OIL/WATER FLOW IN A HORIZONTAL PIPE EXPERIMENTAL AND SIMULATION - DISPERSEDED FLOW PATTERN

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In multiphase fluids flow, the formation of dispersed patterns, where one of the phases is completely dispersed in the other one (continuous medium) is common, for example, in crude oil extraction and during the transport of water/oil mixtures.

In this work, experimental and numerical studies were carried out for the flow of an oil/water mixture in a horizontal pipe, the dispersed liquid being a paraffin (oil with density 843 kg.m-3 and viscosity 0.025 Pa.s) and the continuous medium a water solution doped with NaCl (1000 $μS.cm^{-1}$). The tests were made for oil concentrations of 0.01, 0.13 and 0.22 v/v and velocities of the mixture between 0.9 and 2.6 m.s-1. Experimental work was performed in a pilot rig equipped with an Electrical Impedance Tomography (EIT) system. Information on pressure drop, EIT maps, volumetric concentrations in the vertical diameter of the pipe and flow images were obtained. Simulations were performed in 2D geometry using the Eulerian-Eulerian approach and the k-ε model for turbulence modelling. The model was implemented in a Computational Fluid Dynamics (CFD) platform with the program COMSOL Multiphysics version 5.3. The simulations were carried out using the Schiller-Neumann correlation for the drag coefficient and two equations for the viscosity calculation: Guth and Simba (1936) and Pal (2000). For the validation of the simulations, the pressure drop was the main control parameter.

The simulations predicted the fully dispersed flow patterns which were confirmed experimentally and the pressure drop calculated when using the Pal (2000) equation for the viscosity calculation showed the best fit. By withdrawing samples of the oil/water mixture for different positions on the vertical diameter, which were later analysed through optical microscopy, it was possible to confirm the dispersion of the oil phase in the water phase, the size of the oil drops being dependent on the oil concentration and flow velocity. The results of the images of the flows obtained by the photographs, EIT and simulations were in good agreement, the same being observed for the 1D concentration profiles referred to the vertical pipe diameter.

*Keywords: Oil/water flows, dispersed flow pattern, pressure drop, Euler-Euler model.*