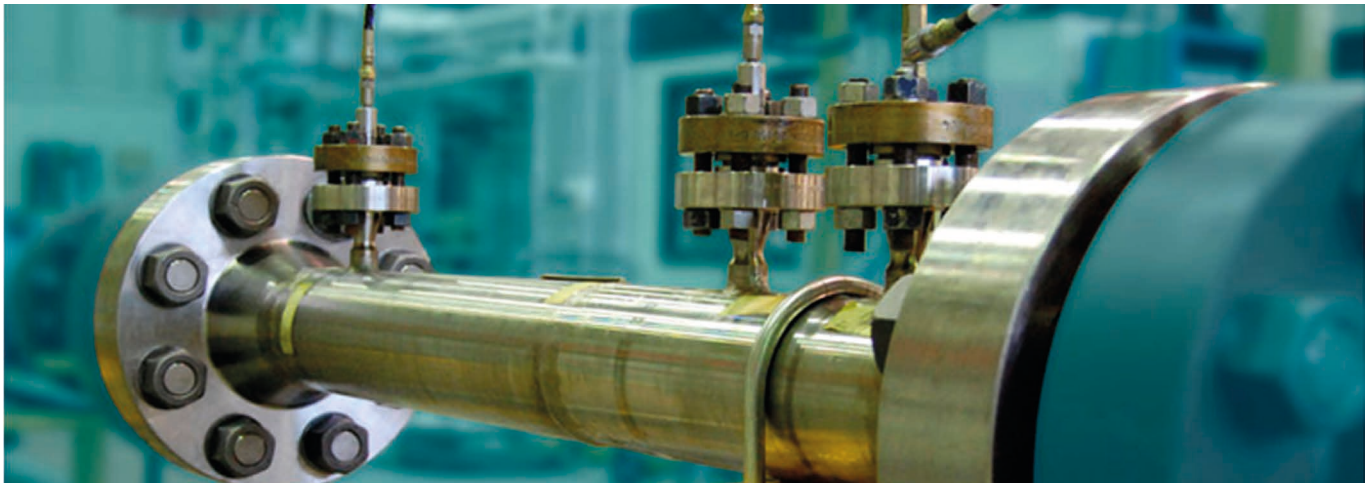


MultiTrace™ - a method for multiphase metering and calibration

Gas and oil wells produce a mixture of phases; water, gas and oil or condensate. Accurate volumetric measurement of each phase produced is essential for reservoir management and production optimization.

The MultiTrace™ technique is nonintrusive and accurately measures the production of water, gas and oil/condensate at flowing conditions with the use of chemical tracers. The uncertainty in the measurement has been determined to be better than 10% of the true value for individual liquid phases, and better than 4% for the gas phase. In single phase flow, uncertainties of better than 2% are achieved.

In principle, the technique is capable of measuring water, gas, condensate or crude oil in all sorts of multiphase flows. Wells with liquid fractions up to 100% have been tested successfully.



MultiTrace™ — Principle of Operation

The tracers are selective to the gas, water, oil or condensate phases. The selected tracers are injected into the production stream at a specific concentration and precisely metered rate. A sample of the produced fluids is then taken downstream of the injection point. The actual production rate is calculated from the dilution factor of the tracer in the collected sample.

All required equipment for the MultiTrace™ technique is portable and can be hand carried to the testing site. The tracers are nonradioactive and meet the most strict environmental regulations.

MultiTrace™ Applications

The MultiTrace™ technique is a versatile tool and is applied to many different applications. The measurement turndown, in theory, is unlimited, so both small and large flow rates can be measured. At present liquid flow rates between 1m/d to 6,000 m/d have been measured.

Wet Gas Metering - Venturi and Orifice Flow Meters

The MultiTrace™ technique used in combination with venturi or orifice meters, is ideal for wet gas metering. The tracers are used to determine the liquid production to allow for the correction of the **over-reading** of the gas production by published correlations (de Leeuw, Murdock).

In combination with SmartVent™ wet gas venturi meters, that monitor the total liquid content of the gas stream, the MultiTrace™ technique is used to verify the measured production rates and to establish the water/condensate split of the liquid phase.

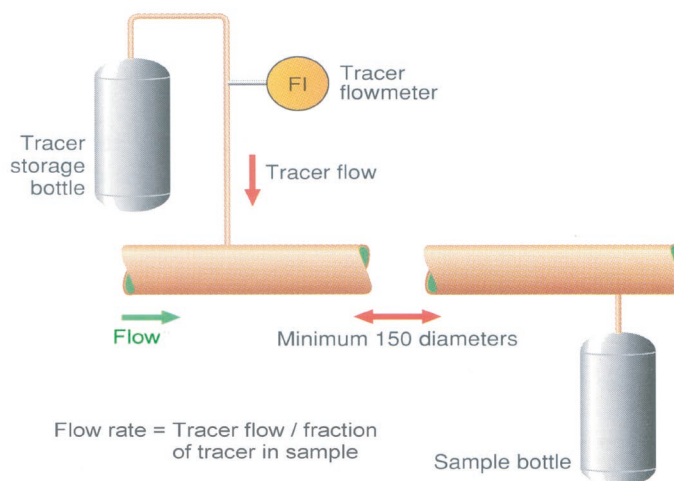
Multiphase Meters – Field Calibration and Verification

Traditionally, separators are used to measure multiphase flow. During recent years, the oil industry has invested in developing on-line multiphase flow meter systems that can replace separators.

The performance of the developed multiphase meters are continuously improving, but their optimum performance is limited to operation within specific flow regimes, velocities, or liquid fractions. Due to these variables and complexity in prediction and measurement of multiphase flow, there is a need for on-site calibration of the meters and verification of their performance. The MultiTrace™ technique has been developed to meet these special requirements.

Well Testing - Replacement of test separators

The MultiTrace™ and the IsoSplit™ techniques in combination with a multiphase meter, or SmartVent™ wet gas venturi meter, provides a unique wellhead metering and PVT sampling system which can replace the test separator. This system can be used for well testing, development of satellite fields, without the use of conventional manifolds and test separators. The MultiTrace™ technique can also be used to determine the performance of existing (test -) separators. The gas, water and oil flow rates can be compared directly to the separator readings and incorrect readings identified.



Gas Flow Rate Measurement

The MultiTrace™ gas tracers are chosen to be specific to the gas phase with little partitioning to the liquid phases. As such, the gas tracer technique can be applied to both single and multiphase applications.

Typical applications include checking or verification of installed (test - separator) flow meters, SmartVent™ wet gas venturi and multiphase meters, and measurement of flow in systems where no flow meters are installed. Advantages of the technique include: in-situ measurements, installation effects accounted for, measurement in irregular shaped conduits, and multiphase operation.

Net Oil and Water cut Measurement

The MultiTrace™ technique has the advantage that it measures the flow rate of the oil and water phases directly and independently. Because the uncertainty of the technique is expressed as a percentage of the actual net oil flow rate, the application is most attractive for wells having relatively high water cuts. Alternative techniques usually rely on measurement of the gross liquid production rate and a separate water cut measurement. But as the oil rate in high water cut wells is only a small fraction of the gross liquid rate, this often leads to high levels of uncertainty in the net oil rate.

Process Control - A General Tool

The MultiTrace™ technique can also be used to study properties of process equipment. Some examples include; determination of liquid retention times, and liquid carry over from the gas outlet of production separators. As such the MultiTrace™ technique is a versatile tool for process control optimization.

Overview of the MultiTrace™ Applications

- Gas, water and oil/condensate flow rate measurement
- Wet gas metering
- Net oil measurement
- Water cut measurement
- Performance verification of (test-) separators
- Field verification of Multiphase meters
- Process equipment diagnostics
- Well testing

In recent years a large number of major oil and gas companies have applied the technique to various applications. Locations include UK,