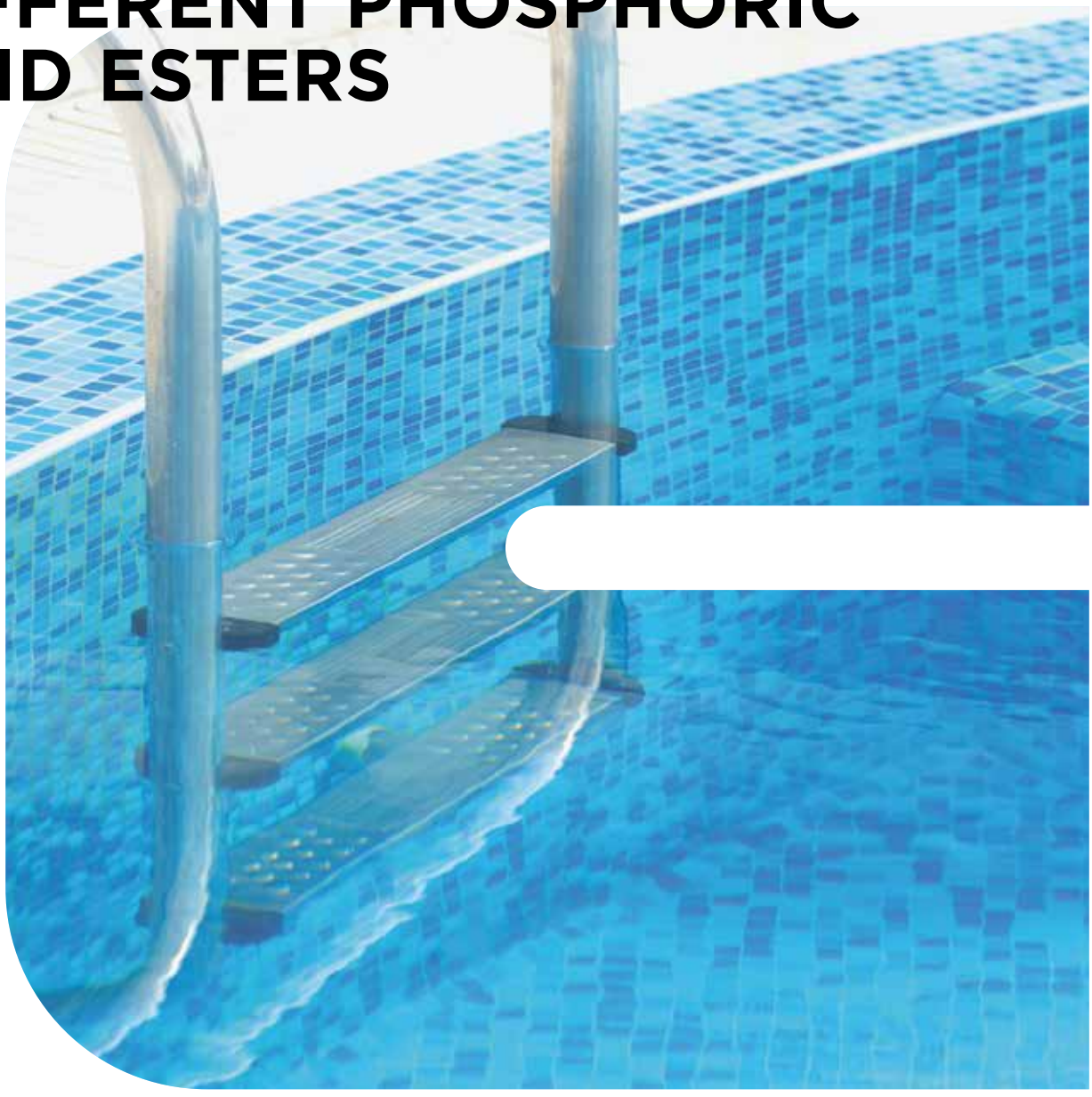
CLARIANT

Hordaphos®

A BROAD VARIETY OF DIFFERENT PHOSPHORIC ACID ESTERS

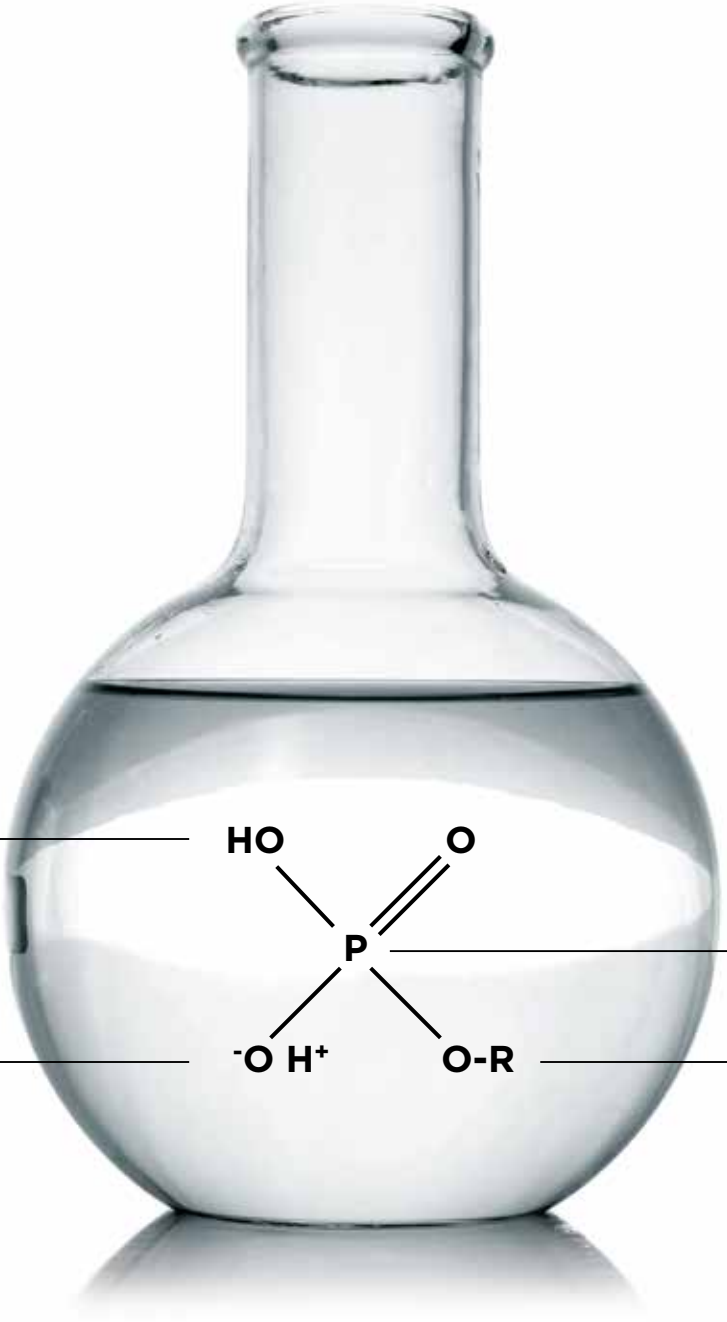


what is precious to you?

The Hordaphos® product group consists of a broad variety of different phosphoric acid esters. The Hordaphos products are synthesized by reacting phosphorus pentoxide or polyphosphoric acid with an alcohol under controlled reaction conditions. By using phosphorus pentoxide as raw material, the produced Hordaphos grades consist mainly of a mixture of mono-, di-, and sometimes traces of triesters. When polyphosphoric acid is used as raw material, the Hordaphos grades are mainly a mixture of phosphoric acid, mono- and diester. The ratio of the phosphoric acid esters as well as the content of by-products is in both cases depending on the alcohol used and the reaction conditions.

HORDAPHOS

»Multifunctional molecule«



ACIDIC
lime and rust dissolving

PHOSPHATIZING
corrosion inhibiting

ANIONIC
antistatic

MULTIFUNCTIONAL
foam regulating
hydrophobic
corrosion inhibiting
emulsifying
dispersing
solubilizing
wetting

High quality and performance – **PROVEN FOR MANY YEARS**

Clariant produces the phosphoric acid esters in a large scaled around-the-clock plant at the Knapsack site, which is located in Germany, not far from Cologne. The key raw materials phosphorus pentoxide and polyphosphoric acid are produced in-house at the same site in one of Europe's biggest production plants for these products. Beyond that, ethoxylated alcohols, which are used for the synthesis of some Hordaphos types, are produced by Clariant as well. Therefore, we produce these esters to highest quality standards and in a competitive set-up. Furthermore, our employees in the development department have extensive experience in phosphorus chemistry and will be delighted to assist you in any way they can.

A multitude of different phosphoric acid esters and product compositions are possible by using a wide range of different alcohols as raw materials and different reaction conditions. The Clariant Hordaphos product portfolio provides phosphoric acid esters, which were developed as tailor-made additives for many different applications. Clariant's Hordaphos products have prooved their high performance for many years now in various application fields. Hordaphos grades substantially improve the performance of cleaning products, for example.

As multifunctional additives the Hordaphos phosphoric acid esters are used in industrial and professional cleaning products, but also in pigment pastes and paints. Beyond that, they are used in formulations for metal working, metal cleaning, textile production, crop protection, mining, and many more application fields.

Depending on the Hordaphos grade they can act as a mild acid, corrosion inhibitor, antistatic agent, wetting agent, brightener, foam stabilizer or defoamer, dispersing and/or emulsifying agent, to name just the main properties.

This multifunctionality and diversity will be explained in more detail for some selected examples. Phosphoric acid esters are nearly as acidic as phosphoric acid and have similar phosphatizing properties but phosphoric acid esters are by far less corrosive due to the organic modification by the added alcohol. Antistatic properties are generated by the ionic phosphate functionality. Furthermore, strong dispersing properties occur when the phosphoric acid ester is synthesized with a long chained alcohol.

Short chained phosphoric acid esters are sold under the trade mark Hordaphos CC. In aqueous solution they act as proton donors and are much less corrosive compared to pure acids. Therefore, they are a good choice as suitable base substances for acidic cleaning. In particular, they can be applied to remove mineral-based deposits such as lime. In this regard, the combination of strong cleaning power and extremely low corrosivity is a distinguishing mark of the Hordaphos CC grades.

With increasing chain length of the incorporated alcohol the hydrophobic character of the Hordaphos grades increases, solubility in water declines and acidity is reduced. The Hordaphos products are non-toxic and environmentally friendlier. They are liquid (except Hordaphos MDST, which is a white solid) and therefore easy to handle. Hordaphos MDGB, for example, is completely miscible with water and acts as a strong corrosion inhibitor in acidic media. While phosphoric acids with longer chain lengths of the alcohol – like Hordaphos MDO, MDST or 222 for example – are only emulsifiable in water. These long chain phosphoric acid esters show different dispersing and wetting effects, depending on their chemical structure.

The properties of the different Hordaphos products are summarized in the table on pages 13 and 14.

Hordaphos – **ADDED VALUE FOR CLEANING PRODUCTS**

Cleaning enhancers with built-in corrosion protection

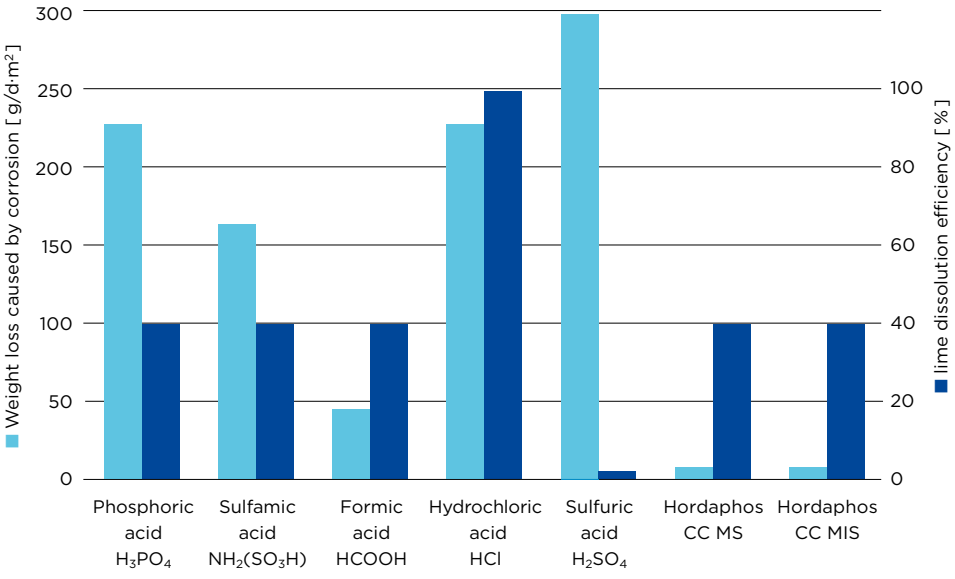
Removing limescale or rust is a major challenge for cleaners in many fields of application. While grease and organic contaminations can be removed by neutral or alkaline cleaners, for contaminations consisting of mineral deposits such as lime, cement slurry or corrosion and oxidation precipitates of iron(III) or manganese(IV) salts, acid cleaners have to be used. Strong acids remove such deposits easily but they also attack and damage the surface. Iron and steel in particular, as well as aluminum alloys, are attacked severely by inorganic and organic acids, but plastic, glass and ceramic surfaces are also corroded by strong chemicals. The use of phosphoric acid esters as additives to strong acids or the complete replacement of acids by phosphoric acid esters is an elegant way to overcome these problems.

The corrosivity of acids in aqueous media can be substantially reduced or even completely eliminated by suitable Hordaphos products, which act as corrosion inhibitors, such as Clariant's Hordaphos MDGB. Another option to combine strong cleaning power with high surface protection is to use Hordaphos CC grades or Hordaphos MDE. These products are effective cleaning agents themselves with very low corrosion potential and high surface protection properties.

HORDAPHOS CC GRADES – mild but efficient acids

- Excellent cleaning performance and high limescale-dissolving power
- Effective in cleaners for sanitation, automotive and food processing industries
- Remove mineral-based, oxidation and corrosion deposits
- Low corrosion rates on metallic and non-metallic materials
- Effective even in hard water
- Higher solubility for various salts and oxides than phosphoric acid: prevention of precipitates
- Are recommended as base components for acidic cleaners
- Owing to their good wetting action they require only small additions of surfactants to fine-tune the cleaner
- Clear and colorless liquids, they are miscible in all proportions with polar and hydrophilic solvents e. g. water, alcohols, esters and ketones.
- They are not miscible with nonpolar solvents such as benzene, toluene and petroleum ether. A substantial amount can however be incorporated by adding suitable surface-active substances. The Hordaphos CC grades are fully compatible with these.
- No crystallization or phase separation occurs at temperatures down to - 30 °C.
- Low foaming

FIGURE 1: Corrosivity and lime dissolution efficiency of acids compared to Hordaphos CC grades.



Hordaphos
ADDED VALUE FOR CLEANING PRODUCTS

HORDAPHOS MDGB –

strong corrosion inhibitor in acidic media

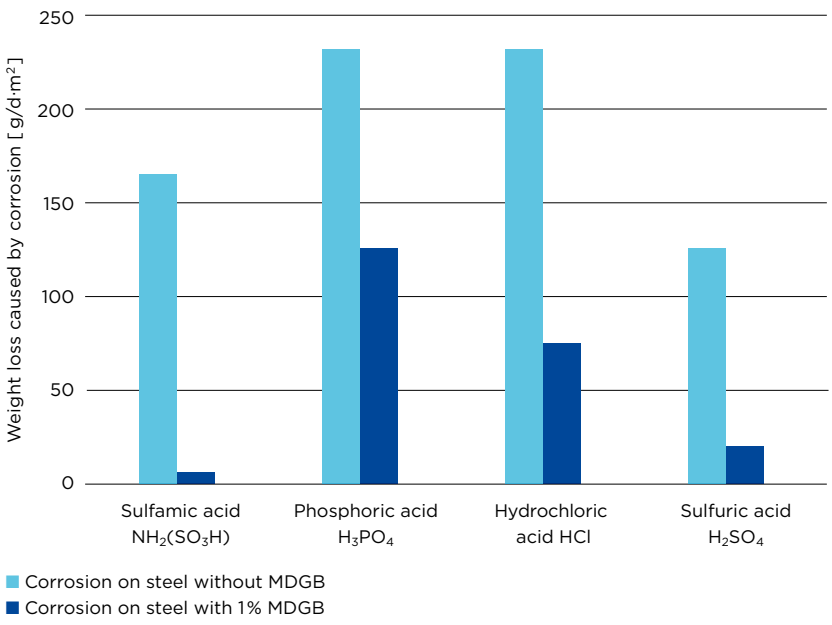
- Based on a mixture of C2- and C4-alcohols
- Effective corrosion inhibitor for acidic aqueous systems even at low concentrations
- Works on common metal surfaces (e. g. steel, copper, different alloys)
- Substantially reduces the corrosivity of various acids: hydrochloric acid, sulfamic acid, sulfuric acid, nitric acid, phosphoric acid, acetic acid, maleic acid, etc.
- Effective in cleaners for the food processing industry
- Hordaphos MDGB is a low-viscosity liquid that can be readily metered

HORDAPHOS MDE –

cleaning agent for metal surfaces

- Effective in acidic pickling and degreasing agents for derusting and degreasing for industrial metal cleaning
- Effective cleaning additive for the building and sanitation sectors
- Produces high-gloss effect on chromium, stainless steel, copper, brass, etc.
- Antistatic agent
- Soluble in water and oil
- Wetting agent
- Usable in aqueous flame-retardant preparations

FIGURE 2: Corrosivity of different acids with and without Hordaphos MDGB

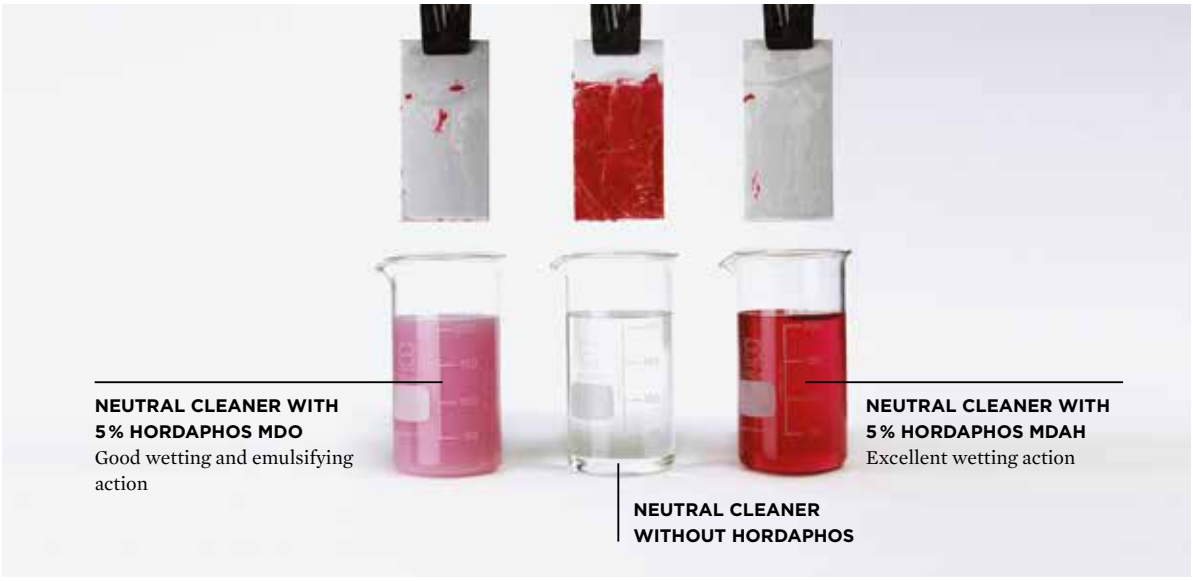


Weight loss of steel caused by corrosion: Corrosivity of different acids (10 % solution) with and without the addition of Hordaphos MDGB (weight loss in gram per day and square meter; DIN 50905).
The presence of Hordaphos MDGB substantially reduces the corrosion rates.

Hordaphos
POWER FOR INDUSTRIAL AND INSTITUTIONAL CLEANING

The cleaning of industrial and institutional equipment, such as abattoirs, meat processing plants and dairies, as well as engineering workshops or garages, requires very strong cleaning agents. Hordaphos MDO has been especially developed to act as a powerful wetting and dirt suspending agent to remove oil and grease, but also dried blood, fat, casein residues, rust, paint and stubborn stains from various surfaces.

FIGURE 3: Removal of grease with Hordaphos MDO or Hordaphos MDAH, demonstrated with colored mineral lubricating grease.



HORDAPHOS MDO –
heavy duty cleaner and foam stabilizer

- Strong cleaning enhancer for industrial and institutional equipment
- High cleaning efficiency (low concentrations needed)
- Foam stabilizer
- Strong emulsifying and dispersing properties
- Acidic phosphoric acid ester with high alkali stability

Hordaphos 222
THE ADDED EXTRA FOR LIQUID AND SOLID DETERGENTS

HORDAPHOS 222 –

for liquid detergents and dry cleaning

- Used in liquid wool and light-duty detergents for hand and machine washing in the temperature range between 20 °C and 30 °C
- Antistatic agent in maintenance products (plastic surface etc.)
- Antistatic and softening effect on laundry (wool)
- Acts as a foam-regulator for washing applications
- Strong dispersing and emulsifying properties (for example, chlorinated hydrocarbons and benzene in water)
- Suitable for dry cleaning applications
- Detergents-booster
- Additive for aluminum treatment

Hordaphos
FOR PRINTING INKS, PAINTS AND COATINGS

VERSATILE ADDITIVES FOR PRINTING INKS, PAINTS AND COATINGS

Depending on the field of application, printing inks, paints and coatings have to fulfill several requirements considering that the substances contained in the pigmented system hugely influence its properties. Common ingredients are

· pigments
· fillers
· solvents
· binders
· additives (dispersing agents, emulsifiers, wetting agents, corrosion inhibitors, defoamers, antistatic agents, flame retardants and flow agents)

Clariant's Hordaphos products are serving these requirements for additives. In order to grant specific properties to a coating material, ink, paint or to the product made from it, additives and auxiliaries are added in small amounts. The effect of an additive is restricted to a specific instance of use while auxiliaries can perform various functions at the same time – **they are called multi-functional additives in such cases.**

WETTING AND DISPERSING AGENTS FOR PIGMENTS

The pigment must be very finely distributed in the binder in order to develop full color intensity and to achieve the maximum gloss. To prevent the particles from agglomerating, flocculating or settling, each pigment particle has to be wetted with sufficient binder. In that case dispersing agents and wetting agents are used.

Wetting agents support pigment wetting by lowering the viscosity of the mill base and enable a higher amount of pigment to be used. They support pigment dispersion and shorten the dispersing time. Dispersing agents weaken the intermolecular forces and prevent agglomeration which can take place as a result of electrostatic charging, formation of a protective covering or steric hindrance.

Due to their excellent dispersing power, Hordaphos MDIT, Hordaphos MDAH and Hordaphos 222 are recommended as dispersing agents. Additionally, these products lower the surface tension and increase the wetting power.

STABILIZERS FOR AQUEOUS METALLIC PIGMENT PASTES

Water-based metallic pigment pastes for aqueous paints and printing inks must be protected against corrosion to prevent an undesired change in the metallic color.

Hordaphos MDIT, Hordaphos MDAH and Hordaphos MDB are recommended for stabilizing metallic pigment pastes.

ANTISTATIC AGENT AND ADHESION PROMOTER

To prevent troublesome electrostatic charges which can occur on plastic films in particular, antistatic agents are added. Hordaphos MDB is recommended as an antistatic agent to increase the surface conductivity.

Polar groups in the paint formulation and in the substrate are responsible for the adhesion of the paint to the substrate in general. Adhesion promoters are used to increase the adhesion of the paint film to the substrate by interacting with polar groups in the substrate (e. g. metal oxide surface) resp. to strengthen this property.

Hordaphos MDB is recommended as an adhesion promoter.

Hordaphos
FOR PRINTING INKS, PAINTS AND COATINGS

SUBSTRATE WETTING AGENTS

Substances that lower the surface or interfacial tension at phase boundaries are called wetting agents. They make it easier to wet the substrate which is a prerequisite for good adhesion of the paint to the substrate.

Hordaphos MDIT, Hordaphos MDAH and Hordaphos MDO are recommended as wetting agents in paints.

SOLUBILIZING AGENT / CORROSION INHIBITOR

Hordaphos MDAH is recommended as a solubilizing agent for color bases and as a corrosion inhibitor.

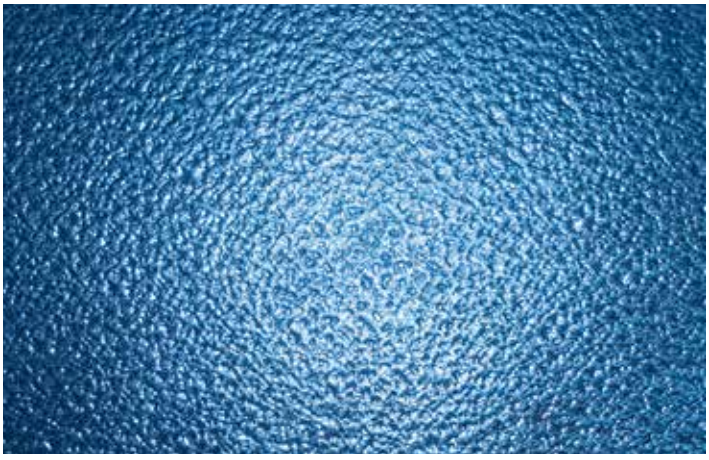
As a result, the color intensity is increased and the adjoining metal parts are protected.

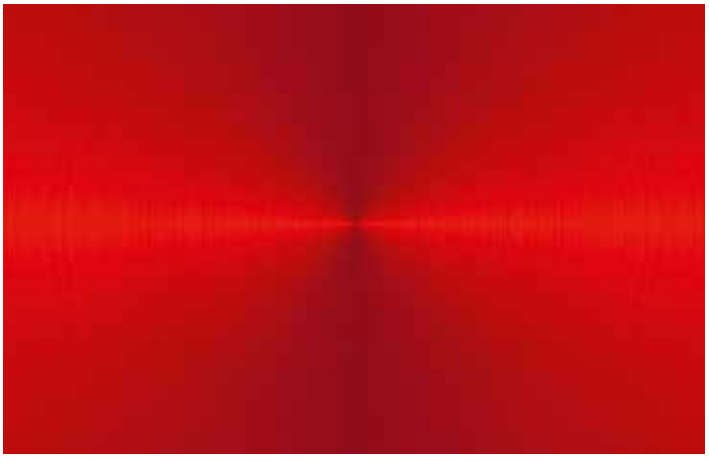
SOFTENING AGENT

The elasticity of coatings and printing inks is increased by softening agents as they avoid the formation of nips or cracks of the ink when the card-board is folded.

Hordaphos MDB and Hordaphos MOB are known for their excellent softening ability.

Depending on the system the acidic Hordaphos grade should be neutralized with an amine.





Product overview
HORDAPHOS FOR PRINTING INKS, PAINTS AND COATINGS

TECHNICAL DATA	HORDAPHOS MDAH	HORDAPHOS MDB	HORDAPHOS MDIT
Chain length	8	4	13
Phosphorus content [%]	11.0 – 12.0	16.7 – 17.7	8.0 – 9.0
Viscosity at RT (approx.) [mPa·s]	320	180	800
Acid number [mg KOH/g]	290 – 330	450 – 490	215 – 245
pH at RT (approx.), 10 g/l H_2O	2.5	2.2	2.5
Solubility in water at RT	emulsifiable	emulsifiable	not soluble
Color	colorless	colorless	colorless
State at RT	liquid	liquid	liquid
Surface tension (Noüy at RT 5 g/l) [mN/m]	30	34	54
Density at RT [g/cm³]	1.00 – 1.04	1.12 – 1.16	0.97 – 0.99

APPLICATION PROPERTIES			
Dispersing agent in pigment preparation	■		■
Wetting agent	■		■
Stabilizer	■	■	■
Antistatic agent		■	
Adhesion promoter		■	
Substrate wetting agent	■		■
Solubilizing agent	■		
Softener for printing inks		■	

■ suitable

HORDAPHOS MDO	HORDAPHOS MOB	HORDAPHOS 222
8	4	12 + 4 EO
11.0 – 13.0	19.6 – 20.6	4.3 – 5.3
250	500	500
295 – 345	630 – 680	125 – 155
2.6	1.5	2.5
emulsifiable	soluble	emulsifiable
colorless	colorless	colorless
liquid	liquid	liquid
24	52	28
1.00 – 1.04	1.22 – 1.26	1.00 – 1.04
		■
■		■
■		
	■	

Product overview
HORDAPHOS IN CLEANING PRODUCTS

TECHNICAL DATA	HORDAPHOS CC MN	HORDAPHOS CC MS	HORDAPHOS CC MIN	HORDAPHOS CC MIS
Chain length	1	1	1 – 3	1 – 3
Phosphorus content [%]	25.0 – 27.0	27.0 – 29.0	23.0 – 25.0	23.0 – 25.0
Viscosity at RT (approx.) [mPa·s]	50	300	70	1000
Acid number [mg KOH/g]	900 – 960	950 – 1010	829 – 879	780 – 840
pH at RT (approx.), 10 g/l H_2O	1.5	1.5	1.8	1.5
Solubility in water at RT	soluble	soluble	soluble	soluble
Color	colorless	colorless	colorless	colorless
State at RT	liquid	liquid	liquid	liquid
Surface tension (Noüy at RT 5 g/l) [mN/m]	54	63	61	59
Density at RT [g/cm³]	1.55 – 1.59	1.55 – 1.61	1.46 – 1.50	1.37 – 1.41
APPLICATION PROPERTIES				
Corrosion inhibition				
Mild acid with low corrosion potential	■	■■	■	■■
Dissolving limescale	■■	■■	■■	■■
Rust removal	■	■	■	■
Enhancing cleaning	■	■	■	■
Wetting effect				
Dispersing effect				
Polishing effect on metals				■
Antistatic effect				
Foam stabilization				
Defoamer				
Rinse aid	■	■	■	■
MAIN APPLICATION				
Acidic cleaners	■	■	■	■
Alkaline cleaners				
Neutral cleaners				

■ suitable ■■ highly suitable

HORDAPHOS MDE	HORDAPHOS MDGB	HORDAPHOS MDO	HORDAPHOS 222	HORDAPHOS MDST
2	2 – 4	8	12 + 4 EO	18
22.1 – 23.1	19.0 – 20.0	11.0 – 13.0	4.3 – 5.3	6.1 – 6.7
300	1100	250	500	–
670 – 710	600 – 700	295 – 345	125 – 155	165 – 195
1.5	1.5	2.6	2.5	2.5
soluble	soluble	emulsifiable	emulsifiable	emulsifiable
colorless	colorless	colorless	colorless	white
liquid	liquid	liquid	liquid	solid
61	43	24	28	40
1.30 – 1.34	1.32 – 1.38	1.00 – 1.04	1.00 – 1.04	1.00 – 1.06
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