Fluid level prediction for separator in oilfield using scattering gamma ray and artificial neural network

C. M., Salgado[1], R. C., Nunes[2]
e-mail: otero@ien.gov.br, chaffin@ien.gov.br

[1] *DIRA, IEN;* [2]*SEREA, IEN*

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The fluid level is one of the most important parameters characterizing multiphase flows. The use of techniques for determination this parameter of water-gasoil-air flows with adequate precision is required for control the quantity of fluid volume. An interesting application in the area of oil extraction is the measurement of interface level; where basically in the extraction has an oil separator and water.
The goal is that via density difference if you can separate and know the interface level of the mixture, without loss and with safety. Gamma ray densitometry is most commonly used for this purpose [1]. The scattering gamma-ray beam was used for the fluid level prediction [2]. A multilayer perceptron neural network (ANN) is used for predict the fluid level from data recorded by detector. The cross section of the Compton scattering is calculated using the Klein–Nishina equation.

Developing of ANN

The approach is based on pulse height distributions (PHD) pattern recognition by means of ANN for predicting of the fluid level in water-gasoil-air flows. ANNs can be defined as a mathematical system consist of simple processing elements named neurons running in parallel which can be generated as multiple layers. A 3-layer feed-forward multilayer perceptron (MLP) has been used with Back-propagation algorithm. The required data set for training the network was obtained from the simulations using the MCNP-X code.
The inputs are registered scattering PHD in the NaI(Tl) detector. Combinations of fluid levels were simulated and the scattered flux has been calculated. The scattered PHD is the ANN input and fluid level as output. A Test set was used for stopping criteria: cross validation in order to avoid over-training. Many regions of the PHD will be tested for improved accuracy of the training.

Geometry simulated

A polyethylene container with an inner diameter of 40 cm, 3 mm thickness, and height of 25 cm was used as the main vessel. A 1x1" NaI(Tl) detector) was placed under the vessel to record backscatter gamma-ray from a ^{137}Cs source. A lead collimator with 0.5 cm beam diameter was used to make a narrow beam. The Water, gasoil and air with densities 1 g.cm^{-3}, 0.86 g.cm^{-3} and 1.2E-3 g.cm^{-3} were used. These fluids were located in a container with 3 layers as height is H_1+H_2+H_3=25 cm. The number of samples with different fluid level composed water-gasoil-air flows will be obtained using mathematical simulations. The acquired data sets (PHD) from samples will be used for training the ANN.

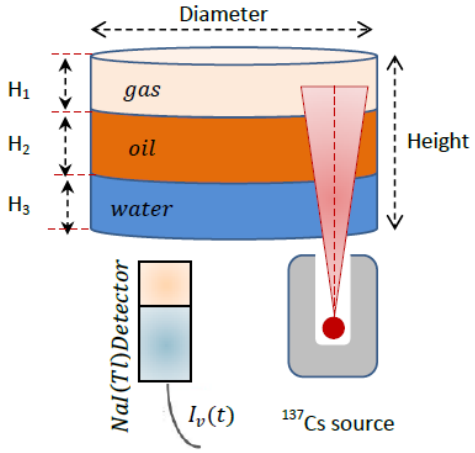

Figure 1. Simulated system

Discussion

In this study, the recorded backscatter gamma ray PHD from a detector together with ANN has sufficient information to calculate the fluid level in multiphase flows. By the way, the ANN can more accurately fluid level predict. Studies in progress are been made to design an ANN and develop a measurement geometry for predict fluid levels more accurately.

References

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