Abstract

The present study has investigated the hydrodynamics of liquid-liquid two phase flow through a horizontal pipe. An indigenously developed optical probe has been used for the identification of the different flow patterns. The presence of different phase contents and various interfacial features along the optical path gives rise to attenuation and scattering and makes the identification possible. The probability density function (PDF) analysis and the wavelet multiresolution technique have been adopted for development of an objective flow pattern indicator. Attempts have been made to identify the interfacial configurations in the oil continuous regime where not much could be revealed through visualization or photography related techniques. The information obtained from the probe signals at low phase flow rates has been exploited for this purpose. In addition, a sampling technique has been devised to understand the distribution of water in the continuous oil phase. A flow pattern map has been constructed from the information thus obtained. It represents the regions of existence of pure stratification, mixed stratification as well as fully dispersed flows in the water continuous regime and the presence of inverted plug flow and inverted dispersed flow in the oil continuous regime. The close agreement of the present flow pattern map with the maps available in literature reveals the effectiveness of the objective flow pattern indicator for liquid-liquid horizontal flows.

The influence of the mixer design on the downstream distribution of the two liquids has been studied and it has revealed that a slight change in the mixer design does not influence the downstream patterns. However, a completely different design may ensure the disappearance or a prolonged existence of a particular flow distribution.

Extensive experiments have been carried out to estimate water holdup and pressure drop during liquid-liquid flows through horizontal pipes. The deviation of the insitu composition from the input fraction is noted to understand the effect of slip between the

phases. Further efforts have been directed to identify the flow patterns from the time dependent pressure signals and the statistical analysis of the random signals. An analysis of the holdup and pressure drop characteristics have been performed in the different flow patterns. A separated flow model has been considered for stratified flow while the homogeneous flow model has been adopted for dispersed and oil continuous flow. Both the separated and homogeneous models are used to analyse the stratified mixed pattern as it combines the characteristics of stratification with dispersion. The models have been validated with the present experimental data as well as the data reported in literature.

The effectiveness of an orifice meter as an online metering device has been tested in the present study. Prior to testing the effectiveness of an orifice as an online mass flow metering device, studies have been directed to observe the influence of the orifice on the phase distribution of the two liquids in the pipe. The optical probe along with the photographic technique has been used for the identification of the flow patterns both at the upstream and downstream of the orifice. The studies have revealed that the orifice can be used as an effective homogenizer/emulsifier to disperse liquid-liquid flows.