Study of gas pipeline cracks using Compton scattering.

M. F., Freitas[1], C. M., Salgado[2]
e-mail: marcelafreita@gmail.com, otero@ien.gov.br

[1] CNEM, IEN, [2]DIRA, IEN

Keywords: gas pipelines, densitometry, gamma ray source, pipe, cracks.

This report presents a methodology for predicting cracks in pipe used in gas pipelines. The approximation is based on the principles of gamma densitometry to calculate the density of the pipe wall in order to investigate possible cracks. The gamma-ray densitometry technique has been applied satisfactorily in many areas, such as: petrochemical, oil industry and mining. It has been used for prediction of density [1] and thickness measurements [2]. This method of absorbing gamma rays can provide reliable measurements of the density of the analyzed material, improving accuracy. However, in this type of measures difficulties are encountered, such as: extension and large diameter of the pipes, presence of fluids that due to differences in density interfere with the accuracy of density estimation. In contrast, in Compton scattering, the detector and the source can be arranged on the same side of the tube and an image? of the cross-section of the duct can be directly obtained from the scattered radiation. Theoretical model were developed using the mathematical code MCNP-X based on simulations using the Monte Carlo method to develop a suitable counting geometry for crack detection by calculating density. The model consists of a carbon steel pipeline 5" in diameter and 0.17" thick, inside the pipeline the natural gas fluid (density of 0.766 kg.m-3 -20 ° C, 1 atm) was used. A source of ^{137}Cs (662 keV) with narrow beam was appropriately used in the simulation with the angle of 4.29º divergence. Two lead collimated 3"x3" NaI(Tl) detectors were properly positioned, the first at an angle of 30º (D1) and the second at 60º (D2) as shown in Figure 1.

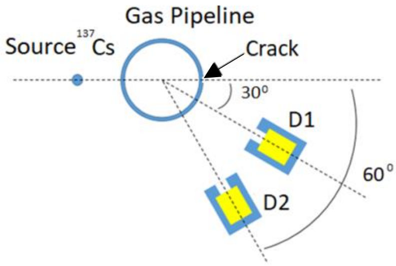

Figure 1. Simulated geometry

For the study of the crack in the pipelines, cracks were added in the rectangular (parallelog ram) format of 3 mm of thickness, 50 mm of he ight, the width was changed/modified from 2 mm to 16 mm, in steps of 2 mm na figura 1 não consigo ver isto. The first simulation was done without the crack.

In the Figures 2 and Figure 3 is showed results of the scattering photons in relation to the crack width variation was analyzed in the detectors D1 and D2. Can be observed there was an increase in the number of photons scattered as a function of reduction of the crack width, as can best be seen at the energies of 480 keV for the D1 detector and 310 keV for the D1 detector.

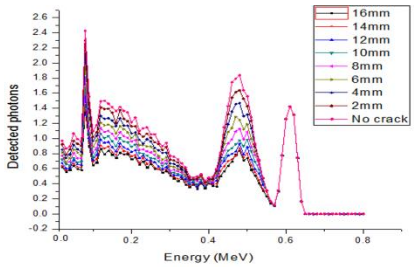

Figure 2. Scattering photons detected by detector D1

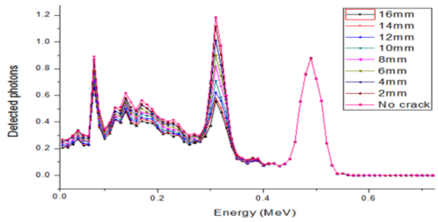

Figure 3. Scattering photons detected by detector D2

Based on the results, it was possible to define a relation between the crack width as a function of the number of scattering photons detected by detectors D1 e D2, using as reference at the energies of 480 keV and 310 keV respectively.

References

[1] ACHMAD, B.; HUSSEIN, E. M. A. An X-ray Compton scatter method for density measurement at a point within an object. **Applied Radiation and Isotopes**, Amsterdam, v. 60, n. 6, p. 805-814, 2004.

[2] KHORSANDI, M.; FEGHHI, S. A. H. Design and construction of a prototype gamma-ray densitometer for petroleum products monitoring applications. **Measurement**, Amsterdam, v. 44, n. 9, p. 1512-1515, nov. 2011.