Some Recent Advances in Multi-Phase Flow Measurement

Presented By :

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Outline

- ✓ Problem Statement
- ✓ Introduction
- ✓ Advancements: Solution to the Problems of Multi-Phase Flow Measurement
- ✓ Conclusion

Problem Statement

The production stream from the oil well bores usually contains gas, crude oil, water, and particulate materials in a highly mixed state. The ability to monitor and control the separation processes is one of the critical issues in the oil and gas extraction industry.

Introduction

✓Multiphase flow measurement is a catchall term that describes multiple fluid components in a flowing stream.

✓For instance, water and oil are considered to be multiphase in the oil and gas industry, even though they are both liquids.

✓Two-phase flow is a difficult subject principally because of the complexity of the form in which the two fluids exist inside the pipe, known as the flow regime.

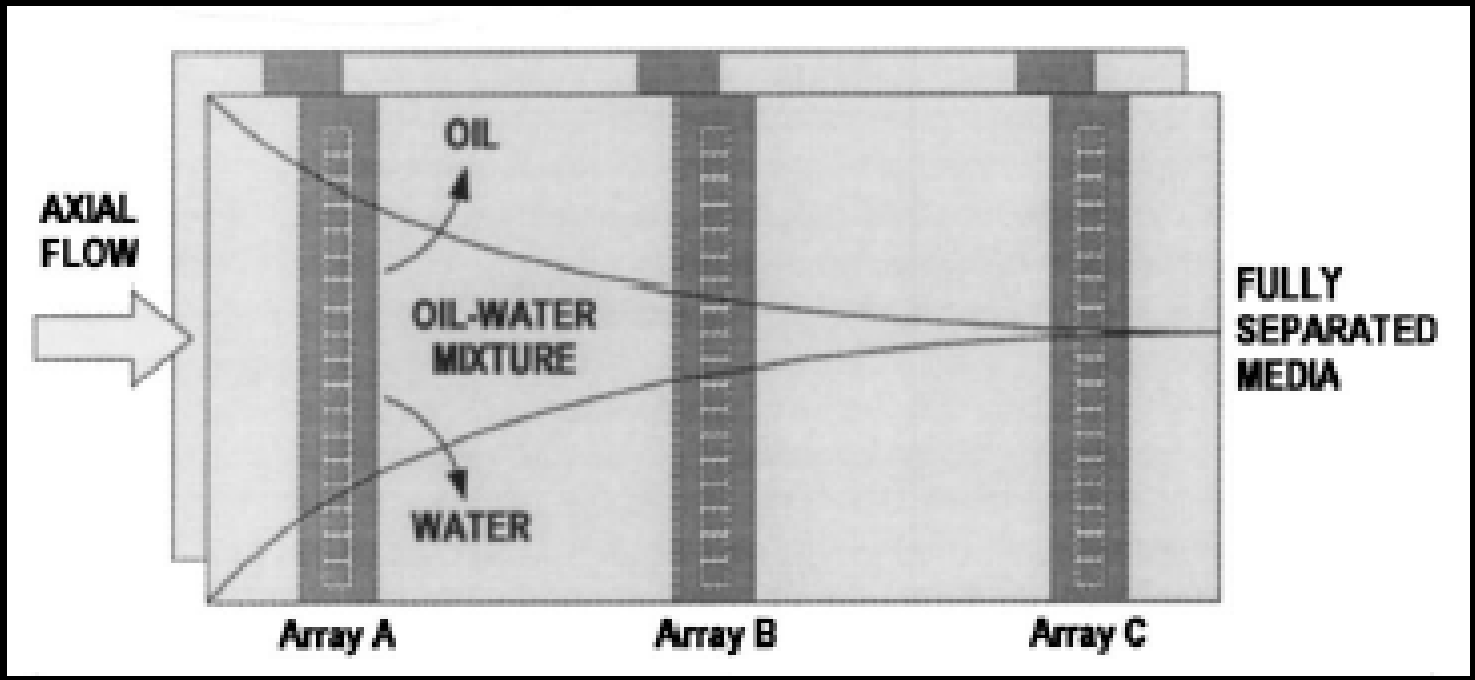
To overcome the elementary aspects of multi-phase flow measurement, intended advancements have provided some solutions to the problem of Multi-Phase flow Measurement.

Advancements

I. Distributed Sensor Arrays Method for monitoring.
II. Methods based on Capacitance and Conductance Sensors.
III. Capacitance Sensors based methods for measuring distribution.
IV. Transducer and Accelerometer based method using noise-analysis.
V. Vibratory Type Transducer Based Methods.
VI. Application of a compact sensor body for measuring Multi-Phase Flow in a Pipe.

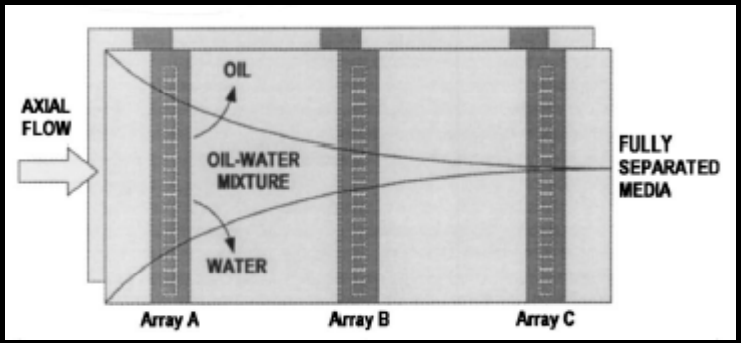
I. Distributed Sensor Arrays Method for monitoring

A novel approach is proposed in designing sensors and instrumentation for monitoring and controlling multiphase processes, based on the concept of distributed sensor arrays, embedded within vital plant components.



Orientation of phases in a single channel

All the plates are equipped with 54 detection electrodes, arranged in three arrays. These were located close to the inlet, in the middle, and close to the outlet from the Parallel Plate Interceptor.

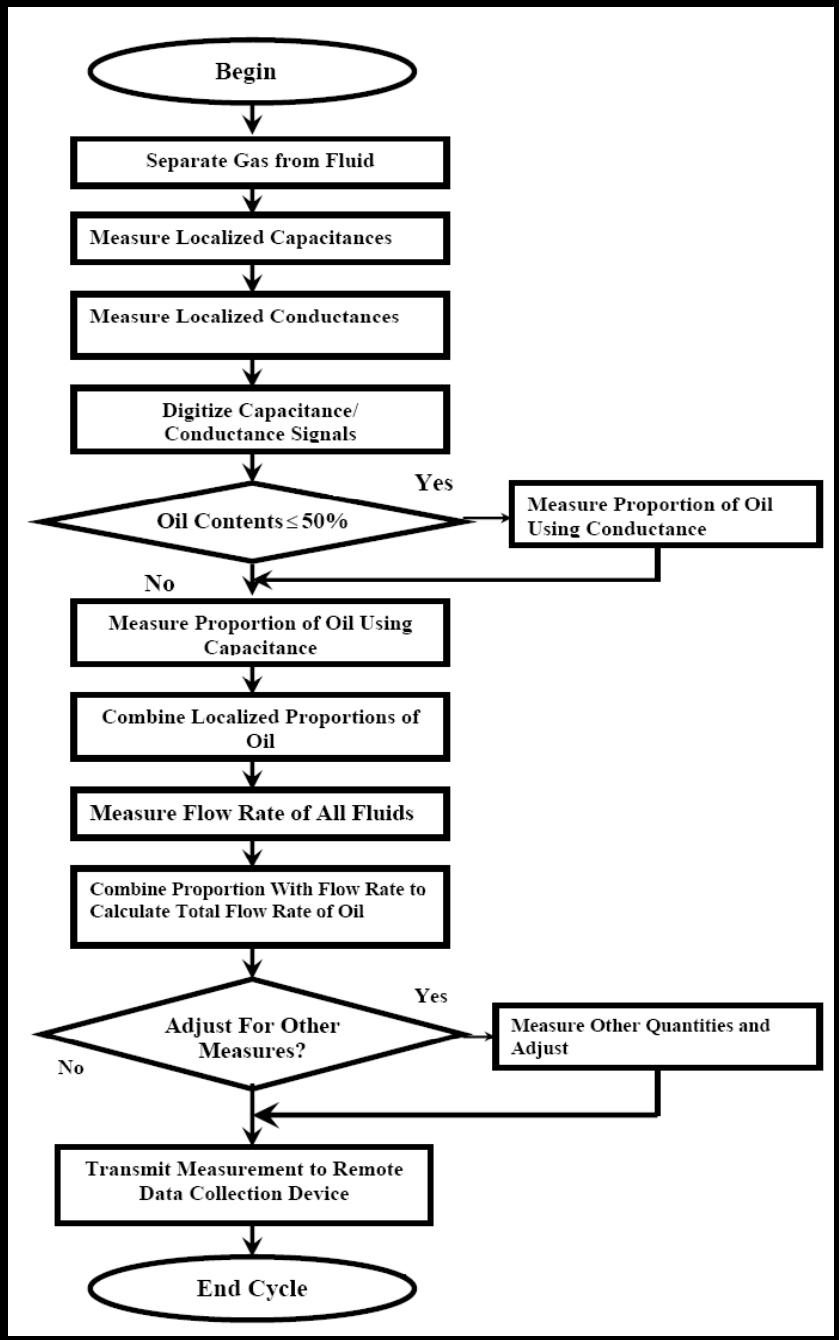


ANOTHER METHOD FOR MONITORING MULTIPHASE PROCESSES WITH SENSOR ARRAYS

- This method measures an amount of oil in a flow of fluid at varying depths of the flow of fluid.

- Each of the sensor arrays includes a Capacitance sensor and Conductance sensor being configured to respond to a specific capacitance/conductance of the particular flow of fluid adjacent to the capacitance/conductance sensor.

A flowchart of the routine showing the prototype of sensor arrays method

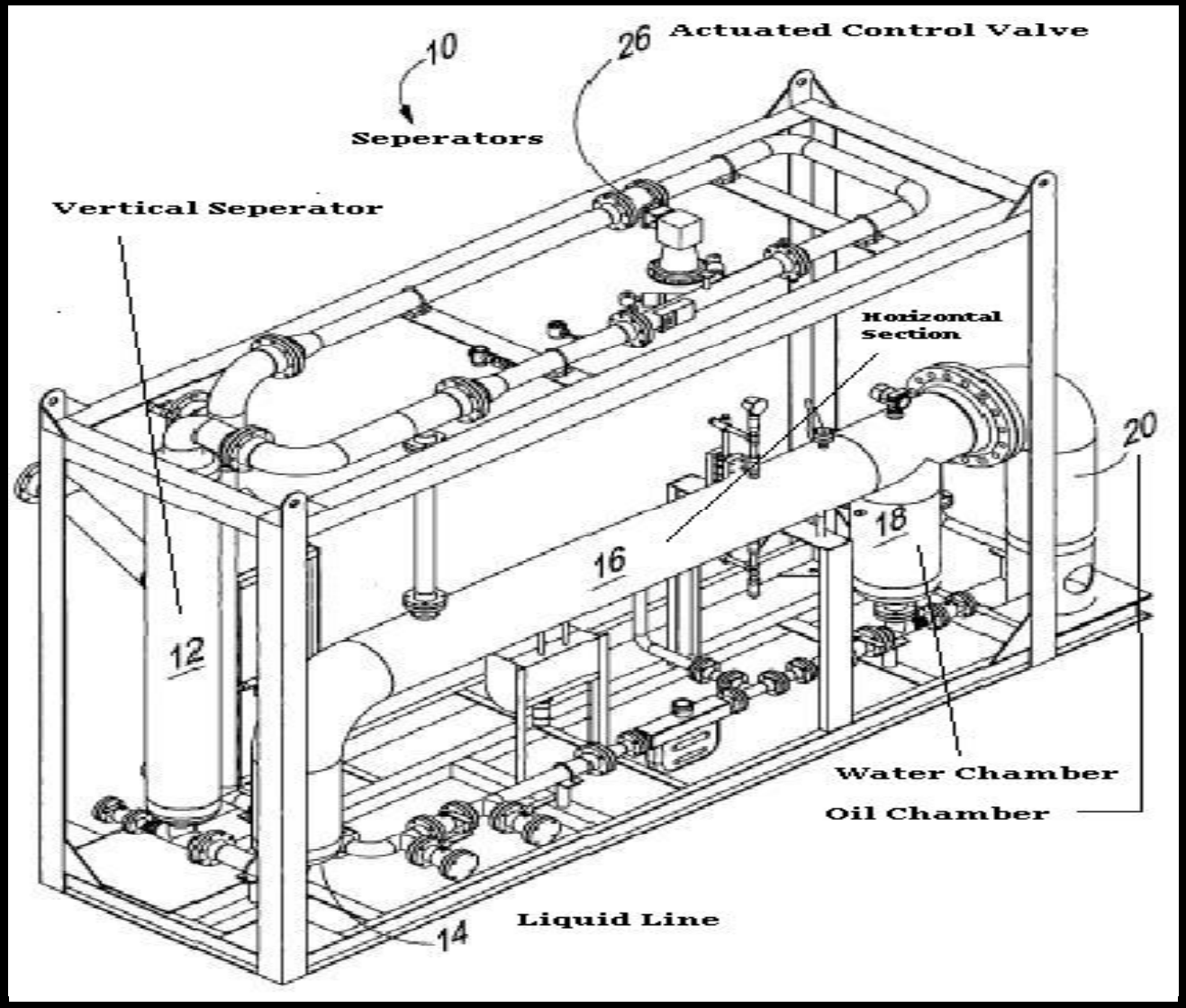

Begin
Separate Gas from Fluid
Measure Localized Capacitances
Measure Localized Conductances
Digitize Capacitance/ Conductance Signals
Oil Contents ≤ 50%
Yes
Measure Proportion of Oil Using Conductance
No
Measure Proportion of Oil Using Capacitance
Combine Localized Proportions of Oil
Measure Flow Rate of All Fluids
Combine Proportion With Flow Rate to Calculate Total Flow Rate of Oil
Adjust For Other Measures?
Yes
Measure Other Quantities and Adjust
No
Transmit Measurement to Remote Data Collection Device
End Cycle

This method measures an amount of oil in a flow of fluid at varying depths of the flow of fluid.

II. Methods based on Capacitance and Conductance Sensors

Comment

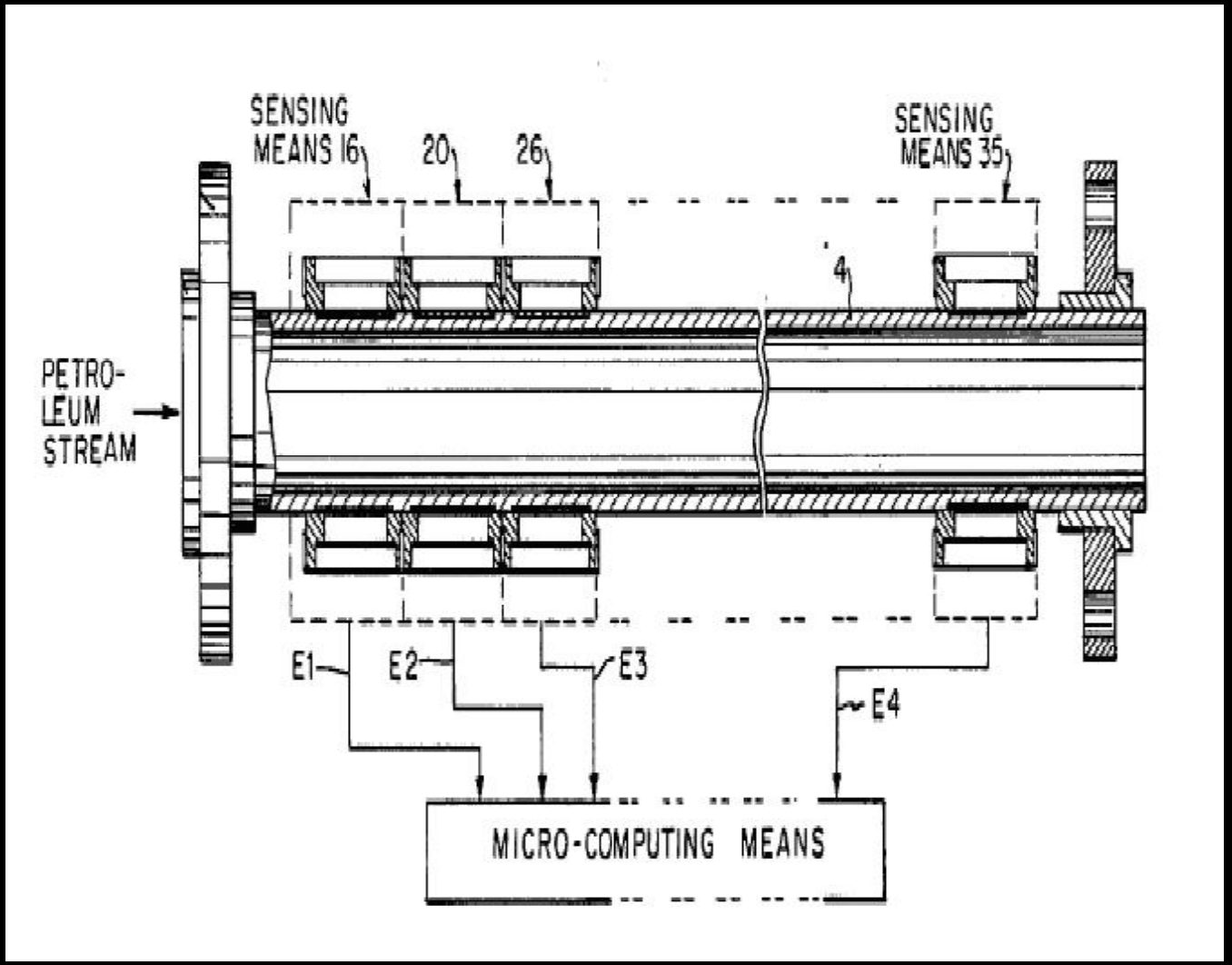
In the multiphase flow, the main point of concern is to do the measurement of a particular phase. Separation of the flow stream into the different phases is allowing the measurement of a particular phase.


10
26
Actuated Control Valve
Seperators
Vertical Seperator
Horizontal Section
20
18
16
12
Water Chamber
Oil Chamber
14
Liquid Line

III. Capacitance Sensors based Methods for measuring Distribution

The main point of concern here is measuring Multi-Phase Distribution with in a flowing petroleum stream.

A vital approach named as petroleum steam measurement system is proposed.


SENSING MEANS 16
20
26
SENSING MEANS 35
4
PETRO-LEUM STREAM
E1
E2
E3
E4
MICRO-COMPUTING MEANS

- ✓ First and second sensors have been arranged with the cell and spaced at a predetermined distance apart, sense the capacitance of the petroleum stream and provides representative signals.
- ✓ A third sensor senses the capacitance of petroleum stream and provides a corresponding signal.
- ✓ A fourth sensor senses the capacitance of the petroleum stream and provides a Corresponding signal

IV. Transducer and Accelerometer based method using noise analysis.

It is proposed that this technique can be applied to steam and liquid water flow mixtures where the signal from an accelerometer mounted on an external pipe surface is evaluated to determine flow rate.

Process Flow Loop

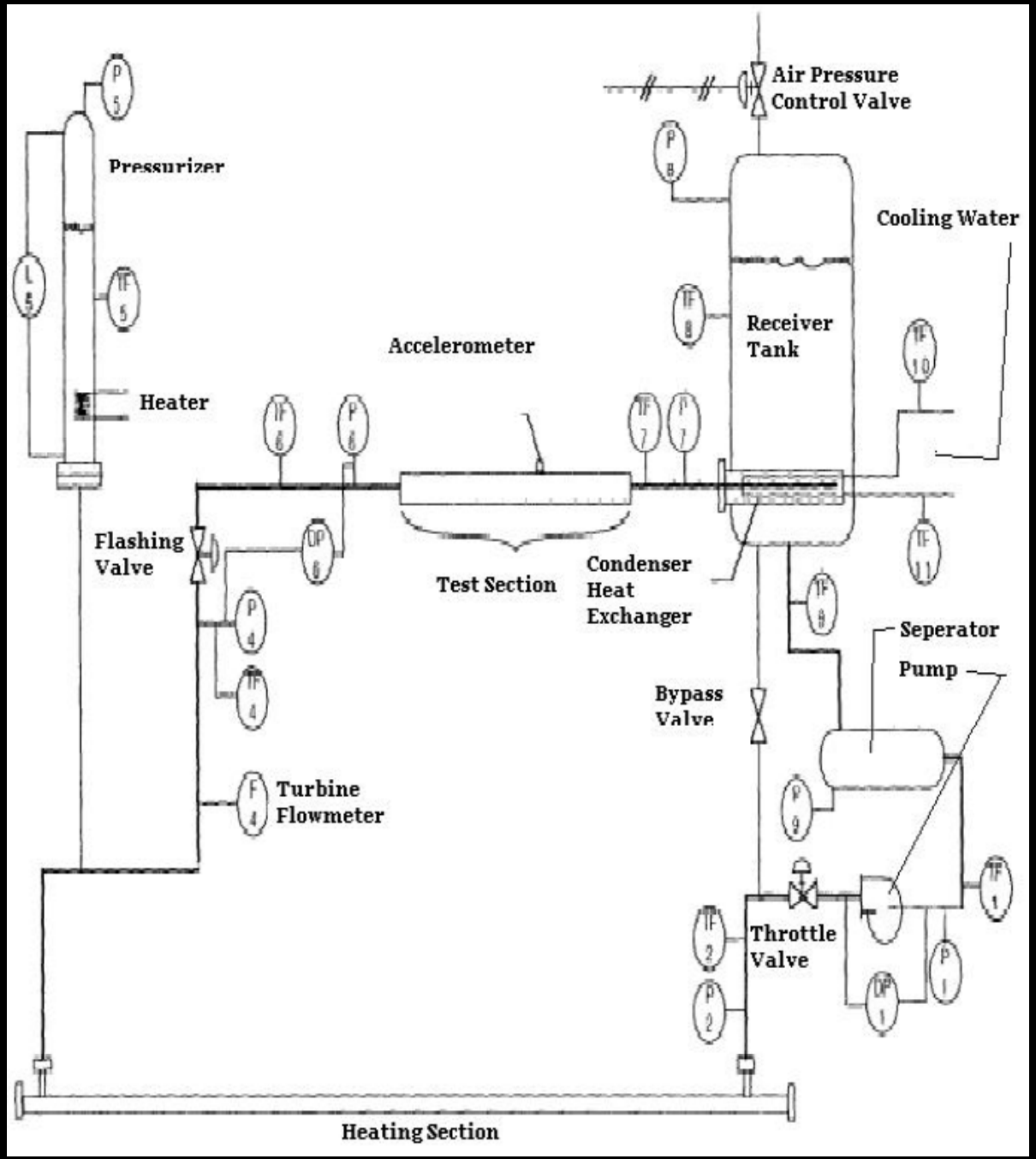

Air Pressure
Control Valve
Pressurizer
Cooling Water
Receiver
Tank
Accelerometer
Heater
Flashing
Valve
Test Section
Condenser
Heat
Exchanger
Seperator
Pump
Bypass
Valve
Turbine
Flowmeter
Throttle
Valve
Heating Section

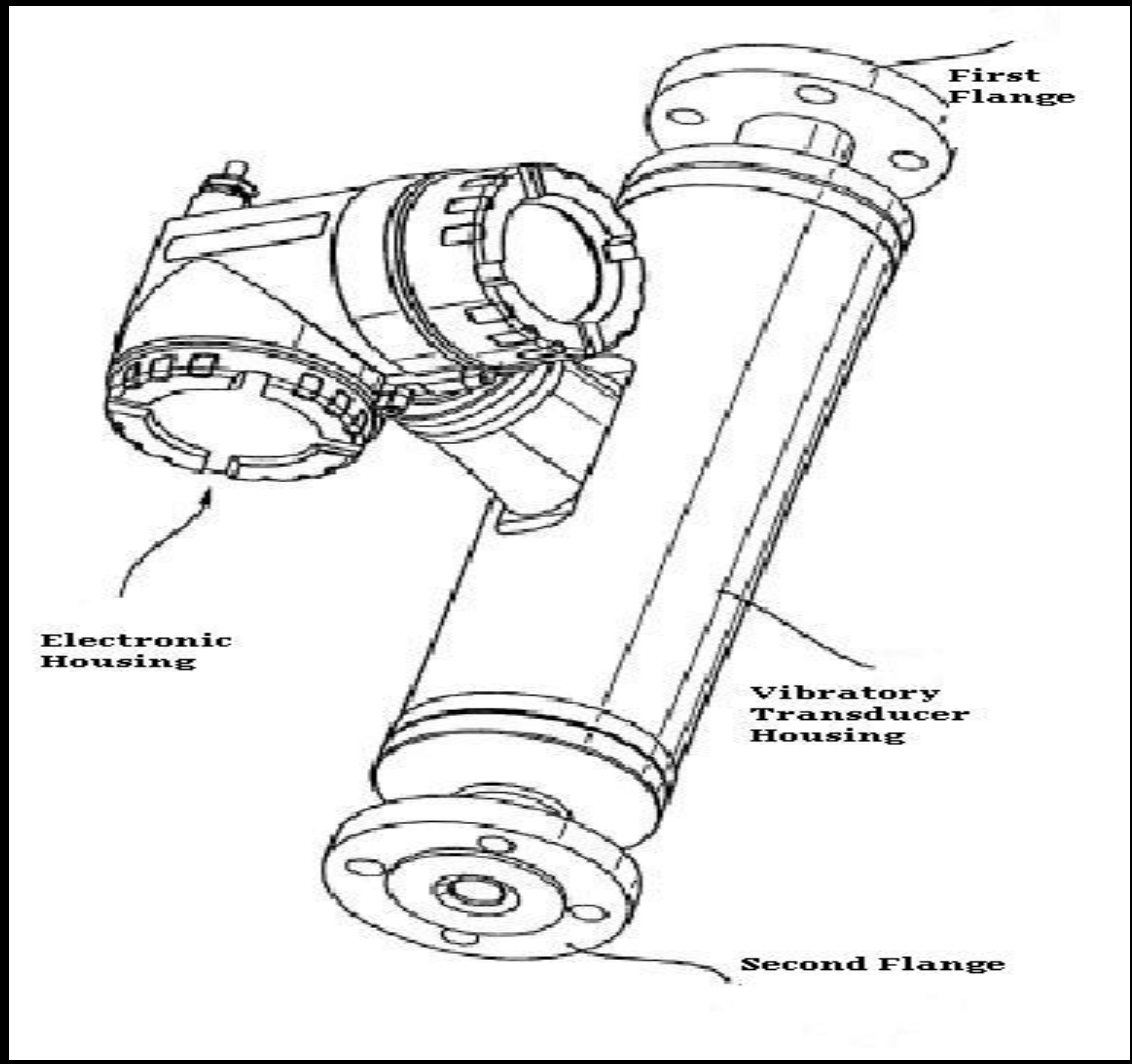
Figure is a closed loop where water is pumped under pressure through an electric heater, flashed across a throttling valve and passed through a test section. The steam fraction is then condensed, before the water is re-circulated through the loop.

The loop was instrumented with the necessary temperature, pressure, and flow (liquid) sensors to adequately monitor the process and determine the two phase operating conditions. Process data was recorded on a personal computer data acquisition system. The testing has been expanded to identify those parameters important to this measurement .

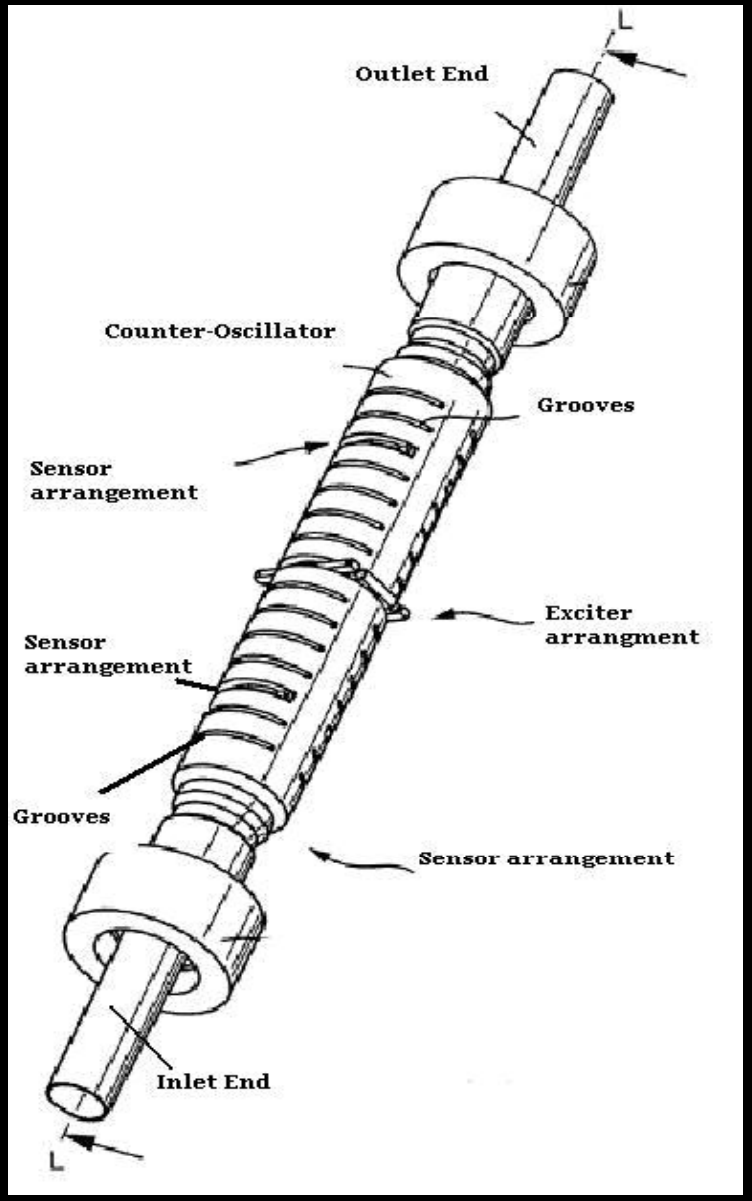
V. Vibratory Type transducer based methods

In this application, the measuring device comprises, for measuring multi-phase mixture.

Figure shows an inline measuring device which can be inserted into a pipeline for measuring a mass flow rate of a fluid guided in the pipeline. Figure 9 shows, in a perspective, side view, an example of an embodiment for a measurement transducer of the vibratory-type suited for the measuring device of Figure. The transducer includes at least one measuring tube inserted into the course of the pipeline. An exciter arrangement acts on the measuring tube for causing at least one measuring tube to vibrate. A sensor arrangement senses vibrations of at least one measuring tube and delivers at least one oscillation measurement signal representing oscillations of the measuring tube.



Inlet Measurement Device

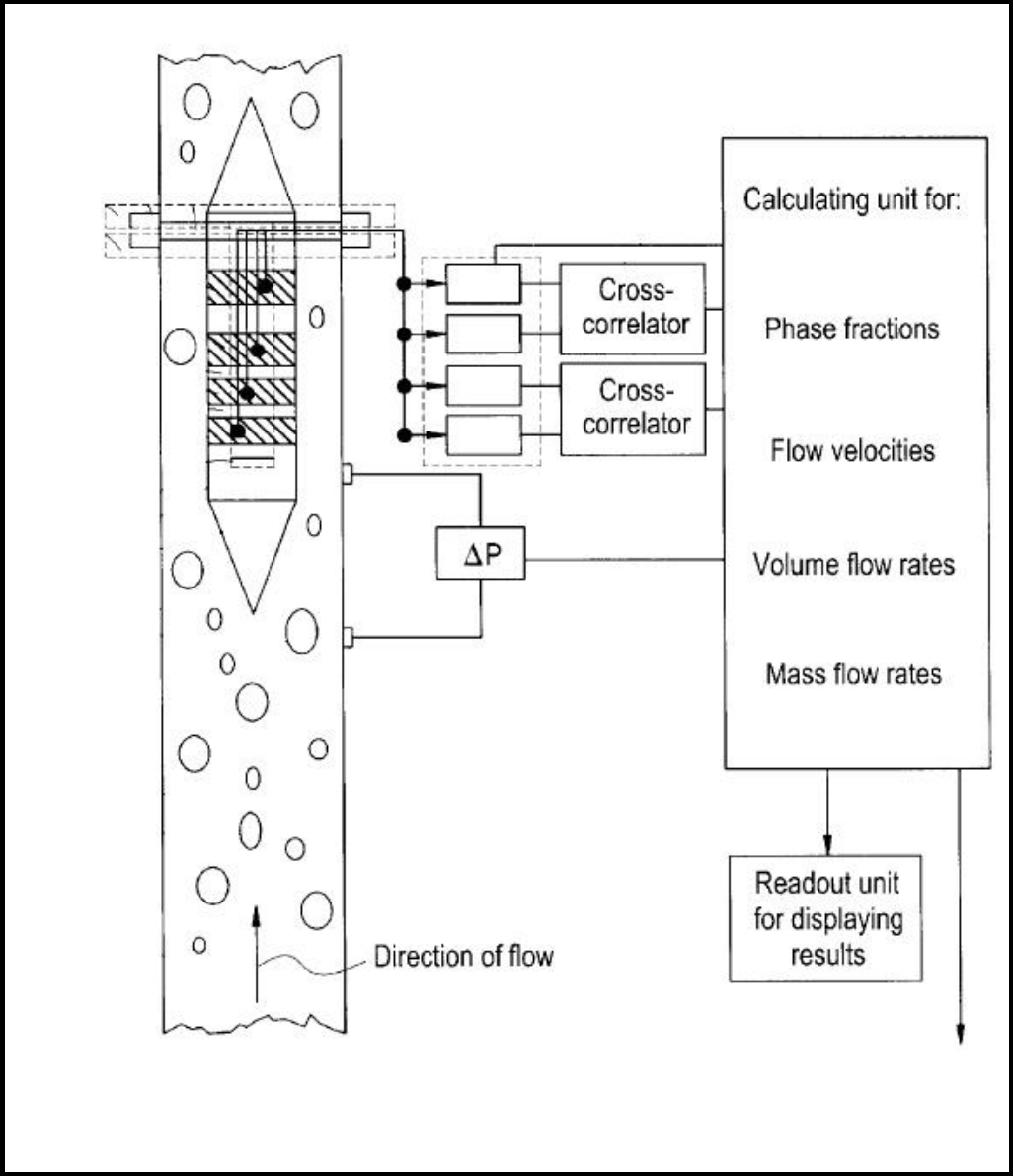


Prototype for a vibratory-type measurement transducer

VI. Application of a compact sensor body for measuring multi-phase flow in a pipe

- ✓ In petroleum industry, the point of concern is the determination of characteristic parameters of a multiphase flow and the individual flow rates of the oil.

- ✓ In this application, the system has been described in the form for measuring characteristic parameters of a multiphase flow of crude oil or condensate, produced and/or injected water, or natural gas in a transport pipe, as well as a method that uses the measured parameters for determining the individual flow rates for crude oil/condensate/water/natural gas.



A sensor body prototype with differential pressure gauge in the upstream end of the sensor body.

The system comprises a compact sensor body having a substantially circular cross-section, which sensor body has been located centrally inside a transport pipe having a relatively constant inner diameter and having a circular cross-section to sense the differential pressure and calculating phase fractions. The sensor body will in a first variant form a coaxial sensor wherein the flow has been transported in an annular space between the body exterior and the inner pipe surface.

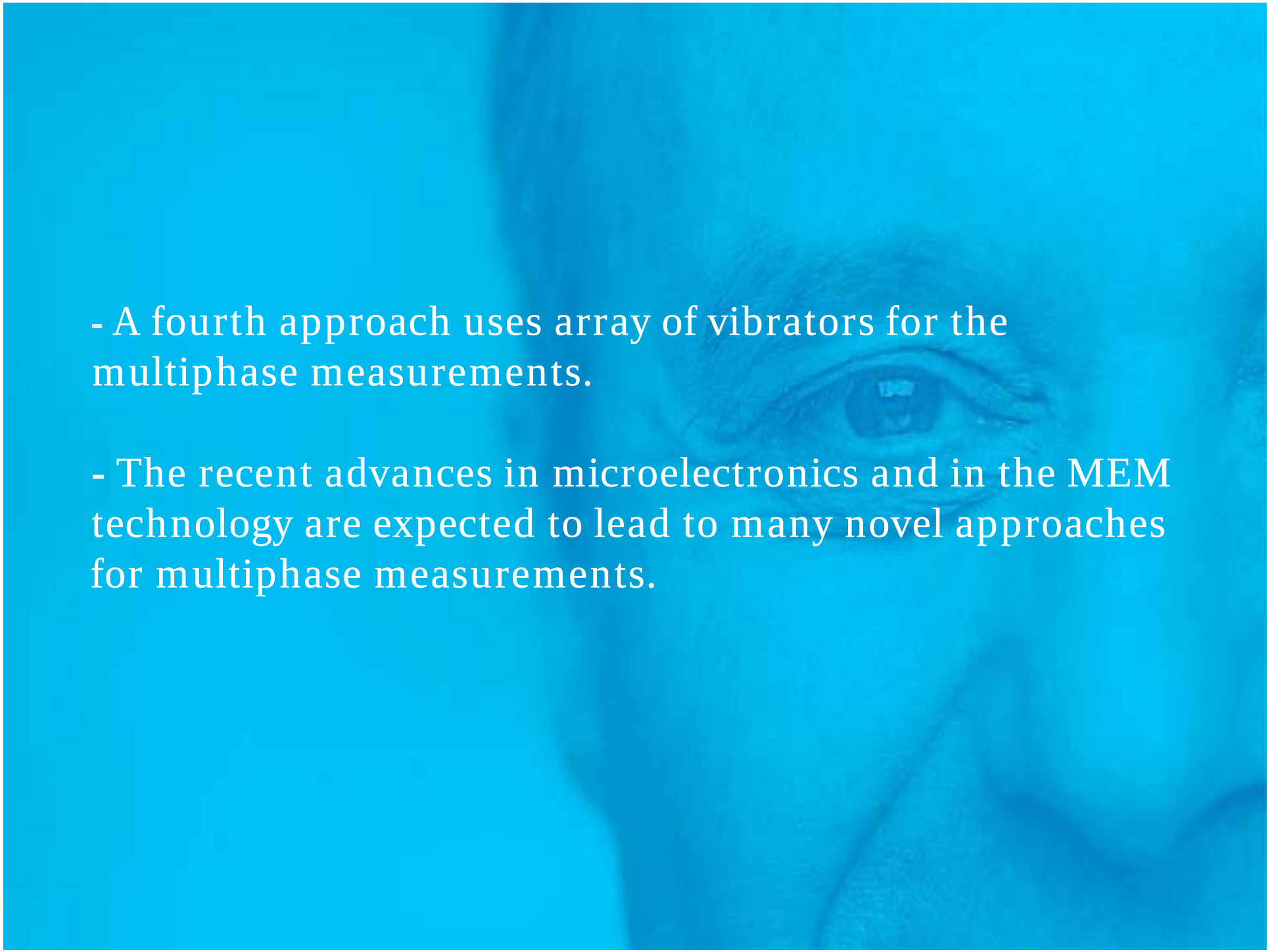
Further, the sensor body has been placed concentrically in relation to the transport pipe. When the multi-phase fluid flows through the pipe, a differential pressure will arise between an area upstream of the sensor insert and the area midway on the sensor insert, due to the cross-section area narrowing caused by the insert.

Conclusion

- Several novel approaches for multi-phase flow monitoring and measurement have been presented. The first approach is based on distributed sensors that can be mounted on plates inside the gas-oil separators, or using special submergible structures.

In a second approach a capacitive sensor array mounted on a special pipe section is used to monitor multiphase flow.

A third method proposes the use of the characteristics of the flow noise, measured by a transducer array, to monitor the multiphase flow.



- A fourth approach uses array of vibrators for the multiphase measurements.

- The recent advances in microelectronics and in the MEM technology are expected to lead to many novel approaches for multiphase measurements.

Question Session

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Thank You