Global Oilfield Solutions

Low dosage hydrate inhibitors for the Oilfield Industry: Luvicap®

BASF
We create chemistry

The formation of natural gas hydrates can be a serious issue in oil and gas production. Hydrates are crystalline, ice-like solids that form when small gas molecules, such as methane, ethane, and propane are trapped in cages of water molecules under high-pressure and low temperature conditions. These conditions are often encountered in offshore operations, such as subsea flowlines and in onshore applications under cold-weather conditions in northern regions.

Gas hydrates can form in various parts of the production system. Hydrates have been found in downhole tubing, wellhead trees, manifolds, jumpers, flow lines, pipelines, separators or any location that is under pressure, contains water and is subjected to cold environments.

The problems associated with the formation of gas hydrates can include:

- Plugging of flow lines
- Reduction of gas throughput
- Increased pressure differences across the system
- Damage to downstream equipment by hydrate debris

General information

Product	Description	Form	Active content	pH value
Luvicap® EG	Polyvinylcaprolactam (VCap) in ethylene glycol	Liquid	41%	7
Luvicap® 55W	Vinylpyrrolidone (VP)/Vinylcaprolactam (Vcap) 1:1 copolymer	Liquid	50%	8

Function guide

Recently, a new group of non-thermodynamic chemical inhibitors has been developed. These chemicals are very different from the traditional thermodynamic inhibitors (e.g., methanol (MeOH) and monoethylene glycol (MEG)) because they do not shift the thermodynamic hydrate equilibrium conditions towards lower temperatures and higher pressures. Instead, these inhibitors interfere with the process of hydrate formation. Since the effective dosages of this new type of chemical inhibitors are much lower than those required for thermodynamic inhibitors, the inhibitors are usually classified as “low dosage hydrate inhibitors” (LDHI). The effective concentration for LDHI typically ranges from 500 ppm to 3% of the total amount of water being treated thereby reducing the overall costs as well the storage and handling hazards associated with thermodynamic inhibitors. The two types of LDHI are kinetic hydrate inhibitors (KHI) and anti-agglomerates (AA).

Kinetic Hydrate Inhibitors (KHI)

Some LDHI effectively interfere with the nucleation and crystallization of hydrate molecules, thus extending the time required to form hydrates (known as induction time). These products are called kinetic hydrate inhibitors (KHI) and are mainly polymer-based materials in aqueous or glycol based solvent systems. The induction time is a function of the subcooling, which defines to what extent the actual temperature is below the hydrate formation temperature. It has been experienced in the field that the Luvicap® technology can effectively protect systems up to 8–10 °C subcooling for at least 24 hours. In some systems where the subcooling is lower the Luvicap® technology can give protection of 1 week or longer.

Anti-Agglomerants (AA)

LDHI can also modify hydrate particles by adsorbing on or incorporating into the hydrate crystals. These chemicals have at least one long hydrocarbon chain to prevent the agglomeration of hydrate particles so that they stay dispersed as a slurry. For this reason, these chemicals are referred to as anti-agglomerants (AA).

			Cloud point [°C]			Application	
Flash point	Relative MW	CEFAS registered	Fresh brine	10% NaCl	Subcooling [deg C]	KHI	AA
> 61 °C	Ultra-Low		40	25	8–10	✓	
> 61 °C	Ultra-Low		80	55	8–10	✓	

Cover picture: SEM (Scanning Electron Microscopy) image of hydrate crystals in false color representation.

Monitoring

Monitoring of the inhibitor performance is crucial to the success of any LDHI (KHI or AA) program. The effectiveness of hydrate inhibitors usually depends on the analysis of indirect indicators since hydrate formation can not be determined in situ. These indicators are almost the same as the indicators for traditional thermodynamic inhibition programs (e.g., MeOH and MEG).

- One indicator is to ensure that LDHI is delivered and distributed evenly throughout the system. The operator can look for the break-through of LDHI at the end of a flow line or at the separator.
- Increased pressure drop across the pipeline is a good indicator of hydrate formation. The increase in pressure drop can result from a partial blockage and / or increased viscosity due to hydrate slurry. If KHI is used for hydrate control, a pressure drop across the pipeline should not be observed.
- The effectiveness of KHI can also be monitored by observing any sudden drop or gradual decrease in water production rate. The loss of water may indicate the consumption of water caused by hydrate formation.

Luvicap® EG case studies*

Case study #1 offshore

Challenges

A hydrate plugging issue in a subsea flow line was being experienced. This well is located approximately ten miles (16 km) from the processing production facility. Everyday operations were shut in so that the flow line could be depressurized for hydrate removal. The incumbent hydrate inhibitor was deployed at 80 quarts (76 liter) per day (60,000 ppm or 6%). It was suggested that the incumbent hydrate inhibitor, most likely a blend of alcohols and glycols (i.e., a thermodynamic hydrate inhibitor) was being vaporized into the gas phase due to its high volatility. This, as well as partitioning into the oil phase, prevented the inhibitor from strongly entering the water phase where it was most needed, a common observation in high gas rate, low fluid rate wells. Only after saturation of the gas phase, excess alcohol and glycol can partition into the water phase for hydrate inhibition.

SOLUTION

Based on the limited success of the incumbent product, the local service company recommended that injection of a new hydrate inhibitor based on Luvicap® EG was required. The new Luvicap® EG based hydrate inhibitor injection was started at the existing location upstream of the choke, at an initial injection rate of 2% based on water production, i.e. 25 quarts (24 liter) per day. The effectiveness of the hydrate control strategy was even more impressive than anticipated. Under the previous treating regime, the flow line suffered almost daily incidences of hydrate formation, resulting in total field shut down and requiring the flow line pressure to be bled down. As the field is essentially unmanned, this would require daily trips to the field by operator personnel, with the associated helicopter transportation costs. When Luvicap® EG based hydrate inhibitor was introduced to the field, these incidences were completely eliminated.

RECOMMENDATIONS

Luvicap® EG hydrate inhibitor should be applied on a continuous basis into the flowing gas, upstream of the hydrate forming region. It can be applied at 0.5% to 3% based on water production, some 10–20 times less volume than for example methanol or other typical thermodynamic hydrate inhibitor.

* Data provided by external partner

Case study #2 offshore

CHALLENGES

A local service company was requested to help operations due to level control issues in a high pressure separator. After examination of the system, it appeared that the displacers on the separator were malfunctioning. The local service company assisted operations in removal of the displacers and found hydrates coated around the displacers. This not only caused problems with the movement of the displacers, but as the hydrates melted, it created a foam on top of the condensate which affected the way the HP separator functions.

RESULTS

The local service provider formulated and recommended a hydrate inhibitor containing Luvicap® EG for field trial. With the new Luvicap® EG based formulation, it was possible to reduce the chemical consumption from approximately 50 gallons/day (189 liters/day) – incumbent thermodynamic inhibitor methanol – to 2 gallons/day (7.6 liters/day) and to successfully mitigate the hydrate problem in the separator.

Case study #3 onshore

CHALLENGES

A local services company performed a field survey at an onshore well. The aim was to prevent freezing on the flow line and separator function issues related to freezing. A review of the incumbent methanol treatment (methanol was being pumped at 3 locations at a total of 50 gallons/day (189 liters/day)) showed it was underperforming. The service company recommended a Luvicap® EG hydrate inhibitor suggesting that it would perform better at reduced costs.

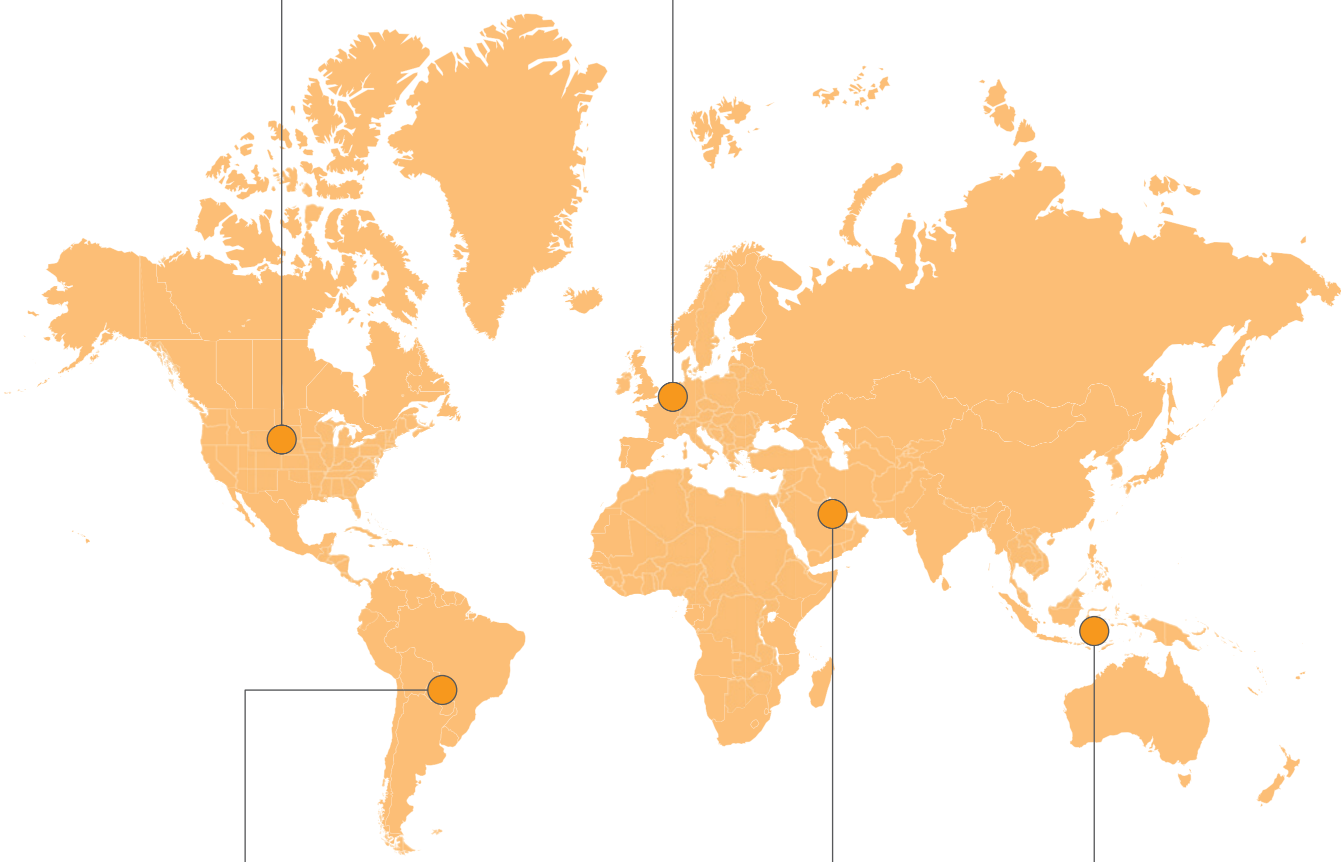
RESULTS

The local service company initially recommended to treat with Luvicap® EG at 10 gallons/day (37.9 liters/day). Field testing showed that the product performed better than expected requiring only 5 gallons/day (19 liters/day). With this the Luvicap® EG based hydrate inhibitor not only performed better than methanol, but also achieved significant costs savings.

Luvicap® products are proven technologies worldwide

Successful application to either replace or reduce methanol onshore and offshore, helping to improve operating efficiency.

First application of KHI (Luvicap® technology) for gas and oil system with a subcooling of 8–10 °C, which reduced CAPEX for new developments.



Successful replacement for methanol onshore and offshore, which allowed for greater control and flexibility for hydrate inhibition.

Successful application in a sour gas system with a subcooling of 8–10 °C, which reduced CAPEX for new developments.

Successful application in drilling fluids as a replacement for mono-ethylene glycol allowing for greater control and flexibility in hydrate inhibition.

North America – Global Headquarters

BASF Corporation
Global Oilfield Solutions
3120 Hayes Road
Suite 200
Houston, TX 77082
US
Phone: +1 800 7941019
Fax: +1 877 2451806

Europe

BASF SE
Global Oilfield Solutions
G-EVG/GM – J542 S
67056 Ludwigshafen
Germany
Phone: +49 621 60-0

Asia

BASF South East Asia Pte. Ltd.
Global Oilfield Solutions
33 Tuas Avenue 11,
Singapore 639090
Singapore
Phone: +65 6860 7051

South America

BASF S.A.
Global Oilfield Solutions
Avenida das Nações Unidas,
14.171 Morumbi
04794-000 São Paulo
Brazil
Phone: +55 11 2039-3482
Fax: +55 11 2039-2786

Middle East / North Africa

BASF Middle East LLC
Global Oilfield Solutions
P. O. Box 2996
Dubai
United Arab Emirates
Phone: +971 4 8072222
Fax: +971 4 8072149

For further information:
oilfieldsolutions@basf.com
www.oilfield-solutions.basf.com

EVG1449e

BASF
We create chemistry