AN LDA STUDY OF RUSHTON TANGENTIAL VELOCITY IN MIXING OF POLYMERIC LIQUIDS

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Abstract

Polymer processing in stirred tank reactors has received significant interest in chemical industries. Mean tangential and fluctuations velocities were measured using a two-component Laser Doppler Anemometry system for a typical Rushton turbine impeller. Test fluids were different concentrations of polyacrylamide (PAA) solutions with rheological properties typical of those found in polymer processes. It is shown that the correlations for mean tangential velocities in Newtonian fluids do not apply to the case of polymeric liquids. New correlations are given in the lower part of the transition region, i. e. $30 < Re < 2000$, for mean tangential values along the center line of the impeller tip. It is also shown that the dimensionless mean velocity distributions are not affected by impeller speed. Furthermore, they decrease with increasing fluid concentration.

Keywords: Laser Doppler Anemometer (LDA); Rushton turbine; polymeric liquids; mixing tank; velocity profile

Introduction

Many transformation processes in the food and bio industries, chemical and polymer processes involve mixing of complex fluid streams such as viscoelastic materials. The flow conditions in the mixers are known to govern the mixing process efficiency and product quality. These flow conditions are particularly sensitive to the non-Newtonian properties such as elasticity of the media at hand. Although it is now recognized that close clearance impellers are more effective for mixing rheologically complex fluids, however, the classical Rushton turbine remains the most common impeller in industrial and research equipment particularly in fermentation industry [1].

Experimental

Measurements were performed in a cylindrical tank of Plexiglas. The specifications of LDA, tank and Rushton turbine impeller are given in Reference [2]. Test fluids were several concentrations of PAA solutions and their specifications are in elsewhere [3].

Results

Figure 1 shows an example of the local tangential velocities at different radial positions obtained through LDA measurements. These velocities are normalized by the blade tip speed. Dimensionless tangential velocity for different concentrations of PAA solutions at various impeller speeds show that the velocity profiles for the different impeller speeds have the same exponential decay and are