Products for Oilfield Applications
Delivering proven and sustainable oilfield solutions
Huntsman Performance Products
Global Technology

<table>
<thead>
<tr>
<th>USA</th>
<th>SOUTH AMERICA</th>
<th>EUROPE</th>
<th>APAC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional Office</strong></td>
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- **USA**
  - Regional Office: The Woodlands (Texas)
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  - Manufacturing Location:
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    - Dayton (Texas)
    - Freeport (Texas)
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    - Petfurdo (Hungary)

- **APAC**
  - Regional Office: Singapore (Singapore)
  - Research and Development Site: Brooklyn (Australia)
  - Manufacturing Location:
    - Ankleshwar (India)
    - Botany (Australia)
    - Jurong (Singapore)
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; 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, Environmental, and Health & Safety (EH&S) departments.

Huntsman’s global manufacturing footprint and experience also allows us to provide customized products.

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

<table>
<thead>
<tr>
<th>Generic</th>
<th>Chemistry</th>
<th>Huntsman Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amines</strong></td>
<td>Alkanolamines</td>
<td>MEA, DEA, TEA, DMEA, MDEA, MMEA, AEEA, DGA™ Agent</td>
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<tr>
<td></td>
<td>Morpholines</td>
<td>Morpholine, N-methylmorpholine, N-ethylmorpholine, N-methylmorpholine Oxide</td>
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<td>Substituted Propylamines</td>
<td>DMAPA, MOPA, APM</td>
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<td>Ethyleneamines</td>
<td>EDA, DETA, TETA, TEPA, AEP, Ethyleneamine E100</td>
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<td></td>
<td>Polyoxyalkyleneamines</td>
<td>JEFFAMINE® Amines</td>
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<tr>
<td><strong>Carbonates</strong></td>
<td>Ethylene Carbonate</td>
<td>JEFFSOL® EC</td>
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<tr>
<td></td>
<td>Propylene Carbonate</td>
<td>JEFFSOL® PC</td>
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<td></td>
<td>Butylene Carbonate</td>
<td>JEFFSOL® BC</td>
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<tr>
<td></td>
<td>Glycerine Carbonate</td>
<td>JEFFSOL® GC</td>
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<td><strong>Glycols</strong></td>
<td></td>
<td>MEG, DEG, TEG</td>
</tr>
<tr>
<td><strong>Maleic Anhydride</strong></td>
<td>Maleic Anhydride</td>
<td>Maleic Anhydride</td>
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<tr>
<td><strong>Surfactants</strong></td>
<td>Anionic</td>
<td>Alkylphenol Ether Sulfates, Alkylphenol Ether Phosphates, Anionic Blends, Alkyl Sulfates, Alkyl Ether Carboxylic Acids and Salts, Alkyl Ether Sulfates, Sulfosuccinates, Alkyl Phosphates, Alkylbenzene Sulfonic Acids and Salts</td>
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<td></td>
<td>Cationic</td>
<td>Alkyl Dimethylamines, Quaternized Amine Ethoxylates, Quaternary Ammonium Compounds</td>
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<td>Nonionic</td>
<td>Alkyl Polysaccharides, Alkylamine Ethoxylates, Amine Oxides, Block Copolymers, Alkoxylates, Alkanolamides</td>
</tr>
<tr>
<td></td>
<td>Polymeric</td>
<td>Polycarboxylates</td>
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Drilling

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).

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).

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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 optimized emulsifier is 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 polymeric surfactant emulsifiers are 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.

SURFONIC® OFS 124-128 clay control agents are blends of amines with primary and secondary functionality for use in water-external drilling muds, hydraulic fracturing and other stimulation fluids where shale and other water-sensitive formations are present.

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.

The reaction products of one of Huntsman’s ethylenamines — diethylenetriamine (DETA), triethylenetetramine (TETA), tetraethylenepentamine (TEPA) or Ethyleneamine 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).
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 surfactant allows well bore cleanup in high-brine completion fluids.

### Huntsman Products

<table>
<thead>
<tr>
<th>Application</th>
<th>Chemistry</th>
<th>Huntsman Products</th>
</tr>
</thead>
<tbody>
<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>

### Chemical Structures

- **Linear Alkyl**: \( -O\left(CH_2=\text{C}-O\right)_x\left(CH_2-\text{CH}_2-O\right)_y\text{SO}_3\Theta^+ \)
- **SURFONIC® OFE 201**
Huntsman offers a range of specialty chemicals for production applications.

### Production Chemicals

<table>
<thead>
<tr>
<th>Application</th>
<th>Chemistry</th>
<th>Huntsman Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaners/Degreasers</td>
<td>Alkylether Methyl Blends, Sulfonates, Linear Alkylbenzene Sulfonic Acid</td>
<td>SURFONIC® OFE 321, OFE 201, SURFONIC® VBS Series</td>
</tr>
<tr>
<td>Corrosion Inhibitors —</td>
<td>Quaternary Ammonium Compounds, Nonylphenol Ethoxylates</td>
<td>TERIC® N Series, SURFONIC® N Series</td>
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<tr>
<td>Water Soluble</td>
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<tr>
<td>Corrosion Inhibitors</td>
<td>Amine Intermediates, Amine Blends, Imidazoline, Phosphate Esters, Alkoxylated Fatty Amines, Quaternary Ammonium Compounds</td>
<td>Amine Derivatives, SURFONIC® EDA-4/80, SURFONIC® OFC 100, SURFONIC® PE Series, SURFONIC® T Series, EMPIGEN® BAC Series</td>
</tr>
<tr>
<td>Defoamers</td>
<td>Polyols, Fatty Alcohol Ethoxylates</td>
<td>SURFONIC® POA-17R2, SURFONIC® LF Series</td>
</tr>
<tr>
<td>Demulsifiers</td>
<td>Polyetheramines, Polyols, Polymines</td>
<td>SURFONIC® OFD Series, JEFFAMINE® Series, JEFFOX® WL Series</td>
</tr>
<tr>
<td>Foamers</td>
<td>Proprietary Amphoteric Blends</td>
<td>SURFONIC® OFW 144, 146 AND 148</td>
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<tr>
<td>Hydrate Inhibitors</td>
<td>MEG, Quaternary Amines, Amine Blends Polymeric</td>
<td>JEFF-FLOW® H Series</td>
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<tr>
<td>Paraffin and Asphaltenene</td>
<td>Maleic-based Polymers, Ethoxylates, Alkylbenzene Sulfonates, Sulfonates</td>
<td>JEFF-FLOW® P Series, JEFF-FLOW® A Series, SURFONIC® L Series, SURFONIC® OFE 201</td>
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<tr>
<td>Control</td>
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<tr>
<td>Scale Inhibitors</td>
<td>Phosphate Esters, Polyetheramines, Amine Phosphates</td>
<td>SURFONIC® PE Series, SURFONIC® EDA-4/80, SURFONIC® OFI Series</td>
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<tr>
<td>Specialized Solvents</td>
<td>Propylene Carbonate, Alcohol Ethoxylates, Glycol-based Solvents</td>
<td>JEFFSOL® PC, SURFONIC® L Series</td>
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<tr>
<td>Sulfur Scavengers</td>
<td>Triazines</td>
<td>SURFONIC® OFD 300, SURFONIC® NB Series, SURFONIC® PC Series, JEFFAMINE® M 1000, ECOTERIC™ 7500</td>
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<tr>
<td>Water Clarifiers</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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Huntsman’s ethyleneamines, particularly aminoethylethanolamine (AEEA), diethylenetriamine (DETA) and triethylenetetramine (TETA), can be reacted with fatty acids to form imidazolines. SURFONIC® OFC 100 and 200 are 1:1 DETA:TOFA and AEEA:TOFA imidazolines, respectively. More water-soluble imidazoline derivatives may be prepared via ethoxylation. SURFONIC® OFC 105 and 130 are 10- and 20-mole ethoxylates of SURFONIC® OFC 100, respectively.

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 5,822,792; 5,391,636 and 3,514,251).

Methoxypropylamine (MOPA) and Morpholine provide 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 amines 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.

\[
\text{H}_2\text{N-CH}_2\text{-CH}_2\text{-N-CH}_2\text{-CH}_2\text{-NH}_2 + R\text{-COOH} \rightarrow \text{imidazoline derived from oleic acid and Huntsman’s DETA}
\]

\[
\text{H}_2\text{N-CH}_2\text{-CH}_2\text{-N-CH}_2\text{-CH}_2\text{-OH} + R\text{-COOH} \rightarrow \text{imidazoline derived from oleic acid and Huntsman’s AEEA}
\]

\[
R = \text{C}_{17}, \text{unsaturated}
\]
Production Chemicals

SCALE INHIBITOR

- **XTA 892** and **SURFONIC® EDA-4/80** products ethoxylated ethyleneamines can be reacted with fatty acid anhydrides or mixed with acidic phosphate esters to form corrosion inhibitors for water- and oil-based systems.

- **SURFONIC® OFI 230S** and **232S** polyaminomethylene phosphonates can be used in scale inhibiting.

- **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.

Production Chemicals

PARAFFIN AND ASPHALTENE CONTROL

- **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 **XOF-30A** 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.

- **XOF-23A** and **XOF-25A** 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:

### Anionic
- SURFONIC® OFD 750
- XOF-22A

### Polyol
- SURFONIC® OFD 101
- SURFONIC® OFD 328
- SURFONIC® OFD 335
- SURFONIC® POA-17R2
- JEFFOX® WL 660
- JEFFOX® WL 5000

### Oxyalkylated Polyamine
- SURFONIC® OFD 150
- SURFONIC® OFD 300
- SURFONIC® OFD 301
- SURFONIC® OFD 302
- SURFONIC® OFD 360

### Polyetheramine
- JEFFAMINE® D 400
- JEFFAMINE® ED 900
- JEFFAMINE® ED 2003
- JEFFAMINE® M 2070
- JEFFAMINE® T 403
- JEFFAMINE® T 3000

**Huntsman**'s oilfield demulsifiers are effective components of demulsifier formulations. These materials should be formulated with other materials based on 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.
About Huntsman

Huntsman Corporation is a publicly traded global manufacturer and marketer of differentiated and specialty chemicals with 2017 revenues of approximately $8 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 75 manufacturing, R&D and operations facilities in approximately 30 countries and employ approximately 10,000 associates within our four distinct business divisions. For more information about Huntsman, please visit the company’s website at www.huntsman.com.

Huntsman Performance Products

Performance Products brings together innovation and world-leading process technologies to produce more than 2,000 components used to formulate products that enhance people’s lives:

- **Amines**: One of the largest global producers of specialty amines used in composites, coatings, fuel and lube additives, and gas treating
- **Maleic Anhydride**: A leading global producer and supplier into areas such as unsaturated polyester resins, food, oil additives and coatings
- **Surfactants**: Integrated producer of a wide range of products for home and personal care, oilfield, agriculture, and process industries
- **Ethylene and Derivatives**: Highly integrated manufacturer of ethylene, ethylene oxide, ethylene glycol and other derivatives

The division has 14 manufacturing plants and had 2017 revenues of USD 2.1 billion.

Contact a Huntsman sales representative for more information.

www.huntsman.com/pp