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Huntsman Performance Products
Global Technology

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Huntsman Performance Products (Huntsman) is a leading global producer of intermediate chemistries and technologies that add value to customers worldwide. Huntsman products are used in a variety of applications throughout the oil production industry — from production chemicals, such as corrosion inhibitors, demulsifiers and paraffin dispersants; to drilling additives; cementing super plasticizers and repair systems for cementing failures.

With growing concerns about energy security, Huntsman’s chemistries are helping to optimize exploration and production of hydrocarbons. Huntsman offers an outstanding range of specialized technologies, world-scale manufacturing, a global distribution network and in-depth understanding of the oil industry’s regulatory compliance issues, through the Company’s Regulatory and Environmental Health & Safety (EH&S) departments.

Huntsman’s global manufacturing footprint and experience also allows the Company to provide customized products manufactured under a non-disclosure agreement.

By taking a holistic, full process approach from product concept through to commercial large-scale production, the Company is well-placed to deliver proven and sustainable oilfield solutions.
# Huntsman Chemistry Overview

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<td>Maleic Anhydride</td>
<td>Maleic Anhydride</td>
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<td>Polymeric</td>
<td>Naphthalene Sulfonates</td>
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Drilling

Huntsman offers a range of specialty chemicals designed specifically for drilling applications:

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<tr>
<td>Wetting Agents</td>
<td>Ethoxylates</td>
<td>SURFONIC® N Series</td>
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**Components**

- **JEFFSOL® Propylene Carbonate Solvent (PC)**
  Clay is often added to drilling muds for viscosity and dispersion control. Use of JEFFSOL® propylene carbonate solvent to activate hydrophobized clay greatly improves the effectiveness and ease of use of clay in such formulations. Typically, the propylene carbonate is added to the system after the clay has been added to the oil, but it is also possible to mix the propylene carbonate with the clay to form a premix prior to addition to the oil phase. (US Patent Application 20060148654 and US Patent 4,425,244).

Propylene carbonate is also an effective catalyst for the “water glass reaction,” where metal silicates are precipitated in a well bore to offer a durable shield against water-reactive shale when drilling with water-based muds. (US Patent 7,137,459).
SURFONIC® OFS 500 polyol is a cloud point glycol system useful for lubrication and as a shale anti-swelling agent for water-based drilling muds used in formations with reactive shales. The product functions as a partial potassium chloride (KCl) replacement in drilling formulations. It is possible to tune the performance of the SURFONIC® OFS 500 to the temperature and KCl salt concentration of the mud system. The product is registered on chemical inventories in many regions of the world. A separate bulletin further describing the use and benefits of SURFONIC® OFS 500 polyol is available upon request.

SURFONIC® OFS 300 additive is a high molecular weight polyglycol. It can also be used in water-based muds to build viscosity and to protect water-sensitive shale.

SURFONIC® MW-100 is an optimized emulsifier for vegetable oils. It can be used to formulate emulsion muds or as a cleaner to remove a vegetable oil-based mud from casing prior to cementing.

SURFONIC® OFE 243 and OFE 244 are polymeric surfactant emulsifiers for oil-based muds with an internal phase with electrolytes.

The SURFONIC® N Series nonylphenol ethoxylates and L Series alcohol ethoxylates are used in many applications, including as wetting agents and emulsifiers for paraffin dispersants, as emulsifiers in drilling muds and as primary surfactants for formulating microemulsions of d-limonene for cleaners.

NANSA® EVM Series surfactants, which are calcium salts of dodecylbenzene sulfonic acid (DDBSA), are often used in the formulation of emulsion muds.

XTF 951 is a polyglycerol drilling fluid additive for invert drilling applications. It can be used as the internal phase of a non-aqueous mud to minimize the shale swelling caused by a water internal phase. The product is also useful in lubricating the drilling mud to reduce “fretting.” XTF 951, which is water-soluble and considered to be of low toxicity, can act as a shale inhibitor in water-based muds as well.

**Components, continued.**

The reaction products of one of Huntsman’s ethylenamines — diethylenetriamine (DETA), triethylenetetramine (TETA), tetraethylenepentamine (TEPA) or Ethylenamine E 100, — with tall oil fatty acid and maleic anhydride or citric acid are widely used as emulsifiers for making invert (water-in-oil) emulsion muds. (US patent 4,663,076).
Huntsman offers a range of specialty chemicals for cementing applications.

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<thead>
<tr>
<th>Application</th>
<th>Chemistry</th>
<th>Huntsman Products</th>
</tr>
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<tbody>
<tr>
<td>Cement Flow Enhancers</td>
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<td>DEHSCOFIX® 108, 158</td>
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<tr>
<td>Curing Agents</td>
<td>Polyetheramines</td>
<td>JEFFAMINE® D, T Series</td>
</tr>
<tr>
<td>Dispersant</td>
<td>Polyetheramines</td>
<td>JEFFAMINE® M Series</td>
</tr>
<tr>
<td>Well Bore Cleanup</td>
<td>Extended chain surfactants, formulated detergents</td>
<td>SURFONIC® OFE 201, SURFONIC® VBS-D10</td>
</tr>
</tbody>
</table>

- **DEHSCOFIX® 108** dispersant and similar dispersant products in the DEHSCOFIX® naphthalene sulfonate formaldehyde condensate product line are effective water-reducing, cement flow-enhancing additives for the management of flow in a cementing operation.

- Epoxy formulations based on DGEBA resins and **JEFFAMINE®** curing agents are effective remedial cementing systems for correcting faults in a cementing job. Solvent-free, water-dispersible systems can be created by pre-reacting (or modifying) an epoxy resin with a mono-functional polyetheramine, such as JEFFAMINE® M 1000 or M 2070 amine, to form an epoxy adduct capable of emulsifying/dispersing the bulk of the epoxy resin.

- Primary epoxy curing agents such as JEFFAMINE® D 230, D 400 and T 403 polyetheramines, can then be mixed with the modified resin to create a slow-set epoxy formulation. (US Patent 5,049,411 and US Patent Application 20060234871).

- The ultra-low IFT provided by SURFONIC® OFE 201 allows well bore cleanup in high-brine completion fluids.

**DEHSCOFIX® family of NSF cementing additives**
Huntsman offers a range of specialty chemicals for production applications.

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<th>Application</th>
<th>Chemistry</th>
<th>Huntsman Products</th>
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<tbody>
<tr>
<td><strong>Corrosion Inhibitors — Water Soluble</strong></td>
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<td>EMPIGEN® BAC, AS Series, TERIC® N Series, SURFONIC® N Series</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Defoamers</strong></td>
<td>Polyols, Fatty Alcohol Ethoxylates</td>
<td>SURFONIC® POA-17R2, SURFONIC® LF Series</td>
</tr>
<tr>
<td><strong>Demulsifiers</strong></td>
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<td>SURFONIC® OFD Series, JEFFAMINE® Series, JEFFOX® WL Series</td>
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<tr>
<td><strong>Cleaners/Degreasers</strong></td>
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<td>SURFONIC® OFE 321, OFE 201, SURFONIC® VBS Series</td>
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<tr>
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<tr>
<td><strong>Paraffin and Asphaltene Control</strong></td>
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<td><strong>Water Clarifiers</strong></td>
<td>Polyamines, Polymers, Polysaccharides</td>
<td>SURFONIC® OFD 300, SURFONIC® NB Series, SURFONIC® PC Series, JEFFAMINE® M 1000, ECOTERIC® 7500</td>
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</table>
Huntsman’s ethylenamines, particularly aminoethylethanolamine (AEEA), diethylenetriamine (DETA) and triethylenetetramine (TETA), can be reacted with fatty acids to form imidazolines, which are used as corrosion inhibitors in oilfield applications.

Amidoamines made from tetraethylenpentamine (TEPA) and Ethyleneamine E 100 reacted with fatty acids are also popular corrosion inhibitors. These amidoamines can be further reacted with acrylic acid or maleic anhydride to form emulsifiers for drilling muds and corrosion inhibitors.

XTA 892 and SURFONIC® EDA-4/80 products are ethoxylated ethyleneamines that can be reacted with fatty acid anhydrides or mixed with acidic phosphate esters to form corrosion inhibitors for water- and oil-based systems. (US Patents 5,582,792; 5,391,636 and 3,514,251).

Methoxypropylamine (MOPA) provides for vapor phase or “top of line” corrosion protection.

Ethanolamines DEA and MDEA can be used for acid neutralization.

Amine C6 and Amine C8 are fairly strong amines, which are valuable for increasing alkalinity in corrosion inhibitor formulations. The amides are formed when reacted with fatty acids or phosphate esters. They also have some surfactant properties.

Phosphate esters derived from ethoxylated alcohols or alkylphenols can be formulated into corrosion inhibitors for high water-cut systems in the oilfield. (US Patents 5,611,992 and 3,510,436). SURFONIC® PE-1198LA and PE-2852 surfactants are products for consideration in this application. Amine C6 or Amine C8 can be used to neutralize the phosphate esters, giving some alkalinity and buffering to the formulation.

Alkoxylated fatty amines, like SURFONIC® T-2 surfactant, can be used to prevent corrosion and to thicken hydrochloric acid (HCl) in acidizing formulations. Generally, propargyl alcohol is used in combination with the surfactant for complete anti-corrosion protection.

Ethanolamine TEA can be used to make phosphates.
Effective scale inhibitors can be produced by reacting polyphosphoric acid with SURFONIC® EDA-4/80 ethoxylate or XTA 892. The resulting materials are effective in preventing calcium carbonate (CaCO₃), calcium sulfate (CaSO₄) and barium sulfate (BaSO₄) scale.

Amine C9 is another amine that can be used as a reactant to form this class of chemical. (US Patents 4,155,869 and 3,477,956). After reaction, the phosphates of the hydroxyamines are often formulated with isopropanol and acetic acid.

SURFONIC® PE-2852 phosphate ester can be used without further reaction as a scale inhibitor.

JEFF-FLOW® P 359, P 961, P 962, P 963, P 964 and P 965 polymers are pour point depressants for waxy crude oil. They work by modifying the crystal structure of paraffin in produced fluids.

In hot oiling applications, SURFONIC® N Series nonylphenol ethoxylates and NANSA® SSA alkylbenzene sulfonic acid are used to help penetrate and dissolve the wax during treatment.

Other paraffin dispersants can be formulated from solvent mixtures and surfactants. One example is a mix of Stoddard solvent with SURFONIC® L24-2 and L24-9 surfactants.

JEFF-FLOW® A 2524 surfactant is an oil-soluble asphaltene dispersant capable of both preventing precipitation of asphaltenes and redispersing previously settled agglomerations.

NANSA® SMA 118, SMA 122 and SMA 158 alkylaryl sulfonates, with side chains of intermediate length, are able to keep asphaltenes dispersed in crude oil and oil emulsions.

Amidoamines derived from Huntsman’s JEFF-FLOW® A 100 and A 300 and tall oil fatty acid (TOFA) have also been used as asphaltene dispersants, especially in systems where water is present.
The Huntsman demulsifier base can be grouped into four families:

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**Huntsman’s** oilfield demulsifiers are effective components of demulsifier formulations. These materials should be formulated with other materials based on bottle field tests to create effective demulsifier formulations.

- **Anionic**: These products are resistant to over-treating. They offer solids wetting capability and can help destabilize emulsions containing fine particles. They do not drop water as quickly as other classes of demulsifiers.

- **Polyol**: The polyol demulsifiers are effective emulsion breakers and are available in a wide range of relative solubility number (RSN) values. Although high RSN value polyols may cause water clarity issues, such issues can normally be corrected with combinations of low RSN alkylphenol resin alkoxylates.

The polyol demulsifiers can give good emulsion breaking, but often need other materials to complete the separation of the water. SURFONIC® OFD 101 demulsifier is a diol, while SURFONIC® OFD 328 and OFD 335 demulsifiers are triols. SURFONIC® OFD 328 and 335 demulsifiers have found wide range applicability in Eastern European crudes.

- **Oxyalkylated Polyamine**: The oxyalkylated polyamine demulsifiers exhibit good emulsion-breaking characteristics. In most cases, they tend to be slow water-coalescing agents though, in some cases, water drop can be rapid. Some products in this class are good overall demulsifiers for heavy oils and oil sands production. In some crude oils, these materials have a water-shedding capability.

- **Polyetheramine**: The etheramines are used in treatment of microemulsions produced in enhanced oil recovery (EOR) activities. These hydrophobic amines interact with the EOR formulation components and shift the hydrophilic-lipophilic balance (HLB) of the system, destroying the microemulsion, which releases the oil and water into separate phases. The treatment rate and product selection must be done carefully to prevent undesirable conditions, such as oil dispersed in water.
Huntsman Performance Products - Energy SBU

Alternate energy - Lithium-ion batteries
Alternate energy - Solar
Alternate energy - Wind
Enhanced oil recovery
Gas treating
Oilfield chemicals

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Mastering Molecular Science for Future Energy Solutions

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