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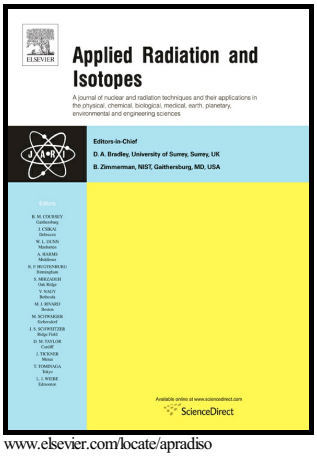

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Inorganic scale thickness prediction in oil pipelines by the gamma-ray attenuation and Artificial Neural Network

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Abstract

Scale can be defined as chemical compounds inorganic, initially insoluble, and which precipitate accumulating in the internal wall of pipes, surface equipment and/or parts of components involved in the production and transport of oil. These compounds, when precipitating, cause problems in the oil industry and consequently result in losses in the optimization of the extraction process. Although the importance and impact of the precipitation of these compounds in the technological and economic scope, there is still the difficulty in determining methods that enable the identification and quantification of the scale at an initial stage. The use of the gamma transmission technique may provide support for a better understanding of the deposition of these compounds, making it a suitable tool for the non-invasive determination of their deposition in oil transport pipelines. The geometry used for the scale detection include a 280 mm diameter steel tube containing barium sulphate scale ($BaSO_4$) ranging from 0,5 to 6 cm, a gamma radiation source with divergent beam and as NaI(Tl) 2x2" scintillation detector. The opening size of the collimated beam was evaluated (2 to 7 mm) to also quantify the associated error in calculating the scale. The study was realized with computer simulation, using the MCNP-X code and validated by means of analytical equations. Data obtained by the simulation were used to train an artificial neural network (ANN), making the study system more complex and closer to the real one. The input data provided for training, testing and validation of the network consisted of ducts with 04 different internal diameters (D1, D2, D3 and D4) and 14 different scale thicknesses (0.5 to 7cm, with steps of 0.5 cm). The network presented generalization capacity and good convergence, with 70% of cases with less than 10% relative error and linear correlation coefficient of 0.994, which indicates the possibility of using this study for this purpose.

Keywords: Gamma Transmission, Scale, Artificial Neural Network, MCNP-X code.

1. INTRODUCTION

In the oil industry, a production of oil and natural gas involves the transport of fluids in the liquid and gaseous phase to a processing unit where a phase separation is performed. This