Prediction of scale thickness in pipelines using artificial neural network and gamma rays by MCNP6 code

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This report presents a method to study the deposition of scale in pipelines of multiphase systems (oil/water/gas), commonly found in the petroleum industry [1]. The scale prediction for the pipelines is done through artificial neural network (ANN), trained by using simulated data obtained with MCNPX code [2], and gamma-ray transmission measurements. The model considered only barium sulfate ($BaSO_4$) as main scale's material. The transmission setup is composed of a ^{137}Cs (662 keV) volumetric source and one NaI(Tl) detector placed around the pipe. The pulse height distributions recorded in the detectors are used as input data of the ANN. The scale thickness in the oil industry's pipes can be calculated by the artificial neural network regardless of the presence of fluids with satisfactory results in water-gas-oil multiphase system with annular flow regime. The simulated setup is shown in Figure 1.

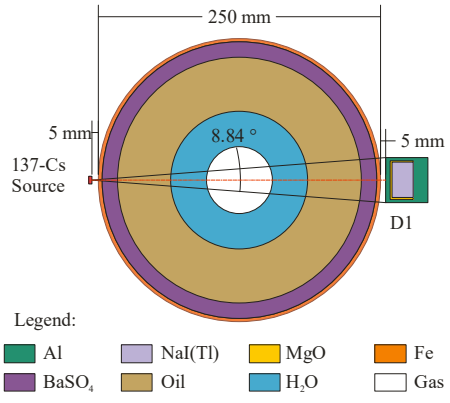

Figure 1. Simulated system.

The data from the scale predicted by the ANN were fit to a linear equation by the least-squares procedure and the linear correlation coefficient showed to be of 0.999. A good agreement between the scale thickness predicted by the ANN and the scale thickness considered in the simulations shows the ability of generalization of the network. The values predicted by the ANN for scale thickness were close to the thickness considered in the simulations and are showed in the Figure 2. It can be observed that the ANN could adequately predict the scales even when the volume of the material is modified due to the smaller diameter of the pipe caused by the scale.

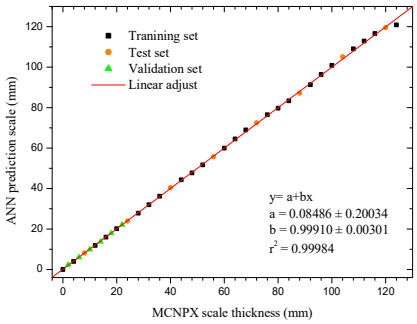

Figure 2. Results obtained for all sets.

The results obtained for the validation set are shown in Table 1 and indicate that the ANN could adequately predict the scale thickness.

Table 1 - ANN prediction for the validation set.

Scale thickness (mm)		Difference	Relative Error (%)
Real	Predicted (ANN)		
2	2.36	-0.39	19.67
6	5.99	0.14	5.43
10	9.87	0.76	1.94
14	13.77	-0.37	1.06
18	17.93	-0.15	0.51
20	22.11	0.08	0.66

The final results have presented for all patterns maximum relative error of 1.21%. 94% of the Test data were predicted with relative error below ±5%. The results indicate that the methodology can be used since the proposed ANNs could correctly predict the scale thickness with satisfactory results.

References

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