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Prediction of Pressure Gradient in Horizontal Dispersed Oil-Water Flow

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Abstract

The purpose of this thesis is to improve the prediction of pressure gradient in dispersed oil-water flow in horizontal pipes. The homogeneous model is commonly used for predicting the pressure gradient where the mixture of oil and water is treated as a pseudo-single fluid. The prediction of the pressure gradient using the homogenous model can be improved by either improving and/or developing new correlations for friction factor and mixture viscosity. Currently, large numbers of friction factor and viscosity correlations are available in the literature. In this study, the performances of these correlations were evaluated against 484 experimental pressure gradient data points using statistical error parameters: average percent error, APE, absolute average percent error, AAPE and standard deviation SD. These data were collected from 10 different sources and covered wide range of pipe diameters, oil viscosities, densities and pipe materials. The comparisons revealed that the performances of all the friction factor correlations in predicting pressure gradient are generally the same. On the other hand, the performances of the viscosity correlations in predicting the pressure gradient are very different. Taylor, Pal and Rhodes, Einstein and Pal (Eq. 16) viscosity correlations gave better prediction in comparison to the other correlations with AAPE of 25%. The worst prediction was obtained using Yaron and Gal-Or and Al-Sarkhi correlations with AAPE of 37% and 35% respectively.

The influence of pipe diameter, pipe material and oil viscosity on the prediction of the pressure gradient was also investigated. It was found that the error in predicting the pressure gradient increases as the pipe diameter increases and decreases as the oil viscosity increases. The effect of pipe material was also examined using acrylic and steel pipe. Pressure gradient in steel pipe is slightly higher than that of acrylic pipe.

An attempt was also made to improve the prediction of pressure gradient in horizontal dispersed oil-water flow. Blasius and Hinze friction factor was modified by considering all system parameters that may affect the friction factor. The improved correlations were able to better predict the pressure gradient with AAPE of 22%. All the system parameters that may affect the mixture viscosity were also considered and a simple viscosity correlation was developed. The new proposed viscosity correlation outperformed the existing correlations when used to predict the pressure gradient with AAPE of 21%.