Corrosion inhibitors for Oilfield applications
Unleash the full potential of your corrosion inhibitor formulations

Nouryon has a long history of supplying the Oil- and Gas Industry with efficient and reliable corrosion inhibitor bases for multiple uses. With our wide portfolio of surfactants and polymers, deep organic and surface chemistry knowledge, sustainability focus, regulatory expertise and global footprint, we can help you all the way from the design of your formulation to the final use of your product.

Our offering includes a range of base inhibitors (Armohib CI series), the heart of the formulation, as well as a number of versatile co-inhibitors and/or co-surfactants. Most of these are based on amine chemistry, but also e.g. phosphate ester based enhancers are available. Some of the co-inhibitors may also be used as primary inhibitors for special cases outside the upstream oilfield area, like in high-temperature environments such as refineries or boilers/condensers in Water Treatment systems. In addition, we provide formulation aids and wetting agents, ideal to resolve compatibility challenges or top-up the integrity or performance of your formulations. More over, we supply highly efficient proprietary blends for HCl- or organic acid inhibition.

This brochure features a deep-dive into some of our Armohib CI products as well as an overview table showing our offering in the area. A selection guide is provided below, as well as some formulation examples and selected performance data.

Want to know more? Ask us!

Selection guide

Armohib® CI-219
highest standard imidazoline corrosion inhibitor

Imidazoline chemistry is the basis for one of the dominating types of film-forming organic corrosion inhibitors for oil- and gas installations globally. With Armohib CI-219, Nouryon offers a superior quality Tall Oil Fatty Acid (TOFA) imidazoline.

Features
- High imidazoline contents, >70%
- Flexible solubility profile for different purposes by organic acid addition
- Easy to handle, clear liquid at room temperature, and with a pour point well below -15°C
- High film persistence independently proven by AFM measurements

Recommended uses
- For low- and middle range temperature oil-and gas recovery, treatment or transport scenarios
- Formulated as oil soluble, oil soluble-water dispersible or water soluble-oil dispersible depending on requirement of the specific application
- Formulation with enhancers such as Na-thiosulfate is possible and will boost performance versus sweet corrosion further

Armohib CI-209
Armohib CI-209 is a variant of CI-219 based on regionally sourced raw materials, can be applied the same way.

Storage and handling
Armohib CI-219 should always be homogenized before use, unless the entire quantity is used.

Typical properties
- Active content: 50%
- Charge characteristics: Amine - varying with pH
- Flash point: >125°C
- Viscosity: 5-50 mPa.s
- Pour point: >-10°C

Formulation and performance examples
Water based, high Fp, high neutralization
- Ingredient: Armohib CI-219
- Concentration: 24%
- BDG: 33%
- GAA: 17%
- Water: up to 50%

The pH (2% in water) of this water soluble/oil dispersible formulation will be around 5.0.

Sweat corrosion inhibition performance with Armohib CI-219 as single inhibitor in a two-phase system, no enhancer added
- Time (h): 0, 2, 4, 6, 8, 10
- Corrosion rate (mm/yr): 0.01
- Conditions: 60°C
- Partitioning oil to brine: 80% oil, 20% brine
- Oil (crude oil) to water (3% NaCl)
- Concentrations are indicated in weight percent
- GAA is Glacial Acetic Acid
- BDG is Butyl diglycol
- When reference is made to “water”, this refers to soft water
- Other water qualities may require formulation modifications

High imidazoline content, can be formulated to meet various harsh corrosion challenges

Selection guide

Imidazolines
- Armohib® CI-300
  - Extra high imidazoline contents, impairs handling
- Armohib® CI-209
  - Sweet CO2 corrosion
  - Medium-temperature Gas Cl
- Armohib® CI-411
  - Water soluble imidazoline
- Armohib® CI-5150
  - Extra high imidazoline
  - (<low boiling amine)
- Armohib CI-5174
- Armohib CI-209
- Armohib CI-31
- Armohib CI-3174
- Ethoquad O/25
- Ethoquad CI-25
- Ethoquad MCB
- Ethoduomeen T/22
- Ethoquad C/25

Amines and Quats
- Armohib C
  - Duomeen C, T, O
  - Ethoduomeen T/22
  - Arquad MCB
  - Arquad HTB-75

Secondary inhibitors / formulations aids
- Duomeen O
- Ethomeen T/15
- Ethomeen T/25
- Ethomeen T/313
- Ethomeen CI-513
- Ethomeen CI-513
- Ethomeen CI-303
- Ethomeen T/22
- Ethomeen T/25
- Ethomeen T/313
- Ethomeen CI-28
- Ethomeen CI-35

Blends
- Armohib® CI-209
  - Solvent based, for gas pipelines, etc

Water based formulation examples
- Ingredietnt: Armohib CI-219
- Concentration: 10%
- BDG: 10%
- GAA: 10%
- Water: 70%

Armohib CI-219 w/ 10 ppm active CI added
- Corrosion rate: 0.01
- Partitioning oil to brine: 80% oil, 20% brine
- Oil (crude oil) to water (3% NaCl)
- Concentrations are indicated in weight percent
- GAA is Glacial Acetic Acid
- BDG is Butyl diglycol
- When reference is made to “water”, this refers to soft water
- Other water qualities may require formulation modifications

Solvent based formulation examples
- Ingredient: Armohib CI-219
- Concentration: 10%
- BDG: 10%
- GAA: 10%
- Aliphatic solvent: up to 100%
- Aromatic solvent: up to 100%

For these types of systems, a soluble amine should ideally be mixed with a water dispersible film-forming amine.

Concentrations in the formulation examples are indicated in weight percent
- GAA is Glacial Acetic Acid
- BDG is Butyl diglycol
- When reference is made to “water”, this refers to soft water
- Other water qualities may require formulation modifications
**Armohib® CI-5150**

for exemplary corrosion control

With unique chemistry, Armohib CI-5150 meets today’s strictest environmental requirements and is extremely easy to use.

**Technology**

This novel corrosion inhibitor technology has been developed by Nouryon specifically for use in the oilfield. It is designed to maintain exemplary corrosion control, compared with industry standards, whilst having clearly improved ecotoxicity characteristics. This allows the material to be used in environmentally sensitive offshore marine locations.

The unique, patented film-forming alkyl polyamine-based chemistry displays multiple positive-charge functionality along the polymer chain providing several points of adhesion to the metal surface, giving great film integrity under various conditions. In addition, this chemistry results in first-class brine compatibility. Armohib CI-5150 demonstrates excellent oil to brine partitioning in discrete phase laboratory tests, currently involving data up to +80°C and above.

**Recommended uses**

- Sweet corrosion / pipeline applications
- Severe brine environments
- Corrosion control in environmentally sensitive oilfield production applications
- Topside or umbilical-fed production systems that require film-forming corrosion control
- Formulated in various organic systems or in aqueous systems for ease of use and/or minimized cost/ performance profile
- High flashpoint blends as well as methanol-based formulations for extremely cold conditions can be recommended

**Regulatory information**

Armohib CI-5150 is REACH and TSCA compliant. In addition, the product is approved for all parts of the North Sea as well as any other region applying OSPAR regulations. It is classified WGK4 in Germany (water hazard class).

**Storage and handling**

Armohib CI-5150 should always be homogenized before use, unless the entire quantity is used. Use in alkaline water-based formulations is not recommended.

**Features**

- Excellent sweet corrosion inhibiting properties when tested under standard conditions and against benchmark chemistries, 99.8% protection at 10 ppm dosage in a non-optimized formulation demonstrated
- Corrosion reduction of >99% at 10 ppm dosage demonstrated in RCE (30 Pa wall shear stress) tests, indicating stable performance also under high flow conditions (data obtained in 3% NaCl brine at +60°C)
- Optimized performance also for organic acid inhibition at elevated temperatures, e.g. >95% protection of carbon steel in 10% citric acid after 24h at +95°C
- Low order of ecotoxicity, making the product suitable for use in the most stringent regulatory environments
- Aquatoxicity 10-100 times lower than for common oilfield CI bases such as benzalkonium chlorides and imidazolines, no dangerous to the environment label
- Testing has shown CI-5150 is not skin irritating, sensitizing or mutagenic
- Easy to handle, being a clear liquid at room temperature
- In-house formulation studies have shown the active material to be extremely flexible when formulated, allowing the chemist to develop both aqueous and solvent-based corrosion inhibitor solutions, including with environmentally acceptable solvents

**Armohib® CI-5174**

a versatile corrosion inhibitor

Armohib CI-5174 is an innovative, polymeric amine for cutting edge formulations.

**Technology**

This novel corrosion inhibitor technology, developed by Nouryon specifically for use in the oilfield, has been designed to maintain exemplary corrosion control while offering versatile functionality and highest ease of handling, allowing the material to be used in a variety of formulation alternatives.

The film-forming alkyl polyamine-based chemistry results in multiple heteroatom functionality along the polymer chain, which is believed to enable several points of adhesion to the metal surface giving greater film integrity under various conditions. Feedback from the field indicates a maintained level of corrosion protection in spite of lower dosage levels and longer intervals between dosage compared to previously used chemistry.

Armohib CI-5174 demonstrates excellent oil to brine partitioning in discrete phase laboratory tests and distribution properties can easily be tuned by modifying the solubility profile, for example by adding acetic acid.

**Features**

- Excellent sweet corrosion inhibiting properties when tested under standard conditions and against benchmark chemistries, 99.4% protection at 10 ppm dosage in a non-optimized formulation demonstrated
- Compatible with base inhibitor synergists such as Na-thiosulfate
- Combined H₂S- and CO₂-corrosion inhibitor
- Protective film integrity also under high flow conditions demonstrated by RCE testing, where a 10 ppm active inhibitor dosage yielded 99% protection at 30 Pa wall shear stress (data obtained in 3% NaCl brine at +60°C)
- Easy to handle, being a clear liquid at room temperature and having a pour-point of ~12°C
- A significantly lower foam profile than e.g. alkyl benzylammonium chlorides and fatty acid imidazoline acetates

**Recommended uses**

- Sweet and sour corrosion / pipeline applications
- Topside or umbilical-fed production systems that require film-forming corrosion control
- Corrosion applications where turbulent fluid flow compromise film integrity leading to excess corrosion rates or and/or high dosage of standard active inhibitor
- Formulated in various organic solvents or in aqueous solutions for ease of use and optimized cost/ performance profile
- High flashpoint blends as well as methanol-based formulations for extremely cold conditions and/or umbilical application can be recommended

**Storage and handling**

Armohib CI-5174 should always be homogenized before use, unless the entire quantity is used. Use in alkaline water-based formulations is not recommended.
Corrosion inhibitors offering overview

<table>
<thead>
<tr>
<th>GENERAL CHARACTERISTICS</th>
<th>SOLUBILITY</th>
<th>FUNCTIONALITY &amp; USE</th>
<th>REGULATORY DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical form</td>
<td>Chemistry</td>
<td>Active</td>
<td>Pour point °C</td>
</tr>
<tr>
<td>Acid Corrosion Inhibitors</td>
<td>Armohib CI-23</td>
<td>Liquid</td>
<td>Proprietary surfactant blend</td>
</tr>
<tr>
<td></td>
<td>Armohib CI-33</td>
<td>Liquid</td>
<td>Proprietary surfactant blend</td>
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<tr>
<td></td>
<td>Armohib CI-41</td>
<td>Liquid</td>
<td>Polyamine + TIPA imidazole</td>
</tr>
<tr>
<td></td>
<td>Armohib CI-209*</td>
<td>Liquid</td>
<td>DETA + TIPA imidazole</td>
</tr>
<tr>
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<td>Armohib CI-219</td>
<td>Liquid</td>
<td>DETA + TIPA imidazole</td>
</tr>
<tr>
<td></td>
<td>Armohib CI-300</td>
<td>Liquid</td>
<td>TIPA + TIO imidazole</td>
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<tr>
<td></td>
<td>Armohib CI-5150</td>
<td>Liquid</td>
<td>Polymeric Ether Quat</td>
</tr>
<tr>
<td></td>
<td>Armohib CI-5124</td>
<td>Liquid</td>
<td>Polymeric Ether Amine</td>
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<tr>
<td></td>
<td>Armeen C</td>
<td>Liquid</td>
<td>Cocosalkylamine</td>
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<tr>
<td></td>
<td>Duomeen C</td>
<td>Paste</td>
<td>N-coco-1,3-diaminopropane</td>
</tr>
<tr>
<td></td>
<td>Duomeen T</td>
<td>Paste</td>
<td>N-tallow-1,3-diaminopropane</td>
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Ethoxylated Amines and Diamines

<table>
<thead>
<tr>
<th>Chemistry</th>
<th>Active</th>
<th>Pour point °C</th>
<th>Viscosity mPa•s @20°C</th>
<th>Flash point °C</th>
<th>pH</th>
<th>Foam mm³/min</th>
<th>Surface tension mN/m</th>
<th>Solubility</th>
<th>SEC inhibitor</th>
<th>Functionality</th>
<th>Regulatory Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethoquad CI-32</td>
<td>Liquid</td>
<td>Cocoalkylamine + 2 EO</td>
<td>100%</td>
<td>8</td>
<td>nd</td>
<td>193</td>
<td>-</td>
<td>-</td>
<td>D nd S nd S S D nd</td>
<td>Gen CI, formulaid Add to acid solution</td>
<td>Cleaning</td>
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<tr>
<td></td>
<td>Ethoquad CI-35</td>
<td>Liquid</td>
<td>Cocoalkylamine + 5 EO</td>
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<td>-5</td>
<td>150</td>
<td>&gt;100</td>
<td>9-11</td>
<td>100/70</td>
<td>30</td>
<td>S nd S nd S S S S</td>
</tr>
<tr>
<td></td>
<td>Ethoquad CI-25</td>
<td>Liquid</td>
<td>Cocoalkylamine + 15 EO</td>
<td>100%</td>
<td>-10</td>
<td>210</td>
<td>&gt;100</td>
<td>9-11</td>
<td>106/5</td>
<td>38</td>
<td>S S S S I I S</td>
</tr>
<tr>
<td></td>
<td>Ethoquad CI-12</td>
<td>Liquid</td>
<td>Cholalkylamine + 2 EO</td>
<td>100%</td>
<td>1</td>
<td>150</td>
<td>&gt;100</td>
<td>-</td>
<td>-</td>
<td>D nd</td>
<td>S nd S S S S S S S S</td>
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<tr>
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<td>Ethoquad CI-12</td>
<td>Paste</td>
<td>Tallowalkylamine + 2 EO</td>
<td>100%</td>
<td>32</td>
<td>340</td>
<td>&gt;100</td>
<td>-</td>
<td>-</td>
<td>D nd</td>
<td>S nd S nd S S S S</td>
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<td>Tallowalkylamine + 5 EO</td>
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<td>8</td>
<td>160</td>
<td>&gt;100</td>
<td>10</td>
<td>35/15</td>
<td>31</td>
<td>S nd S nd S S S S</td>
</tr>
<tr>
<td></td>
<td>Ethoquad CI-25</td>
<td>Liquid</td>
<td>Tallowalkylamine + 15 EO</td>
<td>100%</td>
<td>5</td>
<td>310</td>
<td>&gt;100</td>
<td>9-11</td>
<td>55/15</td>
<td>39</td>
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<td></td>
<td>Ethoquad CI-13</td>
<td>Liquid</td>
<td>Tallowalkylamine + 5 EO</td>
<td>100%</td>
<td>20</td>
<td>950</td>
<td>&gt;100</td>
<td>-</td>
<td>-</td>
<td>D S S S S S S S S</td>
<td>Gen CI, formulaid Add to acid solution</td>
</tr>
<tr>
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<td>Ethoquad CI-13</td>
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<td>Tallowalkylamine + 5 EO</td>
<td>100%</td>
<td>100</td>
<td>360</td>
<td>&gt;100</td>
<td>10</td>
<td>35/15</td>
<td>38</td>
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<td>360</td>
<td>&gt;100</td>
<td>10</td>
<td>35/15</td>
<td>38</td>
<td>S S S S I I I</td>
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<td>10</td>
<td>35/15</td>
<td>38</td>
<td>S S S S I I I</td>
</tr>
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Ethoxyated Quats

<table>
<thead>
<tr>
<th>Chemistry</th>
<th>Active</th>
<th>Pour point °C</th>
<th>Viscosity mPa•s @20°C</th>
<th>Flash point °C</th>
<th>pH</th>
<th>Foam mm³/min</th>
<th>Surface tension mN/m</th>
<th>Solubility</th>
<th>SEC inhibitor</th>
<th>Functionality</th>
<th>Regulatory Data</th>
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</thead>
<tbody>
<tr>
<td>Ethoquad CI-12</td>
<td>Liquid</td>
<td>Cocoalkyl methyl ammonium chloride + 15 EO</td>
<td>&gt;95%</td>
<td>15</td>
<td>1150 (b/p5)</td>
<td>127</td>
<td>6-8</td>
<td>nd</td>
<td>43</td>
<td>S S S S I D I</td>
<td>High temp / High brine Add intensifier</td>
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<td>Ethoquad CI-12</td>
<td>Liquid</td>
<td>Cocoalkyl methyl ammonium chloride + 2 EO</td>
<td>69% (in PG)</td>
<td>nd</td>
<td>104</td>
<td>6-8</td>
<td>nd</td>
<td>40</td>
<td>S S S S S S D D</td>
<td>High temp / High brine Add intensifier</td>
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Benzyl Quats

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<th>Flash point °C</th>
<th>pH</th>
<th>Foam mm³/min</th>
<th>Surface tension mN/m</th>
<th>Solubility</th>
<th>SEC inhibitor</th>
<th>Functionality</th>
<th>Regulatory Data</th>
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</thead>
<tbody>
<tr>
<td>Arquad MCB-50</td>
<td>Liquid</td>
<td>Cocobenzyl dimethylammonium chloride</td>
<td>50% (in water)</td>
<td>nd</td>
<td>130</td>
<td>&gt;60</td>
<td>6-9 (10%)</td>
<td>89/18</td>
<td>-</td>
<td>S nd S nd S nd</td>
<td>Sec inhibitor, formulaid Add to acid solution</td>
</tr>
<tr>
<td></td>
<td>Arquad HTB-75</td>
<td>Paste</td>
<td>Vegetable oil benzylmethylammonium chloride</td>
<td>75% (in IPA / water)</td>
<td>nd</td>
<td>65 (g/b)</td>
<td>31</td>
<td>6-9</td>
<td>-</td>
<td>nd nd nd nd nd nd</td>
<td>Sec inhibitor, formulaid Add to acid solution</td>
</tr>
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</table>

Phosphonate Esters

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<th>Flash point °C</th>
<th>pH</th>
<th>Foam mm³/min</th>
<th>Surface tension mN/m</th>
<th>Solubility</th>
<th>SEC inhibitor</th>
<th>Functionality</th>
<th>Regulatory Data</th>
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</thead>
<tbody>
<tr>
<td>Phospholn P65</td>
<td>Liquid</td>
<td>Alkyl Phosphite Ester, Free Acid</td>
<td>100%</td>
<td>12</td>
<td>1985</td>
<td>&gt;150</td>
<td>2-3</td>
<td>10/8</td>
<td>-</td>
<td>D S S S S S S</td>
<td>Inhibition booster Flexible for oil / water</td>
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Armoclean 4350

<table>
<thead>
<tr>
<th>Chemistry</th>
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<th>Viscosity mPa•s @20°C</th>
<th>Flash point °C</th>
<th>pH</th>
<th>Foam mm³/min</th>
<th>Surface tension mN/m</th>
<th>Solubility</th>
<th>SEC inhibitor</th>
<th>Functionality</th>
<th>Regulatory Data</th>
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</thead>
<tbody>
<tr>
<td>Armoclean 6000</td>
<td>Liquid</td>
<td>Alkyl glucoside</td>
<td>65% (in water)</td>
<td>nd</td>
<td>160 (g/b)</td>
<td>60</td>
<td>6-8</td>
<td>0/0</td>
<td>33</td>
<td>S nd</td>
<td>I nd l I nd</td>
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<tr>
<td></td>
<td>Armoclean 6040</td>
<td>Liquid</td>
<td>Alkyl glucoside</td>
<td>75% (in water)</td>
<td>-9</td>
<td>775</td>
<td>&gt;100</td>
<td>6-9</td>
<td>34</td>
<td>D nd</td>
<td>I nd l I nd</td>
</tr>
</tbody>
</table>

* regional Americas variant of CI-219

 formulations Excellent brine tolerance Yes Yes
We are a global specialty chemicals leader. Markets worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, energy, food, pharmaceuticals, and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability and innovation, we have established a world-class business and built strong partnerships with our customers.

We operate in over 80 countries around the world and our portfolio of industry-leading brands includes Armovis, Aromox, Armoclean, Armohib, Witbreak and Versa.

For more information visit surfacechemistry.nouryon.com

Contact us directly for detailed product information and sample request at oilfield@nouryon.com

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