Field Experiences Using the Roxar Multiphase Meter in Tight Oil Shale Flowback Operations
In This Bulletin

In unconventional developments, the term flowback is defined as the period where the well is producing back most of the water that was pumped into the rock formation during hydraulic fracturing. This bulletin uses field examples to discuss both the performance and the advantages of using Roxar Multiphase Meters to monitor this flowback period.

Background

Hydraulic fracturing

After the unconventional well has been drilled and completed, a mixture of water and chemical additives are pumped down the well at high pressures. This creates fractures in the rock, and a proppant such as a sand is injected to keep the fractures open. This provides a conduit for the natural gas and oil to flow to the well and up to the surface. When the well is opened, it enters the flowback phase.

Flowback operations

Once a horizontal well is hydraulically fractured, the next step is to clean up the well by flowing it back to remove water and remove proppant from the wellbore.

Flowback fluid is initially comprised primarily of the fracking water used and is also typically contaminated with organic solids, heavy metals, residual chemicals from fracturing and naturally occurring radioactive material (NORM) of varying concentrations. Typically, only a portion of the injected fracking water is recovered. Flowback is the primary stage of fracking water recovery, however further recovery does occur during initial production following the flowback period. Flowback fluid can be treated and reused in later hydraulic fracturing operations, to reduce the volume of freshwater required and to mitigate issues arising from off-site disposal of flowback fluid.

Customer Pain

Oil and gas operators today strive to improve well performance through technology and innovation. Those innovations include identifying efficiency improvements, improving infrastructure and reducing service cost. These challenges apply to the entire industry, including subsea, offshore and onshore, including tight oil and gas (such as shale plays).

As per the SPE Journal Paper by Trent Jacobs (“Improving Shale Production Through Flowback Analysis”), it is stated that some operators “are using the early production and flowing pressure data of flowback fluids to establish their production benchmarks”.

Further, the paper states that:

“And even though the most effective flowback analysis strategies require the use of high-rate data gathering systems at the wellhead, the capital investment remains modest compared with other diagnostic technologies”.

It is worth noting the SPE paper referred to above relates to flowback and how the data gathered during this period can be used to inform future choices and developments. The paper does not relate to the use of Multiphase metering; however, the topic is very relevant within the discussion.

Emerson Solution

Emerson has obtained good experience in using the Roxar Multiphase Meter in flowback operations, see figure 1 of a meter installed in the field.

Roxar Multiphase Meter

The Roxar MPFM 2600 platform applies a combination of measurement techniques for determining phase fractions and velocities. These measurement principles have been used by Roxar for more than 25 years and in over 1,500 meter installations around the world. The result is a meter that accurately characterizes flow and provides a cost-effective and flexible solution for a range of applications, from measurement at the wellhead to complex well testing.
Benefits of using multiphase meters

The following optimization goals are often sought after and can be achieved using a multiphase meter:

- Provide confidence that production changes are real
- Reduce production allocation errors
- Reduce reservoir characterization uncertainties
- Deliver production optimization to planned targets
- Determine production data anomaly causes without sending personnel to the field
- Reduce operations and maintenance costs and safety risks
- Reduce reactive maintenance events
- Improve HSE performance
- Reduce overall cost

Field experience in flowback

Below are graphs showing the Roxar Multiphase Meter (figure 2) and the separator data (figure 3) during flowback testing. As it can be seen, the MPFM and the separator are trending closely against each other. Flowrates for gas, total liquid and oil are similar, with only minor differences. The multiphase meter is producing a slightly higher standard gas flow than the separator. The reason is related to how the standard gas rate was calculated. When the multiphase meter converts the gas rate to standard conditions, it considers solution gas that is in a liquid state at measurement (actual) conditions, will become free gas at standard conditions, while the separator does not. Please see the suggested further reading section, for further details how the Roxar Multiphase Meter converts from actual to standard conditions. The separator is showing somewhat more water than the multiphase meter. This was related to an incorrect dielectric parameter settings (e.g. reference permittivity set too high), essentially causing the meter to underestimate the watercut. The reference permittivity was corrected and the meter’s raw data measurements were reprocessed for final reporting.

Test was considered successful by both the operator and Emerson. It should be noted the resolution of results are considerably higher for the multiphase meter, providing increased detail within results and potentially allowing for early anomaly detection and correspondingly swift response.
During flowback testing, one operator installed the Roxar SAM Acoustic Sand Monitor on the piping next to the Roxar Multiphase Meter, and a second Roxar SAM further downstream, after their sand trap systems. In this way, the results from the two sand monitors could be compared and used to monitor the efficiency of the sand traps. Adjustments and improvement can then be made accordingly, and utilised when considering optimum arrangements for future wells.

**Added Value for Customer**

This bulletin has demonstrated that the compact solution of the MPFM 2600 can successfully be used on flowback operations, and combined with the Roxar Acoustic Sand Monitor, improves the integrity of operator assets and optimizes oil & gas production at high resolution.

Accurate, continuous measurement data and process diagnostics provide:

- Alerts to process upsets or abnormal operation
- Insight into the operation that traditional technologies often cannot provide
- Confidence in measurement and well behaviour

Ultimately, the goal is to optimize production through the reduction in environmental exposure, to maximize revenue streams and to reduce operating costs.

**Suggested Further Reading**

Technical Bulletin – Use of PVT and EOS in the Conversion from Actual to Standard Conditions within the Roxar MPFM 2600 MVG

Technical Bulletin – Challenges and Multiphase Metering Solutions in High Watercut Wells

SPE 174831 – Maximizing Well Deliverability in the Eagle Ford Shale Through Flowback Operations (Devon Energy)

SPE Journal Paper 1215-0037 – Improving Shale Production Through Flowback Analysis

**Roxar SAM Acoustic Sand Monitor**

In addition to the MPFM 2600, a Roxar SAM Acoustic Sand Monitor was installed onto the skid piping, see figure 4.

This is an intelligent non-intrusive device that provides an immediate indication to the onset of sand and particle production. The sand monitor utilizes the acoustic noise produced by sand particles to calculate real-time sand production in oil, gas or multiphase pipeline flows. Such information allows operators to protect the integrity of their assets and optimizing oil & gas production. The compact, robust design provides easy installation and retrieval on the outside of the production pipe-work.

Combining the MPFM 2600 and the Roxar SAM Acoustic Sand Monitor essentially provides a 4-phase measurement system (gas, oil, water and sand), in which the sand monitor utilizes the velocity from the MPFM 2600 to quantify the amount of sand produced.

In this particular field test, the shale well produced significant quantities of sand and other particles, and the information from the combined MPFM 2600 and the Roxar SAM Acoustic Sand Monitor system allowed the operator to make informed decisions to optimize the flowback period.