Study of gas pipelines corrosion using gamma-ray scattering beam

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Most of the natural gas production is transported through gas pipelines, which require periodic inspections to evaluate the structural integrity of the pipelines due to possible defects caused by internal and external degradations, which can cause leakage and rupture, causing environmental disasters and damage to the population and economy of the local region. Therefore, this report presents a methodology for predicting loss of thickness caused by corrosion used in gas pipelines. The study is based on the principles of gamma densitometry to calculate the density of the pipe wall in order to investigate possible corrosions [1]. The interference of the natural gas fluid for the density calculations is considered in the methodology. In this study, the MCNPX code [2] is used to perform the simulations, to develop a more appropriate counting geometry. Simulations with different losses of pipe thickness caused by corrosion were used, and it is possible to detect the smallest loss of thickness possible by a NaI(Tl) detector. A carbon steel pipe API 5L Grade B with 4″ of diameter and 54 mm of thickness, filled with natural gas with internal pressure of 50 kgf.cm^{-2} was used in the model. The detection system uses a ^{137}Cs (662 keV) gamma-ray source and 2×2″ NaI(Tl) detector to obtain scattered beam. Different scattering angles are analyzed. The detector was collimated with lead, with a front opening, as shown in Figure 1.

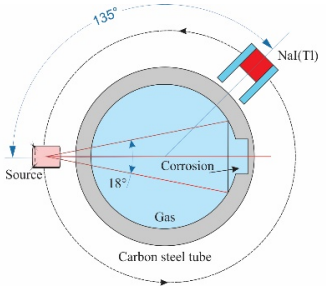

Figure 1. Proposed geometry

Geometry was developed aiming to study corrosions using scattered beam, performing a scanning system around the pipeline in order to determine ruptures on the internal region of the pipe. The width (W) ranged from 0 to 30 mm. The thickness (T) ranged from 0 to 5 mm. The proposed model is shown in Figure 2.

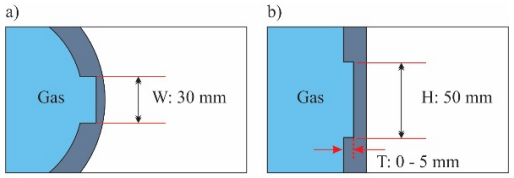

Figure 2. Dimensions of simulated corrosions: a) frontal view; b) upper view

In Figure 3 are presented corrosion width data detected by the detector positioned 135º of the source. The loss of material was made by varying the corrosion values (W, H, T) in a given range until the technique was not sensitive.

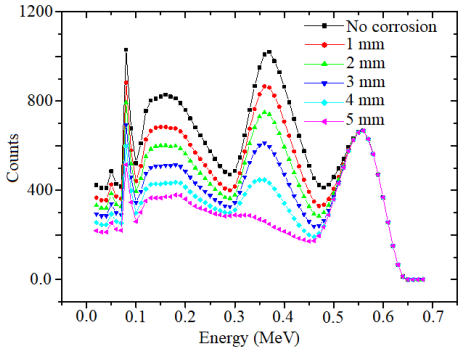

Figure 3. Scattered photons depending on corrosion width at 135° detector

Using this proposed geometry, it was possible to determine thickness loss of 0.5 mm that occurred by internal corrosion and 8 mm of width, and the material loss being 0.8 cm^3 of carbon steel. Reference materials are being acquired for experimental validation of the proposed methodology.

References

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