

# Monitoring system applied to oil by-products interface in pipelines

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This report presents a methodology to precisely identify the interface region, which is formed in the transport of petroleum by-products in polyducts, using gamma densitometry [1]. The simulated geometry is composed for a collimated <sup>137</sup>C source and a NaI(Tl) detector to measure the transmitted beam. The modeling using the MCNPX code [2] was validated experimentally on stratified flow regime using water and oil by the volume fractions. A schematic flowchart of a polyduct carrying products crude oil and gasoline, as well as the interface that is formed between the batches of these products, is shown in Figure 1.

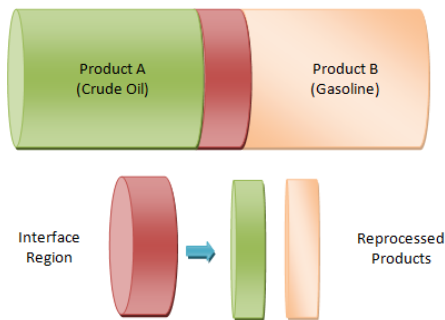


Figure 1. Interface region in the polyduct.

It can be seen that product crude oil was being pumped through the duct, so this pumping is interrupted and then product gasoline pumping begins. An interface region of the two products is formed and at the terminal of the polyduct three tanks are used to separate both products and the product generated from the mixture. Using the trigonometric method and mathematical manipulations, the calculation of the water volumetric fraction is obtained from the Equation 1.

$$\alpha(h) = \frac{\pi R^2}{2} + R^2 \cdot \sin^{-1} \left( \frac{h-R}{R} \right) + (h-R) \cdot \sqrt{R^2 - (h-R)^2}$$

Equation 1

Where: h – fluid thickness (cm); R – duct radius (cm) and y – axis of the coordinates of the Cartesian plane.

Results of volume fractions were obtained using Equation and these results are shown in Table 1.

Table 1 - Comparison of results obtained by analytical solution and MCNPX code.

Water volume fraction (%)		
Equation Analytic	MCNPX code	Relative Error (%)
50	49.8	0.4
60	60.1	-0.2
70	69.7	0.4
80	79.6	0.4
90	89.5	0.5

Simulations were made with different water volume fractions and the results are shown in Figure 2.

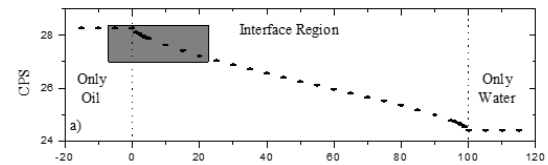


Figure 2. Interface region determination.

The experiments were performed to obtain the volume fractions. Each spectrum was obtained over a period of 20 hours. For the 50% of water volume fraction experiment, the calculated volume fraction was 48.45% with a relative error of 3.08%. This result indicates that the measurement system is in agreement when compared with the analytical equations. The final results present the determination of the region interface with an accuracy of 1% for have different volume fractions calculated using the MCNPX code.

## References

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- [2] PELOWITZ, D. B. "MCNPX TM User's Manual," Version 2.5.0, LA-CP-05-0369, Los Alamos National Laboratory, 2005.