Hydrate Control

Kinetic gas hydrate inhibitors, highly efficient methanol and glycols replacement

Kinetic Hydrate Control

Gas transmission lines and newly drilled wells are particularly vulnerable to plugging by hydrate ice deposits. Gas hydrates form when water molecules organize around guest molecules. In connection with natural gas operations, the most common of these are light hydrocarbons, nitrogen, hydrogen sulfide and carbon dioxide. Gas hydrates may form in any situation where compressed gas contacts water.

Traditional hydrate control treatments involve the introduction of methanol or glycols, so-called thermodynamic hydrate inhibitors (THIs), into the system. These solvents shift the thermodynamic equilibrium of hydrate formation toward higher pressures and lower temperatures, permitting unimpeded water and gas flows under conditions that would otherwise be conducive to hydrate formation. However, high volumes of solvent, between 20 and 50% of the water phase, are required, which reduces pipeline capacity, increase worker exposure and incur costs associated with removal by the receiver.

Custom Hydrate Protection

Huntsman can simulate hydrate formation for any gas mixture and field condition to provide customized hydrate protection plans. We offer amine-based JEFF-FLOW and polymer-based JEFF-FLOW H. Each product may be applied alone, in combination, or together with SURFONIC H inhibitors may also be formulated with SURFONIC® CHX series corrosion inhibitors to provide superior corrosion protection.

• INCREASED PIPELINE CAPACITY
• REDUCED CHEMICAL COSTS
• IMPROVED CORROSION CONTROL
• REDUCED WORKER EXPOSURE

About Huntsman

Huntsman Corporation is a publicly traded global manufacturer and marketer of differentiated chemicals with 2016 revenues of approximately $10 billion. Our chemical products number in the thousands and are sold worldwide to manufacturers serving a broad and diverse range of consumer and industrial end markets. We operate more than 100 manufacturing and R&D facilities in approximately 30 countries and employ approximately 15,000 associates within our 5 distinct business divisions: advanced materials, architectural systems, industrial specialties, surface technologies, and titanium solutions. Each product may be applied alone, in combination, or together with proper shipping, handling, and storage procedures, require special precautions in handling. For all products described herein should conduct a sufficient prior description or sample, and any user of products described herein acknowledges that any use of such product, whether used singly or in combination, is at his or her own risk and assumes all risk and liability whatsoever resulting from the use of such product, whether used singly or in combination, for its intended use and assumes all risk and liability whatsoever resulting from the use of such product, whether used singly or in combination.

Disclaimer

Huntsman makes no warranty or guarantee of any kind, express or implied, including but not limited to, the information presented in this document is believed to be reliable and to represent the best available data on these products, to provide formulations that enhance people’s lives.

Huntsman Performance Products

Performance Products brings together innovation and world-leading process technologies to produce more than 2,000 components used in consumer and industrial end markets such as unsaturated polyester resins, food, oil additives, pharmaceuticals, composites, coatings, fuel and lube additives, and gas treating.

Contact a Huntsman sales representative to customize your KHI protection plan.

www.huntsman.com/performance_products
Kinetic Hydrate Control

Gas transmission lines and newly drilled wells are particularly vulnerable to plugging by hydrate ice deposits. Gas hydrates form when water molecules organize around gas molecules. In connection with natural gas operations, the most common of these are light hydrocarbons, nitrogen, hydrogen sulfide, and carbon dioxide. Gas hydrate may form in any situation where compressed gas contacts water.

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Custom Hydrate Protection

Huntsman can simulate hydrate formation for any gas mixture and fluid condition to provide customized protection plans. We offer amine-based JEFF-FLOW® Hy 286 kinetic hydrate inhibitors, polymeric-based JEFF-FLOW® Hy 281 kinetic hydrate inhibitors, JEFF-FLOW® Hy 288 kinetic hydrate inhibitors, JEFF-FLOW® Hy 301 kinetic hydrate inhibitors, JEFF-FLOW® Hy 401 kinetic hydrate inhibitors, JEFF-FLOW® Hy 404 kinetic hydrate inhibitors, and JEFF-FLOW® Hy 407 kinetic hydrate inhibitors. Each product may be applied alone, in combination of up to 4 additives, or with JEFF-FLOW® Hy 301, JEFF-FLOW® Hy 401, or JEFF-FLOW® Hy 404. The use of these additives will allow you to formulate products that enhance people’s lives. Additionally, Huntsman’s technology and manufacturing practices are designed to ensure consistent product quality and reliability.

About Huntsman

Huntsman Corporation is a publicly traded global manufacturer and marketer of differentiated chemicals with 2016 revenues of approximately $9 billion. Our chemical products number in the thousands and are sold worldwide to manufacturers serving a broad and diverse range of consumer and industrial and markets. We operate more than 150 manufacturing and R&D facilities in approximately 35 countries and employ approximately 15,000 associates within our 5 distinct business divisions including the Polyurethanes, Electronics and Advanced Materials division that we intend to spin-off as Venator Materials Corporation. For more information about Huntsman, please visit the company’s website at www.huntsman.com.

Huntsman Performance Products

Huntsman Performance Products brings together innovation and world-leading process technologies to produce more than 2,000 components used in the leading global producer and supplier into a wide range of consumer and industrial end markets. We operate more than 100 manufacturing and R&D facilities in approximately 35 countries and employ approximately 15,000 associates within our 5 distinct business divisions. We offer amine-based JEFF-FLOW® Hy 286 kinetic hydrate inhibitors, polymeric-based JEFF-FLOW® Hy 281 kinetic hydrate inhibitors, JEFF-FLOW® Hy 288 kinetic hydrate inhibitors, JEFF-FLOW® Hy 301 kinetic hydrate inhibitors, JEFF-FLOW® Hy 401 kinetic hydrate inhibitors, JEFF-FLOW® Hy 404 kinetic hydrate inhibitors, and JEFF-FLOW® Hy 407 kinetic hydrate inhibitors. Each product may be applied alone, in combination of up to 4 additives, or with JEFF-FLOW® Hy 301, JEFF-FLOW® Hy 401, or JEFF-FLOW® Hy 404. The use of these additives will allow you to formulate products that enhance people’s lives. Additionally, Huntsman’s technology and manufacturing practices are designed to ensure consistent product quality and reliability.

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www.huntsman.com/Performance_products
Product Usage and Performance

Solutions of JEFF-FL ow® H inhibitors should be injected at the same level as methanol or other THIs until the system is saturated, typically 1-2 days. Thereafter, injection rates may be systematically reduced until pressure fluctuations indicate initial hydrate formation, at which point injection rates should be increased until pressure fluctuations cease. The new rate will typically be 90 to 80% lower than that used previously. The inhibitor solution should be injected upstream of the hydrate formation point using an atomizer nozzle to ensure even distribution. JEFF-FL ow® H technology has been proven in relatively small, new gas wells having high bottom hole pressure. In such wells, decompressing gas could rapidly reach production rates as a result of the Joule-Thompson effect, often dropping gas temperatures to below freezing at the wellhead.

FIGURE 1: Induction times for varying dosages of neat JEFF-FL ow® H 281 inhibitor.

Induction times (Fig. 1) and maximum protection times (Fig. 4), presented for different sub-cooling temperatures. In addition to the benefits of partial or total replacement of traditional THIs, hydrates form more slowly in the presence of JEFF-FL ow® H inhibitors, providing the operator with time to respond before failure occurs. Treatment with JEFF-FL ow® H inhibitors will also dissolve existing hydrate deposits.

Induction times (Fig. 3) and maximum protection times (Fig. 4), the latter measured as the time to reach 5% conversion, are also presented for JEFF-FL ow® H 286 inhibitor. The figures below are intended to provide end-users with general dosage requirements for different sub-cooling cooling requirements.

Hydrate Inhibitors?

Is your gas field ready for Kinetic Hydrate Inhibitors?

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Treatment Alternatives

Consult the following solubility table for guidance if you are seeking an alternative to methanol or glycol as a carrier solvent. Application of Huntsman’s JEFF-FL ow® H 281 and H 286 inhibitors at 4-20% solutions in methanol is recommended. For systems already being treated with methanol or glycol, JEFF-FL ow® H 281 or 286 solutions may be injected using existing equipment and storage tanks. Additional equipment and/or modification of existing equipment is not necessary.

<table>
<thead>
<tr>
<th>Solvent</th>
<th>JEFF-FL ow® H 281</th>
<th>JEFF-FL ow® H 286</th>
</tr>
</thead>
<tbody>
<tr>
<td>methanol</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>glycol</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>diesel fuel</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>mineral oil</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>aromatic 150</td>
<td>5%</td>
<td>10%</td>
</tr>
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Contact Huntsman to customize a KHI protection plan.

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</tr>
<tr>
<td>aromatic 150</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Note: 'S' = soluble, 'NS' = not soluble. If inhibitor is not soluble at a particular temperature below 25˚C, the lowest temperature for which it is soluble is indicated by a superscript representing the temperature in °C. e.g. 'S' = soluble at 25˚C, 5˚C, 0˚C, -5˚C, -10˚C, -15˚C, -20˚C.

1. 'S' = soluble, 'NS' = not soluble. 2. Inhibitor not suitable at sub-zero temperature inside ISO. 3. Treatment temperature for all solutions is limited by equipment materials of construction (e.g., 80˚C, 450°F, 35°C for stainless steel hardware). 4. For a list of recommended solvents and their compatibility with JEFF-FL ow® H inhibitors, please contact Huntsman Support. 5. Equipment and/or modification of existing equipment is not necessary. 6. Openpressurized vessel only.
Sub-Cooling Temperature (˚C)

10.0 10.5 11.0 11.5 12.0

FIGURE 1: Induction times for varying dosages of neat JEFF-FLOW® H 281 Inhibitor.

Time (h)

0 6 12 18 24 30 36 42 48

Approximate 25°C hydrate induction times (h), measured as the time to reach 0.5% conversion, were measured as a function of sub-cooling temperature (∆T) in the presence of Green Canyon gas mixture and DI water at 550 psig. Results are presented for different dosages of JEFF-FLOW® H 281 inhibitor (Fig. 1) and as a 10 wt.% solution in methanol (Fig. 2).

In addition to the benefits of partial or total replacement of methanol or glycol, JEFF-FLOW® H inhibitors will also dissolve existing hydrate deposits. The figures below are intended to provide end-users with general dosage requirements for different sub-cooling temperatures.

Induction times (Fig. 3) and maximum protection times (Fig. 4), the latter measured as the time to reach 5% conversion, are also presented for JEFF-FLOW® H 281 inhibitor. The figures below are intended to provide end-users with general dosage requirements for different sub-cooling temperatures.

In addition to the benefits of partial or total replacement of traditional THIs, hydrates form more slowly in the presence of JEFF-FLOW® H inhibitors, providing the operator with extra time to respond before failure occurs. "Treatment with JEFF-FLOW® H inhibitors will also dissolve existing hydrate deposits."

Is your gas field ready for Kinetic Hydrate Inhibitors?

Contact Huntsman to customize a KHI protection plan.
**Product Usage and Performance**

Solutions of JEFF-FLOW® H inhibitors should be injected at the same level as methane or other H inhibitors until the system is saturated, typically 1-2 days. Thereafter, injection rates may be systematically reduced until pressure fluctuations indicate initial hydrate formation, at which point injection rates should be increased until pressure fluctuations cease. The new rate will typically be 10 to 50% lower than that used previously.

Sub-cooling solutions should be injected upstream of the hydrate formation point using an atomizer nozzle to ensure even distribution. JEFF-FLOW® quantities should be increased until pressure fluctuations cease. The new rate will typically be 50 to 80% lower than that used previously. The inhibitor solution should be injected immediately after the hydrate formation point using an atomizer nozzle to ensure even distribution. JEFF-FLOW® H technology has been proved in relatively shallow, new gas wells having high bottom-hole pressure. In such wells, decompressing gas cools rapidly in production strings as a result of the Joule-Thompson effect, often dropping gas temperatures to below freezing at the wellhead. Pressing gas cools rapidly in production strings as a result of the Joule-Thompson effect, often dropping gas temperatures to below freezing at the wellhead. Induction times for varying dosages of neat JEFF-FLOW® H inhibitors in laboratory tests for an 10% solution in methanol are shown below (Fig. 1) and as a 10 wt. % solution in methanol (Fig. 2). Approximate 50% induction times (s), measured as the time to reach 0.5% conversion, were measured as a function of sub-cooling temperature (°F) in the presence of Green Canyon gas mixture and DI water at 500 psig. Results are presented for different dosages of JEFF-FLOW® H 281 inhibitor read (Fig. 1) and as a 10 wt. % solution in methanol (Fig. 2). Induction times (Fig. 3) and maximum protection times (Fig. 4), the latter measured as the time to reach 5% conversion, are also presented for JEFF-FLOW® H 286 inhibitor. The figures below are intended to provide end-users with general dosage requirements for different sub-cooling temperatures.

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**Treatment Alternatives**

Consult the following solubility table for guidance if you are seeking an alternative to methanol or glycol as a carrier solvent. Application of Huntsman’s JEFF-FLOW® H 281 and H 286 inhibitors at 4 to 20% solutions in methanol is recommended. For systems already being treated with methanol or glycol, JEFF-FLOW® H 281 or H 286 solutions may be injected using existing equipment and storage tanks. Additional equipment and/or modification of existing equipment is not necessary.

**Is your gas field ready for kinetic hydrate inhibitors?**

Contact Huntsman to customize a KHI protection plan.
JEFF-FLOW® H Gas Hydrate Inhibitors

Kinetic gas hydrate inhibitors, highly efficient methanol and glycol replacement

Kinetic Hydrate Control

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Traditional hydrate control treatments involve the introduction of methanol or glycols, so-called Thermodynamic Hydrate Inhibitors (THIs), into the system. These solvents shift the thermodynamic equilibrium of hydrate formation toward higher pressures and lower temperatures, permitting unimpeded water and gas flow under conditions that would otherwise be conducive to hydrate formation. However, high volumes of solvent, between 20 and 50% of the water phase, are required, which reduce pipeline capacity, increase worker exposure and incur costs associated with removal by the receiver.

Custom Hydrate Protection

Huntsman can simulate hydrate formation for any gas mixture and field condition to provide customised hydrate protection plans. We offer amine-based JEFF-FLOW® H and polymer-based JEFF-FLOW® H 286 kinetic hydrate inhibitors. JEFF-FLOW® H inhibits, at a partial to total replacement of traditional THIs. Each product may be applied alone, in combination, or together with THIs, greatly reducing the latter volume otherwise be conducive to hydrate formation. However, high volumes of solvent, between 20 and 50% of the water phase, are required, which reduce pipeline capacity, increase worker exposure and incur costs associated with removal by the receiver.

Huntsman Performance Products

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