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Chapter 15

Turbulence model for axial mixing impeller in unbaffled vessel

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INTRODUCTION

The need to improve design and optimize processes has motivated numerous studies, using local hydrodynamic information inside stirred vessel to develop a better understanding of the complex flows responsible for the reactions. Of particular significance is the current surge in biodiesel research which requires multivariate experimentation with associated high cost. Reactive systems involving multiphase mixing are affected by variables such as impellers number and positions, impeller diameter/ vessel diameter ratio, bottom clearance, bottom shape, baffles and mixing intensity (Baldyga et al., 2001; Farmer et al., 2005). To illustrate this is the transesterification of WCO for biodiesel which terminates early some minutes into the reaction and forms soap as observed in laboratory studies, which is attributed to mass transfer limitation (Slinn and Kendall, 2009; Darnoko and Cheryan, 2000; Mohamed et al., 2010). Reactor configuration has also been attributed to this along with reaction kinetics and with particular reference to baffle, impeller and speed of stirring (Noureddini and Zhu, 1997; Stamenkovic et al., 2007). These reaction/design problems are best considered by applying clever mixing strategy and procedures for control. With focus on axial impeller, the connection between mixing rates can lead to significant improvements in selectivity. Using computational fluid dynamics (CFD), the numerical approach based on the Reynolds Average Navier Stokes (RANS) turbulent model have been used to study fluid involving flow and reaction (Baldyga et al., 2001). The predictive ability is used to investigate our problem in analyzing different reactor configurations and establish qualitative relationship between hydrodynamics of the impellers.

METHOD

Experimental Setup

A cylindrical acrylic flat-bottomed tank was set up in unbaffled vessel (fitted with 4 vertical baffles equally spaced at 90◦ radially) tank with a dished bottom (diameter, 65 mm; height, H=0.15m). A 3-blade