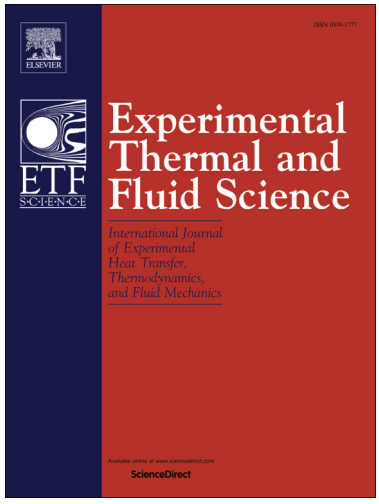

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Different configurations of capacitance sensor for Gas/oil two phase flow measurement: An experimental and numerical study

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Abstract

In this paper, an experimental investigation and numerical study were performed on different electrode configurations for oil-air two phase flow measurement in different patterns. The main electrode configurations are: double ring, concave and double helix that can be compared in terms of sensitivity and phase distribution immunity. For this purpose, finite element simulations were carried out to compare electrode configurations as well as experimental study. Also a new electrode shape (TRFLC) was proposed and compared with the others. The simulation results show different sensitivity for each flow pattern: for stratified regime, TRFLC and for annular regime, concave and helical shapes were more sensitive. Concave shape was strongly dependent on the flow pattern while helical and ring show less dependency. Then, an experimental set up was constructed for oil-air two phase flow in a 26.6 ID horizontal pipe. Also, a capacitance sensor with high sensitivity was designed, using those electrode configurations, to measure small changes in the capacitance values of oil-air two phase flow and converting to voltage by a transducer circuit. The sensor responses for each configuration show TRFLC and concave had the most overall sensitivity for the pipe filled with oil and air which is consistent with the results of simulation. Flow pattern detection with the concave capacitance was clearly possible without the need for signal processing, regimes such as bubbly, slug, plug and wavy, and gas-oil ratio was obtained using helical type with an absolute percentage error less than 8%. In summary, if the main objective is identification of flow regime, then the TRFLC or concave shape is preferred and on the other hand, helical shape is favored if measurement of gas fraction is the target.

Keywords: electrode configuration, two phase flow, gas-oil ratio, capacitance sensor, flow regime, flow map