Detection geometry study to predict scale thickness in oil pipelines using MCNP-X

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This report presents use of the gamma transmission technique may provide support for a better understanding of the deposition of the scales in oil transport pipelines. Oil extraction is accompanied by water and sediment, which mixed with the oil and together with changes in pressure, temperature and fluid flow can cause these elements to precipitate forming deposits of on the walls of the pipes. Due to the chemical affinity of the elements soluble in the sea water and the formation water, chemical reactions may occur that will favor the formation of inorganic deposit, the scale. Fouling may cause: reduction of internal pipe diameters due to accumulation of deposited products, drilling at pipe points and equipment due to corrosion promoting agents, increased energy consumption due to reduced equipment efficiency and shortened life equipment and installation [1].
The geometry used for the study scale detection include a 280 mm diameter iron pipe containing barium sulphide scale ($BaSO_4$) from 5 mm of thickness, a gamma radiation source of ^{137}Césio (662 keV) with divergent beam and as NaI(Tl) 2x2" scintillation detector (Figure 1).

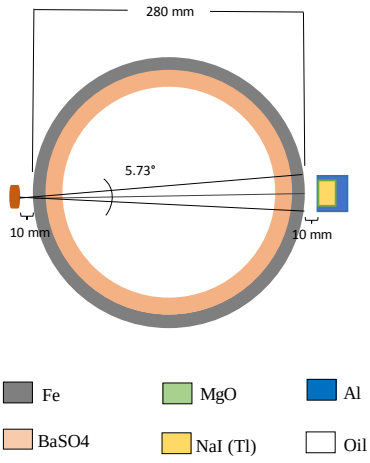

Figure 1. Simulated system.

The opening size of the collimated beam was evaluated (2 to 7 mm) to also quantify the associated error in calculating the scale. The study was realized with computer simulation, using the MCNP-X code.
Table 1 shows the Linear Attenuation Coefficients (LAC) for each material used in the simulations. These data are fundamental for the study of the gamma transmission.

Table 1 – LAC for pipe, scale and oil.

Data	Pipe	Scale	Oil
Density (g/cm³)	8	2.6	0.973
LAC (MCNP-X)	0.578	0.190	0.0775
LAC (NIST)	0.580	0.196	0.0838
Relative error (%)	-0.29	-3.12	-7.51

In the Figure 2 is showed the scale thickness and relative percentage error for the different collimation aperture. The collimating aperture with smaller variances are a pencil-beam and divergent 5.73 °, corresponding to 2 mm.

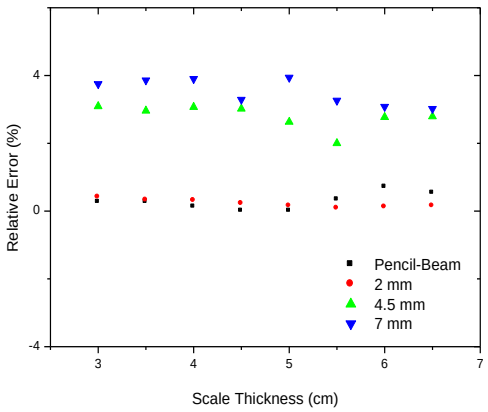

Figure 2. Scale thickness for collimation apertures.

Through the study, it can be used the opening of the collimator 2 mm to minimize the associated calculation errors and ensuring greater reliability in the scale thickness calculations.

References

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