Thickness measurement analysis of metals sheets based on gamma densitometry using MCNPX code

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This report presents a gamma radiation-based study employing two main detection techniques, named dual energy and dual modality, and find how they perform to measure the thickness of 3 different metal sheets: aluminum, iron and copper [1]. In order to evaluate the difference between the two techniques and which of them would give the best results to get the thickness of different metal sheets, the simulations were performed using MCNPX code [2] as follows: 1 - using two radiation sources (^{137}Cs and ^{60}Co) and one NaI (Tl) detector; 2 - using one radiation source (^{137}Cs) and two NaI(Tl) detectors as shown in Figure 1. In all simulations, the detector 1 recorded the transmitted photons from the source at a distance of 4 cm plus the thickness of the analyzed metal sheet positioned between the source and the detector.

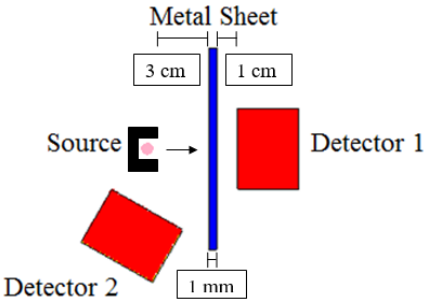

Figure 1. Simulation geometry for dual modality

For each one of these metal sheets the thickness varied up to 4 mm with 1 mm step. To simulate the detector, a cylinder with 3 cm length and 4 cm diameter filled with sodium iodide with a density of 3.67 g/cm³ was utilized. I0 is obtained without the metal sheet. For dual energy, in both energy ranges, 662 keV and 1.34 MeV, it is possible to differentiate each one of the thickness from different metal sheets and shows a similar relation of counts registered at the photopeak area of the detector x thickness. However, it is important to notice that at small thicknesses like 1 mm becomes harder to differentiate metals with similar densities and atomic numbers, as shown in Figure 2.

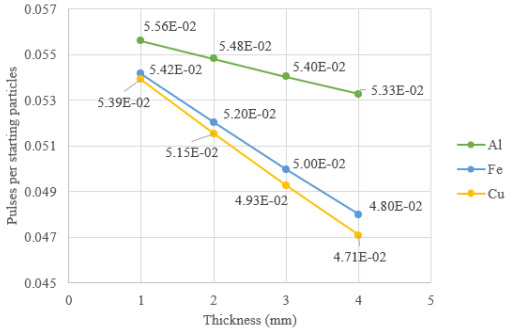

Figure 2. Results using 1.34 MeV energy

For dual modality, the results were obtained by analyzing the scattered radiation through the detector 2. At first, different scattering angles from 20º to 60º were evaluated and it was found that at short angles, like 20º, it is better to differentiate the thickness of each metal. Then, a comparison between the 3 metal sheets was made, as shown in Figure 3.

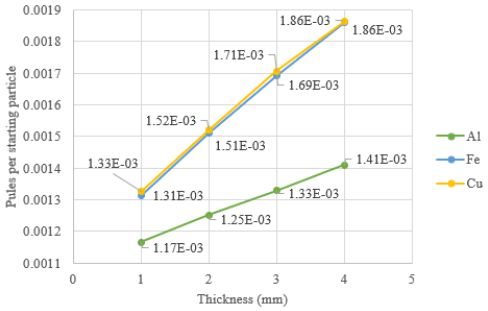

Figure 3. Comparison using the scattering at 20°

It is possible to say that both techniques are important and can be used to differentiate the thickness of each evaluated metal, although it becomes harder at metals with similar densities. Moreover, the dual energy technique has shown in this study better results in order to distinguish metals with similar densities.

References

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