A Multiphase Flow Measurement System Comprising an Impedance Cross Correlation (ICC) Device and an Imaging Electromagnetic Flow Meter (IEF)

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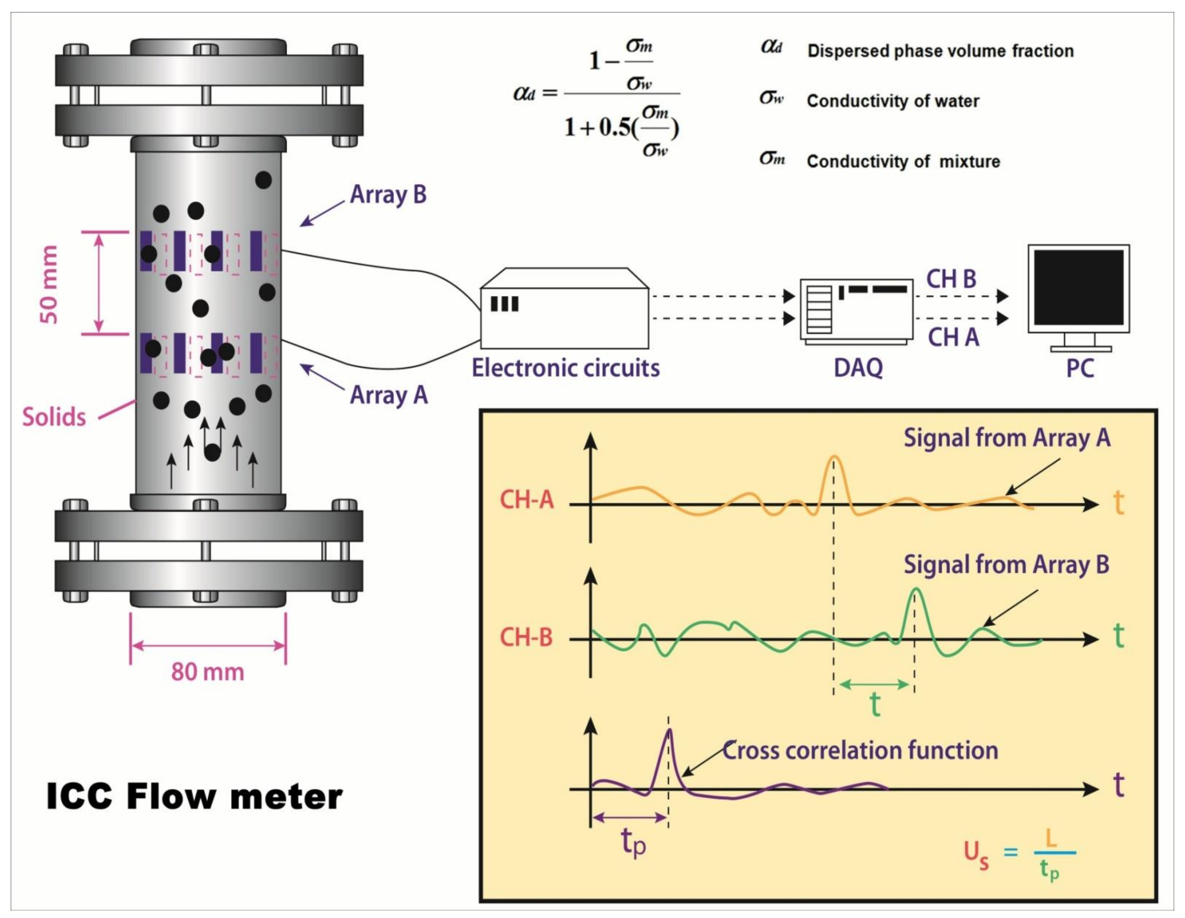
INTRODUCTION

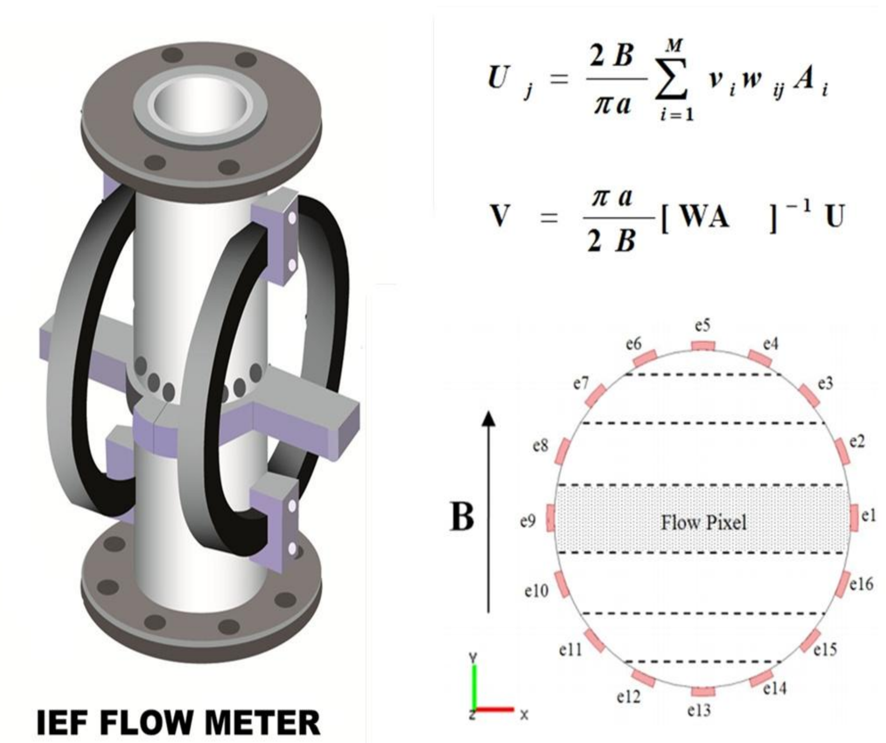
Multiphase flow measurement in particular is becoming increasingly important to the oil industry. Horizontal and inclined two-phase flows are frequently encountered. It is required to measure the velocity and volume fraction of each of the flowing components and this is particularly true in " Production logging" application. Generally the method of measuring multiphase flow depends on a large and expensive separator which is used to split the mixture into its assorted phases which are then measured separately by single phase flow meters. This research investigates a new two-phase flow measurement system which is able to measure the velocity profile, volume fraction profile and volumetric flow rate for each of the dispersed and continuous phases.

OBJECTIVES

- In order to implement a flow meter capable of measuring the following flow parameters: (i) velocity distribution; (ii) volume fraction distribution and (iii) volumetric flow rate ,for each phase in a two-phase flow, the new flow measurement system integrates an impedance cross correlation (ICC) flow meter with an imaging electromagnetic flow meter (IEF).
- Control of the two different devices, and measurement of their high data rates, requires a computer-based tool to implement online monitoring and control. This is based around 'Labview' software and a National Instruments (NI) DAQ board. This system also allows data processing and data fusion from the two systems.

ICC&IEF FLOW METER





DESIGN OF SYSTEM

Fig1. shows the overall design of a two-phase flow measurement system, based a combination of the imaging electromagnetic flow meter (IEF) and impedance cross correlation flow meter (ICC).In *Fig1*. Qc represents the flow rate of the continuous phase; Qd is the flow rate of the dispersed phase. ICC is utilized for measuring the local dispersed phase volume fraction distribution and local dispersed phase velocity distribution . From the IEF flow meter, the velocity profile of the conducting continuous-phase flow is measured

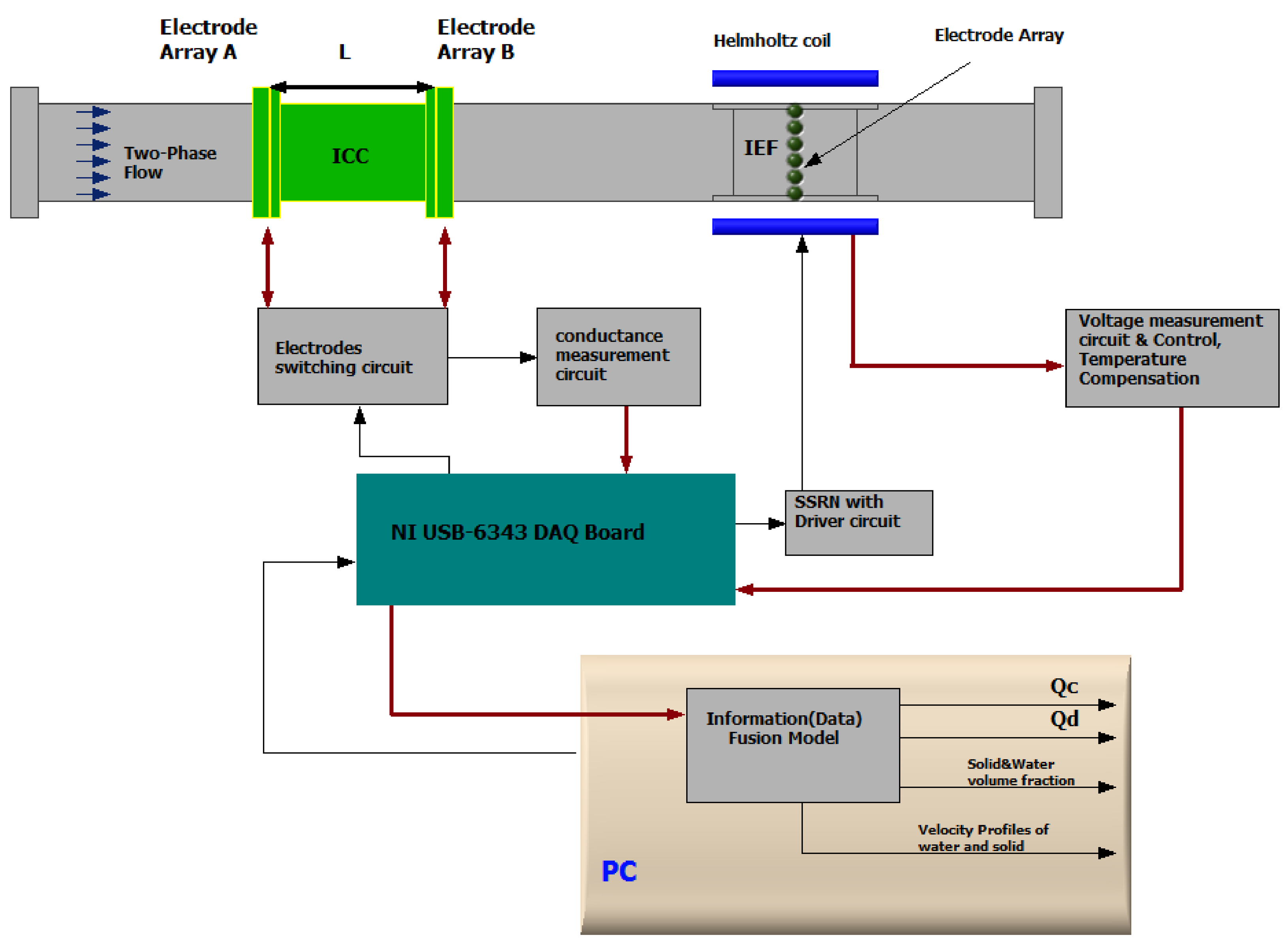
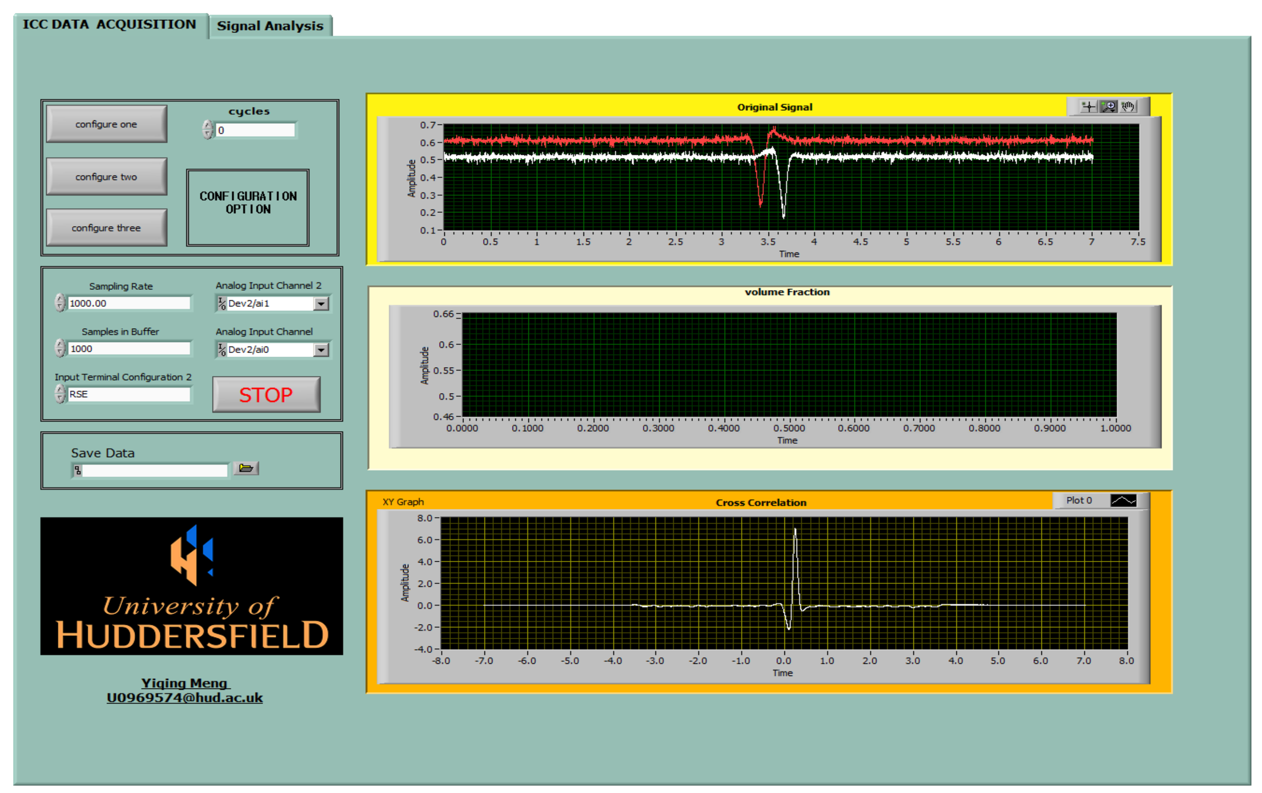


Fig1. Data fusion from IEF flow meter and ICC flow meter for solid/water flow measurement



$$Q_d = \sum_{i=1}^{M} (\alpha_d^{ICC,i})(v_d^{ICC,i})A_i \qquad (1)$$

$$Q_c = \sum_{i=1}^{M} (1-\alpha_d^{ICC,i})(v_c^{IEF,i})A_i \qquad (2)$$

The measured data from the IEF and ICC are combined enabling the volumetric flow rates of the dispersed phase and the continuous phase to be calculated from the measured continuous phase & dispersed phase volume fraction profiles and axial velocity profiles as shown in equations 1 and 2 (A_i is the interrogated cross section area). For stratified flows (such as those encountered in horizontal and inclined multiphase pipelines) these flow rates cannot be accurately measured using ANY alternative technique to that presented here.

SUMMARY

A new method for solid/water two-phase flow measurement based on the fusion of an impedance cross correlation flow meter and an imaging electromagnetic flow meter is proposed. The system will be further integrated with the aim of reducing the overall flow meter size. The system will be tested and characterised in a range of stratified water continuous multiphase flows (e.g. oil-in-water, air-in-water and solids-in-water). Because Labview is a graphical programming language with powerful data processing and analysis, all measurement results can be stored and also displayed online.

FUTURE WORK

- Apply the ICC & IEF flow meters to fully characterise and accurately measure a range of stratified multiphase flows.
- Continue working towards improving the efficiency of the Labview program.
- Continue to further integrate the hardware and software of the IEF/ICC systems.
- Use the system, in conjunction with other flow meters, such as a flow density meter and a Venturi flow meter, to enable three phase flow measurement in oil-water-gas flows.