Measuring Two Phase Flow Parameters Using Impedance Cross-Correlation and Electromagnetic Flow Meters

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INTRODUCTION

The need for a reliable method to measure a multiphase flow parameters, was behind reported many researches throughout the duration of the last century. Separation technology now has a dominant role in the measuring process industries. Where large and expensive separators, usually used to split the mixture into its various phases and metering them individually using single phase flow meter.

This investigation is aimed to provide a two phase flow meter capable to measure the velocity, volume fraction and volumetric flow rate for water and solid inside multi-phase flow loop.

OBJECTIVES

- ❑Integrate the Impedance Cross-Correlation and Electromagnetic techniques into one system in order to produce a flow meter capable to measure solids-liquid flow parameters (velocity distribution, Volume fraction distribution and volumetric flow rate) .
- ❑ The proposed system will integrate with a microcontroller in order to create a portable flow meter capable to measure the multiphase flow parameters without a need for a pc to control it.

IMPEDANCE CROSS-CORRELATION FLOW METER

ICC flow meter has been used to measure the solid parameters inside solid-liquid flow. The system is composed of two arrays of electrodes, separated by an axial distance of 50 mm and each array contains eights electrodes mounted over the internal circumference of the pipe carrying the flow. Furthermore every electrode in each array can be selected to be either "excitation", "measurement" or "earth".

❑***Solid Velocity Distribution:***

Changing the electrode configuration leads to a change in the electric field, and hence in the region of the flow cross section which is interrogated. The local flow velocity in the interrogated region is obtained by cross correlation between the two electrode arrays

$$u_s = \frac{L}{\tau}$$

Where:

L is the distance between array A and B

τ is the time daily between the fluctuation in the output signal in channel A and B

❑ ***Solid Volume Fraction Distribution:***

The local solids volume fraction can be obtained from the mean mixture conductivity in the region under interrogation

$$\alpha_s = \frac{1-\frac{\sigma_m}{\sigma_w}}{1+0.5(\frac{\sigma_m}{\sigma_w})}$$

α_s is the local volume fraction

σ_m is the mean mixture conductivity

σ_w is the mean water conductivity

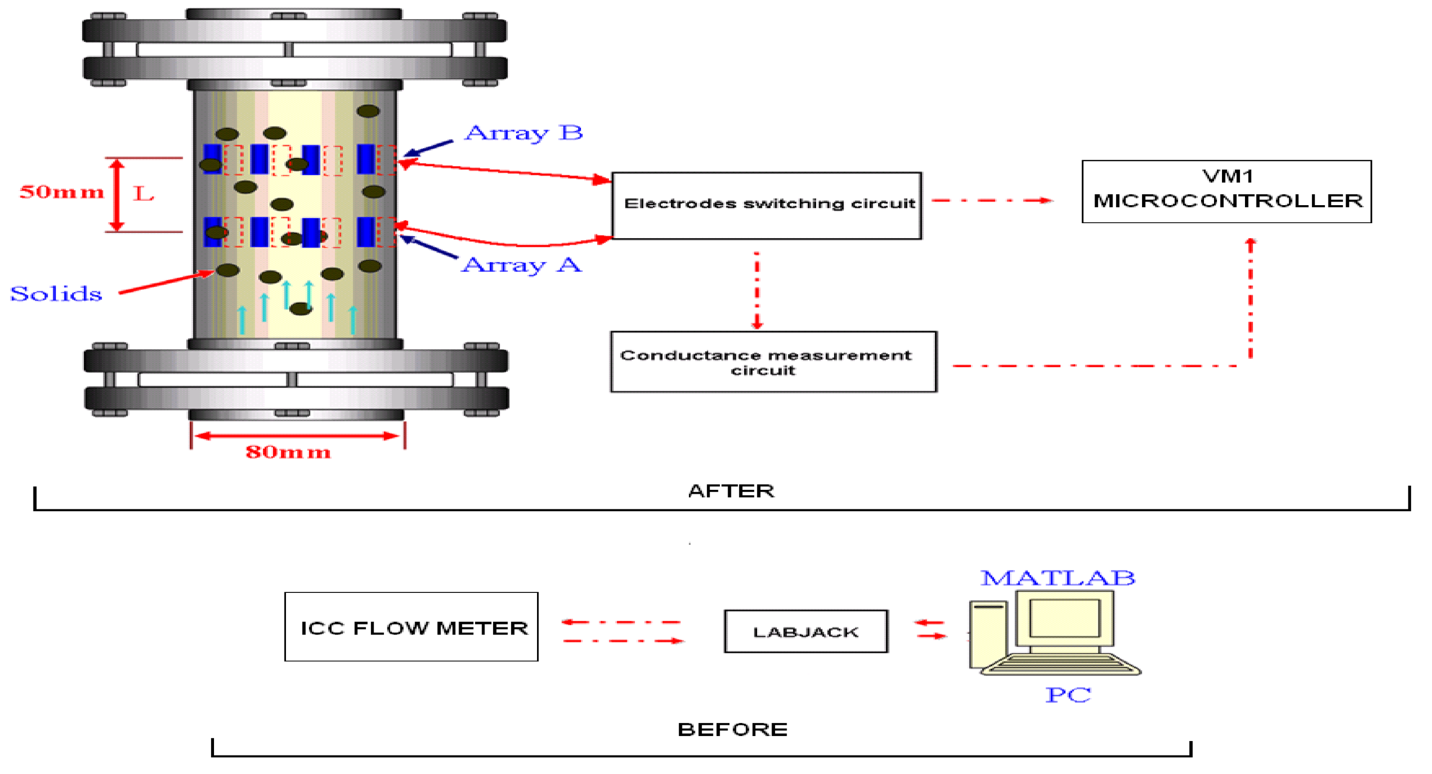

Figure 1: ICC flow meter

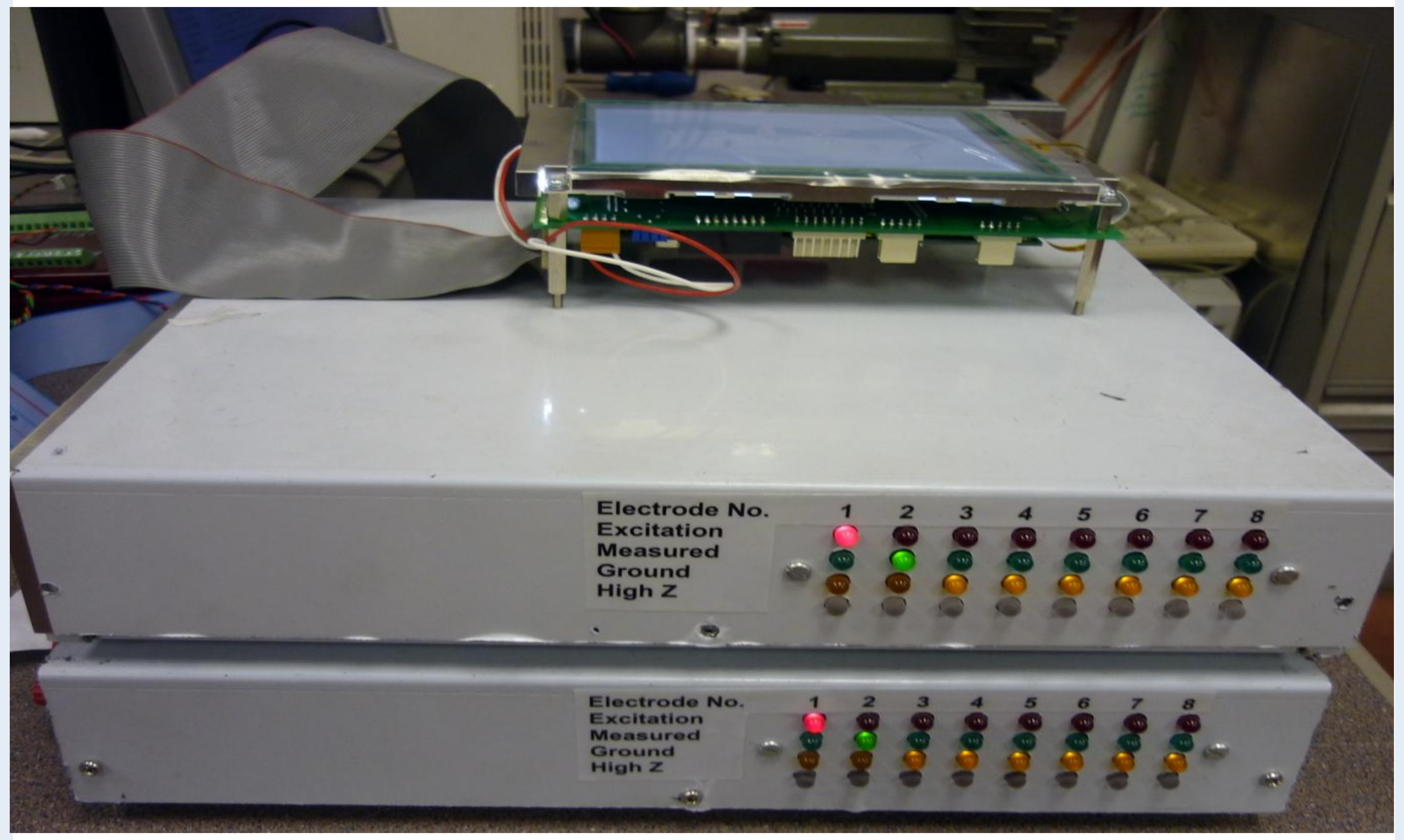

Figure2 : VM1 control the electrode circuit.

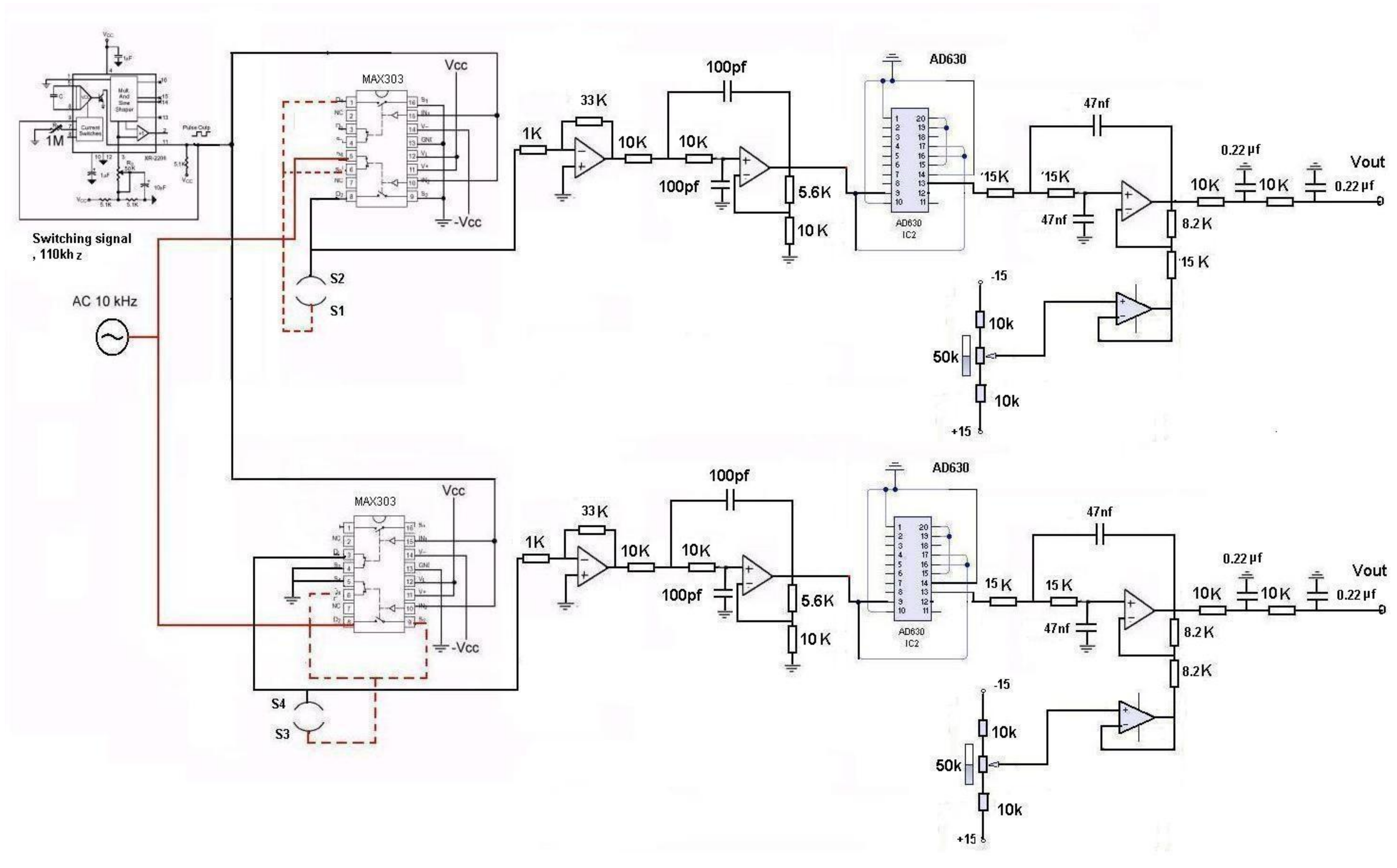

Figure3 : The new conductance circuit design

RESULTS

The following results shows the velocity of bell (density 1398 kg/m3) moving inside ICC flow meter .

The output signals from array A & B   Cross-Correlation Function

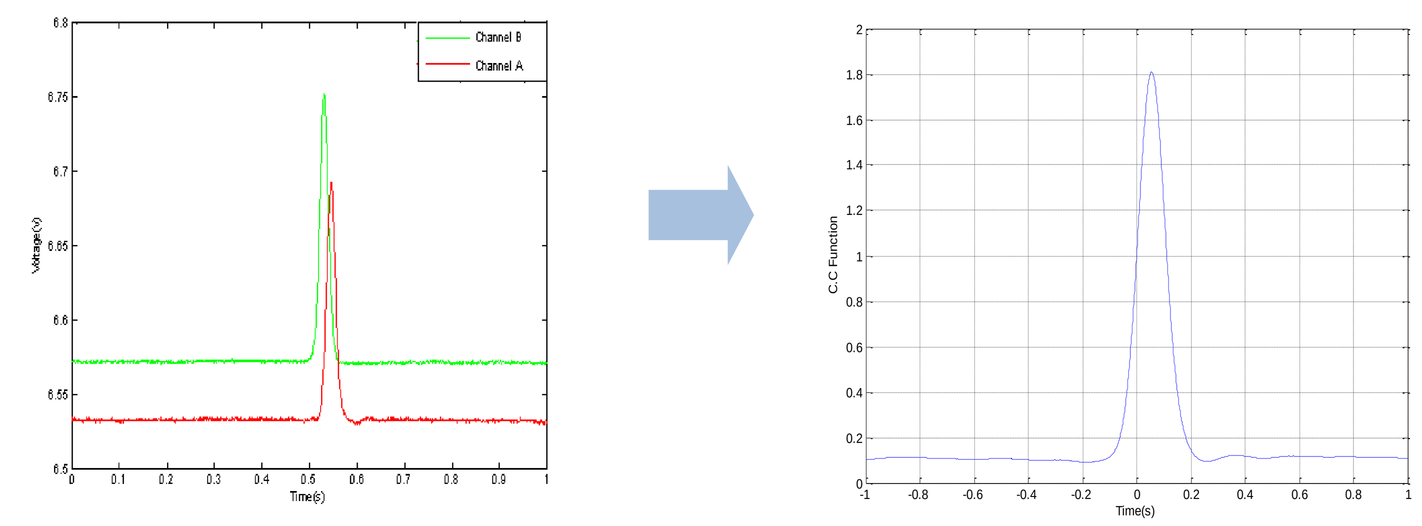

Figure 4: velocity result of a bell moving inside ICC flow meter time daily = 0.9s and Vb=0.055 m/s

ELECTROMAGNETIC FLOW METER

The operation of a magnetic flow meter is based upon Faraday's Law, which states that the voltage induced across any conductor as it moves at right angles through a magnetic field is proportional to the velocity of that conductor.

an electromagnetic flow meter has been used to measure a homogenous gas-liquid two phase flow. The concluded that a homogenous flow would give rise to:

$$\Delta U_{TP} = \frac{4BQ_L}{\pi d(1-\alpha_s)} = \frac{\Delta U_{SP}}{(1-\alpha_s)}$$

ΔU_{TP} is the potential difference between electrodes for two phase flow, Q_L is liquid flow rate, ΔU_{SP} is the potential difference between electrodes for liquid only and finally α_s is the volume fraction for the non-conductance phase.

CONCLUSION

- ❑ The switching system has been developed by integrate the electrode switching circuit with VM1 microcontroller which allowed to select the wanted configuration without using MATLAB program and LABJACK data acquisition.
- ❑The conductance circuit has been successfully improved by reducing the size of the circuit and by removes the noise from the output signals.
- ❑The results of the ball velocity have been compared with the results obtained by S. AL-Hinai (2010), and showed good qualitative agreement.

FUTURE WORK

- ❑Improve the performance of the conductance circuit by built it in Pcb board.
- ❑Improve the electrode switching circuit by reducing its size.
- ❑Continue developing the integration between the ICC system and the VM1 in order to produce a portable flow meter capable to measure multiphase flow parameters without a need for a PC to control it.
- ❑Integrate the ICC flow meter with electromagnetic flow meter in order to achieve a flow meter capable to measure the solid and water parameters

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