



# EXOFOS SERIES

EXTREME PRESSURE (EP) ADDITIVES FOR  
LUBRICATING OILS AND METALWORKING FLUIDS

## KEY BENEFITS

- Excellent Extreme-Pressure (EP) properties
- Enhancing lubricity
- Corrosion control
- Good temperature resistance
- Compatible with a wide range of base oils
- Compatible with other additives
- Ashless

## GENERAL INFO & USES

**EXOFOS SERIES** – acidic phosphate esters. EXOfos products are very useful additives for lubricants due to their excellent extreme pressure (EP) properties, but they are also very effective emulsifiers for water-soluble metalworking fluids, corrosion inhibitors and wetting agents. Phosphate-esters are versatile products, used in many different applications such as metalworking and metal cleaning, architectural finishes, textile wetting, and hard surface detergency. EXOfos products are manufactured with inherent mono- and diester content and will have residual phosphoric acid, alkoxyated and non-alkoxyated.

## KEY APPLICATIONS

- gear oils
- metalworking fluids
- high-temperature lubricants
- greases
- hydraulic fluids

## CLASSIFICATION & LABELLING

In order to obtain this information, please refer to the Safety Data Sheets. These documents are available upon request from your sales representative.

## STORAGE & SHELF LIFE

Please see our respective Technical Data Sheet for general safety guideline. These documents are available upon request from your sales representative.

## DELIVERY

Tank wagons or tanker trucks made of stainless steel, plastic containers with a capacity of 1 m<sup>3</sup>, steel or plastic drums with a capacity of 200 dm<sup>3</sup> and other packaging as agreed with the customer.



## PRODUCTS

**EXOfos PA-080S** – hydrophobic product with high content of phosphorus (11-12%), intended to be applied mainly in oils and greases. A suitable product to work with ferrous metals and aluminium. In addition, EXOfos PA-080S supports corrosion inhibition on ferrous metals. One of the biggest advantages of this product is its anti-foaming property as an additive to mineral base oils.

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**EXOfos PA-1300** – highly hydrophobic additive intended to be applied mainly in oils and greases. EXOfos PA-1300 exhibits EP as well as anti-wear (AW) properties, therefore it can be used as universal additive for application in wide range of conditions. EXOfos PA-1300 is a suitable product for steel and aluminium materials.

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**EXOfos PB-043**- wetting agent and hydrotrope in hard surface cleaners and metal surface preparation formulations.

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**EXOfos PB-065**- alkali compatible and exhibits wetting properties. The product is used as a hydrotrope mainly in alkaline environments and as a dispersing agent.

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**EXOfos PB-083**- product shows excellent wetting, hydrotroping and corrosion inhibition properties. EXOfos PB-083 has strong emulsifying and dispersing properties, high cleaning efficiency and low foaming ability.

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**EXOfos PB-103** – recommended for aluminium and copper alloys. EXOfos PB-103 provides good EP properties and also wetting capability. Product is stable in the alkaline environment. Phosphorus content is 6-7%.

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**EXOfos PD-103LP** – blend, recommended for steel, aluminium and copper alloys and hydrotrope. Product is stable in alkaline environment and compatible with anionic and nonionic surfactants. Phosphorus content is 6-7%.

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**EXOfos PB-133** – recommended as an additive to soluble oils and semi-synthetic metalworking fluids. Product provides good EP properties, it can be used in applications with materials like aluminium and copper. EXOfos PB-133 is stable in the alkaline environment.

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**EXOfos PB-136** – recommended as an additive to soluble oils and semi-synthetic metalworking fluids. Product provides good EP properties, it can be used at work with materials such as aluminium and copper. EXOfos PB-136 is a good wetting agent and exhibits great resistance to both acidic and alkaline environment.

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**EXOfos PB-139** – recommended as an additive to synthetic metalworking fluids. Water-soluble product, exhibits good wettability and resistance to both alkaline and acidic environment. EXOfos PB-139 is a solubilising agent for water systems.

**EXOfos PB-184** – phosphate-ester with 4-5% phosphorus content. Product with superb EP properties. Recommended as an additive for lubricants working at high loads and water miscible lubricants. The product has also a great emulsifying capability. EXOfos PB-184 supports corrosion inhibition for steel, aluminium and copper materials.

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**EXOfos PB-253** – product designed especially for solvent-based applications. Soluble in many different organic solvents. EXOfos PB-253 is a very good wetting agent and lubricating additive.

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**EXOfos PB-257** - has emulsifying and lubricating properties. Soluble in many different organic solvents. EXOfos PB-257 is dispersing agent and is can be use as alternative to exchange nonylphenol ethoxylate based phosphate esters.

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**EXOfos PB-264** – multifunctional additive for neat oils and water-miscible lubricants. This product provides excellent extreme-pressure (EP) properties, as well as emulsifying capability and great resistance to the alkaline environment. EXOfos PB-264 is a suitable product to work with materials such as aluminium or ferrous metals.

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**EXOfos PB-267** phosphorus ester that exhibits emulsifying and lubricating properties. It is used in metalworking fluids. This product provides good extreme-pressure (EP) properties, as well as emulsifying capacity and great resistance to alkaline environment.

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**EXOfos PF-623** works exceptionally well in synthetic and semisynthetic fluids due to good EP and lubricity properties. This ester also has good alkaline compatibility, wetting and detergency attributes.



# EXOFOS - TYPICAL PROPERTIES

Product	CAS	INCI	Appearance <sup>1)</sup>	AV [mg KOH/g] <sup>3)</sup>	P-content [%] <sup>3)</sup>	pH value <sup>5)</sup>	Solidification point [°C] <sup>6)</sup>	Density at 25°C [g/cm <sup>3</sup> ] <sup>3)</sup>
<b>EXOfos PA-080S</b>	12645-31-7	2-Ethylhexyl Phosphate	liquid	290-350	11-12	2.0-3.0 <sup>b</sup>	<-20	~ 1.02
<b>EXOfos PA-1300</b>	52933-07-0	Isotridecyl Phosphate	liquid	135-155	8-9	2.5-3.0 <sup>c</sup>	<-20	~ 0.96
<b>EXOfos PB-043</b>	50769-39-6	Butyl Alcohol Ethoxylate, Phosphate	liquid	200-250	—	~2.0 <sup>a</sup>	~ +12	~ 1.13
<b>EXOfos PB-065</b>	68585-15-9	C6-C10 alcohols, ethoxylated, phosphate	liquid	160-210	—	~2.0 <sup>a</sup>	~ -10	~ 1.1
<b>EXOfos PB-083</b>	68439-39-4	PEG-3 2-Ethylhexyl Phosphate	liquid	180-200	—	~2.0 <sup>a</sup>	<0	~ 1.08
<b>EXOfos PB-103</b>	52019-36-0	PEG-3 decyl phosphate	liquid	160-190	6-7	2.0-2.5 <sup>a</sup>	<-20	~ 1.06
<b>EXOfos PD-103LP</b>	—	PEG-3 decyl phosphate and Alkoxylated alcohols	liquid	130-160	—	2.0-3.0 <sup>a</sup>	<-30	~ 1.00
<b>EXOfos PB-133</b>	9046-01-9	PEG-3 isotridecyl phosphate	liquid	140-160	5-6	1.5-3.0 <sup>a</sup>	<-20	~ 1.02
<b>EXOfos PB-136</b>	9046-01-9	PEG-6 isotridecyl phosphate	liquid	90-150	3-4	1.0-2.5 <sup>a</sup>	~ -15	~ 1.05
<b>EXOfos PB-139</b>	9046-01-9	PEG-9 isotridecyl phosphate	liquid	87-117	3-4	2.0-3.0 <sup>a</sup>	~ -2	~ 1.07
<b>EXOfos PB-184</b>	39464-69-2	PEG-4 oleyl phosphate	liquid	135-160	4-5	2.0-3.0 <sup>b</sup>	~ -4	~ 1.03
<b>EXOfos PB-253</b>	68071-35-2	PEG-3 C12-15 alkyl phosphate	liquid	135-170	5-6	1.0-2.5 <sup>a</sup>	~ +7	~ 1.01
<b>EXOfos PB-257</b>	68071-35-2	PEG-7 C12-15 alkyl phosphate	liquid	110-140	—	2.0-3.0 <sup>b</sup>	~ +7	~ 1.05
<b>EXOfos PB-264</b>	68511-37-5	PEG-4 lauryl phosphate	liquid	150 – 180	6-7	2.0-3.0 <sup>b</sup>	~ +2	~ 1.04
<b>EXOfos PB-267</b>	68511-37-5	PEG-7 lauryl phosphate	liquid	100-125	—	2.0-3.0 <sup>a</sup>	~ +17	~ 1.05
<b>EXOfos PF-623</b>	68130-47-2	C8 – C10 alcohol, ethoxylated, phosphate	liquid	165-190	—	2.0-3.0 <sup>a</sup>	<-20	~ 1.08

1) Visual method at RT

2) PN-EN ISO 4630

3) In-house method

4) PN-ISO 4741 (modified)

5) PN-EN 1262

6) PN-ISO 1392

a - 1% in water

b - 1% in ethanol: water 50:50

c - 1% in ethanol: water 75:25

## EXTREME-PRESSURE PERFORMANCE

Four-ball extreme-pressure (EP) tests in paraffinic group I base oil according to ASTM D2783 (1760 rpm, 10 s)

Sample	Last nonseizure load [N]	Weld point [N]
Paraffinic base oil (ISO VG 22)	392	981
Base oil + 3% EXOfos PA-0835	1236	1569
Base oil + 3% EXOfos PA-1300	981	1236
Base oil + 3% EXOfos PB-133	981	1569
Base oil + 3% EXOfos PB-184	981	1961
Base oil + 3% EXOfos PB-264	1236	1569

Four-ball extreme-pressure (EP) tests in Rapeseed oil methyl esters (RME) or Rapeseed oil according to ASTM D2783 (1760 rpm, 10 s)

Sample	Last nonseizure load [kg]	Weld point [kg]
Rapeseed oil methyl esters (RME)	40	100
Rapeseed oil	80	126
Rapeseed oil + 3% EXOfos PD-103LP	126	160
Rapeseed oil + 3% EXOfos PB-103	126	160
RME + 3% EXOfos PB-257	100	160
RME+ 3% EXOfos PB-267	126	250
RME + 3% EXOfos PF-623	126	200

Four-ball anti-wear performance for EXOfos PA-1300 according to ASTM D4172 (method B: 1200 rpm, 1 h, 75°C, 40 kg)

Sample	Average scar diameter [mm]
Paraffinic base oil (ISO VG 22)	0.84 ± 0.04
Base oil + 0.5% EXOfos PA-1300	0.45 ± 0.03

## OTHER FEATURES

Solubility of EXOfos series products (PN-EN 13955: 25°C, 5% [w/w])

Product	DeminerIALIZED water	Methanol	Ethyl ether	Acetone	Paraffinic base oil	Naphthenic base oil	Rapeseed oil	Rapeseed oil methyl esters (RME)	Extraction naphtha
EXOfos PA-080S	● <sup>2)</sup>	●	●	●	●	●	●	●	●
EXOfos PA-1300	●	●	●	●	●	●	●	●	●
EXOfos PB-043	●	●	●	●	●	●	●	—	—
EXOfos PB-065	●	●	●	●	●	●	●	—	—
EXOfos PB-083	● <sup>1)</sup>	●	●	●	●	●	●	—	—
EXOfos PB-103	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PD-103LP	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PB-133	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PB-136	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PB-139	●	●	●	●	●	●	●	●	●
EXOfos PB-184	● <sup>1)</sup>	●	● <sup>1)</sup>	●	●	●	●	●	●
EXOfos PB-253	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PB-257	● <sup>1)</sup>	●	●	●	●	●	●	●	—
EXOfos PB-264	● <sup>1)</sup>	●	●	●	●	●	●	●	●
EXOfos PB-267	●	●	●	●	●	●	●	●	—
EXOfos PF-623	●	●	●	●	●	●	●	●	—

● soluble      ● insoluble      ● partially soluble

1) – soluble after neutralization

2) – partially soluble after neutralization

## FERROUS MATERIALS CORROSION TESTS:

### Herbert method (PN-M-55789)

Test method description: steel chips are placed on cast iron plate and wetted with analysed solution. The corroded area is evaluated after 24 h. The results are in the range of H0 to H6, where H0 is the best result, H6 – the worst.

Tests performed for products neutralized by triethanolamine to pH value 7-8 in demineralized water.

Concentration	EXOfos PB-264	EXOfos PA-080S	EXOfos PB-184	EXOfos PB-139	EXOfos PA-1300	EXOfos PB-103	EXOfos PB-133
5%	H0	H0	H0	H0	H0	H0	H3
3%	H2	H2	H0	H4	H4	H4	H4

### Chip/filter paper method (DIN-51360)

Test method description: cast iron chips are placed on a filter paper and wett with analysed solution. The corroded area is evaluated after 2 h.

Tests performed for products neutralized by Triethanolamine to pH value 7-8 in demineralized water. In table below the minimum concentrations of EXOfos series products needed to obtain 0 result (any signs of corrosion) are demonstrated.

Sample	Result
Water demi	3/3
1% EXOfos PA 080S/TEA in water demi	0/0
5% EXOfos PB-184/TEA in water demi	0/0
2% EXOfos PB-184/TEA in water demi	0/1
1% EXOfos PA-1300/TEA in water demi	0/0
1% EXOfos PB-103 LP/TEA in water demi	1/1
1% EXOfos PB-083/TEA in water demi	0/0
3% EXOfos PB-264/TEA in water demi	1/2
1% EXOfos PF-623/TEA in water demi	1/1

## Copper corrosion according to ASTM D130-18

Method for evaluating the effect of lubricants on the copper surface. Copper plate placed in the sample for analysis, temperature 50°C, duration 3 hours. Evaluation of changes in the appearance of the plate according to the standard.

Sample	Result
Hard water 20 d	3a/3a
1% EXOfos PB-184/TEA in water 20 d	1a/1a
1% EXOfos PA-1300/TEA in water 20 d	0/0
1% Exofos PB-083/TEA in water 20 d	1a/1a
3% Exofos PB-103/TEA in water 20 d	1a/1a



## CORROSIVE EFFECT ON ALUMINIUM SURFACE

### Proprietary method:

Aluminium alloy PA9, part of the plate immersed in liquid and the rest in the gas phase.  
Test in a sealed glass vessel. Exposure time 2 weeks at 40°C.

Sample	Result of the test in the liquid phase	Result of the test in the gas phase
1% EXOfos PA-1300/TEA in demi water	visible corrosion spots	light tarnish
5% EXOfos PB-184/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PB-264/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PB-139/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PA-1300/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PA-080S/TEA in demi water	no corrosion	no corrosion
5% EXOfos PB-136/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PB-103/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PB-133/TEA in demi water	no corrosion	slight corrosion
5% EXOfos PD-103 LP/TEA in demi water	no corrosion	slight corrosion

PCC Group is still developing this group of products. We welcome opportunities to create new EXOfos series products that will fulfill the specific demands of our clients.



## ANIONIC PHOSPHATE ESTER, ACIDS AND THEIR SALTS - PRODUCT LIST

Product	CAS	Chemical name
EXOfos PA-080S	12645-31-7	2-Ethylhexanol, phosphate
EXOfos PA-1300	52933-07-0	Isotridecyl phosphate
EXOfos PB-043	50769-39-6	Butyl Alcohol Ethoxylate, Phosphate
EXOfos PB-043K	-	Butyl Alcohol Ethoxylate, Phosphate, potassium salt
EXOfos PB-065	68585-15-9	C6-C10 alcohols, ethoxylated, phosphate
EXOfos PB-083	68439-39-4	PEG-3 2-Ethylhexyl Phosphate
EXOfos PB-103	52019-36-0	PEG-3 decyl phosphate
EXOfos PB-133	9046-01-9	PEG-3 isotridecyl phosphate
EXOfos PB-136	9046-01-9	PEG-6 isotridecyl phosphate
EXOfos PB-136B	9046-01-9	PEG-6 isotridecyl phosphate
EXOfos PB-136R	9046-01-9	PEG-6 isotridecyl phosphate
EXOfos PB-137	73038-25-2	PEG-7 isotridecyl phosphate
EXOfos PB-138	9046-01-9	PEG-8 isotridecyl phosphate
EXOfos PB-139	9046-01-9	PEG-9 isotridecyl phosphate
EXOfos PB-184	39464-69-2	PEG-4 oleyl phosphate
EXOfos PB-1810	39464-69-2	Alcohols, C16-18, ethoxylated, phosphates
EXOfos PB-253	68071-35-2	PEG-3 C12-15 alkyl phosphate
EXOfos PB-257	68071-35-2	PEG-7 C12-15 alkyl phosphate
EXOfos PB-264	68511-37-5	PEG-4 lauryl phosphate
EXOfos PB-267	68511-37-5	PEG-7 lauryl phosphate
EXOfos PB-269	68511-37-5	PEG-9 lauryl phosphate
EXOfos PF-623	68130-47-2	C8 – C10 alcohol, ethoxylated, phosphate
EXOfos PD-103LP	-	Mixture: PEG-3 decyl phosphate and Alkoxyated alcohols
ROKAfos 1013	9046-01-9	PEG-10 isotridecyl phosphate
ROKAfos 385	-	2-ethylhexanol polyethylene glycol ether phosphate, sodium salt
ROKAnol PL10	-	Diethanolamine salt of polyoxyethylated (10) and phosphated C12-C14 alcohol
EXOfos PB-104K	68070-99-5	PEG-4 decyl phosphate, potassium salt
EXOfos PC-099E	51811-79-1	Polyethylene glycol nonylphenyl ether phosphate
EXOfos PT-E	90093-37-1	Ethoxylated alkylaryl phenol polyphosphate, acid
EXOfos PT-K60	163436-84-8	Polyarylphenyletherphosphate, potassium salt
EXOfos PT-A75	105362-40-1	Polyarylphenyletherphosphate, Amine salt



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