Experimental validation of volume fractions in two-phase systems using nuclear technique and artificial neural network

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The knowledge of the flow regime and the volume fraction in a multiphase flow is of fundamental importance in predicting the performance of many systems and processes. This work had been performed as part of a doctoral thesis [1]. The objective of this research was the modeling a biphasic flow experiment in a wave regime. This study is based on gamma-ray pulse height distributions pattern recognition by means the artificial neural network (ANN). The detection system uses appropriate one narrow beam geometry, comprised of a gamma-ray source and a NaI(Tl) detector. The model for stratified flow regime had been developed using MCNPX [2], in order to obtain adequate data set used for training and testing the artificial neural network. The Ansys-CFX [3] was used as a computational fluid dynamic software to simulate different volume fractions. Finally, after this training, the ANN was used on the experiments results; thus, it was possible to verify the training of the ANN in a situation closer to reality. A simplified wave model with water was developed (see Figure 1) to be studied experimentally. The experimental wave form (see Figure 2) was made using agar, used to model the water at room temperature (about 23ºC).

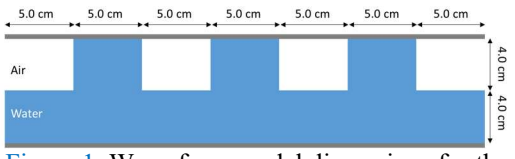

Figure 1. Wave form model dimensions for the experiment.

In order to simulate the fluid flow, the pipe was moved 0.5 cm every 30 seconds, giving a total measurement time of 25 minutes. The volume fraction calculated from the section under study is 20.3% of air. It was carried out three measurements, and their results were placed in the production set of the ANN, after the ANN had been trained.

Figure 2. Experimental wave form scheme.

Table 1 shows the relative percentage deviations (RPDs) for the ANN results for the production set compared to the three measurements of the experimental wave form.

Table 1. ANN prediction for volume fraction of air for the production phase on experimental wave form.

Data	Real VF (%)	ANN predicted VF (%)	RPD
1	20.3	19.5	4.2
2	20.3	21.4	5.1
3	20.3	21.0	3.0

The experimental study were essential to provide results closer to reality. The results showed good accuracy compared to the real values.

References

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