Influence of hydrocarbons in the determination of mass attenuation coefficient using gamma densitometry and MCNPX code

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Nuclear techniques have been used in the oil industry to monitor systems of oil by-products [1]. Therefore, this report presents a study of the influence of hydrocarbons in the determination of mass attenuation coefficient (μ_m) using gamma densitometry and MCNPX code [2]. Measurement geometry consists of a 1¼ × ¾″ NaI(Tl) detector, a point isotropic radiation source (pencil beam) and a sample of hydrocarbons, as follows Figure 1.

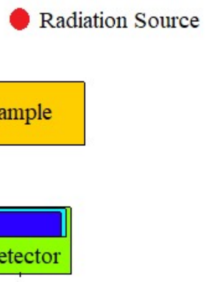

Figure 1. Simulated geometry.

The methodology was validated using a ^{137}Cs (662 keV) radiation source and one sample with high purity (iron – Fe, density = 7.87 g.cm^{-3}) used as reference. The results were compared with reference value from NIST [3]. Results, including relative error (RE %) are presented in Table 1. RE (%) was below 2%, which indicates that the methodology is satisfactory to determine mass attenuation coefficient.

Table 1. Results of MCNPX code and NIST.

Sample	μ (g.cm^{-2})		RE (%)
	MCNPX code	NIST	
Fe	0.07213	0.07346	1.81

Using this well stablished methodology, it was possible to determine mass attenuation coefficient of two hydrocarbons: Oil Lard ($C_{12}H_{18}O$, density = 0.915 g.cm^{-3}) and Oil Hydraulic ($C_{40}H_{33}O_4Cl_6P$, density = 0.871 g.cm^{-3}). Energy range was from 50 keV to 1400 keV, with steps of 50 keV. In addition, energy of ^{241}Am (59.5 keV), ^{137}Cs (662 keV) and ^{60}Co (1173 and 1332 keV) were used in the simulations in order to compare these results with experimental results in future studies. The results were compared with NIST reference values and are presented in Figure 2.

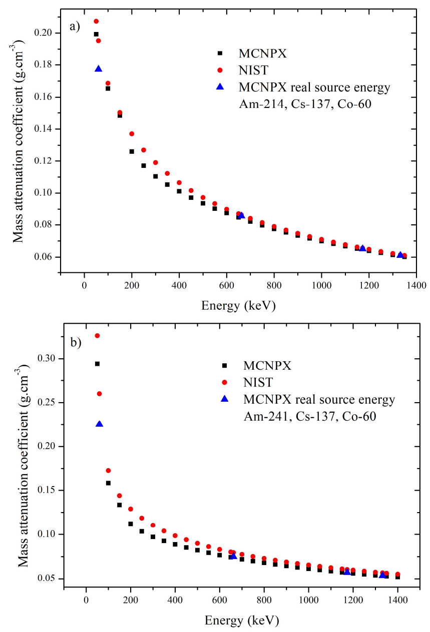

Figure 2. Results of: a) Oil, Lard; b) Oil, Hidraulic.

In high energies, the results are in good agreement with reference values. For both hydrocarbons, there are inconstancies in the same energy range and this will be investigated. In future studies, experimental measures will be taken to determine mass attenuation coefficient and the results will be compared with simulation aiming to evaluate the influence of hydrocarbons in applications of nuclear techniques in oil industry.

References

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