



# Corrosion inhibitors for Oilfield applications

**Nouryon**

# Unleash the full potential of your corrosion inhibitor formulations

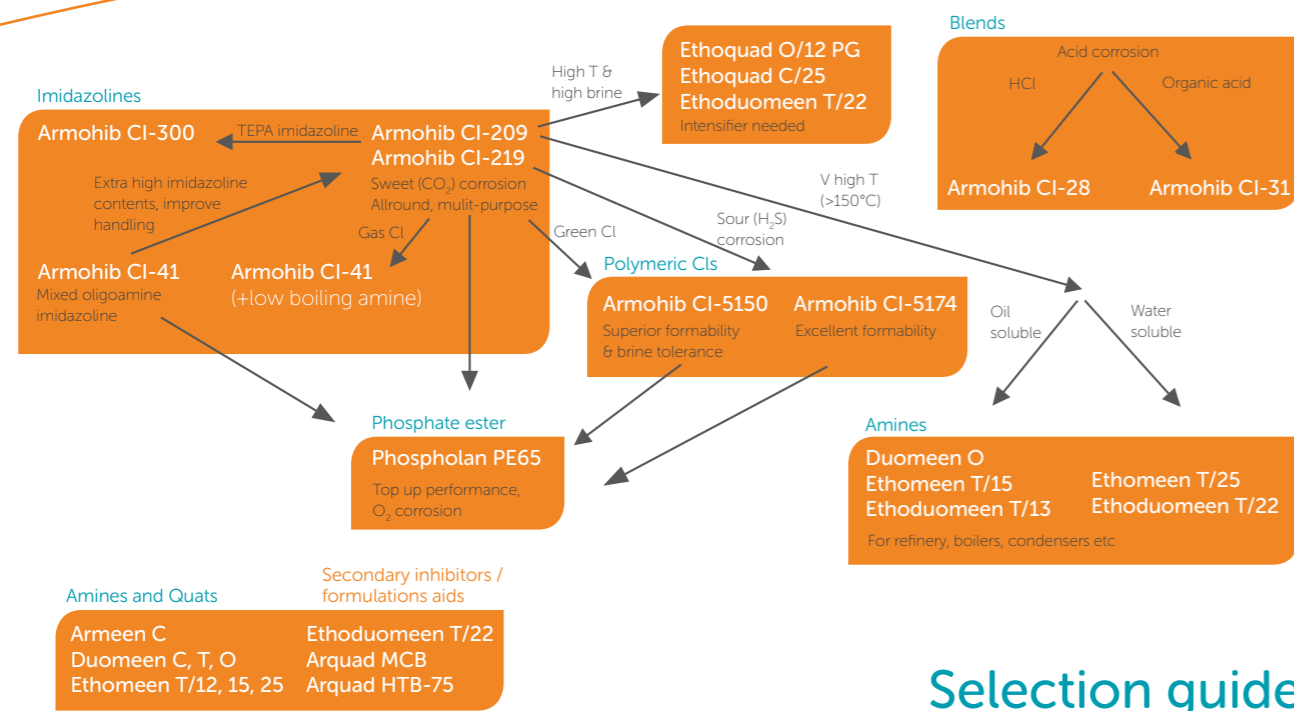
Nouryon has a long history of supplying the Oil- and Gas Industry with efficient and reliable corrosion inhibitor bases for multiple uses. With our wide portfolio of surfactants and polymers, deep organic and surface chemistry knowledge, sustainability focus, regulatory expertise and global footprint, 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 !



# 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.

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

### 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	100%
Charge Characteristics	Amine - varying with pH
Flash point	>125°C
Form	clear liquid
pH, in water/IPA	10.5-12.5
Pour point	<-15°C

## Formulation and performance examples

### Water based, high Fp, high neutralization

Ingredient	Concentration
Armohib CI-219	24%
GAA	10%
BDG	13%
Water	up to 100%

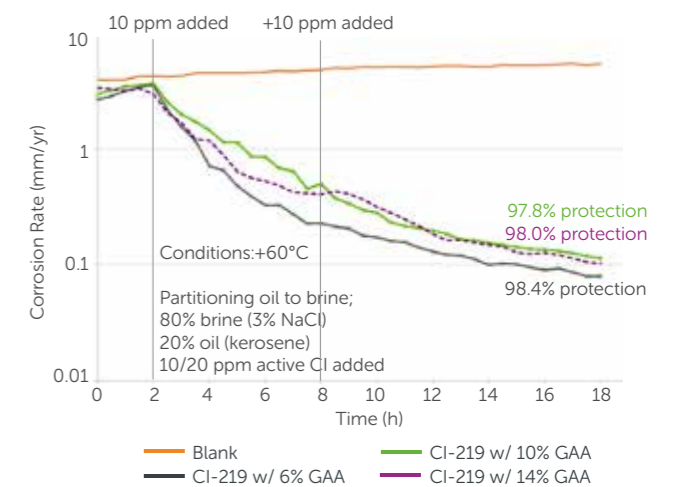
The pH (2% in water) of this water soluble/oil dispersible formulation will be around 5.0.

### Solvent based, for gas pipelines, etc

Ingredient	Concentration
Armohib CI-209	15%
Diethanol amine	15%
GAA	10%
Mutual solvent	35%
Aromatic solvent	up to 100%

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

### Sweet corrosion inhibition performance with Armohib CI-219 as single inhibitor in a two-phase system, no enhancer added



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.

OSPAR approved with superior formulability and brine tolerance

### 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 polyquaternary amine-based chemistry display 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 WGK1 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)
- Compatible with heavy brines as e.g. 26% NaCl, 20% NaCl at +70°C, >30% CaCl<sub>2</sub> and 50 000 ppm Ca/25 000 ppm Na brine at +80°C
- Promising performance also for organic acid inhibition at elevated temperature, 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
- Aquatic toxicity 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.

Proven to reduce total inhibitor dosage

### 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.

### 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.

### 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 H<sub>2</sub>S- and CO<sub>2</sub>-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 benzalkonium chlorides and fatty acid imidazoline acetates



# Corrosion inhibitors offering overview

	GENERAL CHARACTERISTICS										SOLUBILITY						FUNCTIONALITY & USE			REGULATORY DATA		
	Physical form (20°C)	Chemistry	Active content	Pour point °C	Viscosity mPas @20°C	Flash point °C	pH <sup>1)</sup>	Foam mm <sup>2)</sup> imm / 5 min	Surface tension <sup>3)</sup>	Water	Methanol	IPA	BDG	Alifatic solvent	Aromatic solvent	Diesel	Main uses	Formulability	Special properties	TSCA	REACH	OSPAR
																						apvd
<b>Acid Corrosion Inhibitors</b>																						
<b>Armohib CI-28</b>	Liquid	Proprietary surfactant blend	-	11	-	32	-	-	-	-	-	-	-	-	-	-	HCl corrosion inhibitor	Add to acid solution	-	No	No	-
<b>Armohib CI-31</b>	Liquid	Proprietary surfactant blend	-	0	-	>150	-	-	-	-	-	-	-	-	-	-	Organic acids inhibitor	Add to acid solution	-	Yes	No	-
<b>Imidazolines</b>																						
<b>Armohib CI-41</b>	Liquid	Polyamine + TOFA imidazoline	100%	<0	800	>218	-	-	-	D	S	S	S	S	S	S	Gen CI, pipeline, gas etc	Flexible for oil / water	-	Yes	Yes	-
<b>Armohib CI-209*</b>	Liquid	DETA + TOFA imidazoline	100%	<-15	200	>93	11 <sup>a</sup>	-	-	D	S	S	S	S	S	S	Gen CI, pipeline, etc	Flexible for oil / water	High imidazoline cont	Yes	-	-
<b>Armohib CI-219</b>	Liquid	DETA + TOFA imidazoline	100%	<-15	200	>125	10.5-12.5 <sup>b</sup>	-	-	D	S	S	S	S	S	S	Gen CI, pipeline, etc	Flexible for oil / water	High imidazoline cont	Yes	Yes	-
<b>Armohib CI-300</b>	Liquid	TEPA + TOFA imidazoline	100%	-7	430	>100	-	-	-	D	S	S	S	S	S	S	Gen CI, pipeline, gas etc	Flexible for oil / water	-	Yes	Yes	-
<b>Polymeric Corrosion Inhibitors</b>																						
<b>Armohib CI-5150</b>	Liquid	Polymeric Ester Quat	55% (in BDG)	-5	3500	90-94	3.3-4.1	115/102 <sup>d</sup>	31	S	S	D	S	S	S	S	Gen CI, regulated areas	Outstanding	Excellent brine tolerance	Yes	Yes	Yes
<b>Armohib CI-5174</b>	Liquid	Polymeric Ester Amine	100%	-12	1185	>200	7-8	25/0	-	S	S	S	S	I	S	I	Gen CI, sweet+sour corrosion	Flexible for oil / water	Good brine tolerance	No	Yes	-
<b>Amines and Diamines</b>																						
<b>Armeen C</b>	Liquid	Cocoalkylamine	100%	nd	4 (@60)	>100	-	-	-	P	nd	S	nd	S	S	nd	Sec inhibitor, formul aid	Often used as acid salt	-	Yes	Yes	-
<b>Duomeen C</b>	Liquid / Paste	N-coco-1,3-diaminopropane	100%	nd	4 (@60)	>130	-	-	-	P	nd	S	nd	D	S	nd	Sec inhibitor, formul aid	Often used as acid salt	Biocide for fracking (US)	Yes	Yes	-
<b>Duomeen O</b>	Paste	N-oleyl-1,3-diaminopropane	100%	nd	11 (@50)	>150	-	-	-	D	nd	S	nd	S	S	nd	Sec inhibitor, formul aid	-	HT stable for boiler, refinery	Yes	Yes	-
<b>Duomeen T</b>	Paste	N-tallow-1,3-diaminopropane	100%	nd	6 (@60)	>150	-	-	-	D	nd	S	nd	P	D	nd	Sec inhibitor, formul aid	-	HT stable	Yes	Yes	-
<b>Ethoxylated Amines and Diamines</b>																						
<b>Ethomeen C/12</b>	Liquid	Coco alkylamine + 2 EO	100%	8	nd	193	-	-	-	D	nd	S	nd	S	S	nd	Sec inhibitor, formul aid	-	Cleaning	Yes	Yes	-
<b>Ethomeen C/15</b>	Liquid	Coco alkylamine + 5 EO	100%	-5	150	>100	9-11	100/70	30	S	nd	S	nd	S	S	S	Sec inhibitor, formul aid	Water soluble	Cleaning	Yes	Yes	-
<b>Ethomeen C/25</b>	Liquid	Coco alkylamine + 15 EO	100%	<0	200	>100	9-11	110/5	38	S	S	S	S	I	I	I	Sec inhibitor, formul aid	Water soluble	Dispersion, Cleaning	Yes	Yes	-
<b>Ethomeen O/12</b>	Liquid	Oleyl alkylamine + 2 EO	100%	1	150	>100	-	-	-	D	S	S	S	S	S	S	Sec inhibitor, formul aid	Oil soluble, liquid	Acid cleaning	Yes	Yes	-
<b>Ethomeen T/12</b>	Paste	Tallow alkylamine + 2 EO	100%	32	34 (@50)	>100	-	-	-	D	nd	S	nd	S	S	S	Sec inhibitor, formul aid	Oil soluble	Acid cleaning	Yes	Yes	-
<b>Ethomeen T/15</b>	Liquid / Paste	Tallow alkylamine + 5 EO	100%	8	160	>100	10	35/35	31	S	nd	S	nd	S	S	S	Sec inhibitor, formul aid	-	HT stable	Yes	Yes	-
<b>Ethomeen T/25</b>	Liquid	Tallow alkylamine + 15 EO	100%	5	300	>100	9-11	55/15	39	S	S	S	S	I	I	I	Sec inhibitor, formul aid	Water soluble, liquid	HT stable; Cleaning	Yes	Yes	-
<b>Ethodoumeen T/13</b>	Liquid / Paste	Tallow alkyl diamine + 3 EO	100%	20	950	>100	-	-	-	D	S	S	S	S	S	S	Sec inhibitor, formul aid	Oil soluble	HT stable for boiler, refinery	Yes	Yes	-
<b>Ethoduomeen T/22</b>	Liquid	Tallow alkyl diamine + 12 EO	100%	-8	360	>100	-	100/35	38	S	S	S	S	I	I	I	Sec inhibitor, formul aid	Good brine tolerance	HT stable for boiler, refinery	Yes	Yes	-
<b>Ethoxylated Quats</b>																						
<b>Ethoquad C/12</b>	Liquid	Cocoalkyl methyl ammonium chloride + 15 EO	>95%	15	1150 (@25)	127	6-8	nd	43	S	S	S	S	I	D	I	High temp / High brine	Add intensifier	Good brine tolerance	Yes	Pend	-
<b>Ethoquad O/12 PG</b>	Liquid	Oleyl methyl ammonium chloride + 2 EO	69% (in PG)	nd	nd	104	6-8	nd	40	S	S	S	S	D	D	D	High temp / High brine	Add intensifier	Good brine tolerance	Yes	-	-
<b>Benzyl Quats</b>																						
<b>Arquad MCB-50</b>	Liquid	Cocobenzyl dimethyl ammonium chloride	50% (in water)	nd	130	>100	6-9 (10%)	89/18	-	S	nd	S	nd	nd	nd	nd	Sec inhibitor	Water soluble	-	Yes	Yes	-
<b>Arquad HTB-75</b>	Paste	Vegetable oil benzyl dimethyl ammonium chloride	75% (in IPA/water)	nd	65 (@60)	31	6-9 <sup>c</sup>	-	-	nd	nd	nd	nd	nd	nd	nd	Sec inhibitor	-	-	Yes	Yes	-
<b>Phosphate Esters</b>																						
<b>Phospholan PE65</b>	Liquid	Alkyl Phosphate Ester, Free Acid	100%	12	1985	>150	2-3	10/8	-	D	S	S	S	S	S	S	Inhibition booster	Flexible for oil / water	Oxygen corrosion inhibition	Yes	Yes	-
<b>Formulation aids and Wetting agent</b>																						
<b>Armoclean 4350</b>	Liquid	Alcohol alkoxyate	100%	-9	30	>100	7-9.5	5/0	27	D	S	S	S	S	S	S	Wetting agent	Broad	Cleaning	Yes	Yes	Yes
<b>Armoclean 6000</b>	Liquid	Alkyl glucoside	65% (in water)	nd	160 (@30)	>100	6-8	8/0	33	S	nd	I	nd	I	I	nd	Formul aid/hydrotrope	Water based formulations	Excellent brine tolerance	Yes	Yes	Yes
<b>Armoclean 6040</b>	Liquid	Alkyl glucoside	75% (in water)	-9	775	>100	6-8	0/0	34	D	nd	I	nd	I	I	nd	Formul aid/hydrotrope	Water based formulations	Excellent brine tolerance	Yes	Yes	Yes

\* regional Americas variant of CI-219

nd = no data

BDG = Butyl diglycol  
PG = Propylene glycol  
IPA = Isopropyl alcohol

<sup>a</sup> 5% in 3:1 IPA/water  
<sup>b</sup> 3% in 80/20 water/IPA  
<sup>c</sup> 5% in 50/50 water/IPA  
<sup>d</sup> @ +40°C

S = soluble  
D = dispersible  
I = insoluble  
P = paste/gel

Gen = general  
Sec = secondary

HT = high temp (>120°C)

Apvd = approved

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