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ACCUMULATION OF HEAVY METALS IN OIL AND GAS INDUSTRIAL SOLID WASTE

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Abstract: The present study deals with the “Accumulation of Heavy metals in Oil and Gas Industrial Solid Waste” were investigated in the laboratory analysis experiment. The Industrial solid waste samples were collected at the outlet of release channel of the “Oil and Gas Industry” at Kakinada, air-dried and was brought to the laboratory. These samples were tested for water analysis to identify the heavy metals. After testing of analysis Copper (Cu), Zinc (Zn), Iron (Fe) and Manganese (Mn) were reported very high levels in the Industrial Solid waste.

Keywords: Andhra Pradesh, East Godavari, Heavy Metals, Industrial Solid waste, Kakinada, Oil and Gas Industry, Sampling Stations.

I. Introduction

Environmental pollution is one of the major problems associated with rapid industrialization to affect a rise in living standards of the people. Consequently, pollution from wastes has emerged as a by-product of growth and development. The problems relating to disposal of industrial solid waste are associated with lack of infrastructure and technology facilities for industries to take proper safeguards. Any developing country, like India, inevitably has to look for industrialization for uplifting the national economy as well as to build *self-reliance*. Ever increasing demand for industrial raw materials not only results in the dwindling of non-renewable resources day-by-day, but also contributes to the pollution loads. Therefore, for *self-reliance*, efforts are to be made on one hand for the sustainable use of the resources and on the other to control pollution from wastes by exploring their new uses and safe utilization. The contamination of Industrial solid wastes has become a worldwide concern. Improper disposal of Industrial solid wastes is a potential source of contamination and results in enrichment of various types of substances.

II. Literature Review

Management of industrial solid waste is distinctly different from the approach used for municipal waste [1]. There is a lot of similarity between the characteristics of the waste from one municipality or one region and another, but for industrial waste, however, only a few industrial sectors or plants have a high degree of similarity between products and waste generated [2]. Nowadays industrial solid waste management is an important part of industry. The number of contaminated sites, which are polluted by industrial and hazardous waste, are increasing in developing countries [3]. Heavy metals can accumulate in living organisms and cause various diseases [4]. Heavy metal toxicity is potentially dangerous because of bioaccumulation through the food chain and this can cause hazardous effects on livestock and human health [5] and [6]. The contamination of Industrial solid wastes including mine wastes has become a worldwide concern. Several authors have shown a relationship between atmospheric elemental deposition and elevated elemental concentrations in plants and top soils, especially in cities and in the vicinity of emitting factories [7], [8], [9], [10] and [11]. Copper is one of the most abundant trace metal and micronutrient of great importance in agricultural production and occurs as Cu^+ and as Cu^{2+} [12]. Cu is also required as a co-factor of Cu-Zn superoxide dismutase [13]. A vital component of both photosynthetic (plastocyanin) and respiratory electron chains (cytochrome oxidase). Copper is also essential to human life and is required for various biological processes [14]. The average abundance of copper in the earth's crust is recorded as 24 to 55 ppm [15]. Zinc is slowly oxidised in moist air. Zinc is an essential element for the plant growth. Weathering produces Zn^{2+} which can substitute for Mg^{2+} in silicate minerals in the soil. Zinc (Zn) is an essential micronutrient that affects several metabolic processes of plants [16]. The common ores of iron are both iron oxides, and these can be reduced to iron by heating them with carbon in the form of coke. Coke is produced by heating coal in the absence of air. Coke is cheap and provides both the reducing agent for the reaction and also the heat source. The most commonly used iron ores are hematite, Fe_2O_3 and magnetite Fe_3O_4 . The higher oxides (MnO_2 , Mn_2O_3 , and Mn_3O_4) can all be reduced to manganous oxide (MnO) by carbon monoxide, but this

lower oxide can be reduced to the metal only at elevated temperatures by carbon. Accumulation of excessive manganese (Mn) in leaves causes a reduction of photosynthetic rate [17]. Mn is readily transported from root to shoot through the transpiration stream, but not readily remobilized through phloem to other organs after reaching the leaves [18]. Necrotic brown spotting on leaves, petioles and stems is a common symptom of Mn toxicity [19].

III. Study Area

The Kakinada city is the capital of East Godavari District of Andhra Pradesh on the central east coast of India. Kakinada is situated between the latitude 16°57' North and longitude 82°15' East.

The present study deals with the Accumulation Heavy metals in Oil and Gas Industrial Solid waste.

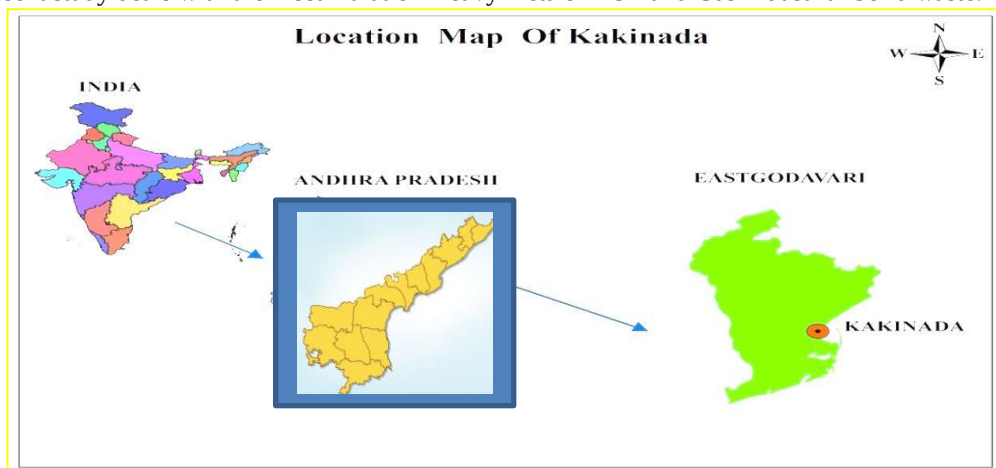


Fig 1: Location Map of Kakinada

IV. Material And Methods

A. Industrial Solid waste Collection

The Industrial solid waste samples were collected at the outlet of release channel of the “Oil and Gas Industry” at Kakinada, air-dried and was brought to the laboratory. Site longitude, latitude and altitude values are **82°16'24.42"E**; **17° 1'24.60"N** and **5 m**. The dried material was powdered in a mortar. ISW Disposal area longitude and latitude values are **17°01'27.52"N** and **82°16'28.48"E**. This Industrial Solid waste was sent to laboratory for estimate analysis of Physico-chemical characters.

V. Results And Discussion

Solid wastes contain both organic and inorganic matter in a variety of forms and a part of this tend to spread to the neighboring systems from where they are deposited. The solid wastes are sufficiently long-lived and very often pollute soil.

A. Physico - Chemical Analysis of ISW

The parameters selected for the study included Colour, Odour, Bulk density, Moisture content, pH, Electrical conductivity, Organic carbon, Organic matter, Total Nitrogen, Total Phosphorus, Exchangeable fractions of Potassium, Sodium, Calcium, Sulphates, and Chlorides. In addition to these, heavy metal contents of Copper, Zinc, Iron and Manganese are also reported. The data is presented in Table-1 & Fig-2.

Table 1: Physico - Chemical characteristics of Industrial Solid Waste (ISW)
(1% = 1 gram/100 gram = 10,000 microgram/gram)

S. No.	Parameter	Characteristic/ Value
1	pH	5.10
2	Colour	Light grey
3	Odour	Not objectionable
4	Bulk density (g/cm^3)	1.222
5	Moisture content (%)	3.25
6	Electrical conductivity (Millimhos)	1.42
7	Organic Carbon (%)	0.20
8	Organic matter (%)	0.34
9	Total Nitrogen (%)	3.8
10	Total Phosphorus (%)	2.14
11	Exchangeable Potassium (%)	0.534
12	Exchangeable Sodium (%)	2.10

13	Available Calcium ($\mu\text{g/g}$)	1120.00
14	Available Magnesium ($\mu\text{g/g}$)	460.00
15	Available Sulfates ($\mu\text{g/g}$)	9.8
16	Chlorides ($\mu\text{g/g}$)	369.50
17	Total Copper ($\mu\text{g/g}$)	208900
18	Total Zinc ($\mu\text{g/g}$)	16.50
19	Total Iron ($\mu\text{g/g}$)	98420
20	Manganese ($\mu\text{g/g}$)	0.197

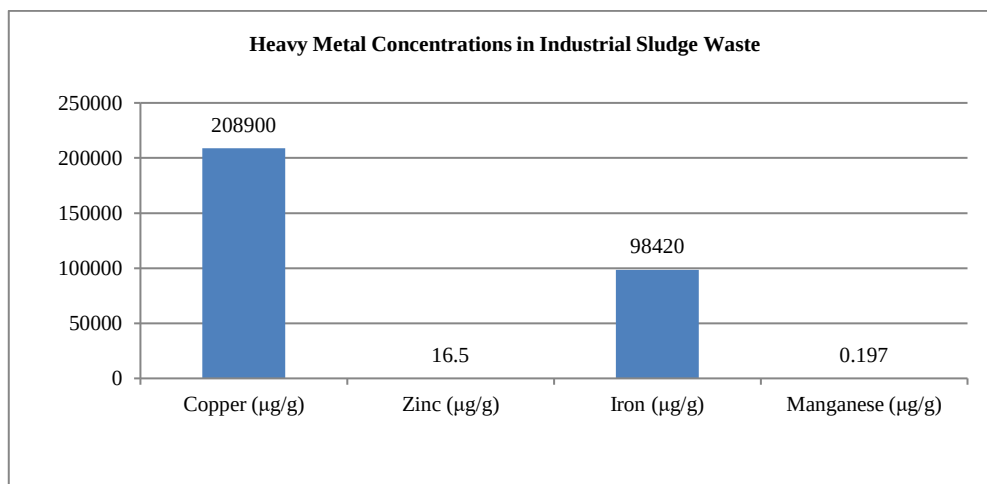


Fig 2: Heavy Metal Concentrations in ISW

B. Physical characteristics of the ISW

The ISW was light greyish white in color without any objectionable odour. The fresh ISW has a Bulk density of 1.222 g/cm^3 and had 3.25% of moisture content (w/w). When wet, the ISW appeared to take semi colloidal and sticky nature.

C. Chemical characteristics of the ISW

The ISW is slightly acidic and had a pH of 5.10 with 1.42 milli mhos/cm of Electrical Conductivity. The Chemical analysis showed that the ISW contained low amounts of Organic Carbon (0.20%) and poor in Organic matter (0.34%). The total nitrogen, total phosphorus and exchangeable potassium were at 3.8%, 2.14% and 0.534%, respectively. The Industrial solid waste recorded high concentrations of heavy metals, like Copper (208900 $\mu\text{g/g}$), Zinc (16.50 $\mu\text{g/g}$), Iron (98420 $\mu\text{g/g}$), and Manganese (0.197 $\mu\text{g/g}$) are reported. Un-Controlled disposal of Industrial Solid waste figure attached. Fig 2. Proper methods of Industrial solid waste disposal have to be undertaken to ensure that it does not affect the environment ground water contamination around the area or cause health hazards to the people, Flora and Fauna living there. The results of the present study urge further research on all agricultural crops grown in the surroundings of the solid waste dumpsites of all industries in different regions and soils. The results of this study stress the need for environmental awareness, adequate regulations and proper management of waste sites by the local municipal authorities.

D. Level of Heavy Metal Concentrations in Industrial Solid waste

$208900 > 16.50 > 98420 > 0.197 \text{ } (\mu\text{g/g})$

$\text{Cu} > \text{Fe} > \text{Zn} > \text{Mn}$

VI. Conclusion

Improper disposal of Industrial solid wastes is a potential source of contamination and results in enrichment of various types of substances. Knowledge of the Physico-chemical characteristics of the wastes is a pre requisite for evaluating their impacts on plants and animals.

VII. Suggestions And Recommendations

- 1) Urban local bodies should identify the areas from where industrial solid waste is generated.
- 2) Urban local bodies may undertake collection, transportation and disposal of solid waste on cost recovery basis as per existing rules and may identify suitable sites for final treatment and disposal of industrial solid waste as per existing rules and regulations.

- 3) It is highly essential that safe and cost effective disposal mechanisms need to be explored and be made available to the industries.
- 4) Screening of all agricultural crops to understand their response to the ISW contamination and also make necessary strategies to advise the farmers.

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