The Effect of Gas Distributor on Hydrodynamic Characteristics in Two-Phase Flow (Gas-Liquid)

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Abstract **The experimental work of two-phase, air-water system was carried out using QVF glass bubble column with 0.1m internal diameter and 2m height. Two types of gas distributor were used, the first type was a porous ceramic distributor (240μm pore size), the second type was perforated plate distributor which was made of Perspex of thickness of 4mm and drilled holes of (1, 1.5, 2mm) hole diameter.**

The electroresistivity probe technique was used to measure the bubble parameters inside the column. A high speed camera was installed in front of the test column for calibration of electroresistivity probe.

Graphical relations between the gas holdup and superficial gas velocity under the effect of different gas distributor types were studied and compared with other work. It is concluded that the type of gas distributor has significant effect on the flow regime of air bubbles flow through stagnant liquid. Also it is found that the gas rate has significant influence on gas holdup at low gas rates.

Gas holdup experimental data for two types of distributor were translated to the empirical correlations.

I.INTRODUCTION

Two-phase flows occur in an extremely wide range of environmental situations and occur extensively throughout industrial plants. Two- phase flow is important in tubular boilers, condensers, heat exchangers, rocket motors, chemical reactors, air-conditioning, refrigerators, distillation columns, desalination, nuclear reactors, oil wells, geothermal wells, process pipe line, oil and gas transportation pipe lines and natural gas liquefaction, Chisholm [1] and Rosant et al. [2]. They provide several advantages during operation and maintenance such as high heat and mass transfer rates, compactness and low operating and maintenance costs, Kantarci et al. [3].

Bubble columns are containers, usually taller than wider, full of liquid equipped with a gas distributor at the bottom, e.g. a perforated plate. Gas is pressed into the column through the plate where individual bubbles are formed to obtain large contact area and reduce the gas rise velocity, Ruzicka [4].

There are some variables that affect the hydrodynamic parameters in bubble column reactors as shown in Fig.1, Al-Dahhan [5].

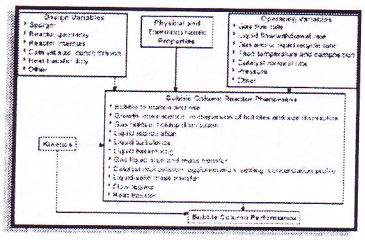

Fig.1 Phenomena that affect the bubble column performance, Dudukovic and Al-Dahhan [5].

Some common gas distributor types that are used in literature studies are perforated plate, porous plate, membrane, ring type distributors and arm spargers, Kantarci et al. [6]. Schumpe and Grund, [7] worked with perforated plate and ring type gas sparger. They concluded that with ring type distributor, the total holdup was smaller. Kumar et al. [8] used the tomographic scanner for imaging gas holdup distribution in air-water system. The scanner has been used to study the effects of various operating parameters (such as column diameter, superficial gas velocity and distributor type) on the gas holdup and its distribution. The experimental investigation shows that the differences in the holdup distribution due to the kind of distributor used are significant at low gas flowrates.

Luo et al. [9] concluded, a gas holdup is strongly affected by the type of gas distributor. Bouaifie et al. [10] stated that, the smaller the bubbles, the grater the gas holdup values. Thus, they concluded that with small orifice gas distributors their gas holdup values were higher. Ruzicka et al. [11] studied the effect of the gas distributor on the formation of the homogeneous bubbling regime and gas holdup ratio in bubble bed. Experiments were performed with air-water system. Four different gas distributors were used: two metal perforated plates (d_o=0.5 and 1mm) and two sintered glass plates (pore size 160-250μm and 100-160μm).They showed that the data of porous plate with pore size (100-160μm) give higher gas holdup than the distributors used. Axial bubble size distribution and gas holdup were determined under the ambient temperature and pressure using the dual electrical conductivity probes technology in a gas-liquid bubble column, and the effects of the gas distributor on the performance of the bubble column were researched by Ye et al. [11]. The effects of three gas distributors, namely, single nozzle, perforated plate and porous plate, on hydrodynamics in an air-water shallow bubble column reactor are investigated by Lau et al. [11]. The results show that single nozzle is not suitable for shallow bed operation. The effect of orifice surface roughness on the liquid weeping phenomenon in a bubble column is investigated over a superficial orifice gas velocity range of 143-703 cm/s, Igbal et al. [12].

Therefore the aim of the present work is to study experimentally the effect of gas distributor design on the hydrodynamic behaviour and bubble characteristics in bubble column such as: gas holdup, and compare the results with other works. Also to study the effect of measurements technique on the results of holdup.