Determination of linear attenuation coefficient for hydrocarbons

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This paper presents a methodology to determine the linear attenuation coefficient in oil. In the petroleum industry, even within the same extraction well, the oils may have different chemical compositions and densities which make the determination of the hydrocarbon chain making up the oil in question a complex task. Several hydrocarbon chains were tested in order to evaluate their influence under the coefficient value. For the calculation of the linear attenuation coefficient using the mathematical simulations, the densities were measured experimentally and the chemical composition used in previous studies, which was the chain of hydrocarbons C_5H_{10} [1].

The calculation of the linear attenuation coefficient is done using Equation 1.

$$I = I_o . e^{-\mu . x} \quad (1)$$

Where:
I: transmitted intensity of gamma rays (photons.cm^{-2}.s^{-1});
I_o: initial incident intensity of gamma rays (photons.cm^{-2}.s^{-1});
x: thickness of the absorber (cm);
μ: linear attenuation coefficient (cm^{-1}).

For the determination of the coefficient, it is necessary to know precisely the distance of the source-detector system, as well as the “thickness” of the sample. The geometry of measurement consists of a lead collimator with aperture of 4.75 mm in order to obtain adequate divergence of gamma radiation beam. The counting time was 7200 seconds, the ^{137}Cs source was used. The alignment of the detector and source system was done by positioning a laser through the opening of the collimator.
The procedure used to calculate the linear attenuation coefficient was to perform a measurement (initial emission) using the detector, the source and the empty sample holder, Figure 1a, and a second measurement (final emission) was made by adding the oil to the sample holder, Figure 1b. The oil level in the center of the sample holder was measured using a pachymeter with an accuracy of ± 0.05 mm.

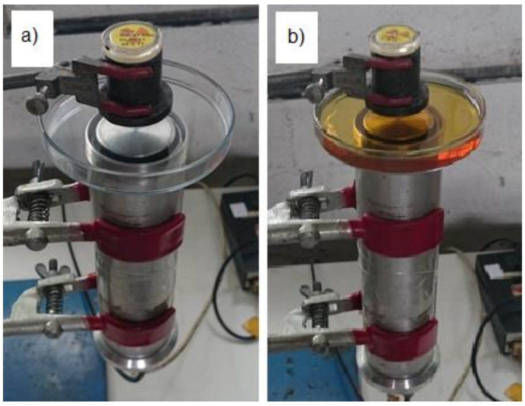

Figure 1. Measuring geometry for oil: a) Initial emission; b) Final emission.

In order to validate the geometry used in previous studies [2], computational simulations were performed in the MCNP-X code. All simulations were performed in the code using the tally f8 command with a number of stories (NPS) equal to $2x10^8$ so that the uncertainty in the photoelectric region was below 1%.
In the experimental procedure the value of the linear attenuation coefficient obtained was 0.00275 cm^{-1} ± 0.98, while in the simulation the value obtained was 0.00278 cm^{-1} ± 0.002 with a relative error of 1%.
These results indicate that it is possible to estimate the chemical composition of the oil using the MCNP-X code.

References

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