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+ MEASUREMENT SOLUTIONS

Net oil measurement in separator applications

How It Works

The measurement and management of water entrained within liquid hydrocarbons is a task well suited for the Scanner* 3100 flow computer. By accepting signals from a variety of field devices, the Scanner 3100 flow computer can compute, record, and report net amounts of water and oil.

Where gas is also being produced, a single Scanner 3100 flow computer can simultaneously compute and report gas amounts together with the oil and water amounts. The fluid computations can include gas/oil ratios (GORs), and water/oil ratios (WORs).

The Scanner 3100 flow computer offers a scalable purpose-built measurement solution for use with a lease automatic custody transfer (LACT) skid or a separator and is an ideal replacement for the NOA-332 device.

Net oil computation

The Scanner 3100 flow computer can compute net water, gross oil, and net oil volumes. Water cut can be measured with a WOR ratio analyzer or a density measurement device such as a Coriolis meter. This is significant because, in the global diversity of operating conditions and expectations, the scanner is effective using all technologies.

In some two-phase and three-phase separator applications, an online WOR analyzer is preferred. This device uses technologies such as capacitance or radio frequency (RF) and infrared absorption. However, accuracy may vary under the following conditions:

+ In the mid-region of a water-oil emulsion where the phase of the mixture transitions from water-in-oil to oil-in-water
+ Where variable flow rates influence mixing and droplet shape
+ Where water salinity or optical properties are changing.

The Coriolis approach offers significant economic and operational benefits:

+ It is easy to understand, operate, and prove in a measurement audit.
+ It is stable across the entire water-cut spectrum (0–100%).
+ Fluid mixing is not required.

A Scanner 3100 computer in a gas, oil, and water measurement application.

Computing volume and water cut from Coriolis measurements

Water cut is calculated using the relative density of dry oil and the relative density of hydrocarbon-free produced water as known constants, and the density of the flowing mixture as measured by a Coriolis meter. For example, if the water has a known relative density of 1.0, the oil has a known relative density of 0.80, and a live measurement of the flowing mixture indicates a relative density of 0.90, the Scanner flow computer computes that the fluid is a 50:50 mixture of water and oil.

Water cut = (Rhof_oil – Rhof_comp) / (Rhof_oil – Rhof_water) × 100

Rhof = density at flowing conditions

Comp = measured mixture density

The Scanner 3100 flow computer collects mass flow rate, density, and temperature simultaneously from a CamCor CT* custody transfer Coriolis flowmeter via a Modbus® serial connection and uses those measurements to compute volume and water cut. Alternatively, or if another manufacturer's Coriolis meter is used, the Scanner 3100 flow computer can collect the measurements via analog or pulse signals.

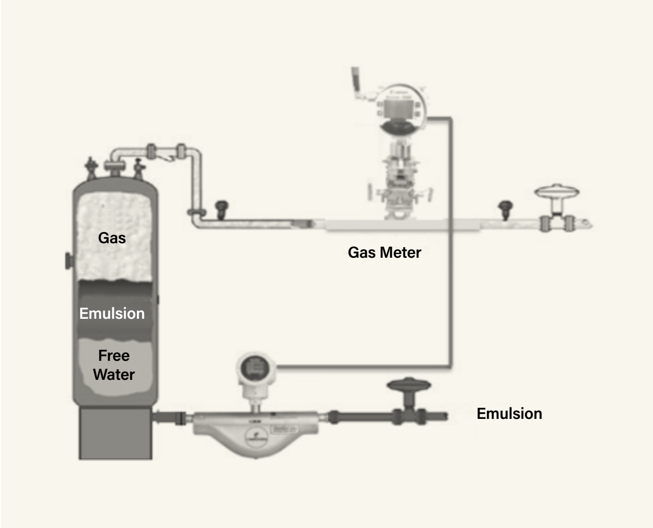
Coriolis measurement is recommended for applications with the following attributes:

+ Where WOR varies greatly, as in a two-phase separator. At the beginning of a dump cycle, flow is 100% water, but as the dump cycle progresses, water content continuously decreases, and by the end of the cycle, the liquid is nearly 100% oil.
+ The oil and water densities at base conditions (relative density) are constant
+ The minimum difference necessary between the relative density of oil and water is dependent on the system accuracy desired and density measurement accuracy of the Coriolis meter selected. Coriolis meters vary between ±0.031 lbm/ft^3 [±0.50 kg/m^3] to ±0.187 lbm/ft^3 [±3.0 kg/m^3]. Based to ±0.031 lbm/ft^3 [±0.50 kg/m^3] performance of a CamCor CT meter the following density differences will generate the resultant measurement accuracy:

Oil-to-Water and Relative Density	Water-Cut Accuracy
0.30	±0.167%
0.20	±0.250%
0.10	±0.50%

For example, if the water has a relative density of 1.05, the oil must have a relative density less than 0.95. The nominal water-cut accuracy with a relative density difference of 0.1 is 0.5%. This means that a true water cut of 50% may compute as any value between 49.5% and 50.5%.

+ The separator is sized for the highest flows, including flow, including slugs. Insufficient fluid retention time will result in gas carry-under and measurement errors. Undersizing is more probable on new wells.



Two-phase separator using a Coriolis flow meter for watercut measurement.

Two-phase separator using a Coriolis flowmeter for water-cut measurement

Coriolis measurement may not be appropriate for the following applications:

+ Fluids are coming from multiple locations. Examples are fluids that are transported by truck from various fields or fluids produced from multiple reservoirs that are fed to a test separator. This challenge may be overcome by using an external table to record the reference relative density of the oil and water by source location, which can then be read by the flow computer. Group separators do not require this lookup function.
+ Reservoir stimulation for oil production involves either miscible floods that dilute the oil or the injection of water with a water with density significantly different from that of the [produced oil or connate water {or both}].
+ The oil contains a high concentration of dissolved gas. Relative density measurement of such fluids requires careful assessment. When a sample is drawn for relative density analysis, gas that was dissolved in the oil under process pressure can break out of solution and escape. Therefore, hydrometer reference measurements should be taken quickly.

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