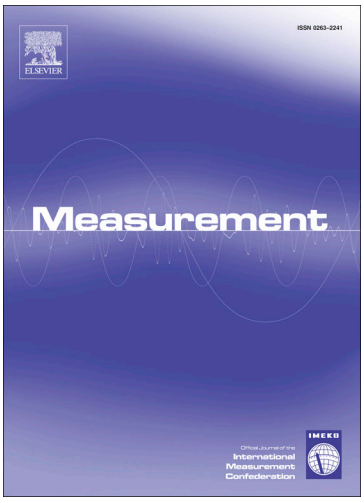

Void Fraction Measurement Using Concave Capacitor Based Sensor – Analytical and Experimental Evaluation

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Void Fraction Measurement Using Concave Capacitor Based Sensor – Analytical and Experimental Evaluation

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Abstract:

Two-phase flow in pipelines is very common in the oil and gas industries. Void fraction is one of the important parameters in two-phase flow. Measurement of void fraction plays an important role in various areas of industries. Two types of measurement techniques are commonly used in electrical methods for macroscale range- variable capacitance type and variable conductance type. A comparatively low cost and non-invasive design of the concave capacitive sensor is analytically evaluated and experimentally validated to measure the void fraction inside the non-metallic pipe. The design is effective to reduce the fringing effect. The electrical model of the concave capacitance sensor is analyzed, which involves all the parasitic capacitances along with the cable capacitances. The capacitance of the sensor varies for the whole range of void fraction (0% to 100%). If the two phases are distilled water and air, the capacitance value varies from 94.0134 pF to 3.4377 pF experimentally for void fraction variation of 0% to 100%. Uncertainty analysis for the proposed sensor design along with the uncertainty budget is presented, for the whole range of measurement. The standard uncertainty is less than 0.97 pF for the whole range of measurement. The procedure for analysis is also discussed in this paper.

Keywords: Concave capacitive sensor, two-phase flow, void fraction, electrical model, non-invasive technique, uncertainty analysis

1. Introduction

Nowadays void fraction measurement in two-phase flow become necessary in various fields such as petrochemical industries, oil industries etc. Sometimes it is very necessary for micro range applications, for example in drugs industries [1]. Different techniques are used there to measure the void fraction of two immiscible fluid phases inside the pipe like invasive methods (wire mesh method, optical probe methods [2] etc.) and non-invasive methods (Gamma-ray attenuation method, electrical methods). Void fraction measurement is also important at some crucial processes like heat