

Uncertainty Analysis for the Measurement of Oil-Water Flow Parameters, Part II: Pressure Drop

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Abstract.

The need to ensure qualitative and reliable measurement of pressure drop of the oil-water flow cannot be over emphasized. In this regard, this study focused on the investigation of uncertainty in the measurement of pressure drop of oil-water flow in different acrylic pipe inclinations (0° , $+5^\circ$, $+10^\circ$ and -5°) and diameters (30.6-, 55.7- and 74.7-mm ID). The working fluids were tap water and mineral-based hydraulic oil (Shell Tellus S2 V 15), with medium viscosity and density of 24 cP and 872 kgm⁻³ respectively while the interfacial tension between the water and the oil was 12.9 mN/m at 25 °C. The selected flow conditions were 0.5 and 1.0 m/s mixture velocities each at 0.1, 0.5 and 0.9 input water volume fractions. The repeatability, accuracy of the pressure transmitter, flow rate of the oil-water mixture and holdup (particularly for the inclined flow) were the sources of errors in the measurement of the pressure drop. The results showed that the average relative uncertainties in the pressure drop in 30.6-mm ID pipe were $\pm 4.6\%$, $\pm 10.8\%$, $\pm 11.2\%$ and $\pm 10.8\%$ in the 0° , $+5^\circ$, $+10^\circ$ and -5° inclined flows respectively. Similarly, the average relative uncertainties in the pressure drop in the horizontal 55.7-mm and 74.7-mm ID pipes were $\pm 5.7\%$ and $\pm 7.5\%$ respectively. The largest contribution to the uncertainty in the pressure drop came from the flow rate and water holdup in the horizontal and inclined pipes respectively. The least contribution in both horizontal and inclined pipes came from the accuracy of the pressure transmitter.

Keywords: Oil-water flow; Pressure drops; Standard uncertainty, Combined standard uncertainty; Expanded uncertainty

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