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Chapter 26

Alternative mixing strategy for biodiesel production: mixed flow impeller characterization

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Abstract

A mixed flow impeller has been used as an alternative mixing strategy for biodiesel production, in order to combine salient hydrodynamic features and overcome stagnation during mixing. This unique combined radial and axial flow is presented is to show the advantage of this impeller. The numerical simulation of this impeller was carried out using the Reynolds stress model (RSM) and results compared well with experimental PIV data for the velocity field at bottom of the vessel for mean, radial and axial velocity than for the surface. Although the RSM was used at a higher computational cost, associated power number and energy of the impeller was also observed to be better predicted.

Keywords: mixed flow impeller, turbulence models, CFD, multiple reference frames

INTRODUCTION

The need to improve mixing processes in stirred vessel has motivated numerous studies, using local hydrodynamic information, to develop better understanding of the complex flows. Typical features like width, shape and inclination are harnessed to improve reaction during flow in a confined space. This is of particular significance with respect to biodiesel production in stirred vessel. Reactive systems involving multiphase mixing have been reported to be affected by variables such as number, positions and type of impellers, impeller diameter/ vessel diameter ratio, bottom clearance, bottom shape and baffling (Baldyga, Henczka et al. 2001; Farmer, Pike et al. 2005). This was demonstrated during the transesterification of WCO for biodiesel production (Darnoko and Cheryan 2000; Slinn and Kendall 2009; Mohamed, Gerber et al. 2010), where speed of stirring affecting biodiesel quality (Noureddini and Zhu 1997; Stamenkovic, Veljkovic et al. 2010). By applying clever mixing strategy product quality can be improved and the connection between mixing rates can lead to significant improvements in selectivity. Using computational fluid dynamics (CFD), we investigate the mixed flow impeller with combined axial and radial flow characteristic.

METHOD

Experimental setup

A cylindrical acrylic vessel (diameter, d = 65 mm and height, H = 0.15m) was set up as a baffled vessel (fitted with 4 vertical baffles equally spaced at 90° radially). A 3-blade mixed flow impeller