



Experimental Observation for Multi Nozzle Liquid Jet Ejector for Chlorine-Aqueous Caustic Soda System at Laboratory Scale

K. S. Agrawal

Assistant Professor, Department of Chemical Engineering
Faculty of Technology and Engineering, The M. S. University of Baroda,
Vadodara, Gujarat, India

Abstract: The prediction of removal efficiency of gas in liquid jet ejector is an important factor as it influences the design of the mass transfer equipment. The major factors which affect the efficiency of jet ejector are flow rates like gas and liquid and the concentration of absorbing liquid and solute in the gas. This paper deals with the experimental set up and procedure for laboratory scale jet ejector.

I. Introduction

Venturi scrubbers in general have been successfully employed for gas cleaning applications over the last five decades, as they show potential for meeting stringent emission standards. They are very efficient even for fine particulate removal. The removal efficiency is not only depending on scrubber geometry but also on the flow rates. There are some models which are available for the same and they are based on statistical techniques. The collection efficiency model used in the algorithm is described in detail elsewhere (Ananthanarayanan and Viswanathan, 1998, 1999; Agrawal, 2012a, 2012b and 2013).

The present study focuses on multi nozzle liquid jet ejector which is one type of venturi scrubber. Liquid jet ejectors are those which are using a mechanical pump to generate a high velocity fluid jet. This fluid jet creates suction and another fluid is entrained into it by transfer of momentum.

Over and above compact construction the liquid jet ejectors can generate high interfacial area and can handle very hot, wet, inflammable and corrosive gases.

The major factors which affect the efficiency of liquid jet ejector are liquid flow rate, gas flow rate, the concentration of absorbing liquid and the concentration of the solute in the gas. Ravindram and Pyla (1986) proposed a theoretical model for the absorption of SO_2 and CO_2 in dilute $NaOH$ based on simultaneous diffusion and irreversible chemical reaction for predicting the amount of gaseous pollutant removed. Agrawal (2012 a, b) proposed a statistical model for absorption of Chlorine into aqueous $NaOH$ Solution.

Many researchers (Volgin et al., 1968; Ravindram and Pyla, 1986; Cramers et al., 1992, 2001; Gamisans et al., 2004, 2002; Mandal, 2003, 2004, 2005; Balamurugan et al., 2007a, 2007b and 2008; Utomo et al., 2008; Yadav, 2008; Li and Li, 2011.) have reported different theories and correlations to predict scrubbing efficiency of jet ejectors.

Uchida and Wen (1973) developed a mathematical model to predict the removal efficiency of SO_2 into water and alkali solution. The simulated results of their model were compared with experimental results and they found that there is a good agreement with the experimental results. They have also found enhancement factor to predict rate of the chemical absorption.

Gamisans et al. (2002) evaluated the suitability of an ejector-venturi scrubber for the removal of two common stack gases, sulphur dioxide and ammonia. They studied the influence of several operating variables for different geometries of venturi tube. A statistical approach was presented by them to characterize the performance of scrubber by varying several factors such as gas pollutant concentration, gas flow rate and liquid flow rate. They carried out the computation by multiple regression analysis making use of the method of the least squares method. They have used commercial software package, STATGRAPHICS, to determine the multiple regression coefficients.

Less attention has been paid in the area of mathematical and statistical modeling. The statistical models have edge

over other models due to their capacity to handle random data correctly. There are several techniques available to relate the controllable factors and experimental facts. Due to complex nature of affluent gases in terms of its concentration of constituents, temperature, quality and quantity, it requires experimentation to improve existing processes and to develop new ones.

II. Experimental set up

The experimental setup for Stage 2 is shown schematically in Figure 1. In this setup the ejector having detail as Figure 2 and Table 1 is installed vertically.

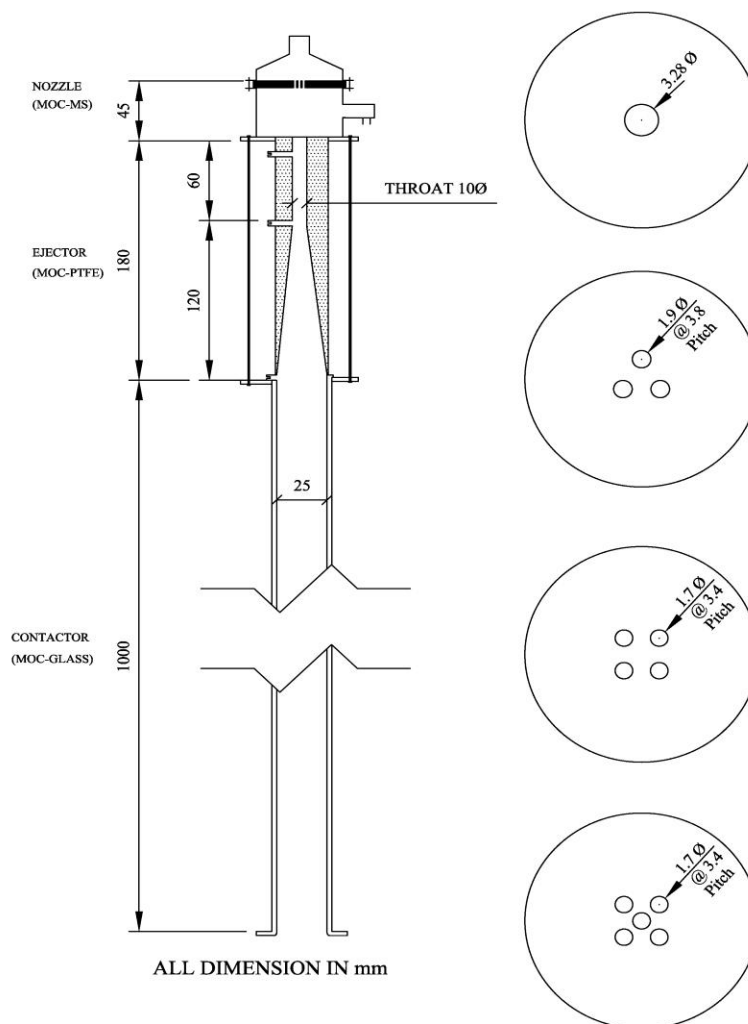


Figure 1: Schematic diagram of experimental set up

The schematic flow diagram is self indicative and self explanatory.

There are two rotameters, RT1 and RT2, to measure flow rates of operating liquid and air respectively. The Cl_2/CO_2 flow rate is measured with the help of soap film meter (GM2). There are four sample points S0, S1, S2 and S3 to collect liquid samples to measure concentration of caustic at inlet of ejector, immediate after free jet, at the end of the throat and at the end of diffuser respectively. There are two liquid tanks (1) separation vessel (SV) (2) solution reservoir (ST). The system contains V-1, V-2, V-3, V-4 and V-5 control valves to control the flow of fluids.

III. Experimental procedure

The procedure is described stepwise as follow.

1. The nozzle plate to be studied was fixed on the jet ejector. Then empty runs were conducted by using water and air to check the leakage.

Nozzle diameter	D_N	3.28 mm	2.0 mm	1.50 mm
Number of nozzle	n	1	3	5
Nozzle No.		2	3	4
pitch *		$2D_N$		
Diameter of Throat/ mixing tube	D_T	10 mm		
Length of Throat/ mixing tube ***	L_T	60mm		
Projection ratio #	P_R	4.5		
Length of the conical diffuser	L_d	120 mm		
Diameter of the diffuser exit	D_C	25 mm		
Diameter of extended contactor	D_C	25 mm		
Length of extended contactor	L_C	1000 mm		
Diameter of the suction chamber	D_S	25 mm		
Length of the suction chamber	L_S	45 mm		
Distance between nozzle & commencement of throat	L_{TN}	45 mm		
Diameter of secondary gas inlet	$D_{G,in}$	10 mm		

Reference :

* Panchal (1991), *** Biswas et al. (1975),
Yadav et a., (2008)

The procedure was repeated for different set of liquid concentration and gas concentration. The results are tabulated.

IV. Conclusion

The experimental set up and procedure for Laboratory scale jet ejector is guideline to Industry scale jet ejector.

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