Chapter 1

INTRODUCTION

1.0 Introduction

Among the available gas-liquid contactors such as spray column, falling film column, packed column, bubble column, plate column, mechanically agitated contactors, jet ejector, etc., venturi scrubber is one of the devices for gas liquid contacting in which a liquid media is used to absorb objectionable gases and particulates from industrial gaseous effluent streams. In venturi type scrubbers a high velocity fluid jet brings the liquid and gas into intimate contact with each other. Venturi scrubbers are basically of two types (Atay, 1986):

1. Those using a mechanical blower to draw a high velocity gas stream through the system. The liquid is originally at rest and is accelerated by the gas, which also disintegrates the liquid into droplets. Gases and particulates are then captured into the relatively slower moving droplets. This is called a "high energy venturi scrubber" (HEVS). The scrubbing liquid can be introduced in two ways viz., the introduction of liquid through nozzles usually at the throat are known as Pearce-Anthony venturi scrubber and those in which the liquid is introduced as a film are usually known as the wetted approach type.

2. Those using a mechanical pump/compressor to generate a high velocity fluid jet. This fluid jet creates suction and another fluid is entrained into it by transfer of momentum. This type of venturi scrubber is called an ejector venturi scrubber or "jet ejector".

The present study focuses on multi nozzle jet ejector.

The jet ejectors have following advantages over other types of contactors:

- Compact and of simple construction.
- Easy operation.
- Very little chances of mechanical failure due to absence of moving parts.
- Lower initial capital cost for comparable capacity.
- Can handle very hot, wet and corrosive gases.
- Can handle sticky, abrasive and inflammable particles.
- Can simultaneously separate fine particulate matter and gaseous pollutant.
- Have ability to handle large gas flow rates without flooding.
- High interfacial area, heat and mass transfer rates.
- Ability to absorb a species selectively from a gas stream using a specific solvent.

However, it is not energy efficient equipment as a fluid moving device. But it has been reported that it has high efficiency as a gas liquid contacting device. (Laurent and Charpentier, 1974; Zlokarmik, 1980; Ogawa et. al., 1983; Charpentier, 1988)

The jet ejectors have also large potential in chemical industries for gas purification and for carrying out gas-liquid reactions like: oxidation, chlorination, hydrogenation and hydroformylation.

Jet ejectors use high kinetic energy of the operating fluid jet to promote:

- Breakup and distribution of the suction fluid into small droplets/bubbles.
- To pull the gas through the system and push through the connected outlet.

A typical liquid gas jet ejector is shown in Figure 1.1. It consists of three sections: a convergent section, a throat section and a divergent section. The gas is pulled and accelerated in the convergent section to higher velocity in the throat. In the divergent section the gas is decelerated allowing some pressure recovery.

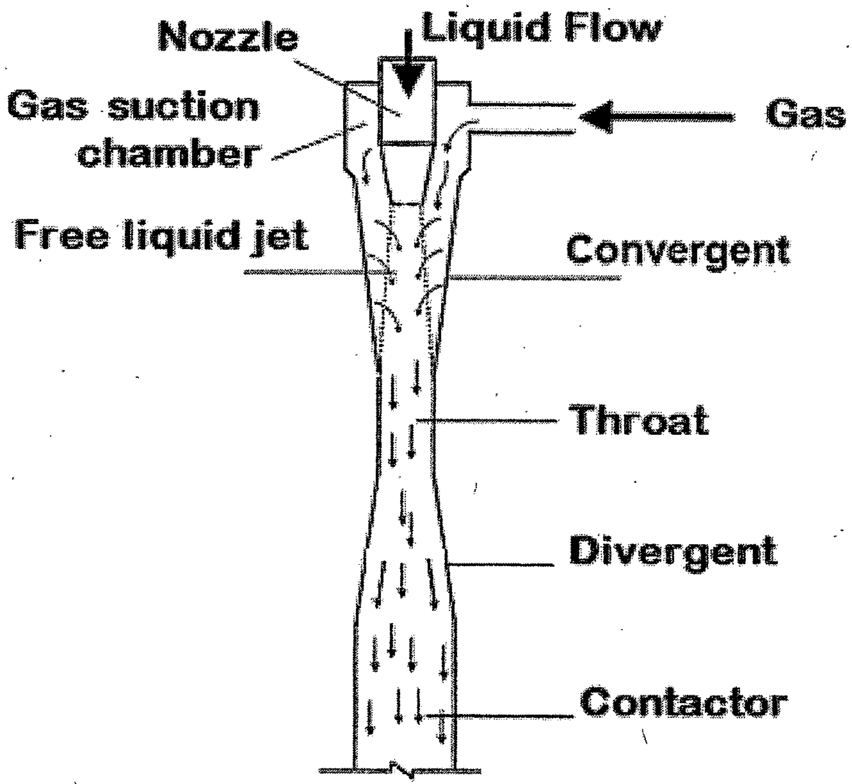

Figure 1.1 : Typical gas-liquid jet ejector

The mass transfer is due to intimate contact between liquid and gas. In case of mass transfer with chemical reaction the species from the gas phase are converted by a chemical reaction with species already present in the liquid phase. It is a complex function of jet ejector geometry, gas and liquid flow rates, their physical properties, jet penetration, bubble/droplet size and size distribution in the throat.

Literature review suggests that very little work has been carried out on gas-liquid mass transfer with chemical reaction using jet ejector type of contactors.

1.1 Background of the proposed research

Absorption of chlorine in aqueous sodium hydroxide in a horizontal jet ejector with single nozzle of 3.2 mm diameter, and 10 mm throat diameter (which had 1 meter long 25mm ID contactor) was investigated by Agrawal (1999). As the results were very encouraging, the further investigation for doctoral degree is continued.

These results his earlier work indicated that most of the mass transfer takes place in the jet ejector and negligible mass transfer in the attached contactor.

The current research work on mass transfer with chemical reaction between two phases (gas and liquid), using multi nozzle jet ejector as contactor is presented in the thesis emphasizing on the following:

- The experimental study of rate of absorption with chemical reaction in multi nozzle jet ejector (laboratory scale and industrial scale) using chlorine-aqueous sodium hydroxide system.
- The models to determine rate constant and mass transfer (absorption) rate for Cl_2 – aqueous NaOH reaction system.
- The mathematical model to study the effect of different diffusivity ratio on enhancement factor for absorption of chlorine in aqueous sodium hydroxide system.
- The numerical model for multi nozzle jet ejector to predict the conversion.
- The mathematical models to predict mass transfer characteristics in multi nozzle jet ejector using Cl_2 - aqueous $NaOH$ solution in laboratory and industrial scale ejector

- The statistical models for determining removal efficiency of Cl_2 by aqueous sodium hydroxide solution.

Note : At some places for the purpose of clarity the word "multi orifice" have been used instead of "multi nozzle".