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On the hydrodynamics characterization of the straight Maxblend® impeller with Newtonian fluids

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ABSTRACT

The hydrodynamics generated by the straight version of the Maxblend® impeller with Newtonian fluids in a baffled stirred vessel under the transitional and turbulent regime has been experimentally characterized by means of the particle image velocimetry technique. The flow fields obtained with the Maxblend were compared with those obtained with a double stage classical pitched blade turbine (PBT) and a double Ekato Intermig® impellers under the same specific power draw. It is shown that these open impellers induce complex local flows in the radial and axial direction, with an intensity decreasing away from the blades. By contrast, the Maxblend impeller generates a more regular circulation pattern, with efficient top-to-bottom pumping.

Keywords: Maxblend®; Flow patterns; Flow visualization; Particle image velocimetry

1. Introduction

The importance of mixing as a key unit operation in many industrial processes has long been recognized. A wide variety of impellers are available for accomplishing mixing operations. Open impellers with pumping or radial discharge are commonly used for low to moderate viscosity. On the other hand, close clearance impellers are preferred for high viscosity applications or processes involving time-dependent rheology or non-Newtonian fluids. Indeed, under these conditions, open impellers tend to generate flow segregations and cavern effects leading to poor reaction selectivity and low mixing efficiency.

The design of an impeller that can operate efficiently under the complete flow regimes, i.e. turbulent to laminar, is still an open challenge. One possibility is the use of wide impellers, such as the Maxblend. This impeller is extensively used in Japan and South East Asia due to its hydrodynamic characteristics such as lower power consumption and dispersion in a wide range of Reynolds numbers.

The Maxblend impeller is an attractive alternative to more conventional impellers for crystallization and polymerization processes. However, only little information on the hydrodynamic performance of such an impeller has been reported in the literature. Yao et al. (2001) compared the performance of straight shape Maxblend impeller with a double helical ribbon. They found that the Maxblend is capable of producing stronger elongational flow when operating at moderate Reynolds number. Similar results were found by Devals et al. (2008), who carried out a numerical study by analyzing the factors affecting the fluid flow performance of the Maxblend impeller operating from the laminar to the transitional regimes. They found that the impeller better performs when operating at Reynolds numbers higher than 10 with both Newtonian and non-Newtonian fluids. Fradette et al. (2007) performed an experimental study with a wedge shape Maxblend impeller. They found that mixing time decreases with the reciprocal of the Reynolds number with Newtonian and non-Newtonian fluids in the laminar regime, in particular between the end of the laminar regime and the early transition regime. These

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