CHAPTER-1

INTRODUCTION

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The efficient dispersion of gases in liquids is of major importance in many chemical engineering operations and its significance will continue to grow with the development of pollution control and waste treatment problems. This has initiated a wide interest among researchers and designers to develop efficient devices for the dispersion of gases in liquids.

A literature review on the design and development of fluid-fluid contacting equipment shows that contactors or reactors belonging to the jet-mixing category with co-current mixing of phases such as ejectors, venturies, and similar devices are gaining importance because of the high interfacial area and turbulence generated in such systems. In a recent paper Kastanek et. al. (1980) have observed that based on the available preliminary data on the different co-current contacting devices, the liquid-jet ejector seems to be most promising. However, this system suffers from the disadvantage of having very short contact time available between the phases. This problem can be overcome by providing a vertical column above the ejector where transfer operations can be taken to completion. Therefore, the present investigation has been undertaken to study the momentum and mass-transfer characteristics of a vertical liquid-jet ejector.

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A considerable amount of information has been reported on the various aspects of jet-pumps and ejectors with gas-jet or liquid-jet and a review by Bonnington and King (1977) lists over 400 references. Since the present work deals with liquid-jet ejector for dispersion of gas, the literature review has been confined to this aspect only.

Some of the earliest reported work in this field are those of Flugel (1939), Hoeffer (1922), Klone (1932), Pfleiderer (1914), and Von-Powell Rammingen (1936). Of these, Von Powell et. al. were the first to report on the phenomena of rapid mixing with sudden throat pressure rise in a liquid-jet gas pump, which was subsequently termed 'mixing shock' by later investigators.

Folsom (1948) and Takashima (1952) analysed the performance of liquid-jet pumps on the basis of an one dimensional homogeneous flow model. Bonnington (1960) carried out tests on a liquid jet-pump to determine conditions for optimum performance. He has studied the effect of several devices like turbulence promoters, multi-jets etc. for promoting mixing.

Bhat, Mitra and Roy (1972) has presented a dimensionless equation correlating their experimental pressure drop data in a horizontal ejector. Biswas, Mitra and Roy (1975) has presented a model for analysing the performance of a horizontal ejector.

Witte (1969) has reported a theoretical analysis of gas-compression in a multi-jet horizontal liquid-jet ejector.

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From the momentum balance and continuity equations he has derived theoretical curves relating the compression ratio to flow-ratio under isothermal and adiabatic conditions. His model shows good agreement with experimental results. Witte has also reported that the optimum number of orifices in a multi-jet configuration would be 19.

Cunningham (1974) and Cunningham and Dopkin (1974) investigated the application of a horizontal liquid-jet pump for gas compression. Based on an 'one dimensional homogeneous flow model' they have presented performance equations for the throat and diffuser sections of the ejector which shows good agreement with the experimental results till a critical gas to liquid flow-ratio. The papers have also reported the effect of various geometrical parameters like throat length and area ratio on the jet-breakup.

In a recent paper, Otake et. al. (1981) has reported investigations on gas-dispersion in a vertical ejector. Two flow-regimes occuring in the ejector have been identified - an undisintegrated jet flow at low secondary flow and a bubble flow regime at higher secondary flow-rates. Empirical correlations have been provided by the authors for the prediction of holdup in an ejector.

Pal, Mitra and Roy (1980) have reported on the hydrodynamics of two-phase gas-liquid flow in a vertical column where the dispersion has been attained by using single-jet vertical ejector. In this work both liquid and gas have been used as primary fluid and dimensionless

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equations have been developed for each of the two cases for the prediction of liquid holdup and pressure drop in the system. Radhakrishnan (1978) in his work used multi-jet ejectors and developed empirical correlations for the prediction of liquid holdup and pressure drop in the vertical column. However, these correlations are limited to results obtained for air-water system only.

In the field of gas-liquid mass transfer in ejectors no literature is available except those of Biswas et. al. (1977) and Radhakrishnan (1978). Biswas et. al. have reported studies on interfacial area and mass-transfer coefficients in a horizontal liquid-gas ejector system. Radhakrishnan reported studies on interfacial area in a vertical multi-jet system. The study reported that interfacial area as high as 5000 m^2/m^3 could be obtained in the system.

As may be seen that though liquid-jet system is very versatile but the studies reported is very meagre. Most of the studies have been restricted to single-jet ejectors and air-water system. The total energy dissipated in the system for gas-liquid mixing, interfacial area generation and mass transfer coefficient are the important parameters for the design of liquid-gas ejectors. Models and correlations of sufficient generality for these parameters have not been reported.

In order to fill these gaps, the present study on gas dispersion in a vertical liquid-jet ejector has been