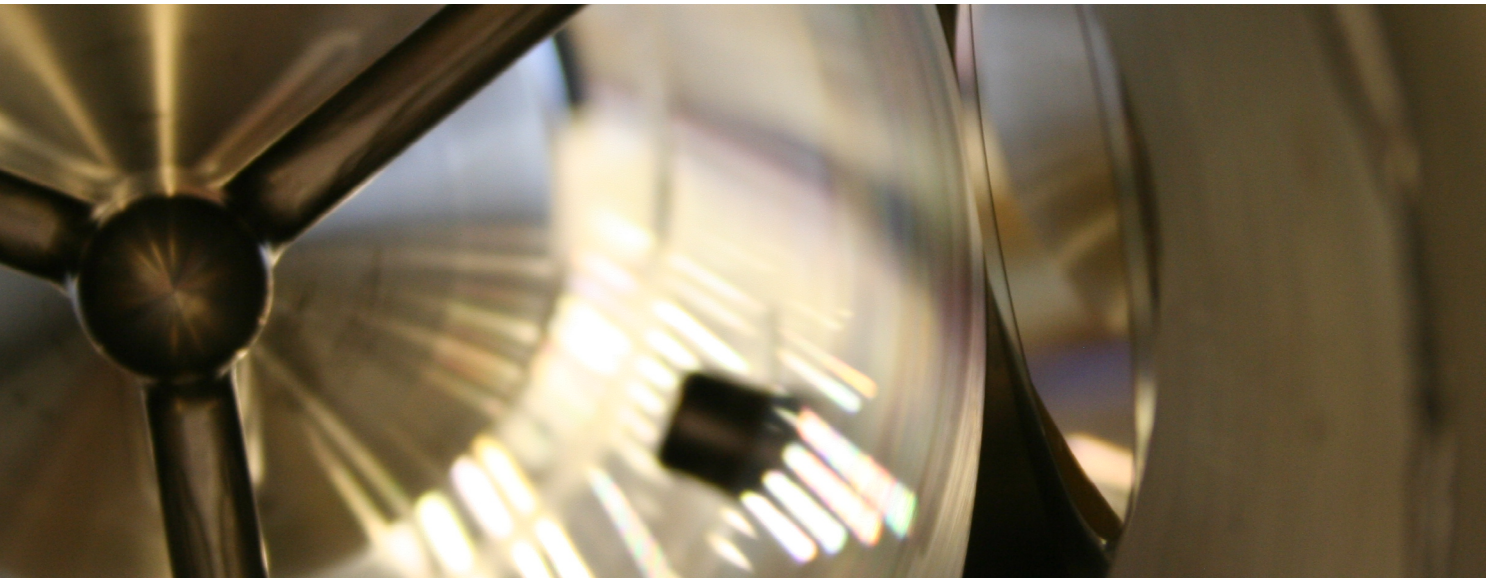
Roxar subsea Wetgas meter

A Specialized Meter for Gas and Gas Condensate Fields



Operators that are looking to develop a subsea wet gas field today face a number of challenges, as the development and field operating conditions increase in complexity:

> "In order to accommodate changing operating conditions and varying fluid compositions, I need access to real-time and accurate water, gas and condensate information as this significantly impacts my flow assurance and hydrocarbon allocation strategies."

Flow assurance, integrity and production optimization challenges

The Roxar subsea Wetgas meter (SWGM) addresses the following operator challenges related to a subsea wet gas field development:

Immediate reasons - formation water breakthrough:

- Increases risks of hydrate formation and therefore the need for increased MEG injection
- Jeopardizes hydrocarbon production due to water coning in the reservoir
- Increases water flow and injected chemicals in lieu of hydrocarbon production

Long-term reasons - formation water production threatens pipeline integrity:

- Pipeline scaling
- Pipeline corrosion & erosion

In addition, the lack of real time, accurate hydrocarbon measurements impacts the hydrocarbon metering and fiscal allocation strategies and obligations.

Performance without compromise

As the industry evolves and faces new challenges, Roxar is continuously developing and improving its measurement solutions. As an answer to the current and future industry requirements, Roxar now offers the next generation subsea Wetgas meter (SWGM). This meter builds on the same measurement principles as the previous generation, but is substantially upgraded with the latest in microwave (µW) technology and with added measurements and functionality.

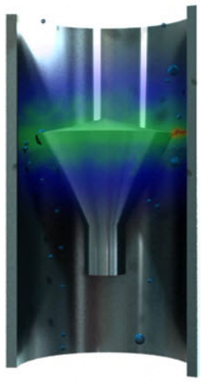
The meter has improved performance in the entire operating range, but with the greatest enhancement in the ultra-high GVF (99-100%). For example, one of many key differentiators for the Roxar SWGM is the ability to measure the absolute level of water in all phases very accurately. Further, special considerations have been taken in order to ensure less dependency on fluid composition data (PVT). A separate salinity sensor has been added to the meter, allowing for direct measurement of the conductivity of the produced water.

Improved measurement uncertainty

A fundamental upgrade to the microwave electronics has been made. While the previous system utilised analogue VCO circuits in order to create microwaves, the latest generation represents a transition into digital frequency measurements. This allows for improved long term stability and time resolution, resulting in a more accurate and sensitive measurement. In fact, the long-term drift of the microwave system is negligible and in practice results in a calibration free meter.

In addition to improving the performance of the meter, the new microwave system also enables additional benefits such as direct water conductivity measurements.

Measurement principle



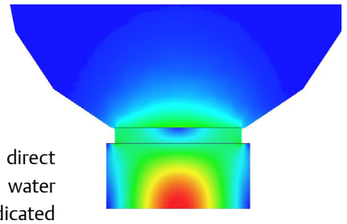
In the Roxar subsea Wetgas meter, the water fraction measurement is obtained by microwave resonance, measuring the dielectric and real permittivity properties of the fluid with low uncertainty and very high sensitivity. In fact, a scientific paper presented in the Measurement Science and Technology journal published by the IOP Institute of Physics, states that microwave resonators offer the highest possible accuracy of measurements of real permittivity. With the microwave measurements, combined with PVT data, the fractions of hydrocarbon and water are calculated.

Flow measurements are obtained by redundant DP measurement over a cone. The cone and meter body form a resonant cavity for microwaves which is sensitive to the flow permittivity. At resonance, the microwaves will propagate throughout the cross section of the pipe; hence, the meter is sensitive to changes in the flow, independent of type of flow. The flow's permittivity is a function of fluid fractions, temperature and water conductivity.

Pressure and temperature are measured by dedicated, redundant transmitters.

The use of a gamma densitometer in the Roxar SWGM is optional. It is used to measure the fluid density and to estimate the condensate content of the wet gas flow. The use of a gamma densitometer is relevant in cases where the hydrocarbon composition may vary and where the condensate content in the well stream could be relatively high.

Best-In-Class salinity measurement system



In order to allow for direct measurement of water conductivity, a dedicated microwave-based sensor is included in the meter. This sensor is a dielectric cavity resonator and is mounted flush in the wall of the meter body, with one end facing the flow. It is extremely sensitive to saline water on the sensor surface, and can measure the salinity with high precision at GVF levels up to 99.99%. It comes as an integrated part of the SWGM, with no changes to electronics or power consumption, as well as the size of the meter, compared to a standard SWGM.

> "The ultimate solution for securing and optimizing production for gas and gas condensate wells."

Best-In-Class water measurements

The sensitivity and accuracy of the Roxar SWGM to detect and quantify water in a wet gas well is unparalleled in the industry. Comprehensive flow testing at e.g. CEESI in the US shows that the measurement uncertainty of the water volume fraction for ultra-high GVF's is in the range of ±0.01 – 0.02%, which represents an improvement in the range of 10 times of that of the previous generation meter, which is still considered a very reliable and accurate wet gas flow meter.

The new microwave system allows for an improved uncertainty specification and sensitivity, and the meter is able to detect changes in the water content of the flow down to 0.2 ppm!

Critical time window for hydrate forming - the need for speed

Field examples exist where the period from formation water breakthrough occuring, to hydrate growth/build-up and pipeline plugging, is less than 20 minutes. Therefore, rapid, highly sensitive measurements are needed to capture the critical time window of a hydrate plug forming in order to take remedial actions to save the well. The Roxar subsea Wetgas meter has the ability to instantaneously detect and measure extremely small changes in water conductivity down to +/- 0.004 S/m. For reference, typical seawater conductivity at 25 °C is ~5.0 S/m.

Operating range and output

The Roxar subsea Wetgas meter is designed to operate from 85% to 100% GVF, and 0% to 100% WLR. The outputs are amongst others flow rates of hydrocarbon gas and condensates, formation water flowrate and condensed water flowrate, water salinity and conductivity, formation water indicator, pressure and temperature. The meter outputs data in both actual and standard conditions.

Added value for the operator

Roxar has a specialized subsea Wetgas meter for gas and gas condensate fields with their own specific set of challenges, providing an optimal solution with no technology compromises. Roxar has an unparalleled install base in several major gas fields all over the world, a 13-year track record of successful applications on some of the world's most challenging wet gas fields.

The subsea Wetgas meter is fully redundant, and has actual mean time to failure (MTTF) > 250 years, and with more than 1250 years of accumulated operational time.

With the Roxar subsea Wetgas meter, by providing sensitive, accurate and reliable measurements of the water in the wet gas stream, operators can take preventative or remedial action, optimize production, prevent hydrate formation, scale and corrosion in the pipelines, and ensure reliability of hydrocarbon supply.

Specifications - Roxar subsea Wetgas meter

Operating Range	85-100% GVF 0-100% WLR
Meter Sizes	3” to 8”
Installation	Vertical upwards flow (recommended)
Typical uncertainty (95% confidence interval)	**Water fraction measurement:** Uncertainty: GVF > 98%: ±0.1 abs. vol.% GVF < 98%: ±0.2 abs. vol.% **Sensitivity:** < 0.00002 abs. vol.% **Total hydrocarbon mass flow:** Uncertainty: ±5% relative **Gas Volumetric Flow Rate:** Uncertainty: ±3% relative **Repeatability** (for both HC mass and Gas flow): ±0.5%
Design pressure and temperature	Up to 690 bar (10,000 psi) -40 to +150 °C
Meter body wetted parts materials	Duplex UNS 31803 Inconel 625 UNS N06625
Flange connection	API, SPO compact or weld neck interface
Length	< 900 mm flange to flange (all sizes)
Weight	~ 850 kg (4” meter)
Density system (optional)	Source: Cs-137, 5 mCi, Half-life 30.1 years
Power	24 VDC (20-30 VDC) Power consumption: 23 W (nominal), 41 W (inrush)
Communication protocol	Modbus RTU, SIIS Level 2 & 3, IWIS
GUI Software	Roxar Fieldwatch
Redundancy	PT, DP, flow computer and electronics, power and communication interface

Head Office Roxar products:

Emerson
Roxar Flow Measurement AS
Tel: +47 51 81 88 00
E-mail: info.roxar@emerson.com
www.Emerson.com/Roxar

CIS
Tel: +7 495 504 3405

Europe
Tel: +47 51 81 88 00

North America
Tel: +1 281 879 2600

Middle East
Tel: +971 4 811 8100

Asia Pacific
Tel: +60 3 2177 4450

Australia
Tel: +61 8 9208 1600

Latin America
Tel: +55 21 2217 8600

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