**Comments on “Drag Reduction Phenomenon in Viscous Oil-Water Dispersed Pipe Flow...” regarding slip ratio**

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*In Rodriguez et al.1 an analytical expression was deduced to predict the slip ratio in dispersed oil-water flow. Although the quantitative agreement was quite good, the expression systematically underestimated the slip ratio. New experimental data of similar flows were collected in two different experimental facilities in pipes of different materials and diameters (26 mm and 82.8 mm i.d.). Oil-water flow data collected within a range of mixture Reynolds numbers from 1∙105 to 20∙106 in glass, acrylic and steel pipes with oil viscosities varying from 7 to 220 mPa.s were used to deduce a more generic correlation for slip ratio as a function of the mixture Froud number (5 < Fr < 70). The underestimation of the slip ratio was corrected.*

**Experiments**

Two test facilities were used to perform the oil-water pipe flow experiments. One was located in the Industrial Multiphase Flow Laboratory (LEMI), USP, Brazil. Experiments were performed in an acrylic pipe with 26 mm i.d. and 12 m long using oil (µ = 220 mPa∙s, ρ = 860 kg/m3) and tap water. The tested ranges of mixture velocities (*Ums*) and oil cuts (oil flow rate over total flow rate) were from 2.7 to 4.6 m/s and from 0.12 to 0.44, respectively. The volumetric fraction was measured using quick-closing valves (refer to Riaño et al.2 for details). The second test facility was the DONAU of Shell Global International B.V., Rijswijk, The Netherlands. Oil (µ = 7.5 mPa∙s, ρ = 887 kg/m3) and brine (µ = 0.8 mPa∙s, ρ = 1070 kg/m3) were used as test fluids. The test section was a 15 m long stainless steel pipe of 82.8 mm i.d. The tested ranges of mixture velocities and oil cuts were from 2.1 to 2.9 m/s and from 0.05 to 0.38, respectively. Two gamma-ray densitometers were used for the measurement of holdup. More details of the DONAU flow loop can be seen in Rodriguez et al.3.

**Results**

To predict more accurately the slip ratio, it is proposed a correction factor for Eq. 14 of Rodriguez et al.1:

 (1)

The correction factor, **,is correlated with the mixture Froude number defined as (Fig. 1).



**Figure 1. Correction factor as a function of Froude number (LHS), and comparison between slip-ratio data and slip-ratio predicted by the proposed correlation (RHS).**

One can see in Fig. 1 (LHS) that at high mixture velocities (high *Fr*) the value of the correction factor tends to 1, which is compatible with a homogeneous dispersion of oil droplets. At low values of mixture velocity (low *Fr*) the effect of eccentricity of the dispersed oil core on slip ratio is introduced (Eq. 2). The excellent agreement between predictions of Eq. (2) and data can be verified in Fig. 1 (RHS).

 (2)

**Conclusions**

The systematic underestimation of the slip ratio by the analytical expression deduced by Rodriguez et al.1 was corrected. The proposed model can be used for the correction of volumetric-fraction prediction tools in similar flow situations where inverted emulsion occurs.

**Literature Cited**

1. Rodriguez IH, Yamaguti HKB, Castro MS, Silva MJ, Rodriguez OMH. Drag Reduction Phenomenon in Viscous Oil-Water Dispersed Pipe Flow: Experimental Investigation and Phenomenological Modeling. *AIChE J.* 2012;58:2900-2910.

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3. Rodriguez IH, Peña HFV, Riaño AB, Henkes R, Rodriguez OMH. Experiments with a Wire-Mesh Sensor for Stratified and Dispersed oil-brine Pipe Flow. *Int J Multiphase Flow.* 2015;70:113-125.