

Vx Technology in Unconventional Oil

APPLICATIONS

- Periodic multiphase well testing operations in strategic growth reservoirs such as heavy oil and tight emulsion environments
 - Extremely low gas rates
 - Low-density contrast between produced liquids
 - High to extremely high viscosities

BENEFITS

- Accurate measurements from reservoir exploration to production
- Improved reservoir estimation and recovery
- Cost reduction by means of steam injection optimization
- Reduction of operational and environmental risks

SUCCESSSES

- Gas lift optimization enabled client to decrease gas lift injection by 30% and to increase heavy oil production by 23%.
- Field tests proved accuracy with viscosities of 400 to 6,000 cP.

Vx¹ technology can now optimize measurements in tight emulsion and heavy oil production.

Vx multiphase well testing technology has been adapted to optimize flow rate metering in heavy oil and tight emulsion environments such as those encountered in well-known areas of Canada, California, Venezuela, Brazil, Mexico, and Indonesia, as well as Chad, the Republic of Congo, Russia, and increasingly elsewhere, including the North Sea.

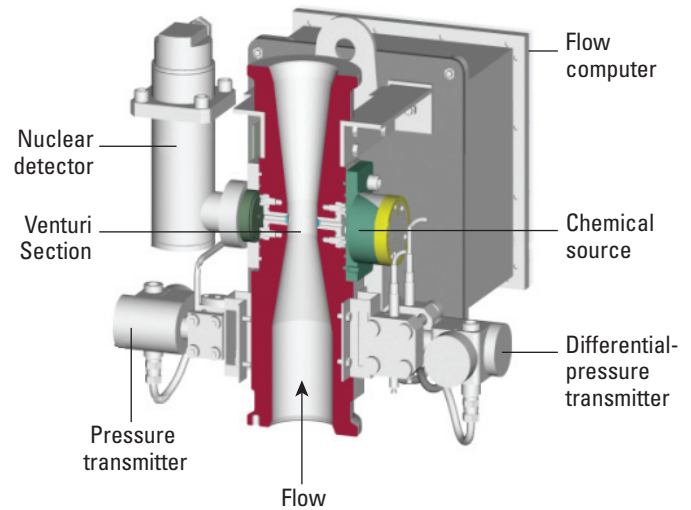
Whether the development opportunity involves oil-in-water or water-in-oil emulsions, the Vx technology-based fractional flowmeter correctly interprets contrasting electrostatic measurements (continuous or alternating phase cycles) to deliver accurate flow measurements in the most demanding environments.

EMULSION CONTROL IS VITAL

Emulsions are commonly created to produce or control wells that require gas lift injection, flowline restrictions, a bottomhole pump, a surface transfer pump, or a pressure drop introduction through chokes, valves, or any other surface equipment that dissipates energy in the fluid.

The greater the amount of agitation, the smaller the droplet size of the dispersed phase. The finer the emulsion, the more stable and difficult the emulsion is to treat.

The amount of water that emulsifies with crude oil in most production systems may vary from



The design of the Vx technology-based fractional flowmeter ensures accurate measurements even in challenging high-viscosity operations.

less than 1% to more than 60%. However, the most common range for emulsified water in heavy oil (< 22.3 API gravity) is 10% to 35%.

This latest development in Vx technology has been proven by field tests in challenging environments, with viscosity values that range from 400 to 6,000 cP at line conditions. Vx technology with the chemical-based fractional flowmeter (insensitive to foam or emulsion structure) successfully faced the operational problems of conventional surface well testing (separators) and the drawbacks of reference measurements for gas and oil flow rates caused by separation (gas bubbles trapped inside the liquid because of the low gravity contrast between oil and water). In addition, the new Vx technology resolved the high retention time otherwise imposed by viscosity.

Testing this new technology against one detrimentally affected by the liquid structure demonstrated an improved accuracy rate of 15% for relative error of the gas and net oil flow rate.

FIELD TESTS PROVE Vx TECHNOLOGY

In the emerging strategic field of heavy oil, Vx technology has proven itself to be an elegant measurement solution for such a complex and challenging environment because of its phase dispersion fractional meter combined with its classical venturi design.

The Schlumberger fluid analysis laboratory performed extensive analyses of a range of emulsion types and variables. Based on the company's extensive experience with Vx technology in heavy oil operations in locations around the world, emulsion behavior has

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been suitably modeled and combined with associated procedures for implementation prior to operation of the flowmeter. A large effort has been expended and will continue to even further extend this package of best practices through incremental improvements in software modeling.

As demonstrated by the samples in the table, no defined theory or simple behavior can account for viscosity change versus phase inversion levels (that is, the point defining where the flow is as water or oil in the continuous phase). This value is in flux even for the same field in water/liquid ratio intervals from 30% to 80%. This phase inversion is able to reach the highest viscosity levels.

Results of Vx Technology-Based Operations in Four High-Emulsion Wells

Well	Line Conditions				Relative Error	
	Pressure, psi	Temperature, degF	Gas Volume Fraction, %	Differential Pressure Volume, mbar	Liquid, %	Gas, %
1	154	149	85	1,113	-6	13
2	174	132	90	1,288	-10	12
3	179	140	83	1,543	-8	10
4	183	130	85	1,369	-8	18

From more than 300 active wells, the four most challenging high-emulsion producing wells within optimum range of a PhaseTester* portable multiphase periodic well testing unit were selected for the field test. Separation issues were pivotal under these conditions. Because the retention time was short, the liquid flow rate was expected to be systematically overestimated (owing to gas going through the liquid line) and the gas flow rate to be underestimated (owing to gas trapped inside the liquid line).

The table shows the final results of the test, which were within the expected accuracy range for Vx technology. Based on the field trial, the client's impression of Vx technology's application to heavy oil was excellent, enabling Schlumberger to regain a field it had helped develop. New procedures enabled immediate production from more than two-thirds of the low-producing wells. Schlumberger optimized production by helping the client properly manage ESP operations and gas injection.

OVERALL BENEFITS ARE CLEAR

As a result of the field trial, the client obtained a better understanding of emulsion behavior, which will prove especially helpful in a high-emulsion production field and will help the client review and adapt production related to other applications. For example, by using gas lift optimization, the client was able to see an increase in heavy oil production of 23%, with a reduction in gas lift injection of 30%.

Vx technology furthermore gave this client the flexibility to meet well testing targets required by its government's ministry of energy, which mandates a minimum number of well tests per month.

Two additional benefits of Vx technology are the greater accuracy and versatility in production control when the PhaseTester service is used.

Vx multiphase flowmeter technology may be the most significant innovation in surface well testing in more than 30 years. Because of its synergy across several global centers of expertise (fluid properties, metering, and sampling), Schlumberger is a world leader in the development of solutions for heavy oil and high-emulsion wells.

Vx technology depends on physical fluid parameters only. It does not require flow calibration, stabilization, long retention periods, or large amounts of costly diluent in high-emulsion environments.

Together with PhaseTester portable multiphase well testing and PhaseWatcher† fixed multiphase well production monitoring, Vx technology offers significant benefits and improvements in reservoir management. It does so through a simple and compact solution with a small logistical footprint, in addition to a large reduction in capital and operating expenses.



Viscosity versus emulsion for different fluids.

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