World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:11, No:09, 2017

Liquid-Liquid Plug Flow Characteristics in Microchannel with T-Junction

Authors : Anna Yagodnitsyna, Alexander Kovalev, Artur Bilsky

Abstract : The efficiency of certain technological processes in two-phase microfluidics such as emulsion production, nanomaterial synthesis, nitration, extraction processes etc. depends on two-phase flow regimes in microchannels. For practical application in chemistry and biochemistry it is very important to predict the expected flow pattern for a large variety of fluids and channel geometries. In the case of immiscible liquids, the plug flow is a typical and optimal regime for chemical reactions and needs to be predicted by empirical data or correlations. In this work flow patterns of immiscible liquid-liquid flow in a rectangular microchannel with T-junction are investigated. Three liquid-liquid flow systems are considered, viz. kerosene – water, paraffin oil – water and castor oil – paraffin oil. Different flow patterns such as parallel flow, slug flow, plug flow, dispersed (droplet) flow, and rivulet flow are observed for different velocity ratios. New flow pattern of the parallel flow with steady wavy interface (serpentine flow) has been found. It is shown that flow pattern maps based on Weber numbers for different liquid-liquid systems do not match well. Weber number multiplied by Ohnesorge number is proposed as a parameter to generalize flow maps. Flow maps based on this parameter are superposed well for all liquid-liquid systems of this work and other experiments. Plug length and velocity are measured for the plug flow regime. When dispersed liquid wets channel walls plug length cannot be predicted by known empirical correlations. By means of particle tracking velocimetry technique instantaneous velocity fields in a plug flow regime were measured. Flow circulation inside plug was calculated using velocity data that can be useful for mass flux prediction in chemical reactions.

Keywords : flow patterns, hydrodynamics, liquid-liquid flow, microchannel
Conference Title : ICMN 2017 : International Conference on Microfluidics and Nanofluidics
Conference Location : Tokyo, Japan
Conference Dates : September 07-08, 2017