A simple capacitance sensor for void fraction measurement in gas-liquid two-phase flow

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Keywords: capacitance technique, void fraction, two-phase flow, gas-liquid flow.

In this work we present a simple and inexpensive capacitance sensor for time averaging void fraction measurement of gas-liquid two-phase flow, which was developed at Experimental Thermalhydraulics Laboratory in the Nuclear Engineering Institute, IEN/CNEN, [1]. The sensor is a non-invasive device causing no flow disturbances. It is formed by two parallel plates and four electronic circuits: a signal input circuit, an amplification circuit, a frequency generator, and a power supply circuit. The frequency generator applies a sinusoidal signal with appropriate frequency into the signal input circuit which converts the capacitance variation value (or void fraction) of the two-phase flow into a voltage signal that goes to the amplifier stage; the output signal of the amplifier stage will be an input to an analogical/digital converter, installed inside of a computer, and it will provide interpretation of the signal behavior. In Figure 1 we can see an overview of the experimental set-up. The sensor capacitor is placed in series with a frequency generator and variable resistors. The additional capacitors provide a filtering action for the sensor signal. The voltage drop V_{C2} across capacitor C2 increases as the sensor capacitance increases and reversely. So the V_{out} voltage also increases and decreases according V_{C2}. Since V_{out} is small amplitude signal, it is amplified on the amplification circuit (not shown).

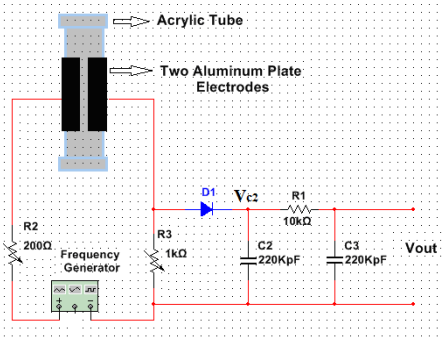

Figure 1. Experimental set-up.

The capacitance sensor was calibrated by using a horizontal acrylic tube filled with a known volume of water. An ultrasonic system was applied for the capacitance sensor calibration, consisting of one transducer, a generator/multiplexer board and a computer (PC) with embedded software to control the board. In Figure 2 is shown the calibration set-up.

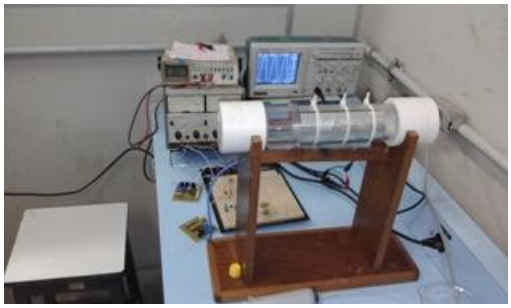

Figure 2. Calibration set-up.

The results of void fraction measurements by capacitance sensor, and ultrasonic system are shown in Figure 3. It can be notice a good agreement between the two techniques, except for a small discrepancy in the case where the tube is empty.

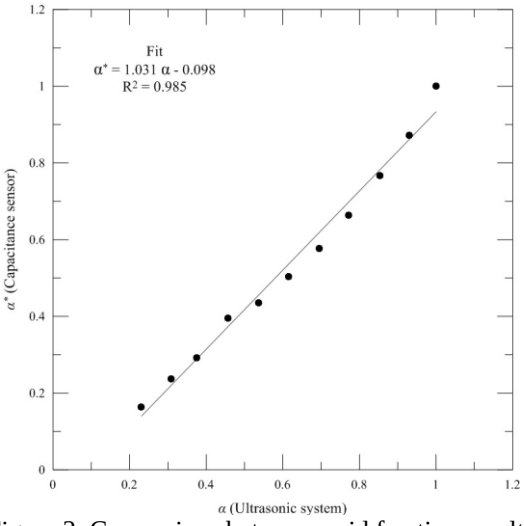

Figure 3. Comparison between void fraction results given by capacitance sensor, and ultrasonic system.

References

[1] SILVA, L. C. R. P. et al. Simple Capacitance Sensor for Void Fraction Measurement in Gas-Liquid Two-Phase Flow. In: In: INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE, - ENFIR - Meeting on Nuclear Reactor Physics and Thermal Hydraulics, 10., 2017, Belo Horizonte. **Anais...** Rio de Janeiro: ABEN, 2017. Não paginado.