THE EFFECTS OF IMPELLER TYPES AND ROTATIONAL SPEEDS ON BUBBLE SIZE DISTRIBUTION IN AN AIR-SALT WATER SYSTEM

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Abstract

The objective of this work was to study the effects of impeller types on bubble breakup characteristics in an aerated mixing vessel. Rushton turbine (RT) and Curve blade impellers (CB) of 6 blades were used in an air-salt water system to observe the bubble breakup characteristics. NaCl (salt) was added to the water as anti-coalescence media. A fixed aeration rate of 5 L/min and varying impeller rotational speeds of 60, 80 and 100 rpm were used for all experiments. A sample of 100 bubbles were collected around the impeller region and analyzed for bubble size distribution (BSD) and bubble Sauter mean diameter (d_{32}). In all cases, BSD curves obtained were almost like a Gaussian distribution, with slight deviations from the symmetry. Bubble sizes generated by Curve blade impellers were found to be smaller than that of the Rushton turbine at constant rotational speeds. And when rotational speeds increased, there was a decrease in bubble size for RT and increase in bubble size for CB.

Key words: Bubble size distribution, Rushton Turbine, Curve Blade impeller, Mass transfer studies

Introduction

In chemical engineering operations and practices, gas-liquid contactors are widely used for carrying out reactions and mass transfer operations. The presence of a gas phase dispersed in a continuous liquid is the reason why such kind of reactors can provide high interfacial area for mass and heat exchange, good mixing and high thermal stability. To develop sufficient understanding of the basic mechanisms of gas-liquid mixing in these systems, one requires more detailed knowledge of the gas-liquid flow and the structure of gas dispersion. This information is of great importance for determining the true mass transfer conditions.

The dispersion of gas in liquid systems can be studied by determining gas bubble sizes and their surface areas, in order to determine mass transfer efficiencies. Smaller bubbles are more desirable in mass transfer operations as they provide larger mass transfer surface areas. Bubbles are produced from trailing vortices behind impeller blades, and the size and shape of the trailing vortices determine the number of bubbles produced and their size distribution. In some early studies, a sophisticated capillary probe technique was used for measuring the local bubble size distribution at 22 locations in a 1.0m stirred vessel [1], [2]. The fully submersible probe developed was interfaced to a microcomputer for high-speed data acquisition and data processing. A detailed quasi-point investigation was carried out of the structure of bubble size distribution in coalescing and non-coalescing gas liquid dispersions the stirred vessel. With a Rushton Turbine, they found that bubble size distribution depends on the position in the tank and the agitation intensity of the impeller. This automated bubble size measurement technique achieved very high rates of sampling from bubble sizes down to 0.3mm.

Then, a study was made on the effect of agitation and impeller speed, due to a Rushton Turbine, on the bubble size and bubble size distribution in an aerated vessel [3]. A non-coalescing system was used, which made it possible to study the bubble breakup process in isolation. With no agitation, the bubble populations were found to exhibit a log-normal distribution. A year later, a researcher gave a comprehensive review on gas dispersion in agitated vessels [4]. He classified the three areas of interest in gas dispersion in agitated tanks as (i) the hydrodynamic flow regimes occurring around the impeller and in the tank (ii) the bubble size and holdup, and (iii) the mass.