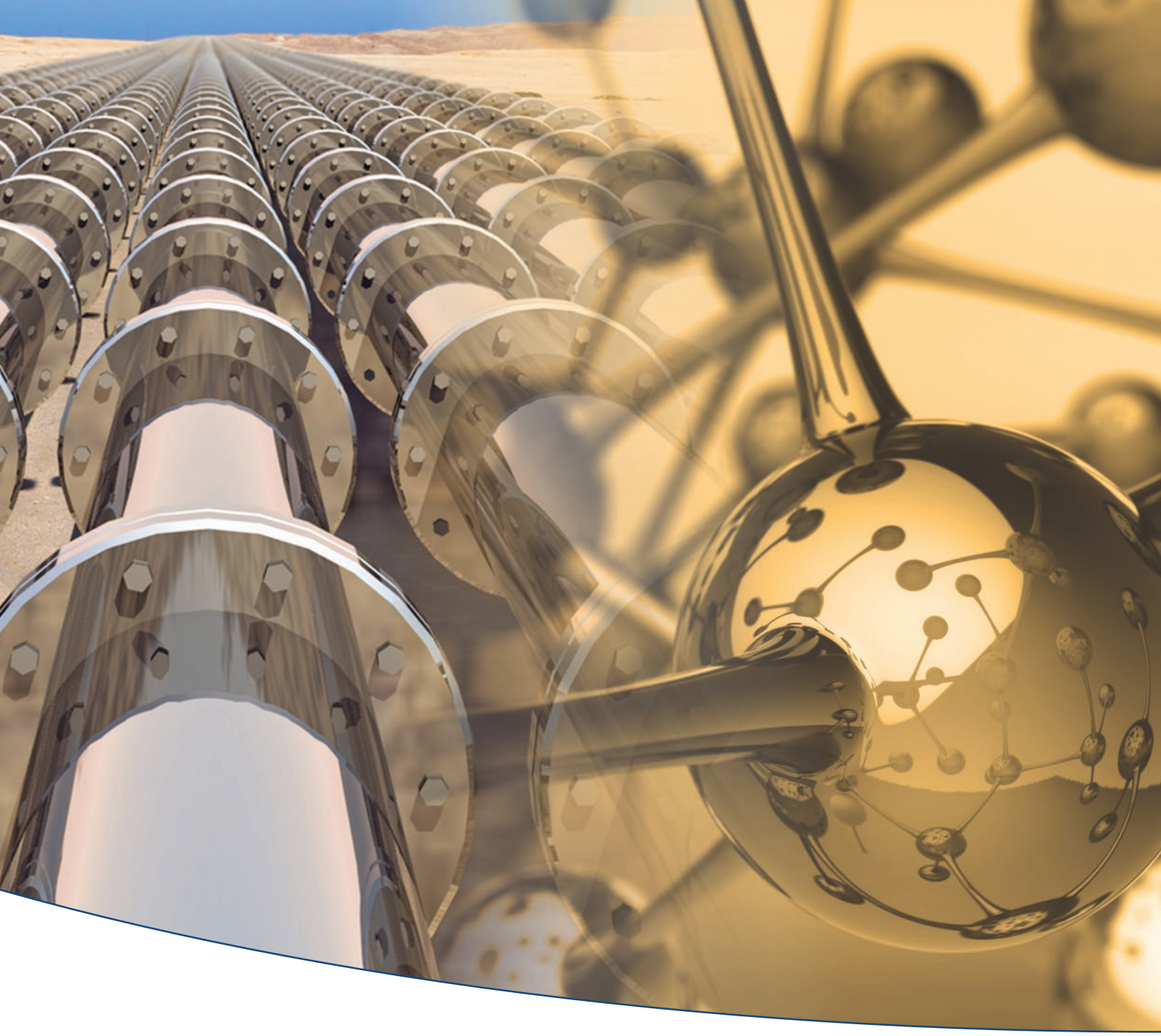


Corrosion inhibitors for asset integrity

Oilfield applications

Nouryon

Unleash the full potential of your corrosion inhibitor formulations

We have 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 Armohib® CI base inhibitors, the heart of the formulation, as well as several versatile co-inhibitors and co-surfactants. While these are mostly built on amine chemistry, we also provide phosphate ester based enhancers. Our chemistries are designed to help protect assets and extend the life of oilfield equipment – upstream, midstream, and downstream, including water treatment.

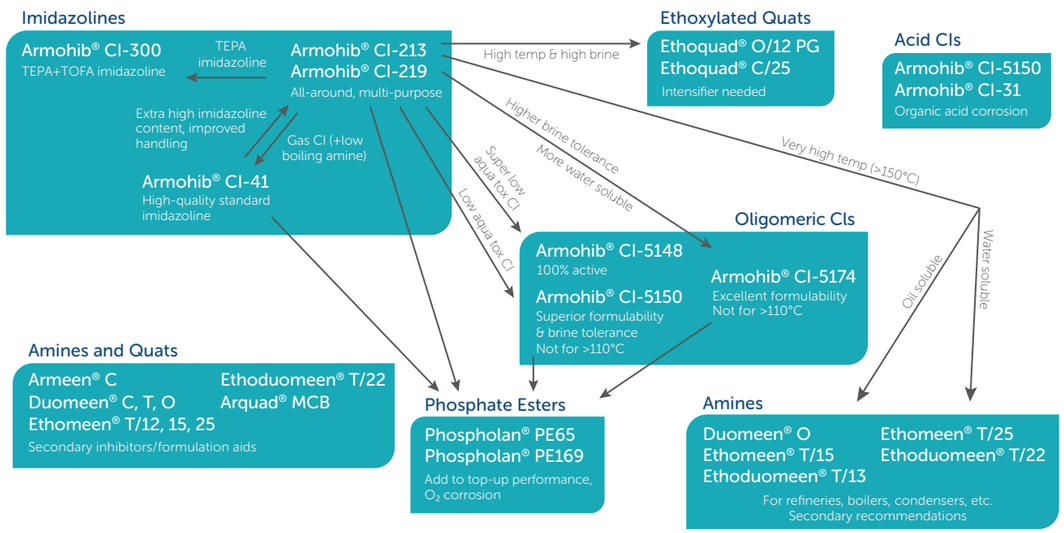
Some of our co-inhibitors may be used as primary inhibitors for special cases such as high-temperature water treatment environments like refineries, boilers, and condensers. In addition, our co-surfactant formulation aids and wetting agents are ideal to resolve compatibility challenges or top-up the integrity or performance of your formulations.

Take a deep dive into our Armohib® CI corrosion inhibitors using the selection guide below as well as the formulation examples, performance data, and portfolio table on the following pages.

Want to know more? Ask us!

Contact us for detailed product information and sample requests – visit nouryon.com/oilfield

Selection guide



Armohib® CI-200 series

highest standard imidazoline corrosion inhibitors

Solvent-free TOFA/DETA imidazolines designed for harsh corrosion challenges

Imidazoline chemistry is the basis for one of the dominating types of film-forming organic corrosion inhibitors for oil and gas installations globally.

Our Armohib® CI-200 series corrosion inhibitors are solvent-free TOFA/DETA* (1:1) imidazolines designed to help improve asset integrity in oilfield applications. Through global manufacturing and testing capabilities, our Armohib® CI-209, CI-213 and CI-219 corrosion inhibitors are tailored with the necessary properties to meet the requirements of various regions.

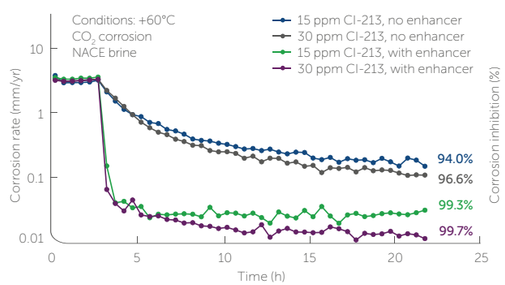
Features

- Flexible solubility profile for different purposes by organic acid addition
- Easy-to-handle clear liquid at room temperature with a pour point below -15°C
- High film persistence independently proven by AFM measurements
- Laboratory validated to show excellent inhibition performance for brines with a range of salinity and temperatures

Recommended uses

- For low- to medium-temperature oilfield applications, including produced fluids treatment and transportation
- Can be formulated for end-use application in multiple solvent packages
- Formulation with enhancers, such as sodium thiosulfate, further boosts corrosion inhibition in sweet and sour field conditions

Sweet corrosion inhibition performance by Armohib® CI-213 corrosion inhibitor with and without enhancer.



Formulation examples

Water based, high flash point, 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.

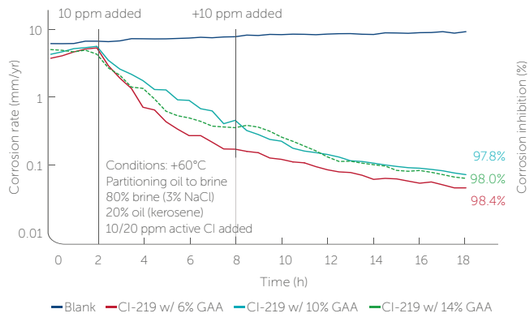
Solvent based high neutralization for gas pipelines and capillary delivery

Ingredient	Concentration, %
Armohib® CI-213	20
GAA	10
Amine	16
Water	up to 100

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

Concentrations in formulation examples indicated in weight %
GAA = glacial acetic acid
BDG = butyl diglycol
References to "water" refer to soft water
Other water qualities may require formulation modifications

Sweet corrosion inhibition performance by Armohib® CI-219 corrosion inhibitor in a two-phase system without additional enhancer.



*Reaction product of tall oil fatty acid and diethylenetriamine

Armohib® CI-5150

exemplary corrosion control

OSPAR approved with superior formulability and brine tolerance

Our Armohib® CI-5150 corrosion inhibitor is extremely easy to use and meets the strictest environmental requirements with its unique chemistry.

Technology

This novel inhibitor technology has been developed to maintain exemplary corrosion control in the oilfield, compared with industry standards. Noticeably advanced ecotoxicity characteristics allows this inhibitor to be used in environmentally sensitive marine locations.

The unique, patented film-forming alkyl oligo quaternary amine based chemistry display multiple positive-charge functionalities along the oligomer chain. This provides several points of adhesion to the metal surface, presenting strong film integrity under various conditions. In addition, this chemistry results in first class brine compatibility. Our Armohib® CI-5150 corrosion inhibitor 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
- Environmentally sensitive oilfield production applications needing corrosion control
- Topside or umbilical-fed production systems requiring film-forming corrosion control
- Various organic or aqueous systems, formulated for ease of use and/or minimized cost/performance profile
- High flash point blends as well as methanol-based formulations for extremely cold conditions can be proposed
- Alkaline water-based formulation use is not recommended

Regulatory information

Armohib® CI-5150 corrosion inhibitor is REACH and TSCA compliant. In addition, it 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).

Features

- Excellent sweet corrosion inhibiting properties when tested under standard conditions and against benchmark chemistries, demonstrating 99.8% protection at 10 ppm dosage in a non-optimized formulation
- Corrosion reduction of >99% at 10 ppm dosage demonstrated in RCE (30 Pa wall shear stress) tests and under high flow conditions (data obtained in 3% sodium chloride (NaCl) brine at +60°C), indicating stable performance
- Compatible with heavy brines as e.g. 26% NaCl, 20% NaCl at +70°C, >30% calcium chloride and 50 000 ppm Ca/25 000 ppm sodium brine at +80°C
- Promising performance 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 it suitable for use in the most stringent regulatory environments
- Aqua 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 Armohib® CI-5150 corrosion inhibitor is not skin irritating, sensitizing or mutagenic
- Easy to handle as a clear liquid at room temperature
- In-house formulation studies have shown the active material to be extremely flexible when formulated, allowing development of both aqueous- and solvent-based corrosion inhibitor solutions, including those with environmentally acceptable solvents

Armohib® CI-5174

versatile corrosion inhibition

Innovative, oligomeric amine proven to reduce total inhibitor dosage and be a seamless fit for cutting edge formulations

Designed to deliver versatile functionality with the greatest ease of handling, this novel oligomeric amine can be used as a corrosion inhibitor in various oilfield formulations.

Technology

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 to deliver stronger film integrity under various conditions. Usage in the field indicates corrosion protection is maintained despite lower dosage levels and longer intervals between doses compared to previously used chemistry.

In discrete phase laboratory tests, our Armohib® CI-5174 corrosion inhibitor demonstrates excellent oil-to-brine partitioning and distribution properties can easily be tuned by modifying the solubility profile, such as by adding acetic acid.

Recommended uses

- Sweet and sour corrosion/pipeline applications
- Topside or umbilical-fed production systems requiring film-forming corrosion control
- Applications where turbulent fluid flow compromises film integrity, leading to excess corrosion rates and/or high dosages of a standard active inhibitor
- Various organic or aqueous systems, formulated for ease of use and/or minimized cost/performance profile
- High flash point blends as well as methanol-based formulations for extremely cold conditions and/or umbilical applications
- Replacement for imidazolines that are not suitable, e.g. due to local regulations or difficult brine conditions

Features

- Excellent sweet corrosion inhibiting properties when tested under standard conditions and against benchmark chemistries, demonstrating 99.4% protection at 10 ppm dosage in a non-optimized formulation
- Compatible with base inhibitor synergists such as sodium thiosulfate
- Combined hydrogen sulfide and carbon dioxide corrosion inhibitor
- Preserves film integrity 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% sodium chloride brine at +60°C)
- Easy to handle as a clear liquid at room temperature with a pour point of -12°C
- Significantly lower foam profile than alkyl benzalkonium chlorides and fatty acid imidazoline acetates
- Improved brine tolerance compared to standard imidazolines

Corrosion inhibitors overview

	General characteristics								Solubility							Functionality and use			Regulatory data		
[1] 1% in water [2] Ross–Miles 50°C, 0.05% [3] mN/m@0.1%	Physical form (20°C)	Chemistry	Active content	Pour point °C	Viscosity mPas @20°C	Flash point °C	pH[1]	Foam mm[2] 0 min / 5 min	Surface tension[3]	Water	Methanol	IPA	BDG	Alifatic solvent	Aromatic solvent	Diesel	Main uses	Formulability	Special properties	TSCA	REACH	OSPAR approval
Acid Corrosion Inhibitors																					
Armohib® CI–31	Liquid	Proprietary surfactant blend	–	0	–	>150	–	–	–	–	–	–	–	–	–	–	Organic acids inhibitor	Add to acid solution	–	Yes	No	–
Imidazolines																					
Armohib® CI–41	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	–
Armohib® CI–219/CI–209*	Liquid	DETA + TOFA imidazoline	100%	<-15	200	>125	10.5–12.5[a]	–	–	D	S	S	S	S	S	S	Gen. CI, pipeline, etc	Flexible for oil/water	High imidazoline content	Yes	Yes	–
Armohib® CI–213	Liquid	DETA + TOFA imidazoline	100%	-24	242	>125	10.5–12.5[a]	–	–	D	S	S	S	–	S	–	Gen. CI, pipeline, etc	Flexible for oil/water	High imidazoline content	Yes	Yes	–
Armohib® CI–300	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	–
Oligomeric Corrosion Inhibitors																					
Armohib® CI–5148	Liquid	Oligomeric ester amine	100%	-18	525	>100	7.2[a]	-	–	D	S	S	S	I	S	D	Gen. CI, regulated areas	Flexible for oil/water	Very low aquatoxicity	No	Yes	Yes
Armohib® CI–5150	Liquid	Oligomeric ester quat	55% (in BDG)	-5	3500	90–94	3.3–4.1	115/102[c]	31	S	S	D	S	S	S	S	Gen. CI, regulated areas	Outstanding	Excellent brine tolerance	Yes	Yes	Yes
Armohib® CI–5174	Liquid	Oligomeric ester amine	100%	-12	1185	>200	7–8	25/0	–	S	S	S	S	I	S	I	Gen. CI, sweet + sour	Flexible for oil/water	Good brine tolerance	No	Yes	–
Amines and Diamines																					
Armeen® C	Liquid	Cocoalkylamine	100%	–	4 (@60)	>100	–	–	–	P	–	S	–	S	S	–	Sec inhibitor, formul. aid	Often used as acid salt	–	Yes	Yes	–
Duomeen® C	Liquid/Paste	N–coco–1,3–diaminopropane	100%	–	4 (@60)	>130	–	–	–	P	–	S	–	D	S	–	Sec inhibitor, formul. aid	Often used as acid salt	Biocide for fracking (US)	Yes	Yes	–
Duomeen® O	Paste	N–oleyl–1,3–diaminopropane	100%	–	11 (@50)	>150	–	–	–	D	–	S	–	S	S	–	Sec inhibitor, formul. aid	–	HT stable for boiler, refinery	Yes	Yes	–
Duomeen® T	Paste	N–tallow–1,3–diaminopropane	100%	–	6 (@60)	>150	–	–	–	D	–	S	–	P	D	–	Sec inhibitor, formul. aid	–	HT stable	Yes	Yes	–
Ethoxylated Amines and Diamines																					
Ethomeen® C/12	Liquid	Coco alkylamine + 2 EO	100%	8	–	193	–	–	–	D	–	S	–	S	S	–	Sec inhibitor, formul. aid	–	Cleaning	Yes	Yes	–
Ethomeen® C/15	Liquid	Coco alkylamine + 5 EO	100%	-5	150	>100	9–11	100/70	30	S	–	S	–	S	S	S	Sec inhibitor, formul. aid	Water soluble	Cleaning	Yes	Yes	–
Ethomeen® C/25	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	–
Ethomeen® O/12	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	–
Ethomeen® T/12	Paste	Tallow alkylamine + 2 EO	100%	32	34 (@50)	>100	–	–	–	D	–	S	–	S	S	S	Sec inhibitor, formul. aid	Oil soluble	Acid cleaning	Yes	Yes	–
Ethomeen® T/15	Liquid/Paste	Tallow alkylamine + 5 EO	100%	8	160	>100	10	35/35	31	S	–	S	–	S	S	S	Sec inhibitor, formul. aid	–	HT stable	Yes	Yes	–
Ethomeen® T/25	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	–
Ethodoumeen® T/13	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	–
Ethoduomeen® T/22	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	–
Ethoxylated Quats																					
Ethoquad® C/25	Liquid	Cocoalkyl methyl ammonium chloride + 15 EO	>95%	15	1150 (@25)	127	6–8	–	43	S	S	S	S	I	D	I	High temp/high brine	Add intensifier	Good brine tolerance	Yes	Pend.	–
Ethoquad® O/12 PG	Liquid	Oleyl methyl ammonium chloride + 2 EO	69% (in PG)	–	–	104	6–8	–	40	S	S	S	S	D	D	D	High temp/high brine	Add intensifier	Good brine tolerance	Yes	–	–
Benzyl Quats																					
Arquad® MCB–50	Liquid	Cocobenzyl dimethyl ammonium chloride	50% (in water)	–	130	>100	6–9 (10%)	89/18	–	S	–	S	–	–	–	–	Sec. inhibitor	Water soluble	–	Yes	Yes	–
Phosphate Esters																					
Phospholan® PE169	Liquid	Alkyl phosphate ester, free acid	100%	-10	900	>150	2–3	108/78	28[c]	D	S	S	S	S	S	S	Inhibition booster	Flexible for oil/water	Oxygen corrosion inhibition	Yes	Yes	–
Phospholan® PE65	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	–
Formulation Aids and Wetting Agents																					
Armoclean® 4350	Liquid	Alcohol alkoxylate	100%	-9	30	>100	7–9.5	5/0	27	D	S	S	S	S	S	S	Wetting agent	Broad	Cleaning	Yes	Yes	Yes
Armoclean® 6000	Liquid	Alkyl glucoside	65% (in water)	–	160 (@30)	>100	6–8	8/0	33	S	–	I	–	I	I	–	Formul. aid/hydrotrope	Water–based formul..	Excellent brine tolerance	Yes	Yes	Yes
Armoclean® 6040	Liquid	Alkyl glucoside	75% (in water)	-9	775	>100	6–8	0/0	34	D	–	I	–	I	I	–	Formul. aid/hydrotrope	Water–based formul.	Excellent brine tolerance	Yes	Yes	Yes

* regional Asian variant of Armohib® CI-219

– = no data

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

[a] 3% in 80/20 water/IPA
[b] @ +40°C
[c] @ pH 6

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

Gen. = general
Sec. = secondary

HT = high temp (>120°C)

Contact us for detailed product information and sample requests.

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Nouryon

Nouryon is a global, specialty chemicals leader. Markets and consumers worldwide rely on our essential solutions to manufacture everyday products, such as personal care, cleaning goods, paints and coatings, agriculture and food, pharmaceuticals, and building products. Furthermore, the dedication of approximately 8,200 employees with a shared commitment to our customers, business growth, safety, sustainability and innovation has resulted in a consistently strong financial performance. We operate in over 80 countries around the world with a portfolio of industry-leading brands. Visit our website and follow us @Nouryon and on LinkedIn.

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