB Simulink Transfer Function for Cooling Tower



III. Experimental

This setup consists of forced draft cooling tower of height 2.03m and 0.0225 sq. m in cross section where air is sent to the tower with the help of blower at the bottom. Heating of water is done by heater at 230V. Water is cooled by the air as long as its temperature is above the wet bulb temperature of the entering air. The flow of water and air is counter-current as the former flows in downward direction and the latter in upward direction through the aluminium foil as shown in the figure. Temperature variation is realized by temperature sensors and flow rates are adjusted with the help of rotameter. Variation in air velocity is measured using manometer. Initially the valves V1-V5 and switches on the panel are ensured at off position. The by-pass valve V3 is opened before switching on the pump. Then the water is heated up with the help of heater at 230V. Then the hot water is allowed to flow through the cooling tower and flow rate adjusted by control valve V2. Later, the flow rate of air is adjusted with the help of valve V4 provided in pipeline. The dry air outlet temperatures (T_3) are noted at 40 LPH at a constant time interval of 2 minutes.

Fig 2: Experimental Setup



IV. Observations

This system represents the first order system with pulse dead time indicated as FOPDT. The following table shows the temperature of outlet air at two different flow rates. The following table shows the dry air and cold air outlet temperature at different flow rates.

Table 1. Reading for Cooling Tower

Time(min)	Dry air outlet temperature (Celsius)
2	52.1
4	51.5
6	52.2
8	52
10	52.5
12	52.7
14	52.5
16	52.4
18	52.1
20	51.8

Table 2. Tuning Rules for PID Controller

Tuning Method	K _c	τ_i	τ_D
Ziegler-Nicholas	$1.2 \tau / k a$	$2.0 a$	$0.5 a$
Cohen-Coon	$\frac{1}{K} \left(\frac{\tau}{a} \right) \left(\frac{4}{3} + \frac{a}{4\tau} \right)$	$a \left[\frac{32+6 \left(\frac{a}{\tau} \right)}{13+8 \left(\frac{a}{\tau} \right)} \right]$	$a \left[\frac{4}{11+2 \left(\frac{a}{\tau} \right)} \right]$
ITAE	$\frac{0.965}{k} \left(\frac{\tau}{a} \right)^{0.855}$	$\frac{\tau}{0.796 - 0.147 \frac{a}{\tau}}$	$\frac{0.308^*}{a \left(\frac{a}{\tau} \right)^{0.929}}$

V. Results and Discussion

The following values are calculated using the above formulae from Table 2.

Table 2. Calculated Values

Method	CC	ZN	ITAE	MOM
ZI	1.46	1.2	27.77	33.62
ZD	0.217	0.3	0.0065	16.52
KC	56.46	50.55	24.115	1.1189

The response curves are obtained using MATLAB Simulink. For 40 LPH dry air outlet temperatures, the response curves are as follows.

Fig 3: CC Method

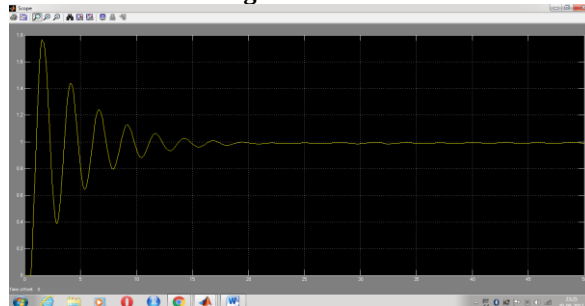


Fig 4: Z-N Method

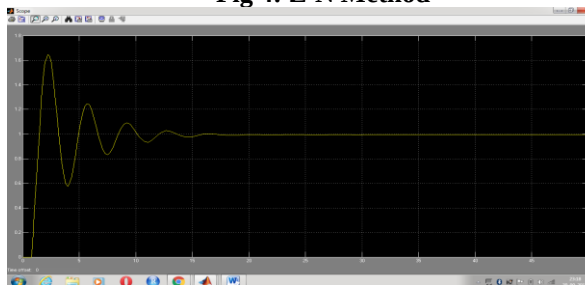


Fig 5: ITAE Method

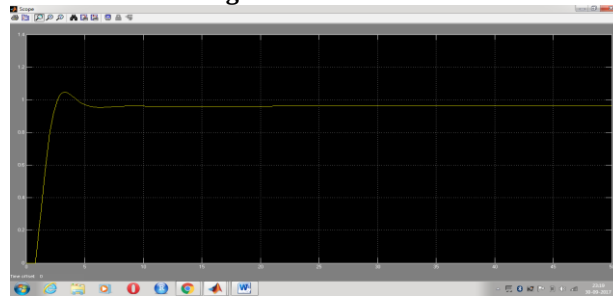
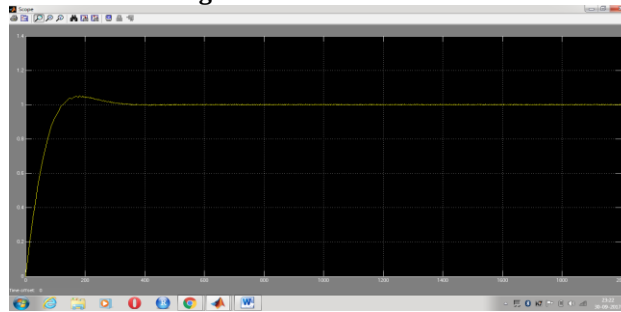


Fig 6: Moment of Method



The simulation result shows that the change in air temperature has reached steady state faster in Moment of method.

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Devulcanisation of Tyre: Separation of Butadiene by Thermal Depolymerisation

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Abstract: The Vulcanized Tyre Waste is ecologically problematic because they are Non-Biodegradable, consume large land source and contains about 20-30% of Sulfur. About 290 million tires are wasted each year, the vulcanised waste recycling is the potential process of reusing up to 80% of the waste. Our work is the Separation of Butadiene from vulcanised tire carried out by the sequence of Unit Operations such as Pulverization, Devulcanization, Solvent Recovery, Thermal Depolymerisation, Dehydrogenation and Distillation. Devulcanization is the most challenging and prevailing process in the rubber and tire industries. Tires have complex composition such as Natural and Synthetic rubber, Reinforcing Fillers, Oils, Antioxidants, Zinc oxide, Accelerators and Sulfur. Devulcanization is generally carried out by four main techniques such as Chemical, Ultrasonic, Microwave, Biological, where Chemical Process is more efficient in solvent recovery process. The Reclaimed Rubber product or sulfur-cured rubber is obtained by Chemical Devulcanization. The Greenhouse Emission of Reclaimed Rubbers and Tires is 0.1 Kg CO₂/Kg and the Total Energy required for the Production is 2.1MJ/Kg. About 25% of Reclaimed Rubber Products is blended with virgin materials to yield high quality product at commercial cost. Monomers obtained from the Thermal Depolymerisation and Butadiene obtained from distillation under increased pressure are the key component in manufacturing Polymers and finds major applications in fields like Resins, Paints, Textiles.

Keywords: Vulcanized Tyres, Devulcanization, Thermal depolymerization.

I. Introduction

Vulcanization, rubber is formed into tyre where rubber is mixed with sulfur and exposed to heat. It is a process of increasing elasticity while decreasing the plasticity of the material. Tyres are a hard, durable rubber product, non-bio degradable and difficult to recycle because it is not easily reformulated. The raw materials that are needed to manufacture a tyre - Elastomers (natural and synthetic rubber 60% - 70%), Reinforcing fillers (carbon black and silica), Plasticizers (resins, oils), Chemicals (sulfur 20-30%), Metal reinforcements (wires, bead wires), Textile reinforcements (rayon, aramid, nylon, polyester). About 290 million tires are wasted each year, the vulcanised waste recycling is the potential process of reusing up to 80% of the waste by devulcanization process. It is the breaking process of cross-linking sulfur bonds in rubber vulcanizates, without cleavage of polymer chain bonds. De-vulcanization is a perfect way of recycling rubber waste because it undergoes a renewal of original chemical formula of elastomers and provides a possibility of recovering elastomers from rubber vulcanizates waste.

II. Pre-Treatment and vulcanized tyre

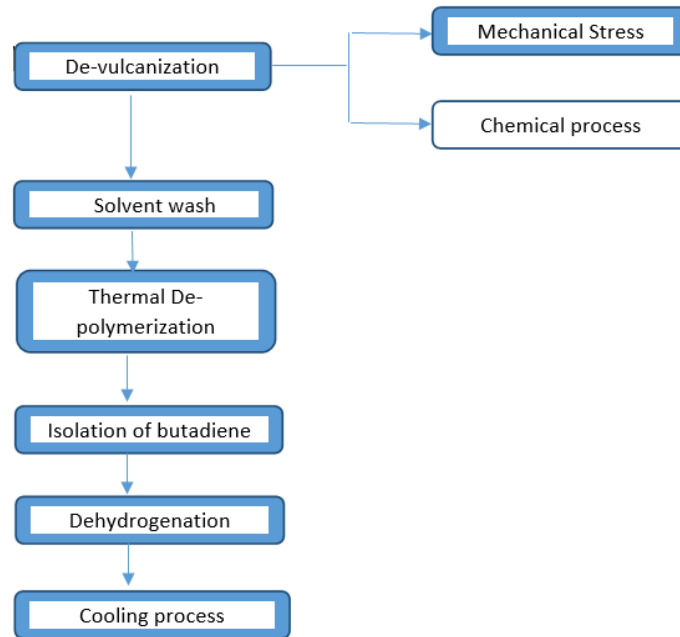
Pre-treatment of vulcanized tyre involves grinding and pulverisation method. Initially grinding involve 3 methods namely ambient grinding, cryogenic grinding, and wet ambient grinding. In our work ambient grinding is performed to reduce vulcanized tyre to 2*2 or 1*1-inch chips. Pulverisation is the process of fine grinding of solid material to reduce them into dust or powder. Rubber chips are pulverised to 30-100 mesh by a pulveriser (twin-screw extruder) [1]. These rubber chips enter through the hopper to the co-rotating twin screw extruder. Extruder provides compression, shear stress, uniform mixing and de-volatilization. The extruder delivers the molten product (200°C) at the rate of 10 kg/hr.

Various Process of Pre-Treated Feed

- De-Vulcanization by Mechanical Stress to obtain reclaim rubber product.
- Solvent washing and removal of soluble impurities.
- Thermal de-polymerisation by hydrous pyrolysis to obtain light crude oil.

- Ceiling temperature maintained to revert 1, 3-butadiene monomer.
- Dehydrogenation to remove impurities (Nitrogen, Oxygen, Sulfur).
- Cooling process by shell and tube heat exchanger to remove butadiene vapour.

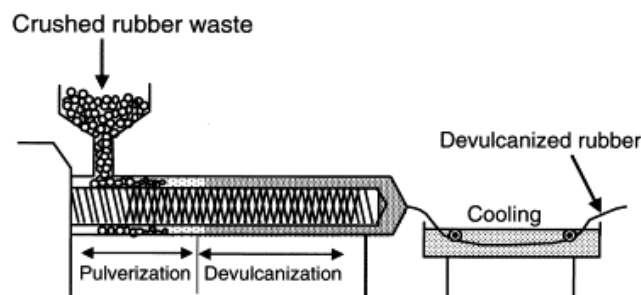
III. Process Block Diagram



IV. Devulcanization of Tyres

Devulcanization of rubber is the process of breaking up the sulfur bond in order to recycle the vulcanised rubber, carried out under high pressure and temperature as there no significant change in microstructure and molecular weight of rubber [7]. Devulcanization methods are Mechanical, Ultrasonic, Chemical, Microwave and Microorganism. Twin screw extruder consist of pulverisation chamber and Devulcanization chamber. Pulverised tyre is devulcanized by the second part of the extruder. Mechanical stress and compression provide homogeneous molten mixture of reclaimed rubber product [2] at the rate of 10 Kg/hr. The optimum temperature (200°C) is maintained in order to prevent degradation of main chain by means of cooling system, and to break different types of sulfur bonds. At the final temperature, there prevail a balance between break down and formation of new bonds.

Figure 1. Manufacture of Devulcanised Rubber



A. Solvent Washer Tank

The molten reclaimed rubber mixture at the temperature of 200°C is subjected to water wash to remove soluble impurities. Water soluble inorganic chemicals like carbon oxides (CO and CO₂), nitrogen oxides, sulfur oxide and volatile organic compounds (mostly hydrocarbons). Water containing impurity is separated from reclaimed rubber mixture using a vacuum belt filter after wash. Rubber cake on the filter cloth is dried for 24 hours at room temperature to remove free moisture content.

B. Thermal Depolymerisation

Devulcanized rubber is thermally depolymerized using hydrous pyrolysis under high temperature and pressure where Complex polymer chain are reduced into light crude oil [5]. The feed stock is mixed with water of same ratio and fed into a pressure vessel reaction chamber. The chamber is heated at constant volume to 250°C, steam evolved rise the pressure to 4MPa. These conditions are maintained for 15 minutes to heat the mixture, after which the pressure is rapidly released to boil off most of the water (Flash evaporation). The mixture results crude hydrocarbon and minerals. The minerals are removed, and the hydrocarbons are sent to the second stage of the reactor where they are heated to 500°C, further breaking down the longer hydrocarbon chain.

V. Isolation of Butadiene

Styrene-Butadiene Rubber (SBR) [3] is used in great quantities in automobile and truck tyres. Broken chain of polymers in thermal depolymerization reactor is subjected to ceiling temperature, measure of the tendency of a polymer to revert to its constituent monomer. Isolation of 1, 3 butadiene monomers from SBR polymer is done by maintaining the feed mixture at ceiling temperature of 1, 3 butadiene that is 585°C. Due to high temperature maintenance about 35-50% of butadiene is separated as monomer.

Table 1. Cooling temperature of Monomers

Monomer	Ceiling temperature (°C)[6]	Structure
1,3-butadiene	585	$\text{CH}_2=\text{CHCH}=\text{CH}_2$
ethylene	610	$\text{CH}_2=\text{CH}_2$
isobutylene	175	$\text{CH}_2=\text{CMe}_2$
isoprene	466	$\text{CH}_2=\text{C}(\text{Me})\text{CH}=\text{CH}_2$
methyl methacrylate	198	$\text{CH}_2=\text{C}(\text{Me})\text{CO}_2\text{Me}$
α -methyl styrene	66	$\text{PhC}(\text{Me})=\text{CH}_2$
styrene	395	$\text{PhCH}=\text{CH}_2$
tetrafluoroethylene	1100	$\text{CF}_2=\text{CF}_2$

A. Composition of Tyres

The compound is composed of several elements; a typical car tire contains about 60 raw materials. The compounds can vary depending on the manufacturer and the objective sought, that depends on the intended use of the tire [4].

Table 2. Materials used in Automobile Tires

Ingredients	Car	Lorry	OTR
Rubber/Elastomers	47%	45%	47%
Carbon Black	21.5%	22%	22%
Metal	16.5%	25%	12%
Textile	5.5%	--	12%
Zinc Oxide	1%	2%	2%
Sulphur	1%	1%	1%
Additives	7.5%	5%	6%
Carbon-based materials, total	74%	67%	76%

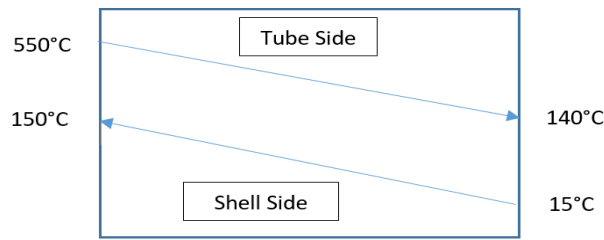
B. Dehydrogenation of Mixture

For better yield of butadiene and to remove impurities from the mixture, dehydrogenation is performed. Dehydrogenation is the process of removal impurities by applying hydrogen at high pressure (above 1 atm) [8]. By dehydrogenation, oxygen is removed as water (H_2O), nitrogen as ammonia (NH_3) and sulfur as hydrogen sulphide (H_2S).

C. Shell and Tube Heat Exchanger

Heat exchanger is used to cool the hot monomer mixture (styrene-butadiene) gas [9]. Inlet temperature of hot gas 550°C and outlet temperature is 140°C, at this temperature styrene is liquid (as boiling point of styrene is 145°C) and butadiene is vapour (as boiling point of butadiene is -4.4°C). Water inlet temperature is 15°C and increased up to 150°C. Butadiene vapour is converted to liquid and stored by compressing gas at room temperature by increasing the pressure to 2.6 atm.

Figure 2. LMTD Diagram for Counter Current Heat Exchanger



VI. Conclusion

The accumulation of solid urban residue, especially vulcanized elastomers like tyres, may bring dangerous environmental impacts. In this way, a very outstanding form of vulcanized elastomers recycling is de-vulcanization process. The de-vulcanized elastomers can be used in the formation of polymeric blends. The process that are carried out in our work is efficient and enough to produce virgin elastomers of butadiene and styrene. Isolation of butadiene of 30-50% by maintaining ceiling temperature is the phenomenal approach for the separation of butadiene as vapour and styrene as liquid. The production of depolymerized monomer mixture is composed of recycled rubber which is still a major challenge for the academic community, since its final properties need to justify all energy expenditures necessary for production, in addition to being economically viable.

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Production of Furan Derivative Fuel from Palm Wastes

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Abstract: Due to recent CO₂ emissions, there occurs Global Warming. Hence one of our main platform chemicals obtained from dehydration of C 6 sugars is Hydroxymethylfurfural (HMF). This above mentioned C6 sugars is prepared by ourselves from palm wastes by Acid hydrolysis. The formic acid-triethylamine mixture (FA/TEA) is used as hydrogen donor for the hydrogenation hydroxymethylfurfural (HMF). This was investigated over a Ru/C catalyst. These HMF with (FA/TEA) is filled in a isothermal batch reactor with agitator, which is coupled with motor for its motion. The reactor should be heated externally by some hot fluids. The reactor with external vent for hot fluid should be covered by means of insulation wall. It has to be within reactor for certain time periods at high temperature. The reactor temperature has to be standardly maintained at above 300 °C. A significant effect of formic acid-triethylamine molar ratio was observed on the product distribution, where 6:3 molar ratio of FA/TEA. Finally, we can recover a transport fuel named DMF. Optimization of the reaction parameters showed that time, temperature, catalyst dosage, hydrogen donors' molar ratio, agitation speed as well as HMF concentration played important roles in the selectivity to the targeted product. It is interesting to note that a very high HMF conversion was achieved particularly as temperature increased. However, the some of the intrinsic properties of the Ru/C catalyst determine the reaction pathway towards DMF or other products. After product recovery, product analysis has to be done & calculations have to be performed to find final product conversion (X_A).

Keywords: Furan; HMF & DMF; Dehydration; Acid hydrolysis; Selectivity.

I. Introduction

In Current progress of daily life cycle, majority of the world needs a fuel for transportation at most made from Crude Oil^[1]. Petroleum & Petrochemicals is the top key trending business in the world as many of the leading multinational companies deals with the petro products^[2]. But these crude sources take millions of years to regenerate. Has these crude sources gets depleted simultaneously, the need for the fuel purpose raises alarmingly^[3]. So, in recent years, some of the car models are proposed by means of electric current. But these electric based models can't render up safety, efficient & mileage prospects^[4]. For that reason, Crude Oil is called as "Black Gold". India's economy mainly depends on it. Whereas in some developed countries like Brazil, bio-fuels like bio - ethanol plays as a vital fuel for transportation^[5]. Environmental experts predict that the available crude sources will get declined by the end of 2050. Hence the world is in search of alternative for crude fuels such as petrol & diesel. Even Bio-fuels now experience some shortage and it has low energy density & low Research Octane Number (ROC)^[6]. Hence, a new furan derivated compound called Dimethyl Furan (DMF) which is produced from waste sources such as Palm wastes by using Isothermal batch reactors^[7]. This has high energy density and high Research Octane Number compared to Crude & Bio- ethanol. It also has high combustible energy. Since it is made from waste sources, it is cost efficient & its raw materials are available abundantly. So, it will be a promising alternative to current fuels as it is derived from simple carbon waste sources. Hence our alternative will be the key solution for fuel circumstances.

II. Materials and Methods

The raw material which is to be processed should have certain qualities to undergo further treatment, to produce fuel. Hence here there are certain list of materials & methods will be proposed to undergo further experiment in the laboratory.

A. Pre-Treatment of Palm Wastes

The Palm wastes which are collected from palm industry effluent is taken as a sample for hydro-thermal treatment^[8]. It had to be filtered to remove impurities and other waste forms. Then it had to be concentrated (via evaporation) in order to increase its concentration. The concentrated solution is a initial source to produce fuel.

B. Extraction of Fructose

The Pre-treated Palm Wastes must be processed to extract fructose. For this Spirulina medium is used to extract fructose from palm wastes. The Spirulina from mixotrophic medium is subjected under microwaves. This microwave focused palm sources have to performed "Acid hydrolysis " finally to extract fructose from palm wastes^[9].

C. Production of fuel

The hydrolysed fructose has to be dehydrated to produce an intermediate named HMF (Hydroxy Methyl Furfural)^[10]. The dehydrated fructose sample is hydrogenated using hydrogen sources (FA/TEA). Here any of the carbon sources (Graphite & Graphene) in combination with ruthenium metal is used as a catalyst^[11]. Finally, the hydrogenated sucrose results in the production of DMF (Dimethyl Furan)^[12].

D. Design of suitable reactor

To recover product, here it is necessary to design a reactor. Since the operation has to performed at high constant temperature and in the presence of catalyst, reactor has to be designed with cooling jacket. The Temperature (T) & Pressure (P), Initial Concentration (C_{A0}) initially fixed and Design Calculations are done to determine Time for reaction (t), Conversion (X_A), Volume of the reactor (V) and Final Concentration (C_{Af}).

E. Determination of rate equation

By experimental analysis, we found that the initial reactant gets converted into a intermediate. Then that intermediate due to its instability reacts with another reactant to recover product. Since this is a non-elementary reaction, it's rate law can't be directly predicted. Hence it is necessary to determine the rate equation.

III. Results and Discussions

The Experimental study after recovering the product from the designed reactor must be analysed for its composition present in it and conversion of the product.

A. Kinetic Analysis and studies

(i). Estimation of rate equation

This reaction is actually a non-elementary reaction and involves two rate constant k_1 & k_2 . By series calculations, the rate equation involving initial reactants is given by

$$r_{AB} = K_1 [A] [B]$$

The rate equation involving intermediate is given by

$$r_{A2*} = K_1 [A] [B] - K_2 [A_2*] [D]$$

The final rate equation of the experiment is given by

$$r_{AD} = K [C_A] [C_B]$$

This rate equation is the final experimentally confirmed equation for this reaction in reactor.

(ii). Determination of kinetic parameters

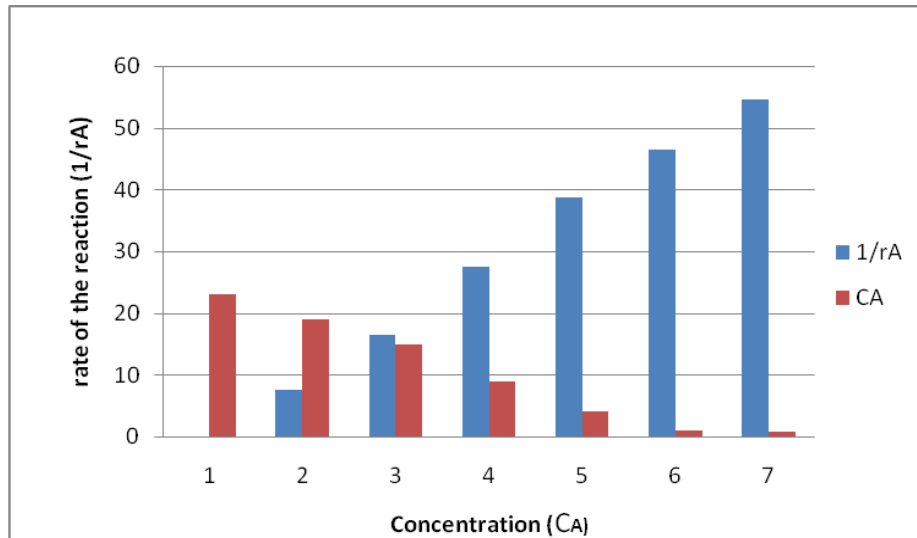
There are two possibilities for the order for our experiment. By tedious analysis it was founded that if both concentrations are initially feed equal then it tends to Then equation becomes,

$$r_{AD} = K [C_A]^2$$

For irreversible reaction, the time of the reaction is given by $t = 1/K [1/C_A - 1/C_B]$. Here in our design project, the total time for the reaction is assumed as five hrs, flow rate, ($v_o = 0.23$ lit/hr) of feed is kept constant and feed rate is kept constant (F_{A0}), Initial concentration fed is, ($C_{A0} = 0.90$ mol/lit) & Concentration after 3 hrs ($C_A = 0.75$ mol/lit). Hence the equations modified as $K = 1/t [1/C_{A0} - 1/C_A]$ Substituee the above values, we get $K = 0.04$ hrs⁻¹.

The conversion of the product is also determined from the obtained rate constant value. The Conversion for irreversible second order reaction is given by, $C_{A0} X_A = Kt$ where, $X_A = Kt / C_{A0}$. Substitute the values we get, $X_A = 0.24$ (24%). From final conversion, the final product concentration has to be estimated. The final concentration has to be found to predict the Volume of the reactor to be designed. The Formula is given by, $X_A = 1 - (C_{Af} / A_0)$. Substituting the above values, we obtain, $C_{Af} = 0.68$ mol/litre.

Figure 1 : Bar chart Analysis of rate with initial and final Concentration (C_A)



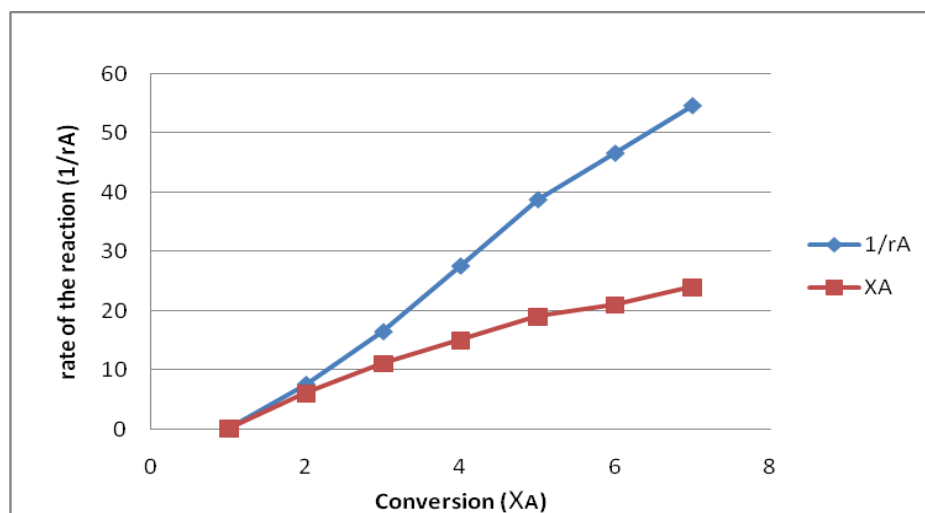
From the estimated final product concentration, volume of the reactor is estimated. The volume of the batch reactor is given by, $V = N_{A0} (1 - X_A) / C_{Af}$. Here, Substitute the values we get, $V = 1.1$ litre. Hence by our calculations, we get the volume of the reactor is nearly 1 litre. So, we have to design a 1 litre volume reactor for achieving that above mentioned conditions and conversion (X_A).

(iii). Estimation of rate of the experiment

The rate of our experiment after determining Conversion (X_A), Volume of the reactor(V), Initial & Final Concentration (C_{Af} & C_{A0}), the rate of our experiment is predicted and it is given by $r_A = K C_A^2$. Substitute the rate constants K & C_A is given by, $r_A = 0.0184$ lit/mol.hrs.

Thus, the final rate of our experiment is calculated above & graphical analysis have been done below.

Figure 2 : Graphical Analysis of rate with Conversion (X_A)



B. Experimental Analysis and studies

In experimental studies, analysis have been performed to enhance product recovery and increase conversion %. Some of the ways of increasing conversion is as follows, by Change of operation period, using Dowtherm fluids, by non- isothermal peration and finally by semi batch operation.

In case of increase in operation time, the conversion percent can be increased. Hence by varying operation time, w.k.t, $X_A = kt / C_{A0}$, Assume $t = 15$ hrs, So $X_A = 0.88$ (88 %). Similarly, when temperature of heating fluids increased in the cooling jacket, the breaking of bonds within the molecule breaks easily and rate of the reaction increases which leads to increase conversion. he dowtherm fluids is the one which has the capability to withstand high temperature. Some of the examples for dowtherm fluids are NaCl, Glycol.etc, (Instead of steam). We made an analysis and found that, instead of loading every reactant inside the reactor (steady state operation), if we load one reactant inside the reactor & another reactant adjusted by valve (unsteady state operation), the flow rate of any one reactant can be varied (generally lowered) and conversion can be increased. Lower the flow rate of dependent reactant(v_0), higher will be the conversion (X_A).

Thus, the above-mentioned techniques are proposed to improve conversion. In order to achieve eternal conversion, there must be better heat and mass transfer between the reactants. When heat and mass transfer come to a play, porosity has a major role. The reactants along with the packed materials (such as glass beads, rings) must be packed (even packing). By this, these packed materials enhance the heat and mass transfer area so that better reaction between the reactants can be achieved. By this ultimate technique, the eternal conversion can be attained.

IV. Conclusion

The study indicates that when rate of the reaction (r_{AD}) enhances, the product recovery peaks i.e. conversion (X_A) increases. This rate of the reaction is increased by above mentioned methods and that resulted in increase in final recovery. Since our research experiment involves non-elementary reaction, the rate and the order estimation were tedious process. At last, the product is recovered and further composition analysis have been performed. By Composition Analysis, we found that the about 65-70% of furan derivated compound was present and further unreacted reactants, and waste compounds have been recovered. There are some possibilities of using the recovered waste as raw materials in other process or rather it can be recycled to recover more product. Thus, from palm sources, after series of methods and formulations, our final product is recovered. Further studies have been performed to improve the quality of the product along with the reduction in energy consumption. So, in future, this will be a promising emerging technology has everyday world needs an alternative to everything. Thus, the proposed method for production of furan fuel will have its market value in future.

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Performance and Emission Analysis on Modified Pent Roof Combustion Chamber (6°) in a Diesel Engine

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Abstract: Vehicle emission is an important public health problem in most cities of the developing world. Exposure to air pollution can lead to respiratory and cardiovascular diseases. Bharat Stage Emission Standard (BSES) are emission standard instituted by the government of India to regulate the output of air pollution from Internal Combustion Engine equipment, including motor vehicles. The modification of profile of the various parts of the IC engine results in reduction of harmful emission. In this project, the modification is done on the piston head i.e., 6° of the piston quantity is removed by machining in VMM is compared with the conventional piston. Performance & Emission Analysis is done with the help of Diesel Engine for different fuel. By modifying, we got the result of very less amount of NOx Emissions & Moderate amount of HC and CO emissions

Keywords: Vehicle emission, 6° piston head, modified combustion chamber, performance and emission analysis, emission reduction.

I. Introduction

Internal Combustion Engines, more popularly known as IC engines, are the ones in which the combustion of fuel takes place inside the engine block itself. After combustion of fuel, much heat energy is generated; this is converted into mechanical energy. In rotary engines, a rotor rotates inside the engine to produce power. In the case of the reciprocating engines, a piston reciprocates within a cylinder. The reciprocating motion of the piston is converted into the rotary motion of the vehicle's wheels. The modification of profile of the various parts of the IC engine results in reduction of harmful emission. In this project, the modification is done on the piston head i.e., 6° of the piston quantity is removed by machining in VMM is compared with the conventional piston. It reduces the emission like NOx, CO & HC etc., It also increases the Performance and Efficiency of Modified Pent Roof Combustion Chamber.

II. Materials and Methods

A. Engine Specification

A 5.5 kW, 1500 rpm, Kirloskar diesel engine is used in this investigation as shown in Figure 1. The detailed specification given in Table 1. Two separate fuel tanks with a fuel switching system are used, one for diesel (D100) and the other for biodiesel (B100). Fuel consumption is measured using optical sensor. A differential pressure transducer is used to measure airflow rate. Engine is coupled with an eddy current dynamometer to control engine torque through computer. Engine speed and load are controlled by varying excitation current to eddy current dynamometer using dynamometer controller. A piezoelectric pressure transducer is installed in engine cylinder head to measure combustion pressure. Signals from pressure transducer are fed to charge amplifier. A high precision crank angle encoder is used to give signals for top dead centre and crank angle. The signals from charge amplifier and crank angle encoder are supplied to data acquisition system. An AVL exhaust gas analyzer and AVL smoke meter are used to measure emission parameters and smoke intensity respectively. Thermocouples (chrommel alumel) are used to measure exhaust temperature, coolant (temperature, and inlet air temperature).

Table: 1 Engine Specification

Make	Kirloskar-TV1
Power and Speed	3.5 KW and 1500 rpm
Type of Engine	Single cylinder, DI and stroke
Compression ratio	16.5:1
Bore and Stroke	80 mm and 110 mm
Method of loading	Eddy current dynamometer
Method of Starting	Manual cranking
Method of cooling	Water
Type of Ignition	Compressed ignition



Figure 1 Diesel Engine Setup

B. Modification of the profile

The modification of the profile of various parts of the IC engine results in reduction of harmful emission. In this project, the modification is done on the piston head i.e., 6° of the piston quantity is removed by machining in VMM. The 2D Diagram of the Conventional and Modified 6° Pent Roof Piston is shown in the Fig 2. The machining of piston and modified piston is shown in Fig 3 and Fig 4.

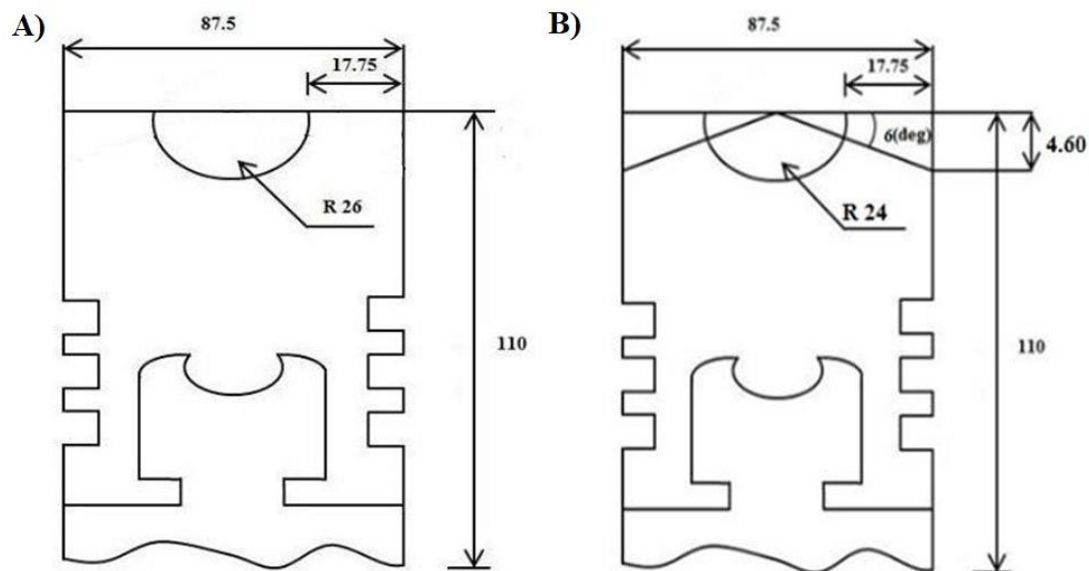


Figure 2 2D Diagram of A) Conventional Piston B) Modified 6° Pent Roof Piston



Fig.3 Machining of the piston



Fig.4 Modified piston

III. Experimental

The flow of air, the level of lubricating oil and the fuel level are checked before starting the engine. The engine is cranked by keeping the decompression lever and the fuel cut off lever of the fuel pump in the ON position. When the engine starts, the decompression lever is disengaged and the speed of the engine is increased to 1500 rpm and maintained. The engine is allowed to run for 15 minutes to reach the steady state conditions. The load is given by Eddy Current Dynamometer. The time taken for 20 cm³ of fuel consumption for every load charge is recorded. Under each load, by the exhaust gas analyzer, CO, CO₂, HC, O₂, NO_x, and by smoke meter, intensity of smoke and exhaust gas temperature are measured and recorded. The experimental Layout is given in Fig 5.

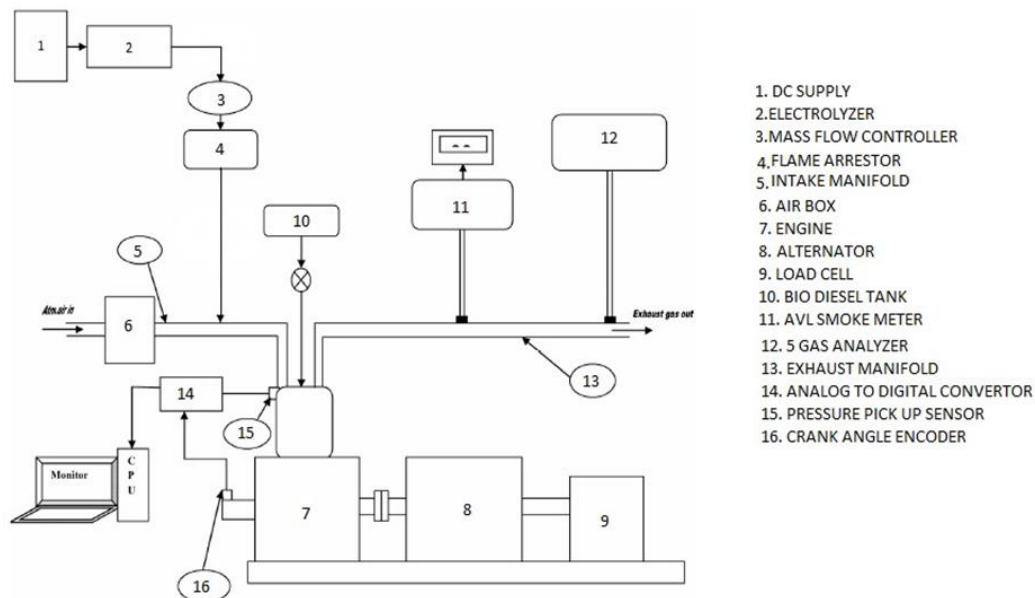


Fig.5 Layout of Experimental setup

IV. Results and Discussions

By following the procedure, the various performance analysis such as Indicated power, Brake power, Specific Fuel Consumption, Indicted Thermal Efficiency, Brake Thermal Efficiency are observed for different loads such as 0%, 25%, 50%, 75% and 100%. Similarly, the emission analysis such as NO_x, HC & CO is observed for different loads. The various observations were taken for both normal & modified piston, for different fuels. The observed readings were represented in graph below.

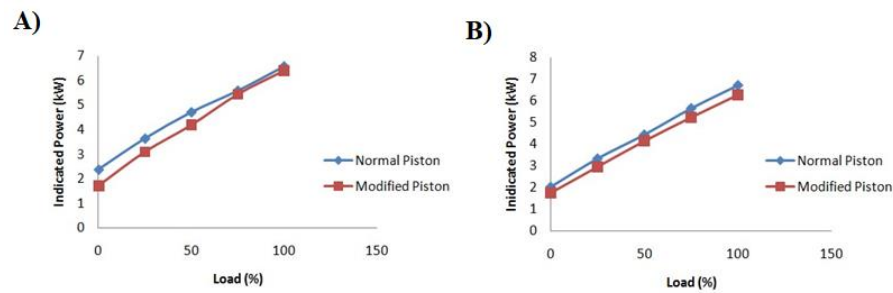


Fig.6 Indicated Power with A) Diesel B) Biodiesel

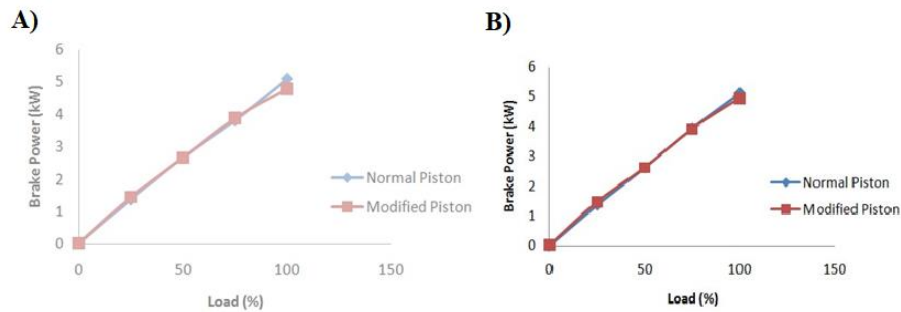


Fig.7 Brake Power with A) Diesel B) Biodiesel

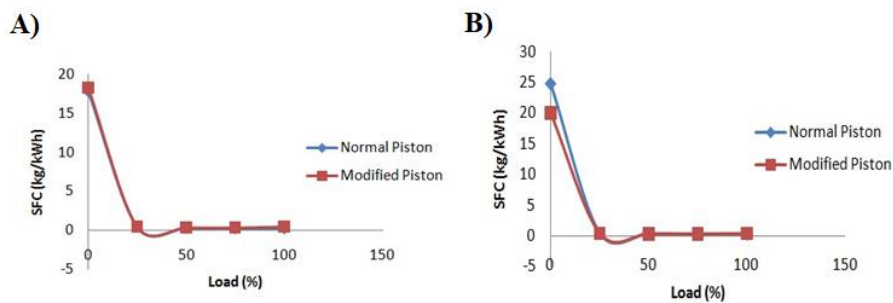


Fig.8 Specific Fuel Consumption with A) Diesel B) Biodiesel

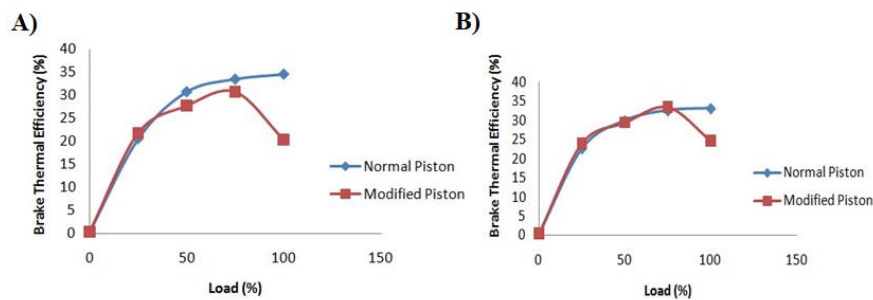


Fig.9 Brake Thermal Efficiency with A) Diesel B) Biodiesel

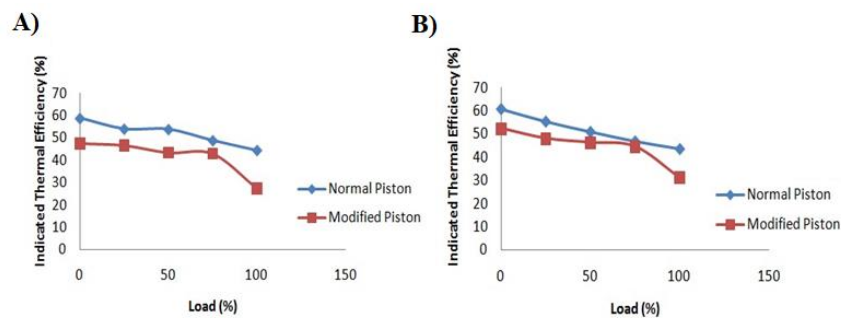


Fig.10 Indicated Thermal Efficiency with A) Diesel B) Biodiesel

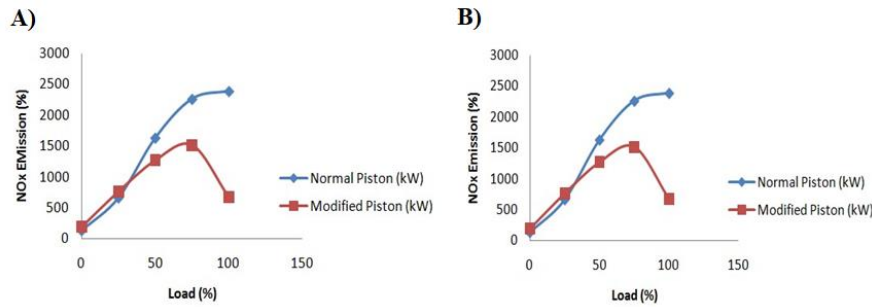


Fig.11 NO_x Emission with A) Diesel B) Biodiesel

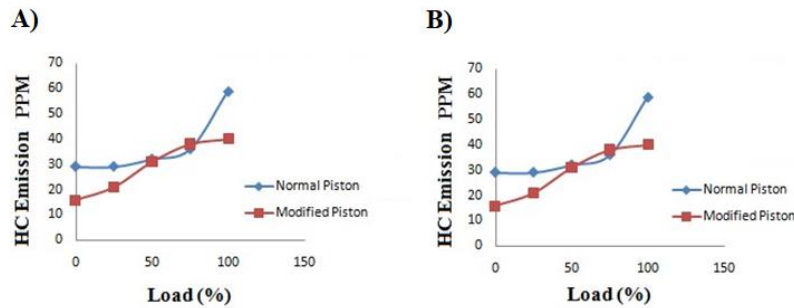


Fig.12 HC Emission with A) Diesel B) Biodiesel

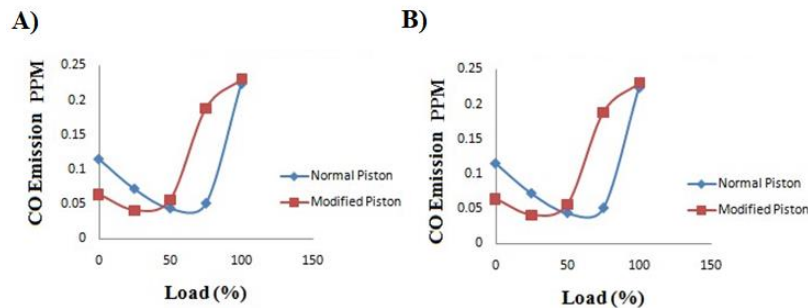


Fig.13 CO Emission with A) Diesel B) Biodiesel

IV. Conclusion

From the graph, it is observed that, the modification of the Pent roof Combustion chamber (i.e., 6° modified piston) gives lesser emission than conventional piston and moderate performance. Almost 50% of the NO_x emission and 25% of the HC emission is reduced, when modified piston is used. This paper gives an impact on the importance of the combustion chamber design and the necessity of research & innovation in the combustion chamber. It gives rise to design and develop the ecofriendly vehicle and an efficient way for clean & green city. It has proven to be very useful and it is being modified further to attain better standards.

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Effect of Bisphenol-A in Drinking of Water on Infertility

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Abstract: Bisphenol-A is an organic synthetic compound .This is the starting material for synthesis of plastic. It is used to harden the plastic and to keep bacteria away from food .BPA will easily soluble in water in 25 degree Celsius. Due to this property this has larger ill effects in human body these materials get in to our body through eating and drinking of foods heated in plastic. In this paper we presented the studies the studies on hormonal change due to increase in content of BPA in human body. The effect of increase in concentration of BPA in human body affects the endocrine system. Various testing method were investigated to find the concentration of BPA in human body (that is urine test).

Keywords: Bisphenol-A, synthetic estrogen, Endocrine disruptor, Infertility, Bioaccumulation, Food

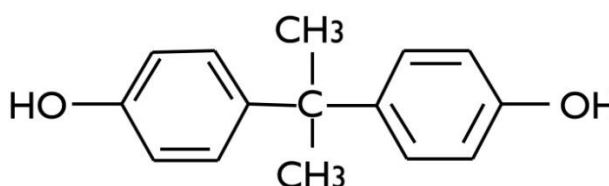
I. Introduction

BPA is a key monomer in the production of the most common form of clear and shatter- proof polycarbonate plastic and also in a variety of everyday goods. Questions regarding the safety and side effects of BPA began to emerge when BPA was found to leech out of plastics and into experimental animal subjects, resulting in an increased incidence of chromosomal anomalies in offspring. There has since been ongoing discussion in both scientific and political spheres about the potential for harm resulting BPA exposure and Potential bioaccumulation. An overview of the paper regarding the effects of BPA on human health is provided, followed by analyzing the BPA levels in human body and detection of BPA levels in plastic products. Safety levels and minimizing exposure of BPA are included for consideration.

II. Facts about Bisphenol -A

Bisphenol-A, more commonly known as BPA. It is a synthetic estrogen and it is used to harden the plastics. It is also part of the epoxy resin that lines many metal cans, like those used for canned vegetables, fruits and meats. The plastic bottles and cans which have recycling code '7' have Bisphenol-A content. Most of the World production about (Six million tonnes per year) is used for the production of the polycarbonate and resins such as the material used to line food cans to prevent corrosion. Polycarbonate plastics have many applications in some food and drink packaging such as water and baby bottles and medical devices which are mainly used in Dental treatment. Metal products such as food cans, bottle tops, and water supply pipes are coated with epoxy resins. BPA can also found in certain thermal composites may also contribute to BPA exposure.

Figure.1 Structure of Bisphenol-A



III. Hormonal Changes Due to Bisphenol-A

BPA is an Endocrine disruptor – meaning that it is a chemical that can interfere with the endocrine (or hormonal system). Endocrine Disruptors can cause cancerous tumours, birth defects and other developmental disorders. Specifically, BPA has been associated with Breast and prostate cancers, genital defects in males, early onset of puberty in females, obesity and behavior problems such as attention-deficit hyperactivity disorder. BPA have an effect on the hormones in our bodies, either by interfering with how they work in the body or by mimicking the hormones in the body. BPA mimics estrogen, an important reproductive hormone. The hormone estrogen is important for both men and women.

Additional traces of BPA can leach into the food from the epoxy resin lining of cans and from consumer products such as polycarbonate tableware, food storage containers, water bottles and baby bottles when they are heated at high temperatures. Recent studies also suggest that we may be exposed to BPA by handling cash register receipts. More research is needed to determine how much BPA from a receipt's coating enters the body and how it gets there. The National Institute of Environmental Health Sciences expect to support more research to determine if BPA in receipts poses a risk to human health.

IV. Analysis of Bisphenol-A

A. Simple Analysis

Bisphenol-A is a substance that can be determined among plastic bottles after such experiment. 3 types of plastics are tested, plastic drinking cups, Plastic water bottles and plastic juice bottles. Three attempts are made for every type of plastic containers. Results obtained are recorded and compared to the guide that will indicate if it possesses Bisphenol – A substance.

Materials and Equipments

Cotton swab, plastic water bottles, plastic Drinking cups, Small disposable white Plastic plate, Plastic Juice bottles/ Soft drink bottles, Electric Stove, Iron (III) Chloride, Ethyl alcohol.

Preparation of Indicator

In the preparation of the indicator, DE-ionized water will be made after de-ionizing the distilled water. The De-ionized water was mixed to iron (III) chloride to form the indicator for the whole samples.

Procedure

1. In a freshly boiled water, the item which to be tested is placed and left for five minutes.
2. Make sure that the container is large enough, so that the plastic item is fit inside itself. The increase in temperature causes the leaching of any Bisphenol A present in plastic item.
3. Then the plastic item is removed from the water containing container.
4. Dip the cotton swab in the alcohol, and rub against the surface of the plastic item for one minute.
5. This swabbing technique should result in the transfer of any free Bisphenol -A onto the cotton swab.
6. Allow the swab to dry in the air for a few minutes.
7. Prepare the indicator solution in accordance with the instruction by mixing $\frac{1}{4}$ tsp. Of the indicator with 1 cup de-ionized water. Label the solution as INDICATOR to avoid mistakes.
8. At the cotton swab, place a drop of INDICATOR and look for a color change. If Bisphenol-A has leached from the plastic container, a purple, blue or green coloration should occur within 5 minutes.
9. Repeat the same procedure using a clean cotton swab.

Table.1 Guide Color for Bisphenol-A

Color that should be seen at the swab if it positively made from Bisphenol-A								
Plastic drinking Cups			Plastic Water Bottles			Plastic Juice Bottles		
Purple	Blue	Green	Purple	Blue	Green	Purple	Blue	Green

This guide was based on a ferric chloride test wherein the organic substance is dissolved in water, methanol or ethanol, then the neutralized iron(III) chloride solution is added a transient or permanent coloration (usually purple, green or blue) indicated the presence of a phenol. This method is able to detect BPA content down to 0.1% .

B. Analysis BPA levels in Human Urine

A morning spot urine specimen was collected and kept at -80 degree Celsius until analysis. Urine (50microlitre) was buffered with 30microlitre of 2.0M sodium acetate buffer (pH 5.0) and hydrolyzed enzymatically with beta-glucuronidase/ sulfatase (4,414/168 U/microlitre) for 3hr at 37 degree Celsius in a shaking water bath. After hydrolysis, 100microlitre of 2N HCl was added, and the hydrolysate was extracted once with 5mL of ethyl acetate with 10 micro gram / litre bisphenol-B (internal standard). After centrifugation, 4mL of supernatant was transferred to a new tube and evaporated with Nitrogen gas (N₂). The residue was dissolved with 200microlitre of 60%acetonitrile in water, and 40microlitre of the solution was injected onto the high-performance liquid chromatography (HPLC) system.

V. Safety Level of Bisphenol-A in Human Body

TDI suggests a safe daily intake of 240 microgram, averagely for a 60Kg person. The typical daily BPA- intake of that person is approximately 4 microgram/Kg bodyweight/day. Due to the small weight and rapid growth of the babies and children, they are at higher risk. One serving of several of the infant foods we tested delivers about 50 micrograms of BPA in one hit, so a 10Kg infant would get 10% extra than the safe exposure limit from this one source alone. Alternative substitutions for BPA are Oleoresin, Poly Vinyl Chloride, Acrylic, Polyester.

VI. Minimizing Exposure to BPA

1. Look for BPA free products in market. Look for products labelled as BPA free. If a Product isn't labelled, keep in mind that some, but not all, plastics marked with recycle code 3 or 8 may be made with BPA.
2. Cut back on cans. Reduce your use of canned foods, since most cans are lined with BPA containing resin.
3. Avoid heat. Experts warn us that microwaving food cans or plastics may also cause BPA leaching into food.
4. Use Alternatives. Use glass, porcelain or stainless steel containers for hot foods and liquids instead of plastic containers.

VII. Conclusion

We have reported that BPA exposure was associated with adverse reproductive endpoints among male workers who were occupationally exposed to BPA, including poor semen quality, decreased sexual function, and reproductive hormone and sperm methylation alteration. Together, these data raised concerns about the potentially deleterious impact of BPA on human reproductive health. Public awareness of on these deleterious effects should be strengthened and protection against BPA exposure should be promoted.

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Recycling of Wash Water from RMC Plants

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Abstract: Disposal of waste water from Ready Mixed Concrete (RMC) operations is an important concern of the ready-mixed concrete producers. Most of the traditional disposal systems are no longer environmentally acceptable. It is a common practice in the ready-mixed concrete industry to wash out transit mixer drum at the end of each batch delivery to prevent fresh concrete residue from settling in the drum using approximately 1000 litres of water. Additionally water arises from washing down the yard and batching plant. The current practices for the disposal of wash water include dumping at the job site or dumping at a landfill. Due to this, the groundwater at the dumping site gets polluted. Hence it is necessary to address the problem of handling wastes produced in the RMC operations. Major issues discussed include, source, quality and quantity of waste water; waste water control systems and chemical stabilizing agents. Alternative solution is to recycle the wastewater and use it as batch water to make fresh concrete. The waste consists mainly of water and a variable proportion of coarse and fine aggregates, cementitious powders and chemical admixture.

Keywords: Wash Water, transit mixer, Disposal at landfill, pollution of water, recycling waste water

I. Introduction

Ready-mixed concrete is a type of concrete that is manufactured in a factory or batching plant, according to a set recipe, and then delivered to a work site, by truck mounted transit mixers. Increase in the use of concrete at the construction end increased the number of RMC plants in India and other countries. In developed countries, nearly 70% of cement consumption is in the form of ready mix concrete and 25% in the form of recast. Whereas in India, ready mix concrete accounts for less than 9% and as much as 82% of cement consumption is in the form of site-mixed concrete. The less consumption of cement in the RMC plants of India is due to shortage of cement supply and the government policies in the early 1970s. According to a 2013 report by BMPTC (Building Materials & Technology Promotion Council), it is estimated that India produces around 35-40 million m³ of concrete annually from around 1000 RMC facilities spread over the country. The projected growth of RMC plants is expected to be over 7% in the next 5 years. Many of the RMC plants in India are modern computerized batching plants with automated controls. Overall ready-mix penetration in India is around 9% but it is projected to be 14% by 2017-18. The demand is highest from the housing segment followed by infrastructure and industry respectively. While earlier, demand for RMC was largely seen in the metros, the industry has now grown to all parts of the country including Tier 2 and 3 cities. In terms of regional distribution, the western and southern regions contribute to majority of India's RMC demand. Both these regions have higher concentration of urban areas with relatively higher number of projects involving construction of multiple high rise buildings and large scale infrastructure projects which compulsorily focus on the quality of concrete and its timely availability.

II. Challenges in RMC Plants

Truck mounted transit mixers are used to transport the concrete to the sites. These truck mounted transit mixers are available in the range of 4 m³ to 9 m³ to carry the concrete. At the end of each working day, it is common practice for the ready-mixed concrete industry to thoroughly clean the inside of a concrete truck's drum and it produces large amounts of waste wash water that leads to problem of environmental impact. For example a transit mixer of capacity 9 m³ contains, at the end of each working day, approximately 200 to 400 kg of returned plastic concrete. This material can be left overnight in the truck with the addition of hydration control admixtures or washed out. When washed out, along with the addition of about 1000litres of water, it produces waste wash water that contains cement particles, aggregates and chemical admixtures. Disposal of this waste water from the RMC operations is a challenge for the most of the cement industries. The current practices for the disposal of

concrete wash water include dumping at the job site, dumping at a landfill or dumping into a concrete wash water pit at the RMC plant. This contaminates the ground water due to its alkaline nature. Wash water also contains high sulphate and chloride content as cement being its main constituent. The total solids are one of the constituent due to which turbidity occurs in the ground water. Since the traditional disposal of wash water is hazardous to the ground water and it is no longer environmentally acceptable, an alternative solution is to recycle and use it for making fresh concrete.

III. Properties of Waste Wash water

The quality of waste wash water from the RMC operations is derived from the source of water itself. Wash water discharge from truck contains cementitious materials and chemical admixture residue. Because of that the wash water cannot be run out from the RMC plant to the environment as effluent without adequate treatment. But the treatment process for the wash water is relatively expensive for the RMC producers. The physical and chemical properties of tap water and wash water are compared with the drinking water specification as per IS: 10500-2012 and it is given in *Table I*. It shows that the wash water cannot be treated and reused either for drinking and irrigation purposes. Hence it can be only be recycled to the concrete making.

Table I Physical and Chemical Properties of Waste Wash Water

S.No	Parameter	Tap Water	Wash Water	IS:10500-2012
1	Turbidity (NTU)	--	690	1
2	Temperature (°C)	25	18.5	--
3	pH	8.0	12.5	6.5 to 8.5
4	Total Solids (mg/l)	530	2500	500
5	Sodium ion (mg/l)	93	260	--
6	Ferrous ion (mg/l)	0.6	26	0.3
7	Total Alkalinity (mg/l Ca CO ₃)	115	835	200
8	Total Hardness (mg/l Ca CO ₃)	196	750	200
9	Sulphate (mg/l)	104	320	200
10	Calcium (mg/l)	49.7	284	75
11	Chlorine (mg/l)	125	125	250
12	Potassium ion (mg/l)	--	51	--
13	Phosphate (mg/l)	0	0.129	--
14	Chromium (mg/l)	0	2.591	--
15	Cadmium (mg/l)	0	0.041	0.01
16	Lead (mg/l)	0	0.604	0.1
17	Copper	0	0.024	0.05
18	COD (mg/l)	--	48	--
19	BOD (mg/l)	--	23.6	--

IV. Recycling of Wash water

The waste wash water can be recycled by mechanical and chemical means. In the mechanical treatment, the aggregate portion and wash water has been separated. The wash water contains water, cement and the thinnest part of the aggregates. This wash water can have a second treatment to separate as clear water and slurry. The clear water consists of water without any suspended solids, where ions have been generated from materials and compounds due to the contact with cement. This can be used either for mixing with the new concrete or for cleaning of the RMC plant equipment. In the chemical treatment method, the hydration of cement was stopped by the stabilizing additive and reactivated by the activating additives. But the disadvantage is, not more than one or two cubic meters of concrete can be activated and remixed with the new concrete. The chemical method of treatment needs a specialist staff to handle the concrete mix. In addition, the use of additives increases the cost of the process.

V. Environmental Regulations to RMC Plant

Production of large amounts of waste wash water coming from the RMC plants leads to problems of environmental impact. National laws usually prohibit the disposal of such types of water due to their extremely high pH value and suspended solid amount and require the water to be treated prior to discharge. Several countries lay limits for different parameters, which will reduce the impact on the environment. Some of the international organizations namely European ready mixed concrete organization and national ready mixed concrete association (USA) has published guidelines for minimizing the environmental impact of ready mixed concrete plants. The ASTM specification for Ready Mixed Concrete (C 94) permits the use of waste water from mixer truck washout operations for making fresh concrete. The levels of impurities permitted in the wash water should be below the maximum concentration criteria as follows: Chloride as Cl⁻ (500 ppm), Sulfates as SO₄ (3000 ppm), Alkalies as Na₂O equivalent (600 ppm), and Total Solids (50,000 ppm). In India IS: 4925 and IS: 4926 addresses all issues relevant to Plant equipment, production and quality of concrete without concern with the environmental impact issues. But in the IS 4926-2003 specification for ready-mix concrete clause 4.6.2, permitted to use waste wash water as long as concrete of satisfactory performance can be produced. It is also indicated to take steps for monitoring the build-up of chlorides in any re-circulated water and that any subsequent

adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water should be monitored and controlled to meet these requirements. Hence in Indian scenario the use of wash water in batching fresh concrete is not being followed in absence of local research and cost effective recycling techniques. At present in India for regulations reference was made to relevant guidelines laid by the central pollution control board and it is given in *Table II* and compared with other country regulations.

Table II Guidelines for the Discharge of Effluents of Waste Water in to the Environment

S.No	Parameter	CPCB, India		NPDES, USA		Concrete Federation UK	Concrete Products Canada	Concrete Batching Industry Australia
		Surface Water	Public Sewers	Process Water	Storm water			
1	Total suspended solids	100	600	50	150	35	75	80
2	pH	5.5-9.0	5.5-9.0	6.0-9.0	6.5-9.0	<9.0	6.5-9.0	6.0-9.0
3	Chlorine	1.0	--	--	--	--	--	--
4	Iron	3.0	3.0	5.0	5.0	--	--	--
5	Chromium	2.0	2.0	--	--	--	--	--
6	COD	250	--	--	120	--	--	--

VI. Waste Wash water Utilization

RMC plants in India should give an emphasis on water conservation by recycling the waste wash water to avoid the environmental problem and wastage. In this regard several researches have been developed a new way to reuse this water in the manufacture of concrete and concrete products.

A) Effect of Waste Wash Water on the Properties of Concrete:

The effect of 100% wash water is to reduce the setting time and compressive strength of cement mortar. But at 50% tap water and 50% waste wash water, maximum compressive strength is achieved in cement mortar. Concrete with waste wash water using different cement contents does not influence the compressive strength at the various ages. No significant effect is found on the workability of concrete using waste wash water.

VII. Conclusion

The disposal of leftover concrete and waste wash water from ready-mix concrete trucks is becoming an increasingly greater environmental concern in all the RMC plants in India. This is due to the non-availability of separate regulatory body for controlling the RMC waste materials. The existing IS: 4926-2003 code has to be reviewed to show the limits on the effluents for recycling to make fresh concrete in the RMC plants. As per the research it shows that the waste wash water has no effect on the strength and durability of concrete. In this line recently UltraTech Cements Ltd., was the first company in India to adopt 'baton wash' (waste wash water) technology for concrete recycling at its plants in India.

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Electro-Coagulation of Synthetic Acid Black 210 and Acid Red 1 dye bath effluent using Fe and Al Electrodes in a recirculation cell

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Abstract: Tannery effluents are mainly characterized by high salinity, high toxicity, high organic loading and specific pollutant, chromium. Various chemicals used in tanning include lime, sodium carbonate, sodium bicarbonate, common salt, sodium sulphate, chrome sulphate, fat liquors, vegetable oils and dyes. Wastewater from tannery dye bath having high chemical oxygen demand exceeding 1600 mg/l and a strong dark colour is categorized as high strength wastewater. Treatment of dye bath effluent by electrocoagulation using Fe and Al electrode materials were investigated. Higher concentrations of wastewater from 1000, 1500, 2000, upto 3500 mg/l are synthetically prepared using Acid Black 210 and Acid Red 1 dyes. These dyes were chosen as about 80% of leather is either black or brown. The effects of wastewater characteristics such as conductivity and pH, and important process variables such as current density and operating time on the TDS, BOD and COD have been explored. Furthermore, the electrode, the distance between the electrodes and energy consumptions for each electrode have been calculated. The results show that Fe was superior to Al as sacrificial electrode material, from COD removal efficiency and energy consumption points.

Keywords: Tannery effluent, Electrocoagulation, Fe and Al electrodes, Acid Black 210, Acid Red 1 dyes

I. Introduction

Leather industry is a red industry according to the Pollution Control Board and it produces a large quantity of waste water. India is the third largest leather producer in the world, behind China and Italy. The Indian leather industry is a large player in the global market, and a major source of foreign exchange revenues. The leather industry in India processes 3000 tons of hide and skins per annum and the total production capacity of India covers about 22% of the world market share. On the other hand, tannery wastes are ranked as the highest pollutants among all other industrial wastes [1]. There are two types of tanning processes namely, vegetable tanning and chrome tanning. The chrome tanning process results in toxic metals especially chromium and it passing to wastewater and not easily eliminated by ordinary treatment process.

Tannery effluents are mainly characterized by high salinity, high toxicity, high organic loading and specific pollutant such as chromium. Various chemicals used in tanning are lime, sodium carbonate, sodium bicarbonate, common salt, sodium sulphate, chrome sulphate, fat liquors, vegetable oils and dyes [2]. Besides these, chemicals such as zinc chloride, mercuric chloride and formaldehyde are also used as disinfectants, sodium chloride in curing and as bleaching powder and sodium fluoride to prevent putrefaction [3]. Hence the tannery effluent is always characterized by its strong color, high COD, high pH, and high dissolved solids [4]. Considering the large amount and the low biodegradability of chemicals present in the tannery productive cycle, tannery wastewater represents serious environmental and technological problems.

Tannery wastewater is usually contaminated with high concentrations of chlorides, aliphatic sulfonates, sulfates, aromatic and ethoxylates, acrylic acid condensates, fatty acids, dyes, proteins, soluble carbohydrates and sodium sulfide and this pose a big problem for treatment of tannery wastewater [5]. Thus it is necessary to find an effective treatment method.

Tannery effluent can be generally classified into four categories soak effluent, lime effluent, chrome effluent and dye bath effluent. This stream, called soak liquor, consists of 2-4% sodium chloride by weight and contains traces of calcium chloride along with bioparticles such as blood, flesh, skin, and other suspended particles [6]. In that soak effluent is first treated biologically and then mixed with the lime effluent in the equalization tank to normalize the pH. The chrome effluent is treated with Magnesium hydroxide and concentrated sulphuric acid to precipitate the Chromium sulphate into hydroxide. This salt is taken to the factories for chemical process and recycled to pure chromium sulphate salts.

Thus the remaining dye bath effluents pose a greater threat in the treatment process highly acidic and dark colour. Wastewater from tannery dye bath having high chemical oxygen demand exceeding 1600 mg/l and a strong dark colour is categorized as high strength wastewater [7]. About 80% of leather is either black or brown and hence for this study Acid Black 210 and Acid Red 1 were used. The molecular structures of the two dyes are shown in the Fig. 1. and Fig. 2.

Figure 1 Acid Black 210

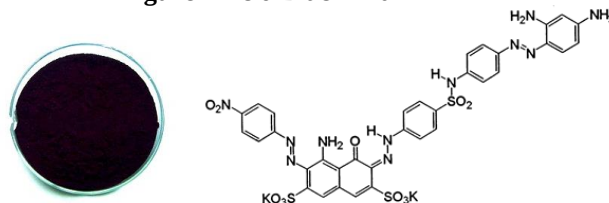
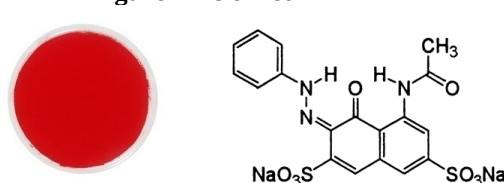


Figure 2 Acid Red 1



Acid Black 210 (M.F/M.W: C₃₄H₂₅N₁₁Na₂O₁₁S₃=938.02) also known as Black NT, Acid Black BRL, Derma Carbon AF, Everlan Black FG, Indacid Black NT or Vicoacid Black J has the maximum wavelength of 610 nm and second peak at 449 nm. Acid Red 1 (M.F/M.W: C₁₈H₁₃N₃Na₂O₈S₂=509.41) also known as Amidonaphthol Red, Pontacyl Carmine, Azophloxine or Red 2G has the maximum wavelength of 506 nm second peak at 532 nm.

Electro coagulation (EC) is a process which depends on responses of water contaminants to strong electric fields and electrically induced oxidation and reduction reactions [8]. EC technique utilizes direct current to cause sacrificial electrode ions to remove undesirable contaminants either by chemical reaction and precipitation or by causing colloidal materials to coalesce and then they are removed by decantation, flotation or by filtration as in normal coagulation. Instead of adding a coagulant externally during EC, coagulants are obtained in situ by the dissolution of the anode.

The advantages of EC process are that it removes suspended and colloidal solids, fats, oil and grease, complex organic compounds, destroys bacteria, virus and cysts, colour, BOD and COD. This process has low operating cost, low power requirement, low maintenance and minimal chemical addition.

When the electrode material used is aluminium, the reactions are as follows [9]:

Anode: $\text{Al(s)} \rightarrow \text{Al}^{3+}(\text{aq}) + 3\text{e}^-$

Solution: $\text{Al}^{3+}(\text{aq}) + 3\text{H}_2\text{O} \rightarrow \text{Al(OH)}_3 + 3\text{H}^+(\text{aq})$

The metal cations (Al^{3+}) form mono complexes with hydroxides ions OH^- are finally converted into Al(OH)_3 in a complex precipitation kinetics.

While in the case of iron or mild steel electrodes, the mechanisms for the production of metal hydroxide are as follows [10]:

Anode: $\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$

$2\text{Fe}^{2+} + 5\text{H}_2\text{O} + 1/2\text{O}_2 \rightarrow 2\text{Fe(OH)}_3 + 4\text{H}^+$

$\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe(OH)}_2$

Cathode: $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH}^- + \text{H}_2$

Overall: $2\text{Fe} + 5\text{H}_2\text{O} + 1/2\text{O}_2 \rightarrow 2\text{Fe(OH)}_3 + 2\text{H}_2$

$\text{Fe} + 2\text{H}_2\text{O} \rightarrow \text{Fe(OH)}_2 + \text{H}_2$

During electrocoagulation process, metal hydroxides formation occurs, these flocs have a large surface area, which are beneficial for a rapid adsorption of soluble organic compounds and trapping of colloidal particles. Finally, these flocs are removed easily from aqueous medium by sedimentation or flotation.

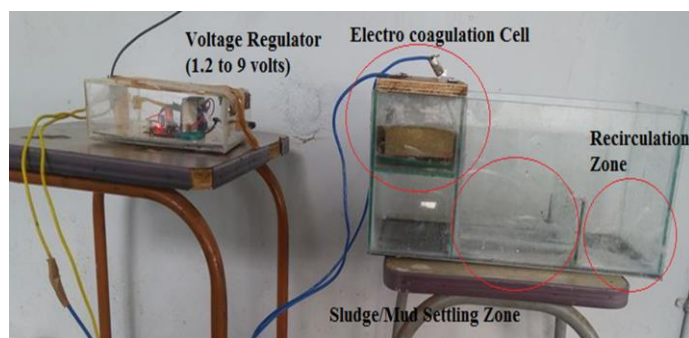
The primary objective was to achieve maximum purification rate at minimum time interval, optimize the pH level at various condition throughout the pre-treatment and also to achieve the electro-coagulation much effective.

II. Materials and Methods

Acid Black 210 and Acid Red 1 were purchased from Gautam Dyes & Chemicals Co., Chennai. Iron and Aluminium electrodes in the form of plates were employed in the electrocoagulation process. Glauber's salt (Sodium sulphate) and vinegar was purchased from Chemico Scientific Company, Erode.

For the batch electro-coagulation, the reactor consists of with the dimension of 18cm x 35cm x 16cm was used. The EC unit consists of four aluminium electrodes as bipolar system in the reactor and DC power supply. The dimensions of the electrodes were 10cm x 8cm x 2mm. The experimental setup is shown in Fig 4.

Figure 4 Experimental Setup for Electro-coagulation cell



III. Experimental

A. Preparation of synthetic dye-bath effluent

The synthetic wastewater of concentration 1000, 1500, 2000, upto 3500 mg/l was prepared and used for the study. Initial 2.5 wt% salt water solution was made using sodium sulphate. For each concentration, the weighed dye powder was made into a paste using cold water then mixed into the warm salt water at 60°C. Few drops of vinegar were added to the solution to get a homogeneous molecular distribution and then the solution was brought to the room temperature. The pH was maintained between 6 and 7. The pH of the solution was adjusted using 1:5 volume sulphuric acid. The buffer solution used in adjusting the pH in the coagulation unit was prepared by mixing 0.2 M NaOH and 0.1 M Na₂CO₃ with distilled water.

B. Batch Electrocoagulation studies

After initial characterization of wastewater, batch experimental studies were conducted to optimize the various parameters such as pH, electrolysis time and voltage. Experiments were performed with two electrodes connected to the DC power supply to determine optimum conditions. In the bipolar connection of electrodes, there is no electrical connection between inner electrodes; only the outer electrodes are connected to the power supply. The space between the six electrodes was maintained 1 cm in all the experiments. In each run the current was varied between 0.4 to 1 A using a AC to DC convertor which can give output current 0-2A and voltage 0-30V. To maintain homogenous mixing of the reactor content, magnetic stirring unit was used and operated at a constant speed. The EC experiments were performed for 120 min and in each run samples were collected at 30 min interval for necessary analysis using UV-Vis Absorption spectrophotometers with the reference wavelength of 610 nm for Acid Black 210 and 506 nm for Acid Red 1.

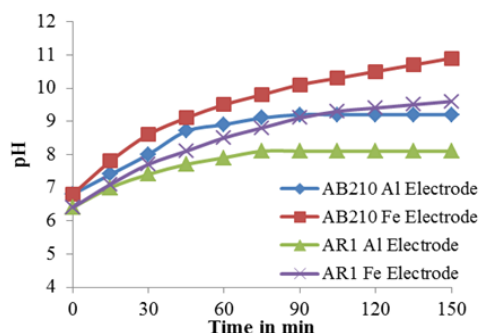
IV. Results and Discussion

A. Change in pH

The electrocoagulation treatment using aluminium electrodes induced an increase in the pH value and the solution pH stabilized at nearly constant value around 9.2 for Acid Black 210 with an initial pH of 6.8 and 8.1 for Acid Red 1 with an initial pH of 6.4, which may be due to the buffering capacity of complex nature of aqua Al³⁺/Al(OH)₃ system.

In the case of mild steel electrodes, pH value increases gradually during the electrocoagulation process due to the continuous dissolution of the electrode and formation of Fe(OH)₃ into the electro coagulation cell as given in the Fig 5.

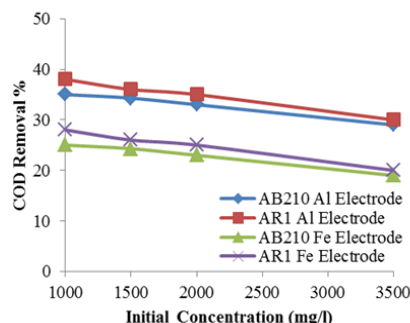
Figure 5 Change in pH during electro coagulation



B. Effect of initial concentration on COD removal

The initial concentration of the effluent was taken as 1000, 1500, 2000 and 3500 mg/l and the experiment were done with a constant current of 1.0 amperes and time 10 minutes and the COD of the solution were calculated separately for Al and Fe electrodes and the readings are given by Figure 3.2. For lower initial concentration the removal percentage was higher hence was found to be inversely related. The Acid Red 1 had a higher resistance towards coagulation compared to that of Acid Black 210. The COD reduction of Acid Black 210 and Acid Red 1 were almost the same as the formation of metallic coagulants and the removal of the pollutants depends only on the current supplied and time.

Figure 6 Effect of initial concentration on COD Removal



C. Effect of current on COD

The resistivity of Aluminium was found from the literature at 20°C as 2.65×10^{-8} ohm.m and mild steel as 15×10^{-8} ohm.m with temperature coefficients 3.8×10^{-3} and 6.6×10^{-3} respectively. Hence the sheet resistance of the aluminium and mild steel electrodes were calculated to be 0.994×10^{-4} ohm and 5.63×10^{-4} ohm respectively. For the Acid Black 210 dye bath solution of concentration 1000 mg/l the initial characteristics were found and tabulated as in Table 1.

Table 1 Initial Characteristics of Synthetic Dye Effluent

S.No	Parameter	Value
1.	COD ppm	3250
2.	BOD ppm	1340
3.	TDS (mg/l)	7200
4.	pH	7.1

Thus for various current values of 0.4, 0.6, 0.8 and 1.0 A the COD removal was calculated and found that the maximum current of 1.0 A had the maximum COD removal percentage.

Figure 7 Effect of current and time - Acid Black 210 – A) Al Electrode B) Fe Electrode

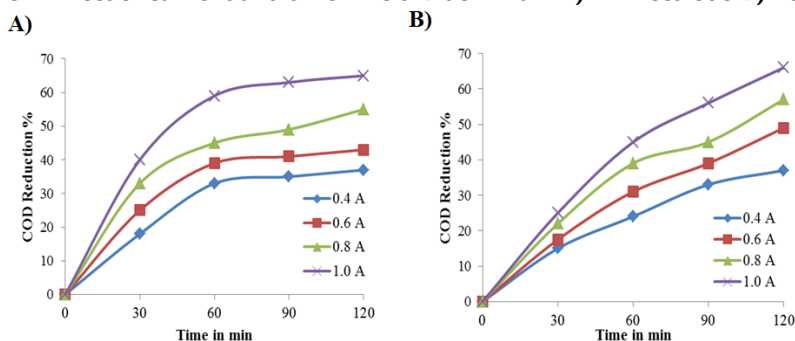
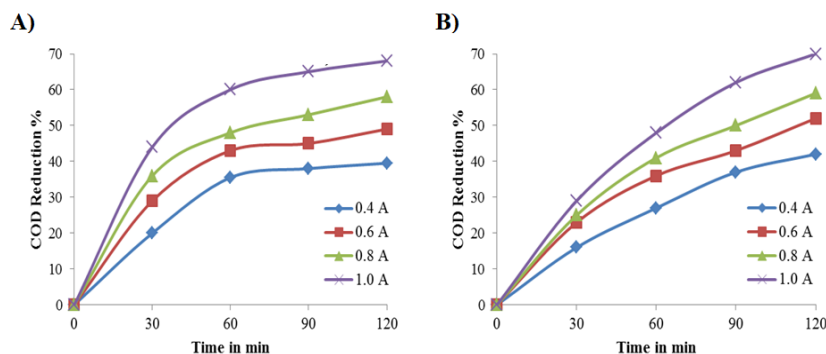


Figure 8 Effect of current and time - Acid Red 1 – A) Al Electrode B) Fe Electrode



The highest cell current produced the quickest treatment reduction of 70.2% and 67.9% COD reduction occurring after 120 min with Fe and Al electrodes respectively. The COD removal % is shown in Figures 3.3-3.6. It may be the fact that the amount of cell current determined the coagulant production rate, and adjusted the rate and size of the bubble production. At higher cell current, the amount of metal oxidized increased, resulting in a greater amount of hydroxide flocs for the removal of pollutants. Furthermore, the bubbles density increased and their size decreased with the increasing of cell current, resulting in a faster removal of pollutants.

Other parameters like BOD5 and TDS for 1000mg/l wastewater at 1.0 A for 120 minutes were also studied and showed a significant reduction and are given by the Table II.

Table II. Percentage Reduction of BOD₅ and TDS for various electrodes

S.No	Category	Percentage Reduction			
		Acid Black 210-Al electrode	Acid Black 210-Fe electrode	Acid Red 1-Al electrode	Acid Red 1-Fe electrode
1.	BOD5 ppm	61.8	66.3	67.8	70.3
2.	TDS mg/l	71.2	74.3	75.5	78.8

V. Conclusion

From the results obtained it can be concluded that the electrocoagulation can be effectively used for the treatment of tannery dye bath effluent. The electrocoagulation generates metallic complex molecules that combine with the high molecular weight dye molecules and thus reduces the COD, BOD and TDS.

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Studies on Performance of Triple Effect Forced Circulation Evaporator at Perundurai Common Effluent Treatment Plant

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Abstract: Saline effluent from textile industries has long been considered waste brine and traditional approaches to its disposal have included evaporation ponds, deep wells, and coastal discharge. However, such effluent is now being considered as a saline resource. Therefore, alternative approaches have been developed to extract available salts and to recover purified water. One such advanced treatment technique is triple effect forced circulation evaporator in Perundurai common effluent treatment plant (PCETP), SIPCOT, Perundurai, to treat the 14 textile industrial waste water. This work presents the performance analysis of triple effect forced circulation evaporator on the basis of variation of operating parameters such as occupied capacity of crystallizer, residence time, temperature of heat exchanger, flow rate of cooling water and their effect on color and size distribution of salt crystals, amount of water separated, amount of salt separated and energy consumption for three effects. This study has been carried out at Common Effluent Treatment Plant (CETP), Perundurai, SIPCOT, Erode) occurs when the efficient residence time is 25-55 minutes.

Keywords: Zero discharge desalination process, Forced circulation evaporator, Separation of salt and water, Forced circulation crystallizer

I. Introduction

India is the second largest export of cotton yarn. There are about 10,000 garment manufacturers and 2200 bleaching and dyeing industries in India. Majority are concentrated at Erode and Tirupur district of Tamil Nadu, Surat in Gujarat and Ludhiana in Punjab. Erode and Tirupur district at least having 50% of dyeing and bleaching industries where in 30% industries are attached to CETP. Dyeing is a combined process of bleaching and coloring, which generates voluminous quantities of wastewaters and in turn causes environmental degradation. These effluents consist of high TDS, chloride, sulphate, hardness and carcinogenic dye ingredients. The untreated textile wastewater can cause rapid depletion of dissolved oxygen if it is directly discharged into the surface water sources due to its high BOD value. The effluents with high levels of BOD and COD values are highly toxic to biological life. The quality of such effluent can be analyzed by their physico-chemical and biological analysis. Monitoring of the environmental parameters of the effluent would allow having, at any time, a precise idea on performance evaluation of ETP and if necessary, appropriate measures may be undertaken to prevent adverse impact on environment. The obtained results were very much useful in identification and rectification of operational and maintenance problems and it can be also utilized to establish methods for improved textile industry and plant waste minimization strategies.

A. Perundurai Common Effluent Treatment Plant (PCETP)

Water treatment is a very important step to change these conditions and to achieve a sustainable situation. India's government has an awareness of this and limits for water effluent quality exist. Unfortunately, this regulation is not closely supervised and a lot of places do not follow the regulation. In newly developed industrial areas advanced wastewater treatment is used for textile effluent, as the one such place is SIPCOT in Perundurai. Each industry bears the responsibility for dealing with the effluent water from their processing. Therefore the 14 textile units together formed PCETP. Each of the units has different shares in the treatment plant and consequently they are allowed different maximum flows that they can discharge to the treatment plant. The treatment plant only handles industrial effluent from those 14 textile industries. PCETP can operate 3600 m³/d wash water and 450 m³/d dye bath.

B. Dye bath treatment plant

The dye bath treatment uses an evaporator for cleaning the water. Before the evaporator the water is pre-treated in the form of sedimentation and fine screening. The evaporation unit is a high technology system that vaporizes the water in eight different evaporation tanks, five falling and three forced circulation

evaporators. The Outcomes from the evaporation tanks are two different waters, condensate water that goes back to the industries and the concentrated water that goes to centrifuge. In centrifuge about 90% of sodium chloride (Na Cl) salt is separated, collected and stored in sacks under roof. They produce 3.6 tons of salt every day, purifying the salt where it can be reused in the textile industries.

C. Wash water treatment plant

In the wash water treatment plant COD and BOD is reduced by 40-60%. They regularly measure pH, TSS, BOD, COD and TDS. The plant has no seasonal variation as the textile industry produces the same quantity the throughout the year. The energy consumption is approximately 0.9 kWh/m³ water treated and the cost is Rs.12-20 m³ treated water.

D. Evaporation

Evaporation is an operation used to remove a liquid from solution, suspension or emulsion by boiling off some of the liquid. It is thus a thermal separation or thermal concentration process. We define the evaporation as one that starts with a liquid product and ends up with more concentrated one [1].

E. Forced circulation Evaporator

Forced circulation evaporation is used if boiling of the product on the heating surfaces is to be avoided due to the fouling characteristics of the product, or to avoid crystallization. The Circulation liquid is heated when it flow through the heat exchanger and then partially evaporated when the pressure is reduced in the separator, cooling the liquid to the boiling temperature corresponding to this pressure. Forced circulation evaporators normally used for liquid which prone to fouling, scaling, and crystallizing or those which are inversely soluble or while concentrating thermally degradable materials.

According to PCETP, different serial units such as pretreatment units, multiple effects falling film and forced circulation has been in operation to separate salt and re usable water. Feed supply of five effect falling film evaporator is the exit stream from pretreatment unit and feed source of three effect forced circulation evaporator is the concentrate of five effect falling film evaporator. This crystallizer is one stage of the zero discharge desalination processes. The authors focus on the crystallizing section. Since forced circulation evaporators are optimally suited as crystallizing evaporators for saline solutions this type is considered, Farshad Farahbod *et al.*³. As in this type of crystallizer the temperature of heat exchanger, flow rate of cooling water, vessel design, vaporization rate and residence time can have a major impact on the size distribution and the amount of crystals produced so, this work has perused on major principles in performance of three effect forced circulation evaporator supposed to salt and water separation.

II. Materials and Methods

The whole evaporator plant is constructed of stainless steel to prevent corrosion from high concentrated sodium chloride in high temperature. Of course the setup is insulated to conserve energy. By means of thermocouple we shall record temperatures of important parts such as on suction line of centrifugal pump, entrance line to heat exchanger (calendria), crystallizer (last effect) and on exit line of heat exchanger (calendria). A glass gauge illustrates the level of liquor in the crystallizer (last effect) and a pressure gauge is provided on top of the crystallizer (last effect) to monitor the vapor pressure and provide safety. Two electrical coils supply energy for heat exchanger and temperature can be set in different values. A surface condenser is situated on top of the crystallizer (last effect) and vapor condenses through it by cooling water circulation from cooling tower.

Slurry from falling film evaporator is pumped from the bottom cone of the crystallizer (last effect) through the tubes of the calendria, where heat is added, and back into the main body of the crystallizer where evaporation occurs. The liquor in a forced circulation evaporator is pumped through the tubes of three effects to decrease tube scaling or salting when precipitates are formed during evaporation. Three circulation pumps keep the crystal slurry in homogeneous suspension throughout the cycle and heat exchanger is located on the discharge side of the circulating pump. The heated liquid then flows into the vapor space, where flash evaporation occurs, giving some super saturation. The vapor leaving is condensed in the condenser and the supersaturated liquid flows down the down flow tube and then up through the bed of fluidized and agitated crystals, which are growing in size. The leaving saturated liquid will be transferred to second and third effect by means of transfer pump, finally goes back as a recycle stream to the heater, where it is joined by the entering fluid. The larger crystals (salts) settle out and with mother liquid are withdrawn as product.

Fig. 1 shows sketch of triple effect forced circulation evaporator in PCETP. Sufficient slurry height (submergence) is maintained in the main body of the crystallizer and at the top of the heat exchanger to prevent local boiling on the tube surface. This is necessary to preclude salt precipitation on the tangential inlet and tubes so a high circulation rate is provided for adequate tube velocity to achieve good heat transfer. Therefore, higher slurry temperature rises are assured which maximize super saturation of the solution. A sufficient quantity of

salt crystals is suspended in the circulating system to provide seed crystals in the main body of the crystallizer for salt growth. Adherence to these basic principles of crystallization results in coarse crystals and minimal wall and tube salting, so less equipment washing is required. The main body of crystallizer is conservatively designed both in diameter and height. It is important to have an adequate free space above the liquor level to allow the liquor droplets entrained in the vapor leaving the boiling surface to reach equilibrium and return by gravity to the circulating slurry. The large diameters result in low vapor velocities which minimize entrainment and provide adequate retention time for salt growth. The condenser is mounted on the vapor body. A short piece of vertical pipe connects the top of the main body of the crystallizer with the condenser to minimize pressure drop. Finally, super saturation is reached by evaporation then circulating liquor is drawn by the centrifugal pump down inside the tube side of the heater and returns to the crystallizer.

A. Feed characteristics

Table.1 shows the average chemical analysis of reject from five effect falling film evaporator which is fed to triple effect forced circulation evaporator during the desalination process.

S.No	Component	Concentration
1	TDS	125000 ppm
2	TH	400 mg/l
3	pH	44312 ppm
4	S.G @ 30 C	1.07

Table.1 the average chemical analysis of forced circulation feed waste water

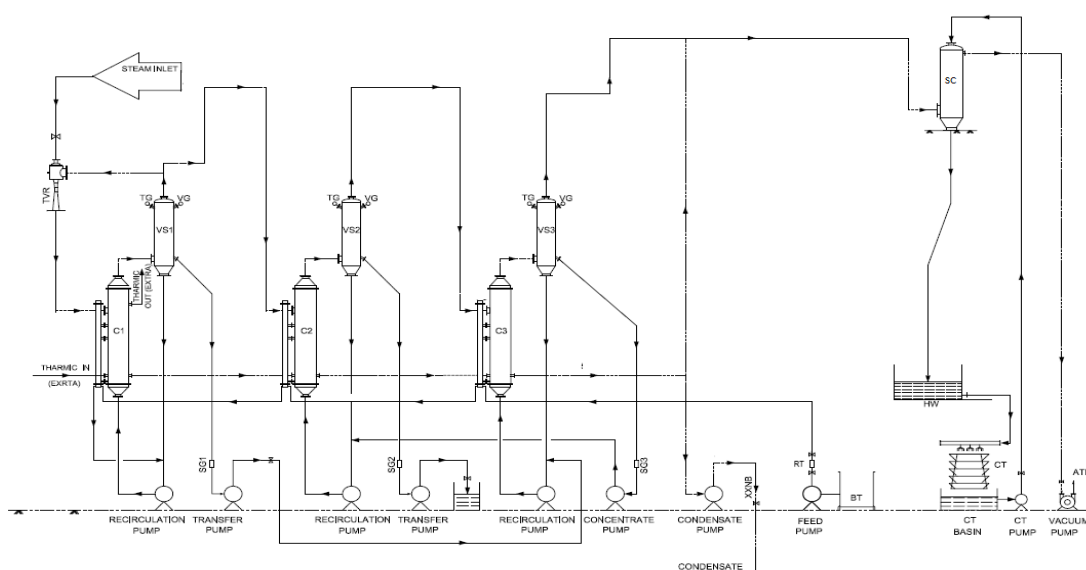


Fig.1 Schematic diagram of triple effect forced circulation evaporator in PCETP

III. Results and Discussion

In this experimental work the cooling water flow rate, residence time and occupied volume percentage of the crystallizer are investigated as major independent variables on crystallization performance and the effect of these parameters is discussed in the following parts.

A. The variation of residence time and its effects:

The effect of residence time variation on the operating parameters such as quality and quantity of separated salt crystals, energy consumption, pH, concentration and density of produced slurry and amount of condensate water separated was studied. As shown in Fig. 2, the amount of condensate water increases with increasing of feed residence time. Fig. 3 shows that consumption of energy is increased with solution temperature and residence time. Fig. 4 shows the amount of salt separated with increasing residence time.

Fig. 5 shows that residence time increases the amount and average size range of produced salt crystals, similar to Juliana Hash *et al* (2008). Size of crystals is enhanced by more circulation and also more vaporization rate because an increase in salt concentration resulted in an overall increase in crystal sizes. Also, the amount of produced crystals increases if vaporization process prolongs. So, optimized results of energy

consumption and amount of produced salt are in 3 hr as residence time compared with 2 hr and 4 hr. The effect of residence time on density of produced slurry is shown in Fig. 6

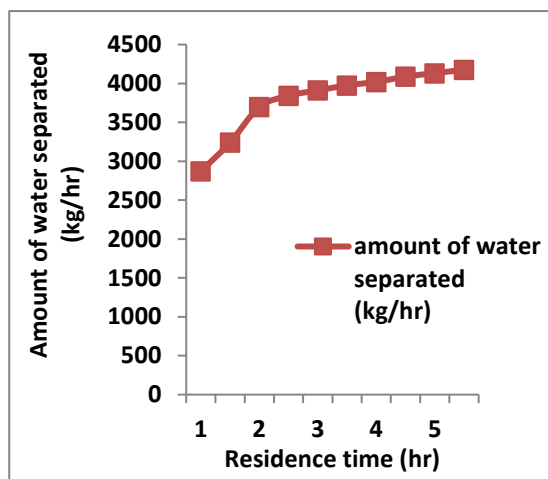


Fig. 2 Variation of Condensate water with residence time

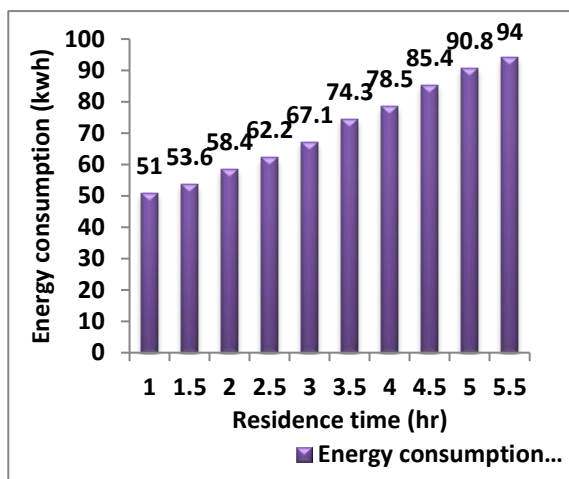


Fig. 3 consumption of energy versus residence time

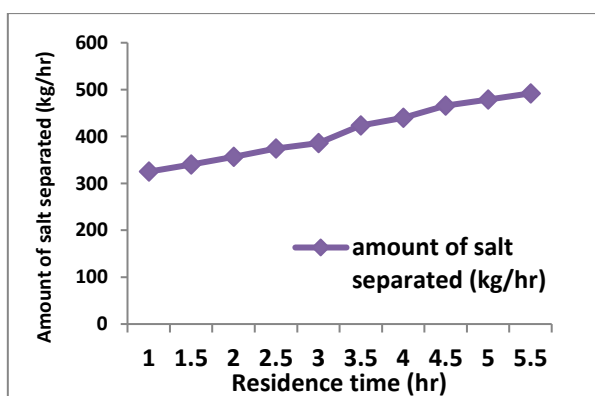


Fig. 4 Amount of salt separated with increasing residence time

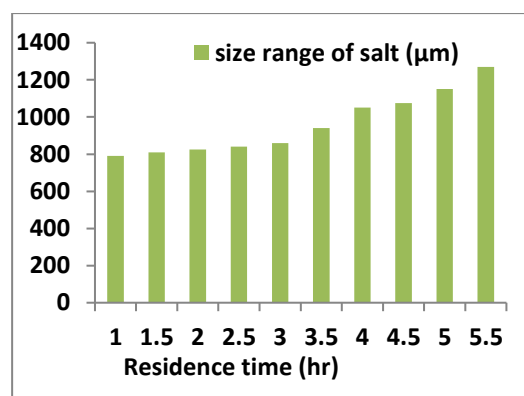


Fig. 5 Average size range versus residence time

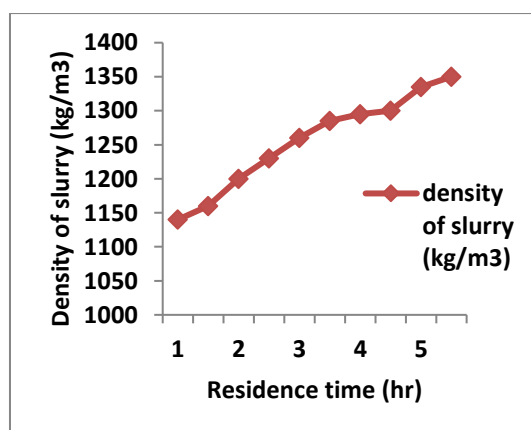


Fig. 6 Density of slurry versus residence time

B. Variation occupied volume % of crystallizer and its effects:

Cooling water flow rate in condenser and residence time of feed in crystallizer (last effect) are extremely important in crystallization process. The occupied volume percentage of the crystallizer is another major parameter which affects the amount of produced salt crystals, growth of crystalline and empty space of crystallizer, Fig. 7 shows the amount of energy consumption versus residence time for different occupied volumes and this obtained 70% total volume of the crystallizer is the best value.

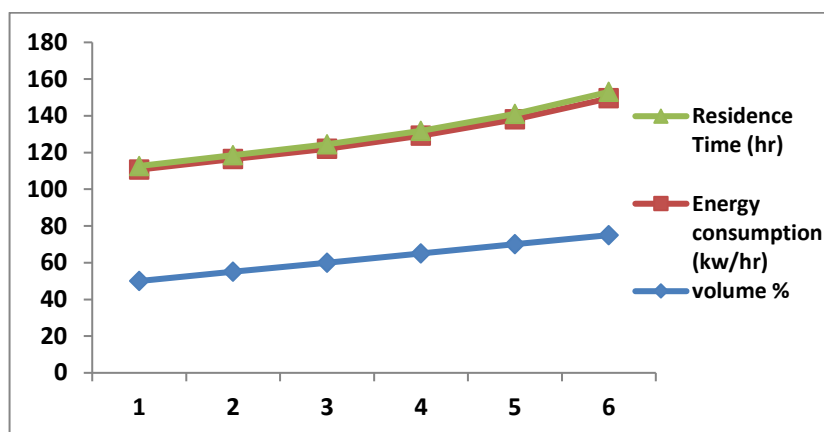


Fig. 7 Amount of energy consumption versus residence time for different volumes

Since forced circulation evaporators are optimally suited as crystallizing evaporators for treating the textile waste water comprising of sodium chloride salt this type is considered Farshad Farahbod *et al.*³ So, in this performance analysis, major variables in performance of triple effect forced circulation evaporator supposed to salt and water separation are investigated. Results show that residence time of 3 hr is the best duration for this Experiment because the crystal growth is in the suitable range (740-860 μ m) and also the maximum rate of salt separated and minimum energy consumption about 67.5 kWh are obtained. Comparing with literature, industrial salt crystals such as fine grade salt and coarse grade are usually in the size range of 0.08 mm and 0.08–2 mm, respectively. So, obtained size distribution of crystals in this work is good enough.

Another major parameter is cooling water flow rate in the condenser and according to the experimental results the optimum value is 210 kg/hr. With this flow rate of cooling water the energy consumption is less and the amount of separated salt is remarkable compared with the other flow rates. Dimensions of the main body and occupied volume space affect the size of salt crystals and also the rate of vaporization, so different occupied volume percentages are studied. Minimum entrainment and also reasonable salt production are obtained when the occupied capacity of crystallizer is 70%.

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