Chemical Papers 67 (9) 1188–1200 (2013)
DOI: 10.2478/s11696-013-0375-z

ORIGINAL PAPER

Investigation of turbulent flow field in a Kenics static mixer by Laser Doppler Anemometry[‡]

Halina Murasiewicz, Zdzislaw Jaworski*

Faculty of Chemical Technology and Engineering, West Pomeranian University of Technology, Szczecin, Aleja Piastow 42, PL-71065 Szczecin, Poland

Received 20 June 2012; Revised 27 January 2013; Accepted 29 January 2013

The main purpose of the present paper was to apply the Laser Doppler Anemometry (LDA) technique to measure turbulent liquid flow in a Kenics static mixer. The LDA set-up was a one-channel backscatter system with argon-ion laser. Measurements in the static mixer were carried out for three values of the Reynolds number: 5000, 10000, and 18000. Water was used as the process liquid. Values of the axial and tangential components of the local, mean, and root mean square velocities were measured inside the static mixer. It was observed that the shape of the velocity profile depends strongly on the Reynolds number, *Re*, as well as on the axial, h, and radial, α, position of the measurement point. Strong dependence of the velocity fluctuations on the Reynolds number was found in the investigated range of *Re* and the measurement point position. Furthermore, one-dimensional energy spectra of the velocity fluctuations were also obtained by means of the Fast Fourier Transform. Fluctuation spectra of the axial and tangential velocities provided information about the energy density of velocity fluctuations in the observed range of Reynolds numbers. A study of the energy spectra led to the conclusion that the energy density increases with the increasing radial distance from the mixer walls at constant values of h, *Re*, and α. Minor variations in the mean value of the energy density, E, were observed together with variations of the measurement point angular position, α. In addition, it was observed that an increase of the Reynolds number causes significant increase of the power spectral density.

Keywords: LDA, static mixer, turbulent flow, one-dimensional energy spectra

Introduction

Static and dynamic mixers are widely used in many branches of industry (Paul et al., 2003). However, static mixers are utilized more often due to their lower operating costs. Kenics mixers are regarded as the most efficient mixers in a wide range of flows. It is expected that these mixers can be operated at high efficiency to meet economic and environments requirements. A detailed study on the mechanism of flow allows development and improvement of the construction of mixers. Many experimental techniques have been designed and developed for this purpose. These techniques allow identification and characterization of the investigated flow. Detailed knowledge about the flow hydrodynamics is essential for the most efficient control of mixing processes. Among available flow visualization techniques, the Laser Doppler Velocimetry (LDV) or Laser Doppler Anemometry (LDA) and the Particle Image Velocimetry (PIV) have become the most widely used methods, also commercially, to study the complex nature of flows. Both methods require optically transparent liquid and equipment walls (Baldi & Yianneskis, 2004), which limits their application in many environments. Moreover, seeding particles must also be added to the process liquid. Some-

*Corresponding author, e-mail: Zdzislaw.Jaworski@zut.edu.pl
[‡]Presented at the 39th International Conference of the Slovak Society of Chemical Engineering, Tatranské Matliare, 21–25 May 2012.