Scale thickness in oil pipelines using gamma rays and MCNP-X code

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In the oil industry, for the control of oil production, it is necessary to know the percentage of each of (oil, water, gas) components flowing through the pipes of the oil wells. Oil and gas extraction is accompanied by water and sludge and this mixture leads to the formation of deposits on the walls of the pipes and equipment. It causes the reduction of the its internal diameter, obstructing the passage of fluids, demanding periodic maintenance actions which increases costs. The formation of insoluble scale types occurs when the injected seawater and formation waters are mixed in the reservoir, interacting chemically and precipitating minerals; which is caused by the precipitation of inorganic salts from produced water [1]. Since seawater and formation water contain high concentration of sulfate anions and divalent cations (calcium, strontium and barium), the mixture causes formation of sulfate salts scales. Among the main scale associated with oil producing wells, barium sulfates ($BaSO_4$) stands out, see Figure 1. There is a need for control the thickness of the scale for the assessment of preventive and corrective measurements without the need of stopping the plant operation.

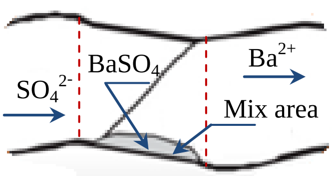

Figure 1. Formation of deposit in oil reservoirs

Several radiation techniques have been used for scale detection in pipelines offshore applications using radiotracers, neutrons, computed radiography and gamma-ray densitometry technique (GDT). The GDT has been applied successfully in several areas such as: chemistry, mining and petroleum industry. This technique is very important in industry and, for this reason, has been investigated and improved by many researchers. This methodology provides real time analysis and has proved to be an asset for flow measurement, thickness measurement, petroleum monitoring applications, gamma-ray scanning technique for troubleshooting analysis of column distillation, material's density prediction and wall thickness pipes. The most common GDT is based on transmission measurements of a gamma-ray beam to determine the density of the material. A radiation detector records the transmitted gamma-ray flux after passing through the fluid and the pipe's wall, see Figure 2.

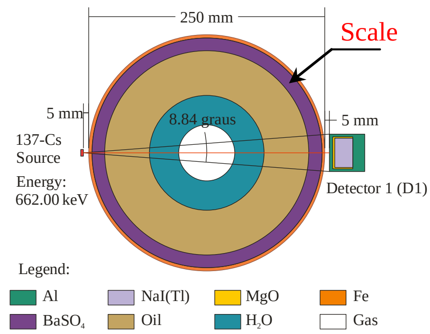

Figure 2. Simulated system

The transmission measurement technique allows monitoring the entire process with cost reduction and has shown to be a potential solution to the preventive control of scale. Furthermore, it is a noninvasive technique, which can detect and quantify the scale and with single measurement geometry. The analysis by transmission measurements may be performed by comparison of the recorded pulses by the detector with the content of a density calibration table or analytical equations. The mathematical simulations consider the interactions of the radiation with all the materials involved both in the pipe, the transport material and the detector itself which, in this case, is the NaI(Tl) detector. This report proposes a methodology to predict the scale thickness in oil extraction pipeline using the technique of transmission of gamma radiation, considering influence of materials in the tube-scale-fluid system with good accuracy using the MCNP-X code. Many models of geometry with scattering and/or transmission detection are being studied in order to obtain more precise results.

References

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