Dynamic performance of a simple capacitance sensor for void fraction measurement of two-phase gas-liquid flow

L. C. R. P. Silva[1], C. A. G. G. Filho[1], J. L. H. Faccini[1] and J. Su[2].
E-mail: reina@ien.gov.br, faccini@ien.gov.br

[1] *LTE, IEN, CNEN*
[2] *PEN, COPPE, UFRJ*

Keywords: two-phase flow measurement, thermodynamics, nuclear engineering.

This report presents the two methods that are being carried out at LTE/IEN to measure the void fraction in a two-phase flow (air/water). Dynamic tests were performed on the capacitance sensor, developed at LTE/IEN, in order to obtain a comparison between the dynamic performance of a simple capacitor and an ultrasonic measurement system [1]. Among the available non-intrusive techniques, these were the most attractive to draw a comparison and evaluate the performance of the simple capacitance sensor [2]. The output signals of the capacitance sensor were synchronized with the ultrasonic pulses reflected by the air-water interface and transmitted to boards embedded in a computer where software recorded the signals. The void fraction of the two-phase gas-liquid flow was measured by processing the capacitance and ultrasonic signals respectively. In Figure 1, an experimental case is presented where the behavior of the liquid height h_L and the void fraction α_{CP} can be evaluated. When h_L decreases, α_{CP} increases, and inversely as expected showing that there is a good synchronization between the ultrasonic system and the capacitance sensor.

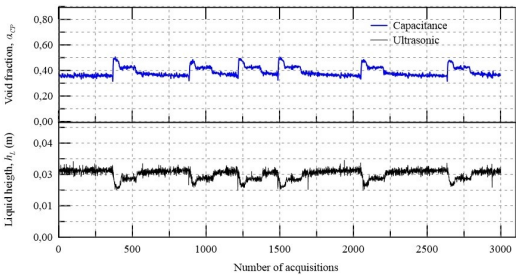

Figure 1. Liquid height ultrasonic measurements, h_L (black) and void fraction capacitance measurements, α_{CP} (blue).

Figures 2 and 3 show the void fraction results given by the ultrasonic system (black curves) and capacitance sensor (blue curves).

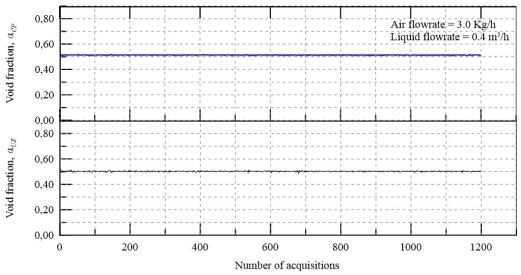

Figure 1. Void fraction measurements provided by the capacitance sensor (blue) and the ultrasonic system (black) for stratified smooth flow.

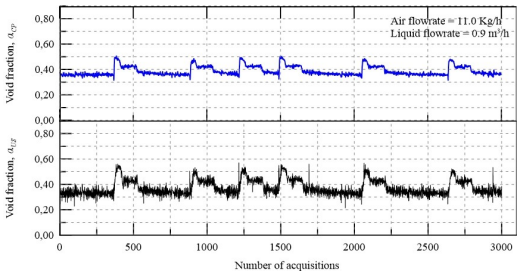

Figure 2. Void fraction measurements provided by the capacitance sensor (blue) and the ultrasonic system (black) for a stratified-intermittent transition flow.

The obtained results indicated that the capacitance sensor combined with the ultrasonic system was able to characterize the different flow regimes, the stratified smooth–wavy flow and the stratified-intermittent transition flow. Additionally, the synchronization between different methods and techniques for measuring the void fraction is an important advance for future research, since it becomes possible to compare the results simultaneously and obtain a more accurate result.

References

[1] SILVA, L. C. R. P.; FACCINI, J.L.H.; SU, J. Dynamic performance of a simple capacitance sensor for void fraction measurement of two-phase gas liquid flow, International Nuclear Atlantic Conference - INAC, Santos, SP, Brazil, October 21-25, 2019.

[2] SILVA, L. C. R. P.; FACCINI, J.L.H.; FARIAS, M. S.; SU, J., “A Simple Capacitance Sensor for Void Fraction Measurement in Gas-Liquid Two-phase Flow”, International Nuclear Atlantic Conference - INAC, Belo Horizonte, MG, Brazil, October 22-27, 2017.