Intelligent Hydrate Management

Hydrates have been a thorn in the side of oil and gas production since before they were first discovered in gas transmission lines as early as 1934.

Since that discovery by E.G. Hammerschmidt, they have been both a topic of scientific inquiry and source of industrial frustration. However, our understanding of hydrate formation and prevention has increased over time, which has led us to develop thermodynamic inhibitors for use upstream. These inhibitors serve as freeze-point depressants, much in the same way that salt or antifreeze are used in winter. In fact, antifreeze is one of the primary inhibitors in use offshore today, and is more often known as monoethylene glycol, or MEG.

The industry has a very good understanding of how MEG inhibits hydrate formation and of the quantities of MEG required to inhibit hydrates at common field temperatures and pressures. However, the industry is also under tremendous pressure to avoid and or mitigate risks, including those associated with hydrates, where possible. Uncertainties in measurement and dosage control, for example, can persuade an operator to use more MEG than is necessary, even more than twice the amount specified at a project’s onset. The impact of increasing the amount of MEG by 100% is seen in the increased CAPEX of distribution facilities (e.g., chemical lines, subsea distribution units) and topsides processing (e.g., reclamation), and increased OPEX of MEG replacement (e.g., disposal, replenishment), utilities used for recovery (e.g., power and disposal), and staff to run processing. This can mean higher costs over the life of the field.

Avoiding risks associated with hydrates can be done without overspending. A different approach to hydrate prevention using MEG can yield the same results with a large reduction in life-of-field cost. OneSubsea® has developed a hydrate management system that accomplishes this by combining industry-proven monitoring, metering, dosing and MEG regeneration technologies that work as a single unit to achieve target inhibition with MEG while preventing unnecessary overdoses.

Traditional Hydrate Inhibition with MEG

A typical MEG system begins its life at the concept select stage. Chemical inhibition, even at very large volumes, is a more proven and cost-effective strategy than its alternatives. Traditional MEG systems comprise various components. The size of the system is affected early in the field development process when the subsurface team determines the water production profiles over the life of the field. Often the water production profile with the greatest potential – or the worst-case scenario – is selected for the initial sizing of the MEG system. The next contributions to the MEG system size come from subsea hardware selections. Chemical injection valves are commonly unmetered and prone to uncertainties from discharge pressure differentials. There is also the absence of accurate water production rates attributable to each well. The most common water production measurement is from separator volumes, distributed to each well via differential well tests performed at interval or via test line to a test separator. The accumulated uncertainty suggests that each well needs to be inhibited to its greatest possible (worst-case scenario) water production profile, which leads to further increasing...
the MEG system size. The last hardware component of a traditional MEG system is the reclamation process installed at arrival facilities. At this point, the design engineer has propagated the uncertainties and added their factor of safety to yield the need for a reclamation facility that might be too big for the field’s actual needs. All of this uncertainty propagates the uncertainties and the fear of hydrate risks lead to the creation of a system that may be more than double the capacity first prescribed.

An oversized system can increase costs both as upfront CAPEX and, perhaps more significantly, as life-of-field OPEX. A topside reclamation system that is larger than necessary requires a larger footprint, weighs more and can consume excessive energy for heating and cooling. It could require more personnel to operate and maintain. Injection valves without metering or proper control can foul over time from poor MEG reclamation and go unnoticed until a more catastrophic failure results. Likewise, without accurate metering of production fluids, increased water cut at a particular well can go unnoticed and uninhibited for a long time, also leading to a catastrophic failure. Even if all equipment were accurate and properly sized, the traditional hydrate management philosophy involves annual updates to detailed study work that explores a set of probable field conditions under expected field operations. Studies of this magnitude can cost upwards of a whole man-year in labour just to update. These are the OPEX costs that the hydrate management system targets for reduction through management of the hydrate inhibition process and, if involved early in the development stage, CAPEX costs have the potential to be reduced as well.

OneSubsea Hydrate Management System

The hydrate management system comprises industry-leading metering, on the production stream and chemical injection lines, as well as the most efficient MEG reclamation facility. It combines these with real-time process simulation, and condition and performance monitoring into an operational system that permits the control of hydrate prevention in a closed loop, open loop, or any blend in between. The system targets a reduction in uncertainties to reduce the overall cost of complete hydrate avoidance.

The hydrate management system starts topsides with the Cameron PureMEG® reclamation and regeneration process. Cameron’s PureMEG technology can reduce salt and solids by up to 100%, protecting the most expensive and vulnerable components of a MEG system. The salt is separated from the brine rather than the MEG, significantly reducing the MEG losses and provides a waste stream suitable for marine disposal. Ultimately, PureMEG technology provides best-in-class MEG recovery and at some of the lowest operational costs in the industry.

To regulate and accurately dose the MEG upstream, the hydrate management system uses Cameron’s chemical injection metering valves (CIMVs). These valves use an ultrasonic flow meter that provides an accuracy of within 3% of the reading to directly measure the chemical injection flow rate. Ultrasonic flow measurement is noninvasive; they are low dp devices and they can be sized to handle flow rates ranging from as low as 0.5 litre per hour in the Low Flow CIMV to over 26,500 litres per hour (approximately 700 tonnes per day of MEG) each in High Flow CIMVs. Efficient MEG distribution through these CIMVs enables the system to target higher water-producing wells, effectively extending the production life of the field.

Measurement of water for the determination of MEG dosage comes from OneSubsea’s suite of metering equipment developed with Schlumberger. The OneSubsea PhaseWatcher Subsea Multiphase and Wet Gas Flow Meter with Vx Technology can accurately capture production flow rates, as well as water fractions with 0.2% accuracy. Adding conductivity probes can bring down the detectable rate of water to below 100 ppm, permitting the determination of accurate water flow rates for even the most dry gas wells.

In addition to improving the hardware for the total MEG system, the hydrate management system adds value with “soft” components. The first of these is Schlumberger’s OLGA Dynamic Multiphase Flow Simulator2. The OLGA simulator presents key internal flowline variables in real time between points of measurement. It can reveal process conditions as if the pipe were transparent throughout. It also can be used for forecasting and to provide what-if scenarios from current conditions yielding live estimates of cool-down times, no-touch times, and other relevant information for hydrate management. Alarms can be configured to notify control room operators of potential operational issues before they occur.

The second soft component is the OneSubsea FRIEND® Remote Surveillance and Diagnostic System, a real-time condition and performance monitoring service. The FRIEND system has been used to monitor subsea equipment, and has led to the adoption of predictive maintenance as an operational alternative to run-to-failure. The FRIEND system displays process information on a web-based graphical user interface (GUI). At its core, it is a sophisticated library of functions and knowledge built over many years of experience that manifest as a suite of detailed warnings and alarms. When applied to the hydrate management system, it becomes both an interface where recommendations and warnings regarding hydrate inhibition, inhibitor flow rate set points, and MEG system variables are issued, as well as a platform hosting the OLGA simulator engine. Thus, the FRIEND system recommends MEG set points based on process conditions throughout the production system (not only where measurements are made) by tying together measurements from PureMEG technology, CIMVs, meters, and the calculations of the OLGA simulator, into a single system for simple deployment. It does so by continuously running the OLGA simulator with only minimal upkeep. What was the one man-year hydrate management strategy project has now become the one day-per-month upkeep project.

Lower Cost Hydrate Inhibition

As part of the hydrate management system, all of these components reduce the operational uncertainty inherent in traditional MEG inhibition systems. This reduction is then made into a tighter control scheme that reduces the amount of MEG used, the MEG lost to process and recovery, and lowers the energy and labour costs of running and maintaining systems. Inhibitor needs are determined through various system measurements combined with live process simulation. Recommendations for operational set points are made through the FRIEND system. The actual amount of inhibitor is distributed with confidence to where it is needed and full inhibition can be achieved without significant overdosing. In addition, selecting and implementing the hydrate management system early in field development enables modifications to processing equipment that will further reduce the total cost of hydrate inhibition, potentially making the otherwise uneconomical field profitable.

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1. PureMEG is a trademark of Cameron International
2. OLGA Dynamic Multiphase Flow Simulator is a trademark of Schlumberger, Ltd.