# Increased injection accuracy from ultrasonic metering valves

*When it comes to subsea chemical injection, accurate dosage delivery can make or break an operator's budget. Fast developing technology and methodology in chemical injection metering are making it possible to reliably address the many flow assurance challenges specific to deepwater production. Until now, traditional low-flow chemical injection metering valves (CIMVs) have experienced reliability and accuracy issues due to blockages caused by debris, costing operators millions of dollars in wasted inhibitor costs and nonproductive time (NPT). While injection of medium and high doses of inhibitors (typically for hydrate management) has recently benefitted from the increased reliability and accuracy, injection of low-dose inhibitors (LDIs) typically for corrosion, scale, or wax can now also benefit. A new low-flow CIMV using a microbore ultrasonic flowmeter has been introduced by Cameron, a Schlumberger company, completing the PULSE* ultrasonic chemical injection metering valves product line.*

*By David Simpson, Cameron, a Schlumberger company*

## Enabling subsea distributed chemical injection

PULSE CIMVs are specifically designed for use with subsea distributed chemical injection systems, which are more cost-effective in long step-out deepwater projects with complex system architectures. A subsea distributed injection method allows precise and accurate injection of chemicals to many individual wells at appropriate injection rates; it employs only a single chemical delivery tubular per chemical in the umbilical to the drill center from where it splits out subsea to each injection point on the trees or manifolds where the CIMV is mounted (Figure 1). The umbilical can thus be made smaller and less complex, significantly reducing costs.

The main goal of subsea distributed chemical injection is to reduce the umbilical size and complexity and, therefore, lower its weight, leading to lower procurement and installation costs. The concept also reduces the size and weight of the topsides chemicals skid on the host facility, where real estate is always at a premium, further reducing capex.

Subsea distributed chemical injection does, however, require greater control and accuracy over the levels of LDIs being injected at multiple points into the production, oftentimes at different subsea locations and pressures. This drives the requirement for highly reliable and accurate subsea low-flow chemical injection metering valve technology.

Gains to deepwater operators are significant in terms of the capex savings on the umbilicals and their installation and the size and weight savings on the host facility from the reduction in chemical injection package size. Significant opex savings can also be achieved on the chemical costs over the life of the field through more reliable and accurate control of the chemical injection rate. A highly reliable and accurate subsea CIMV is essential for this subsea distributed chemical injection approach to be successful.

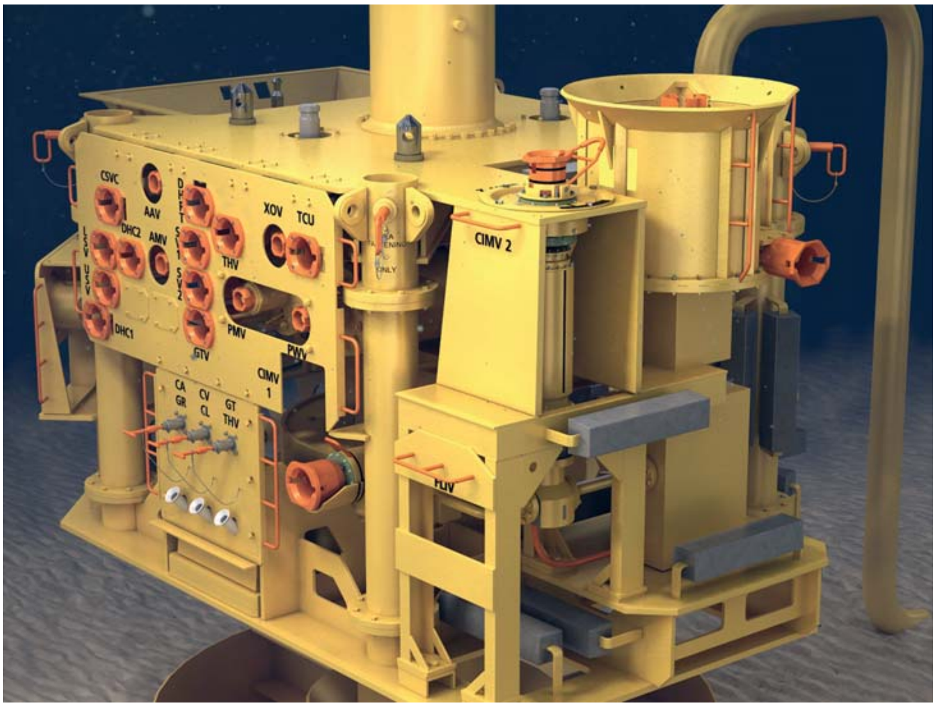


*Figure 1: Subsea production tree with PULSE LF and PULSE HF CIMVs. (Image: Schlumberger)*

## Metering LDIs

Traditional flow measurement technologies used in subsea chemical injection metering valves for LDIs typically use either Venturi-type flow measurement (whereby a pressure drop is measured across a precision orifice) or a positive displacement flow measurement technique which employs a rotating or stroking piston to measure volumetric flow rate. Accuracy with these techniques can be heavily influenced by the properties of the injected chemicals, requiring project-specific chemical calibration during manufacture of these CIMVs. Inaccuracies in flow measurement can also stem from particulate contamination and blockage in the CIMV and from the fact that CIMVs can be engineered years in advance of being put into service (oftentimes with limited knowledge of the chemicals to be injected). A little understood fact is that CIMV system designers are often not provided with critical chemical data, while the CIMV is in the design stage. And then there are operational decisions made to change out injection chemicals used in the field during its life.

These events can render the CIMV as being not properly tailored for the chemicals being used, and ultimately, potential system under performance occurs.

Blockage happens because of particulate contamination of chemicals being injected through the CIMV, blocking onboard filters or tightly fitting moving parts or orifices used for flow measurement.

## Effects of incorrect inhibitor dosage

Delivering the optimum amount of inhibitor is key. Should this not happen, problematic and costly repercussions can occur, especially in deepwater. Under- or overdosing are often tied to chemical injection flowmeter accuracy, which can be heavily influenced by the flowmeter design and properties of the injected chemicals. Under injection can result in scale or wax buildup in production strings or pipelines, for example, lowering the production rate. Should the scale or wax exist in the line for an extended period, the well may have to be shut in to undergo a batch treatment, incurring deferred production and intervention costs. In the case of corrosion inhibitors, SURF (subsea, umbilicals, risers, and flowline) facilities may have to be taken offline until failed components are replaced.

Should systematic overdosing occur, significant chemical excess costs can result; not only in the chemical costs themselves, but also in the additional chemical tankage which takes up valuable deck space on the platform. For instance, based on the selection of the CIMV design alone, a company could inadvertently spend more than USD 2 million over-injecting just one well over the life of the field. Also, excess levels of LDIs in the export crude may affect its value at the refinery.

## Ultrasonic flow measurement

The microbore, nonintrusive PULSE LF* low-flow ultrasonic chemical injection metering valve, for injection rate control of LDIs, offers a highly reliable, debris - tolerant CIMV with best-in-class injection rate accuracy. This single, retrievable unit offers an injection range from 0.25 to 600 L/h (achieving a turndown ratio of 2,400:1) with an injection rate accuracy of better than 2% of reading above 2 L/h compared to the industry standard Venturi-type flowmeter that may only deliver accuracy of 5 to 10 percent full scale.

The PULSE LF CIMV was developed following success of the PULSE MF* medium-flow ultrasonic chemical injection metering valve and PULSE HF* high-flow ultrasonic chemical injection metering valve (used to inject high volumes of MEG or methanol as part of a hydrate mitigation system). The microbore ultrasonic flowmeter at the heart of the PULSE LF CIMV delivers nonintrusive, debris-tolerant flow measurement (based on the "delta T" time-of-flight measurement technique) with no moving parts, is chemical independent with a very low native pressure drop, and does not require any subsea filtration (Figure 2).

Now the PULSE LF ultrasonic flowmeter development addresses the key limitation of present LDI chemical injection technology (sensitivity to blockage) by having the capability to accurately and reliably meter chemical inhibitors without the need for filtration. The turndown ratio of this ultrasonic flowmeter allows one meter to be used across a wide range of injection applications; it is particulate tolerant (contaminated fluid can easily pass through the unrestricted flowmeter tube), provides consistent high accuracy of reading independent of changes in chemical

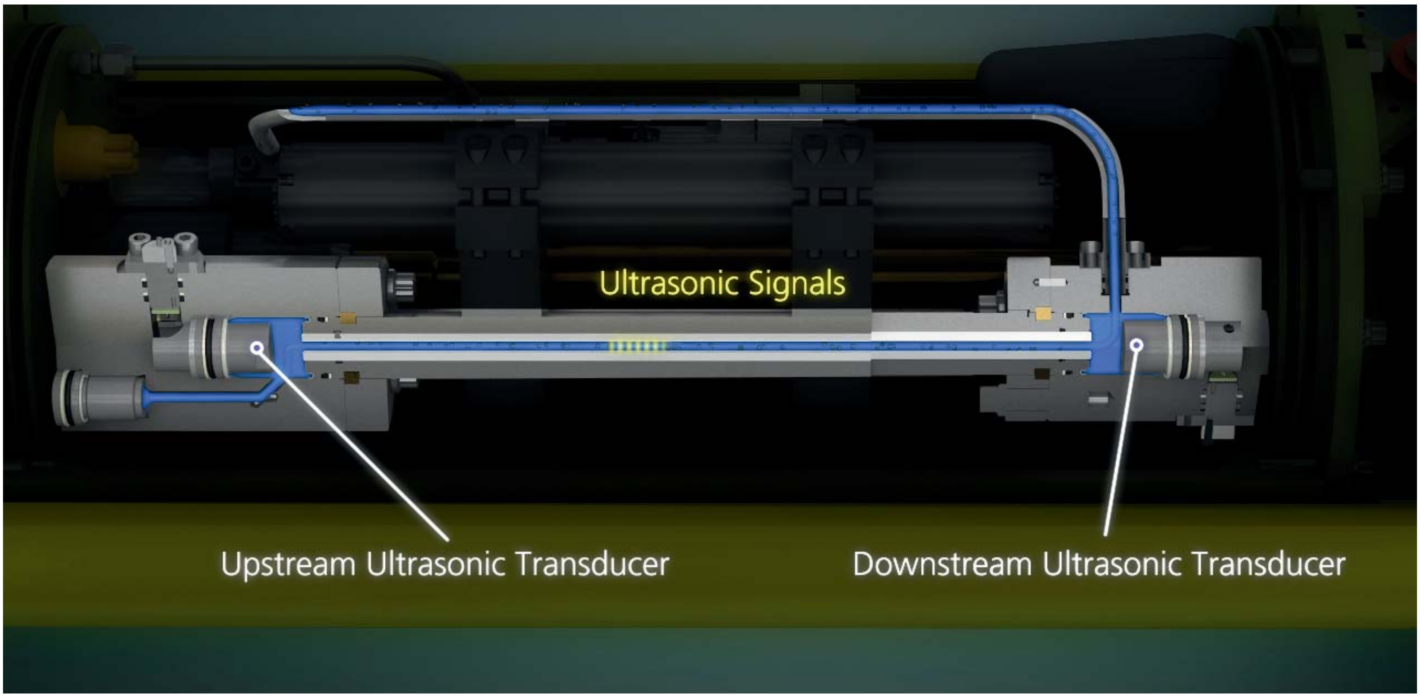


*Figure 2: Nonintrusive microbore ultrasonic flowmeter used in the PULSE LF CIMV. (Image: Schlumberger)*

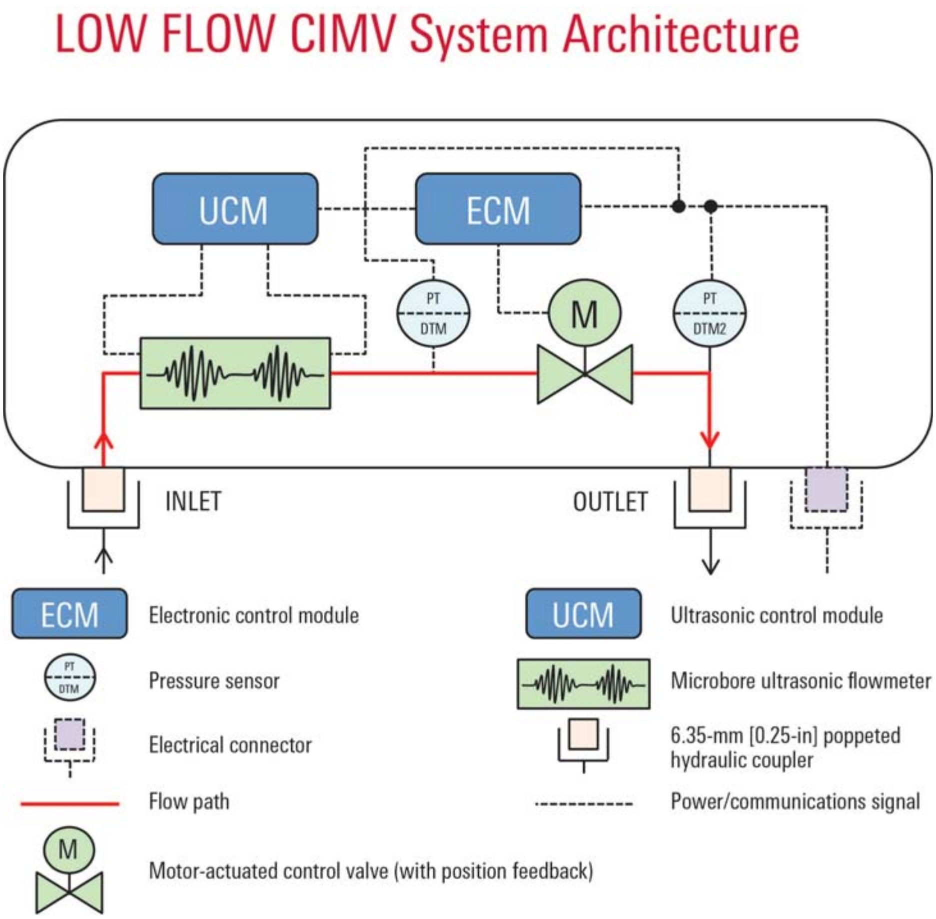


*Figure 3: PULSE CIMV system architecture (Image: Schlumberger)*

properties such as viscosity, and reliably measures chemical inhibitor flow rate. The PULSE CIMV system architecture combines this ultrasonic flowmeter with an electrically actuated needle and seat throttling valve in closed-loop control (Figure 3). Flow rate monitoring and valve actuation via the onboard closed loop control algorithm, along with external communications, are managed by the electronic control module that streams back operational performance data to the operator via the master control station.

Real-time feedback from the flowmeter is used to autonomously control the throttling valve, maintaining a user defined injection rate set point indefinitely regardless of up- or downstream system disturbances. Packaged as an ROV-retrievable device with onboard diagnostics and self-flushing capabilities, the PULSE LF CIMV enables full inhibition without the risk of under- or overdosing. Over the life of a field, accurate flow measurement and control of LDI injection could reduce operational expenditure by tens of millions of dollars.

## About the author

David Simpson is the subsea flow control product champion for Valves and Measurement, Cameron, a Schlumberger company; he assumed this position in 2017. With more than 20 years' experience, he has worked offshore in product design as principal subsea choke design engineer, as a technical account manager, and in product management. He launched the initial Cameron low-flow CIMV technology in 2007 and the third-generation medium- and high-flow designs in 2010. Simpson is a chartered engineer with an honors degree in mechanical engineering from the Dublin Institute of Technology.

## How it works

The microbore ultrasonic flowmeter used in the PULSE LF CIMV and the large-bore ultrasonic flowmeter used in the PULSE MF and HF CIMVs are line-of-sight meters with an ultrasonic transducer at either end of the metering path (Figure 4).

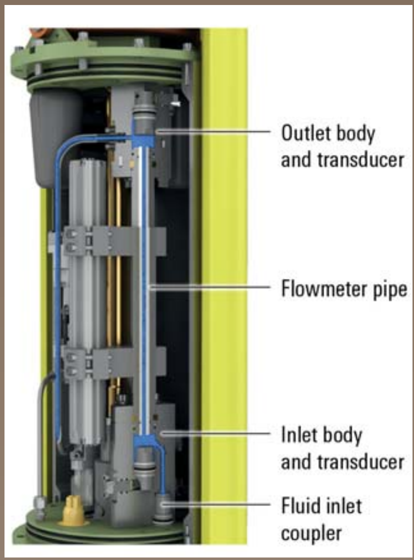


*Figure 4: Chemical flow path through ultrasonic flowmeter. (Image: Schlumberger)*

An ultrasonic pulse is transmitted through the fluid from either transducer with and against the flow direction. The difference in time of flight of the sound pulses in either direction (ΔT) is accurately measured by the onboard ultrasonic control module (UCM). From that ΔT measurement, flow rate of the chemical passing through the flowmeter is calculated. The flowmeter is combined with an electrically actuated throttling valve in closed-loop control. Flow rate monitoring and valve actuation via the onboard closed-loop control algorithm, along with external communications, are managed by the electronic control module (ECM) that streams back operational performance data to the operator via the master control station. Real-time feedback from the flowmeter is used to autonomously control the throttling valve, maintaining a user-defined injection rate set point indefinitely regardless of up- or downstream system disturbances.

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