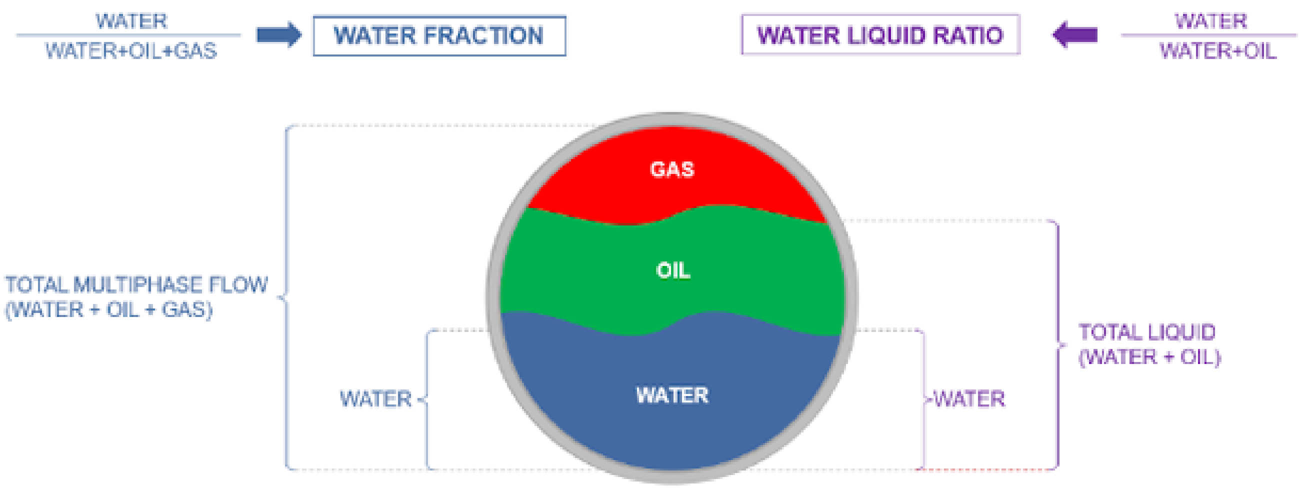
OIL AND GAS

Technology provides greater insight into produced water

Multiphase fraction and conductivity meter offers a commercially viable alternative to traditional well testing

BY FINN ERIK MOHN BERGE   MARCH 31, 2020



Courtesy of: Hammertech

Rising water cuts and a broad range of well and field conditions are becoming increasingly prevalent in oil & gas operations today, particularly with older fields.

As is well known, water cut is the ratio of water produced to total fluid produced. For example, a well that makes 50 barrels of oil per day and 150 barrels of water a day has a water cut of 150/50+150 = 75%.

According to research analysts, IFP Energies Nouvelles (IFPEN), 300 million barrels of water a day are expected to be produced by 2020, an increase of 20% from 2008.

Produced water, however, can be a major inconvenience and cost to operators, reducing pressure in the reservoir as well as production facility capacity. Operators must dispose of the water by discharging it into the environment or by re-injecting into the reservoir.

There is increased pressure on operators to measure water production and water salinity in real-time. This can play a vital role in ensuring that water doesn't gather in pipelines and inhibit oil production, that re-injected water is used to its full potential, and that threats to production from water salinity are pre-empted.

Yet, managing water production is complex, involving many disciplines and highly trained and specialized engineers. Furthermore, identifying the source of the water production, the well, and ultimately the specific water producing zone in the well, can be time consuming.

When it comes to choosing a technology that can trend water behavior and deliver on water production and water salinity, operators often face two different but unsatisfying choices.

One option is using low–cost water cut meters that come with significant data gaps in that they only provide information in water and oil rather than in the multiphase flow.

The other is use of more complex multiphase meters. While providing comprehensive multiphase flow information and accurately characterizing flow regimes, such meters are often cumbersome, expensive, and require considerable maintenance with the need to input pressure, temperature and volume (PVT) information. It is economically infeasible to deploy one multiphase meter on each well.

In short, there seems to be a significant gap when it comes to accurately measuring real-time water content and salinity in multiphase flow. That is changing.

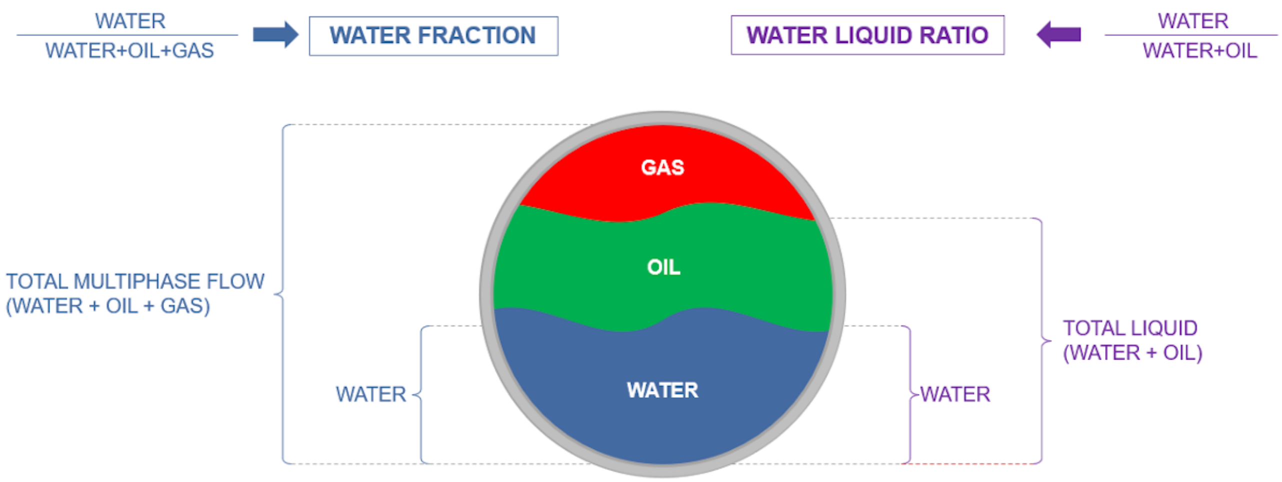


Figure 1. by providing full fraction measurements of different well phases, the high-frequency magnetic field technique is the equivalent of a multi-phase fraction meter. Courtesy of: Hammertech

Full fraction measurements

Hammertech recently introduced a multiphase fraction and conductivity meter that provides direct, robust and cost–efficient multiphase fraction (% water, oil & gas) and water conductivity detection. The meter has gone through a series of testing and installations, demonstrating uncertainty specifications of water fraction and water-in-liquid (WLR) at ± 3% absolute, and conductivity (salinity) at ± 0.5 Siemens/meter.

The meter provides full fraction measurements of the different phases of the well, including water fraction (hold-up), water–in–liquid ratio (WLR) and gas fraction measurement, as well as salinity measurement. In this way, the meter becomes a multiphase fraction meter as per figure 1.

The detection principle around the meter is called high–frequency magnetic field technique (HFMFT), a unique variant of the eddy current measurement technique where an eddy current creates a magnetic field that opposes the change in the magnetic field that created it (see figure 2). The eddy currents then react back on the source of the magnetic field (Lenz's law).

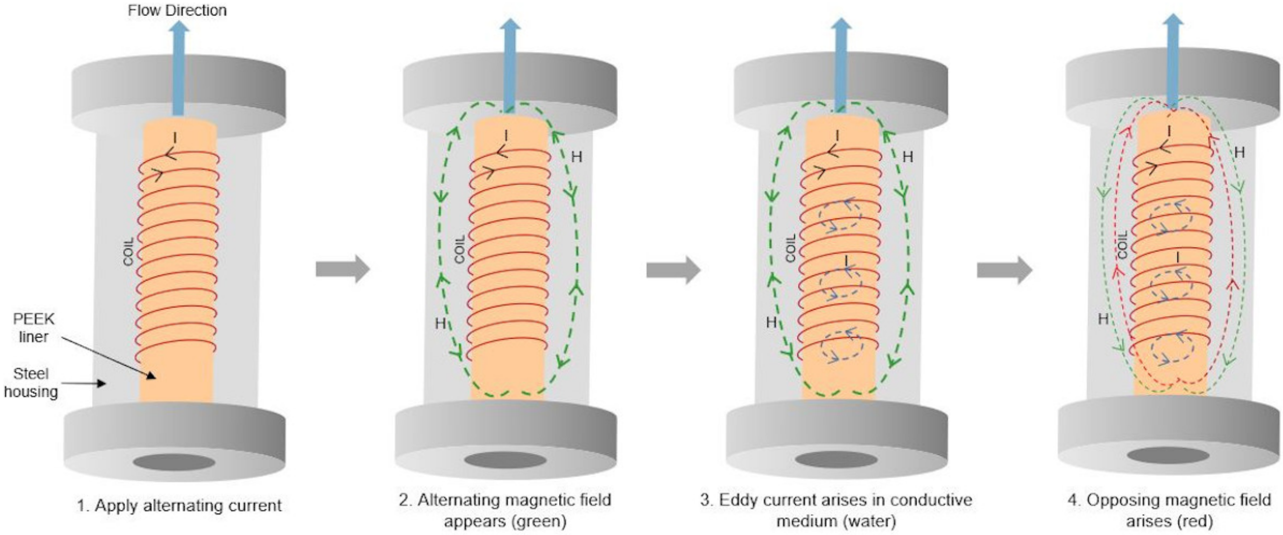


Figure 2. Using an high-frequency magnetic field technique, an eddy current creates a magnetic field that opposes the change in the magnetic field that created it. Courtesy of: Hammertech

When a conductor — in this case the water — is exposed to a varying magnetic field, eddy currents will be induced in the water. These eddy currents induce a magnetic field which opposes the original field and power is lost due to the currents. The loss of power is proportional to the water content, with large amounts of water resulting in large amounts of energy loss and small amounts of water resulting in small amounts of energy loss. The conductivity (salinity) of the water will also affect energy loss.

The meter then measures via dedicated probes the conductivity (and temperature) of the water to differentiate between energy loss caused by the amount of water and energy loss caused by levels of conductivity. Conductivity is then calculated for the water in multiphase flow based on the measured complex permittivity of the water.

Complete overview

What are the benefits of the new meter and what gap is being addressed in the market?

For operators the key benefit is a complete overview of the field through the online trending of water content in multiphase flow. By measuring water fractions, the operator can trend the water level, and if there are no changes (or a slight steady increase), the well is stable and producing as expected. In such cases, expensive well testing crews aren't required.

As soon as there is a change in the water level, however (as detected by the meter), the operator can dispatch a well testing crew to investigate, pinpointing problematic wells (such as when there is excessive water production from the wellhead) and instigating remedial action.

Furthermore, since the salinity of the water is detected, the operator can identify if the water production is a result of too hard water injection.

Reduced CAPEX and OPEX

Another benefit is reduced capital expenditure (CAPEX) and operating expenditure (OPEX) with the costs of the meter equal to just two to three well tests, allowing the operator to access online measurements from each production well. Well test savings combined with increased oil production due to reduced water production can result in $20 million in added value (Figure 3), based on a field of 200 wells with an water production can result in $29 million in added value (Figure 3), based on a field of 200 wells with an average production of 500 bbl/d, and a conservative oil price of $55 a barrel.

Figure 3. Well test savings combined with increased oil production due to reduced water production can result in added value. Courtesy of: Hammertech

The meter is also cost-effective compared to more complex multiphase meter deployments. According to our estimates, replacing a multiphase meter per well on a five-well configuration, installing each well with the new technology meter and then having just a multiphase meter on the manifold can lead to savings of up to $500,000. For a typical field with 50 wells, the savings are thus more than $5 million.

There is also low OPEX with the small, lightweight (27 kg) meter. It is a simple, non-intrusive "plug–and–play" solution with no installation support required, besides being easy to integrate with existing production operations. There are also low power requirements (ca 10 W vs 20+ W for a multi-phase flow meter), and no sensors in contact with the process, which otherwise might lead to potential contamination and inaccurate measurements.

We also conservatively estimate an increase of 0.5% in production following from use of the meter.

One final benefit of the meter relates to PVT data. Multiphase meters rely on the accurate input of PVT data and other fluid parameters to achieve the specifications provided by vendors. This can be a challenging process, especially as such variables are likely to change significantly over the lifetime of the reservoir as fluid and process conditions change. With the multiphase fraction and conductivity meter, however, there is no complicated set up or configurations and no reliance on PVT data.

A viable alternative

As operators continue to wrestle with the challenges of produced water, the multiphase fraction and conductivity meter has come along at just the right time — offering a commercially viable alternative to traditional well testing, water cut and multiphase meter operations, and generating real-time water content and water conductivity measurements.

Finn Erik Mohn Berge is a company vice president with HammerTech.

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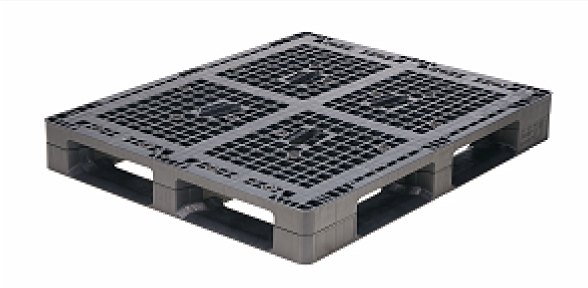

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