FlowSys TopFlow Multiphase Flowmeter
Accurate, Continuous Multiphase Measurement

Overview
FMC Measurement Solutions’ FlowSys TopFlow™ meter is a second generation multiphase meter combining conventional and proven measurement technologies into one compact flow tube. The sensor is a robust, extended-throat Venturi with capacitance and conductance electrodes mounted inside the Venturi throat. A differential pressure transmitter is used to measure the density of individual components of the flow from the well stream. This novel approach to fluid density measurement eliminates the need for a radioactive source commonly used with flowmeters of this type.

The FlowSys TopFlow meter covers a wide measurement range including all water cuts, salinities, viscosities and flow regimes without the need for upstream or downstream flow conditioning, separation devices, mixers or by-pass lines.

Features
Unique features of the FlowSys TopFlow include the following:

**Non-radioactive** – the flowmeter is free of a radioactive source ensuring a safe and less complicated operating environment.

**Compact design** – the slim, short and lightweight design of the meter allows for ease of installation and a significant reduction in offshore platform space and weight.

**High performance** – with minimal pressure drop and the ability to measure flow rate independent of changes to the flow regime, the FlowSys TopFlow meter provides reliable and accurate measurement equal to or better than the data obtained from a test separator.

**Flexibility** – the meter can be operated as a stand-alone flowmeter or interfaced to customer data acquisition systems.

**Remote monitoring** – the meter can be accessed over a telephone line to monitor well performance and allow for online troubleshooting in the event of alarm conditions associated with the meter’s operation.

**Low maintenance** – the meter and all associated components of the system require minimal to no maintenance, significantly reducing operating costs.

**Competitive pricing** – the elimination of many individual components associated with conventional multiphase systems results in a metering solution that can be cost-effective for monitoring each well or placed into a flow manifold to measure a group of wells.

Benefits
- No upstream or downstream installation requirements.
- No radioactive source eliminates wipe testing and import/export restrictions.
- Online data acquisition for meter output and troubleshooting of operating parameters.
- Slim profile allows easy installation in compact offshore platform space.
- Vertical mounting position prevents fluid stratification and minimizes abrasion caused by sand and grit in the flow.

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FMC Kongsberg Subsea
FMC Surface Wellhead
FMC SOFEC Floating Systems
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FMC Fluid Control
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FMC Measurement Solutions
FMC Blending and Transfer

FMC Energy Systems is a market leader in the design, manufacture and supply of petroleum exploration, production, measurement and transportation equipment. Through our focus on development and delivery of cost-effective turnkey systems, we are meeting customer needs for integrated solutions around the globe.

In conjunction with FMC Surface Wellhead, a provider of surface wellhead and completion equipment for standard and critical-service applications worldwide, FMC Measurement Solutions offers the FlowSys TopFlow Multiphase Flowmeter - an advanced technology designed to measure the flowing medium from the well.

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1 FMC Measurement Solutions is under contract with FlowSys AS, Bergen Norway for the manufacture and distribution of the FlowSys TopFlow Multiphase Flowmeter
Flowmeter Components

The FlowSys TopFlow is comprised of the following components:

- Flow sensor/meter
- Field electronics
- Differential and gauge pressure transmitters
- Temperature transmitter
- Computer interface enclosure
- Industrial PC with user interface and software
- Safety barriers
- Power supply

Applications

The FlowSys TopFlow meter provides real-time flow rate information from a well stream or pipeline. Installing a meter on each well monitors production and provides early warning of any problems associated with gas lifting, water or gas breakthrough, or onset of severe slugging conditions. Additionally, the FlowSys TopFlow multiphase meter requires less maintenance and reduces test separator maintenance costs by eliminating or reducing the operating costs and hazards associated with chemicals used to separate oil from water. The meter’s ability to measure fluid density in the absence of radioactive sources has advantages with respect to health, safety and environmental conditions. These features effectively streamline measurement at the wellhead, in the manifold, in the turret, and at any location where multiphase needs to be measured.

Operating Principle

The operation of the FlowSys TopFlow meter is based on well-established measurement principles including Venturi, capacitance, conductance and cross-correlation to determine flow velocity. The critical components of the meter are its extended throat Venturi housing and an insert comprised of PEEK and stainless steel electrodes for measuring capacitance and conductivity of the flow regime. Flow rates of oil, water and gas are calculated based on measurements obtained by these electrodes. With no radioactive densitometer to directly measure the fluid mixture’s density, density is determined indirectly using the well-known, momentum-based “Venturi equation”.

The absence of a radioactive source in the FlowSys TopFlow meter has several advantages, especially with respect to addressing increasingly stringent health, safety and environmental restrictions. These include allowing the application of the meter in regions of the world that prohibit the use of radioactive sources, and avoiding increased operating costs for oil companies by reducing shipping costs associated with regulations for shipping radioactive materials and eliminating the need for wipe tests to check for radioactive leakages.

Figure 1 – Example of a metering output over a 20 minute interval
**Operating Range**

To illustrate the operating envelope (Figure 2), flow rate divided by the pipe cross section area (also known as the superficial velocity) is used on the axes to make the diagram independent of piping and meter dimensions. This velocity can also be described as the velocity of one phase, based on its flow rate, if the other phases were not present.

The operating envelope is limited for several reasons. The maximum range of the differential pressure transmitter limits the maximum liquid flow rate. The maximum gas flow rate is limited by a maximum gas velocity of 25 m/s (82 ft/sec).

The minimum liquid flow rate is mainly determined by a minimum velocity requirement of 0.6 m/s (1.9 ft/sec). A minimum liquid flow rate is needed to create a continuous flow through the meter. This means that a certain momentum is required to prevent back flow through the main metering section, where the velocity is measured by cross-correlation. Also the lower limit of the differential pressure cell, as well as the maximum GVF of 97%, contribute to the determination of the minimum liquid flow rate through the FlowSys TopFlow meter.

**Measurement Uncertainty**

The uncertainty specification for the FlowSys TopFlow meter is shown below at a 90% confidence level for expected deviation from the true values. Since the uncertainty is dependent on the actual gas volume fraction (GVF), the specification has been split into several GVF intervals. The liquid and gas flow rate uncertainties are expressed as relative uncertainty, i.e., as a percentage of reading, while the water cut is an absolute uncertainty. These uncertainties are valid on water cuts in the range of 0-100%.

<table>
<thead>
<tr>
<th>GVF Range (%)</th>
<th>0-25%</th>
<th>25-60%</th>
<th>60-70%</th>
<th>70-85%</th>
<th>85-92%</th>
<th>92-97%</th>
<th>97-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Flow Rate</td>
<td>5%</td>
<td>7%</td>
<td>10%</td>
<td>15%</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Flow Rate</td>
<td>–</td>
<td></td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Cut</td>
<td>2%</td>
<td>3%</td>
<td>5%</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Installation and Calibration**

**Installation**

The flowmeter is designed for installation vertically into the pipeline with the appropriate flange connections to meet piping specifications. There are no requirements for upstream pipe geometry or for minimum length of straight pipe upstream or downstream of the meter.

**Calibration**

The FlowSys TopFlow multiphase flowmeter is calibrated at the factory, in a static state, with different fluids for both the capacitance and conductance detectors.
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MPU 600 Ultrasonic Gas Flow Meter - 3 path meter, for custody transfer or check applications
MPU 200 Ultrasonic (Wet) Gas Flow Meter - 1 path meter, for check applications
MeasureMaster Gas Flow Meter - Dual chamber Orifice fitting
OrificeMaster Gas Flow Meter - Single chamber Orifice fitting
Venturi Tube Gas Flow Meter
AccuLERT - Turbine meter diagnostics tool
EFC 100 Smart Flow Computer, field mounted
FPM 207C Flow Computer, rack mounted
FCS 212 Flow Metering Control System

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