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Void Fraction Experimental Determination in Gas/Liquid Horizontal Pipe Flow by Mean of a Dual Optical Probe

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Extended Abstract

The void fraction is one of the key quantities to measure to fully characterize a liquid vapor two-phase flow and to predict crucial properties for the design of condensers and evaporators such as the friction factor and the heat transfer coefficient in a given channel [1]. These flows are involved in evaporators and are found in several processes in the industry such as power plants, automotive vehicles and air conditioning systems [1]. Due to its importance, its accurate measurement has been the subject of numerous studies in the literature for decades. The void is mostly obtained by mean of the quick-valve method in the experimental test campaigns [2] which is a non-continuous method. However, most experimental techniques for its determination are either cumbersome, intrusive, or depending on an important calibration. Various reviews exist about all the measurement techniques available to determine it [2,4,5]. Thereby, numerous authors have tried over the last decades to develop correlations to predict the void fraction. The main problem lies in the fact that different header and channels configurations, different fluids and different flow patterns were used by the authors for the determination of the correlations, making it difficult to find the appropriate equation. From the review from Márquez-Torres et al. [3], it appears that few study exist about the void fraction in a horizontal pipe using air and water as fluid.

In the present work, dual optical measurements are presented to characterize the void fraction in a 30mm diameter horizontal smooth pipe. The working principle of this instrument relies on the change of refractive index in the measured medium, between the liquid and the gaseous phase. Light is emitted in the sensor until the end of the probe tip located inside the channel. Whether the sensor is surrounded by gas or liquid, the light will be reflected (due to the low optical index of the gaseous phase) and send back to the acquisition system to be converted into an electrical signal or not reflected. The optical probes are thus intrusive and local measurement techniques [4] but does not require any calibration. An air/water mixture of known composition is used as fluid. The experiments cover a several mass-flow rates and inlet gas qualities, to observe several flow regimes, from stratified to intermittent and annular flows. The void fraction results are compared with existing correlations [6] as well as other studies at various pipe diameters [3].

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