# Obstructions identification in petroleum, petroleum derivatives and water transport pipes by means of a radiotracer

C. A. S., Pontes[1], L. E. B, Brandão[2], Salgado, C. M.[3]
e-mail: caspontes@gmail.com, brandao@ien.gov.br, otero@ien.gov.br

*[1] CENS/ IEN [2] SETMQ/ IEN [3] DIRA/ IEN*

*Keywords*: radiotracer, pipelines, obstruction, oil, water.

Pipeline is the main procedure used to transport materials in the petrochemical and petroleum industry and one of the biggest problems in the operations in these installations are the deposition of solid materials that generate complete or partial obstructions. These obstructions are caused by deposition of hydrogenated compounds and/or inorganic salts. Similar problems with obstructions can be found in water transportation pipes too. Considering economic and safety reasons, it is important control the piping of oil and derivatives and identify any obstruction in the pipeline.

The proposal of this work is the use of radiotracer to study of the flow profile of oil in our experimental pipelines and the establishment of a methodology that allows the identification of an obstruction points inside pipeline. The study is based upon the characterization of flow profile using the residence time curves of a $^{82}$Br injected as a pulse and recorded by scintillation detectors positioned externally to the pipe and identify of patterns of an obstruction that have been caused in the pipelines.

It is reasonable to believe that the residence time of a given molecule in a reactor, vessel or pipeline is related to the flowrate of the substance as a whole. In other words, it is to be expected that the time that a molecule of a certain substance spends to abandon a given device is greater or lesser according to the degree and type of obstruction that may be present. This is proven, according to conclusions already established by several authors, in the study of the Residence Time Distribution (RTD) [1].

In this way, for fluids with low dispersion the solution of the RTD function E(t) for the radiotracer curve when traveling a distance L inside the duct is given by Equation 1:

$$E(t) = \frac{u}{\sqrt{4\pi Dt}} e^{(-\frac{(L-ut)^2}{4Dt})} \qquad (1)$$

And for fluids with high dispersion, using the Equation 2:

$$E(t) = \frac{L+ut}{4\sqrt{\pi Dt^3}} e^{(-\frac{(L-ut)^2}{4Dt})} \qquad (2)$$

where u is the velocity of the fluid in meters per second, t is the time in seconds and D is the dispersion coefficient in square meters per second.

All the results were measured on the simulation pipelines for water flow in the Instituto de Engenharia Nuclear (IEN) radiotracer laboratory. The experimental pipelines were built in 3/4" polyvinyl chloride (PVC) ducts with 18 meters length. Three different kind of obstructions were tested. The partial results of the moments [2] mean resident time, τ, variance, $\sigma^2$, skewness, $\gamma^3$, and kurtosis, $\kappa^4$, for a flowrate equal to 200 $L.h^{-1}$ and detectors $D_1$ and $D_2$ positioned at 2m and 1m before the obstruction and $D_3$ and $D_4$ positioned at 1m and 2m after that respectively are shown in Table 1.

Table 1 - Results of the tests for no obstruction and a 1/4" obstruction

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ |
|---|---|---|---|---|
| $\tau$ | 56.9 | 62.7 | 77.4 | 82.1 |
| $\sigma^2$ | 41.4 | 46.2 | 129.4 | 78.3 |
| $\gamma^3$ | 297.8 | 358.0 | 2290.4 | 710.1 |
| $\kappa^4$ | 14.9 | 17.9 | 114.5 | 35.5 |
| $\tau_{1/4"}$ | 59.5 | 65.2 | 79.0 | 84.4 |
| $\sigma^2_{1/4"}$ | 89.6 | 86.4 | 156.1 | 121.4 |
| $\gamma^3_{1/4"}$ | 1423.8 | 1279.2 | 2804.4 | 1596.3 |
| $\kappa^4_{1/4"}$ | 71.2 | 64.0 | 140.2 | 79.8 |

As expected, these partial results indicate variations in magnitudes between two situations with and without obstruction. Results for other test conditions are being processed.

## References

[1] BRANDÃO, L. E. B. **Análise de unidades industriais pela técnica de traçadores radioativos - funções distribuição do tempo de residência**: Relatório técnico – IEN. Rio de Janeiro: Instituto de Engenharia Nuclear, n. 17, 2003.

[2] TORRES, A. P.; OLIVEIRA, F. A. R. Residence time distribution studies in continuous thermal processing of liquid foods: a review, **Journal of Food Engineering**, Amsterdam, v. 36, n. 1, p.1-30, 1998.