Chapter I

INTRODUCTION

1.1 Fluidization

Fluidization is the operation by which solids are transformed into a fluidlike state through contact with a gas or liquid. The packed bed expands when the pressure drop due to the upward flow of fluid through a granular unrestricted bed equals the weight of the packing. As the bed expands, it retains its top horizontal surface with the fluid passing through the bed much as it did when the bed was stationary, Now, however, the porosity is much greater, and the individual particles move under the influence of the passing fluid. The bed has many of the appearances of a boiling liquid and is referred to as being "fluidized"

Two main types of fluidization have been noted. There are two phase fluidization and three phase fluidization. Three phase fluidization, now become very interesting in gas absorption process because of its high capacity and efficiency for a given tower volume.

The expression three-phase fluidization was used to describe fluidization of solid particles by two fluids. A gas and a liquid are the fluidizing media used in the applications and studies of three-phase fluidization that have been described in the literature. Two immiscible liquids could conceivably be used as fluidizing media, such an operation being of potential interest with respect to liquid-liquid extraction.

Three phase fluidization can be classified into three types.

1. Liquid stagnant flow: solid particle and liquid are in column and the bed are fluidized by the introduction of gas blowing upwards.

2. Con-current upward flow of gas and liquid. The liquid forms a continuous phase and the gas a discontinuous bubbling phase: These processes are used on an industrial scale in processes for catalytic hydrogenation of petroleum fractions for the purpose of desulphurization and hydrocracking. Many descreptions of these processes, the so-called H-Oil and Hy-C processes, have been published.

3. Countercurrent downward liquid flow and upward gas flow: A bed of particles of a density lower than that of the liquid may be fluidized by downward liquid flow, the upstream bed surface being supported by a porous screen or a gauge, and the bed expanding in the downward direction. Gas flows upward through the bed as discrete bubbles. Applications and studies of such beds have apparently not been described in the literature. Another type of countercurrent three-phase fluidization, and one that is very interesting and has obtained industrial application, is the so-called turbulent bed contactor. Spherical particles of low density, typically made as hollow polyethylene spheres or

manufactured from polystyrene foam, are fluidized by upward flow of gas, and the resulting fluidized bed is irrigated by downward flowing liquid. This operation is used industrially for absorption of gases in liquid, for scrubbing of gases containing particles, and for cooling and dehumidification of gases. Althrough this process has used in industrially, only a few publications are available concerning its properties.

1.2 Gas Absorption in Fluidized-bed Column

Mass-transfer operation which is called gas absorption involves the transfer of a soluble component of a gas phase into a relatively nonvolatile liquid absorbent. In the most simple case of gas absorption none of the liquid absorbent vaporizes, and the gas contains only one constituent that will dissolve to any extent. For example, ammonia is absorbed from an air-ammonia mixture by liquid water at room temperature. Ammonia is soluble in water, but air is almost insoluble. The water will not vaporize to an appreciable extent at room temperature. Therefore, only ammonia will be transferred from the gas phase to the water. As ammonia is transferred to the liquid phase its concentration will increase until the dissolved ammonia is in equilibrium with that in the gas phase.

The main requirement in the design of absorption equipment is to bring the gas into intimate contact with the liquid, that is, to provide a large interfacial area and a high intensity of interface renewal. The contacting of the phases can be achieved either by the action of gravity (buoyancy) or by mechanical means.

Today many type of gas absorption equipment are commercially available such as wetted wall columns, packed towers, plate towers and spray towers but one of the standard pieces of equipment used is the packed tower. This equipment has optimum capacity and efficiency when operation at gas and liquid rates approaching the flood point but because of the inherent plugging problems with this type of equipment it is normally to design to about 60 percent of the flooding, thus increasing the volume required for any given absorption. A new type of equipment "Gas Absorption in a Fluidized-bed Column" was developed.

This unit use low density spheres for packing which are retained on the grid. Liquid is spray from the top of the column so that the liquid will form film on the sphere. Gas is blownfrom the bottom of the column. Because of the low density of the packing, the solid phase is easily fluidized by upward flow of gas phase, the ease of fluidization being aided by the downflow of the liquid phase. Thus a state of vigorous contacting between the gas and liquid phase may be obtained as they flow through the bed. Because of the turbulent and random motion of the low density spheres, thus allowing both high gas and liquid velocities at modest pressure drop. These turbulent condition must result in high capacity and efficiency for a given tower volume. It is essentially nonclogging and can be useful when a solid phase is presented or is formed by reaction of the contacting fluids.

In the present study, a fluidized-bed column or sometime may be called turbulent contact absorber was designed and constructed. Liquid was spray from the top of the column by a sprayer. Above the sprayer had a grid to prevent the spheres run out of the column. Gas was distributed by cone distributor and blowing upward countercurrent to the liquid.

1.3 Objective and Scope of Study

Gas absorption are found the most commonly unit employed in chemical process industries. Now effectiveness in gas absorption design, which makes the process economical is very important. The efficiency of the gas absorption are improved when the surface contact between two phase are large, low pressure drop across the bed, non clogging performance of the absorber and can run without flooding or by passing at high gas and liquid velocity. Gas absorption in three phase fluidized-bed column provide all these condition. But the technical literature of this type of absorption is quite limited in terms of experimental data or theorectically analysis. The objective of the present work was intended to study the effectiveness of gas absorption in a fluidized-bed column and to study some hydrodynamic characteristic of the column.

To study some hydrodynamic characteristic of the column and the principal factors affecting the magnitude of the increasing in mass transfer coefficient. A fluidized-bed column, which supposedly has high mass transfer coefficient was designed and constructed. Effects of gas velocities, liquid velocities and bed height on hydraulic resistance of bed, liquid holdup and gas holdup were studied and minimum fluidization were also determined. Ammonia gas which was used as solute gas, was mixed with air and to be absorbed by water in the column at room temperature. The principle factors affecting mass transfer were static bed height, gas velocities, liquid velocities, and gas concentration. The results have been summarized, and are expected to be applicable to many absorption process in Thailand.