EXOfos SERIES and ROKAfos 385

pcc Exol

EXOfos SERIES and ROKAfos 385

Chemical description

EXOfos Series is a line of highly active anionic surfactants - acidic phosphate esters. Products are manufactured with inherent mono- and diester content having residual phosphoric acid, alkoxylated and non-alkoxylated materials.

Applications:

- Industrial and institutional cleaning
- Laundry detergents
- Hard surface cleaning

Benefits:

- effective ingredient of laundry detergents
- good cleaning properties
- excellent solubilizing properties
- good wetting properties
- good temperature resistance
- compatible with wide range of nonionic surfactants
- compatible with other additives

Additional information

BASIC PHYSICAL AND CHEMICAL PROPERTIES	EXOfos PB-083	EXOfos PB-103	EXOfos PB-136	EXOfos PB-136B	EXOfos PB-139	EXOfos PB-264	ROKAfos 385
CAS Number	68439-39-4	52019-36-0	9046-01-9	9046-01-9	9046-01-9	68511-37-5	-
INCI Name	POE (3) 2-Ethylhexyl Phosphate	POE (3) C10 alcohol phosphate	POE (6) Tridecyl Ether Phosphate	POE (6) Tridecyl Ether Phosphate	POE (9) Tridecyl Ether Phosphate	POE (4) Lauryl Phosphate	2-ethylhexanol polyethylene glycol ether phosphate, sodium salt
Appearance at (20÷25)°C temperature	(40÷45)°C: clear to slightly opaque yellow liqiud	clear to slightly opaque yellow liqiud	clear to turbid hazy liquid	clear to turbid hazy liquid	clear to turbid hazy liquid	viscous liquid	clear to turbid viscous liquid
Color (Gardner) at (20 ÷ 25)°C	(at 40°C) max 2	(at 40°C) max 2	(at 40°C) max 2	(at 40°C) max 2	(at 40°C) max 3	max 2	max 1 (50% water solution)
pH	-	-	(1%solution) 1.0 ÷ 2.5	-	-	max 1.2	(10% solution) 6.0 ÷ 7.0
Acid Value (to the first inflection point), mg KOH/g	90 ÷ 130	80 ÷ 110	60 ÷ 90	75 ÷ 85	record (50 ÷ 70)	90 ÷ 110	-
Acid Value (to the second inflection point), mg KOH/g	180 ÷ 200	160 ÷ 190	90 ÷ 150	120 -150	87 ÷ 117	150 ÷ 180	-
Water, % (m/m)	max 1	max 1	max. 1	max. 0.8	max 1.0	max 2.0	13 ÷ 15
Active substance, %(m/m)	approx 100	approx 100	approx 100	approx 100	approx 100	approx 100	85 ÷ 87
Density at 25°C, g/mL	approx 1.08	approx 1.07	approx 1.05	approx 1.05	approx 1.05	approx 1.03	1.115
Viscosity at 25°C, cP	approx 700	approx 400	approx 1000	approx 750	approx 1500	approx 800	(at 25°C) 1506
Surface tension of 0.1% solution at 25°C, mN/m	30	27	28	28	35	32	35

Solubility

The solubility of EXOfos Series and ROKAfos 385 in water and other solvents is shown in the table below:

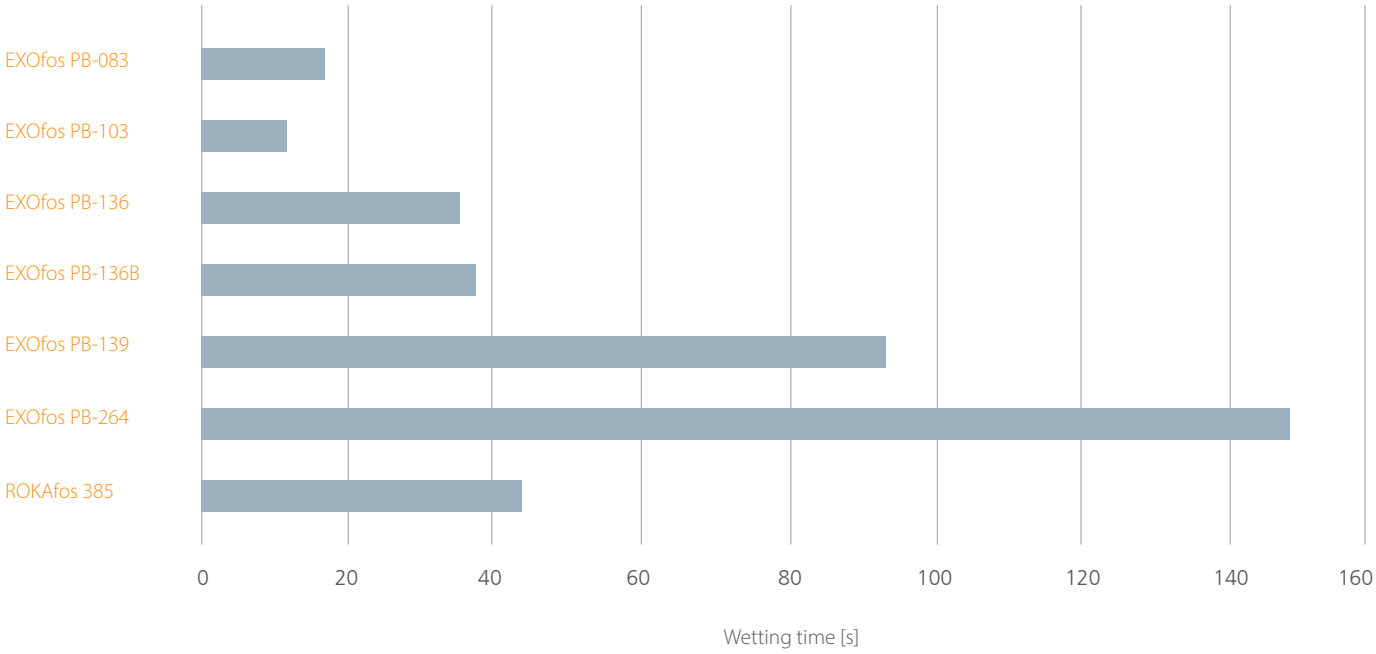
PRODUCT NAME	DEMINERALIZED WATER	METHANOL	ACETONE	ETHYL ETHER
EXOfos PB-083	●	●	●	●
EXOfos PB-103	●	●	●	●
EXOfos PB-136	●	●	●	●
EXOfos PB-136B	●	●	●	●
EXOfos PB-139	●	●	●	●
EXOfos PB-264	●	●	●	●
ROKAfos 385	●	●	●	●

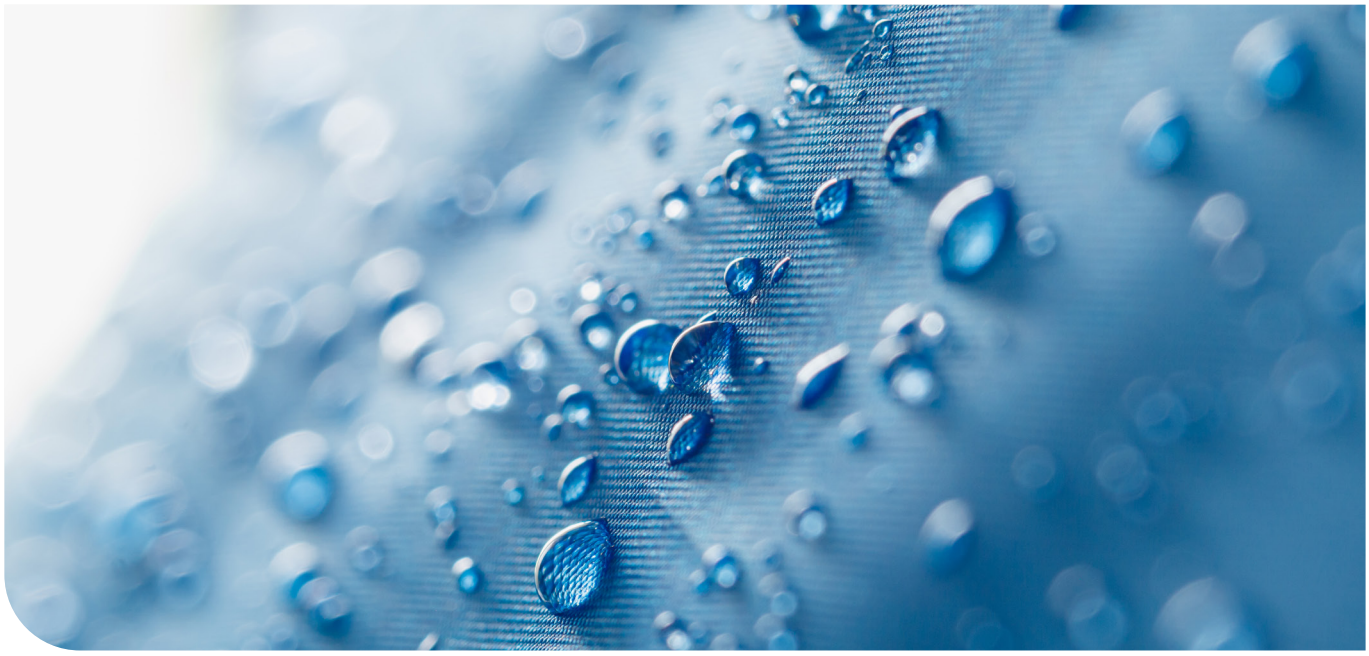
● soluble ● insoluble ● partially soluble

Wetting capability

Surfactants reduce the surface tension of liquids in which they are dissolved. Thanks to them, any liquid (usually water) has greater wetting capability, which increases its ability to get as close as possible to the solid body. This is very important for many surfactant applications, especially in cleaning processes.
The capability of wetting cotton fabric was determined in accordance to PN-EN 1772:2001 Standard.

Concentration of 1.0 g/l, demineralized water; temperature 20°C

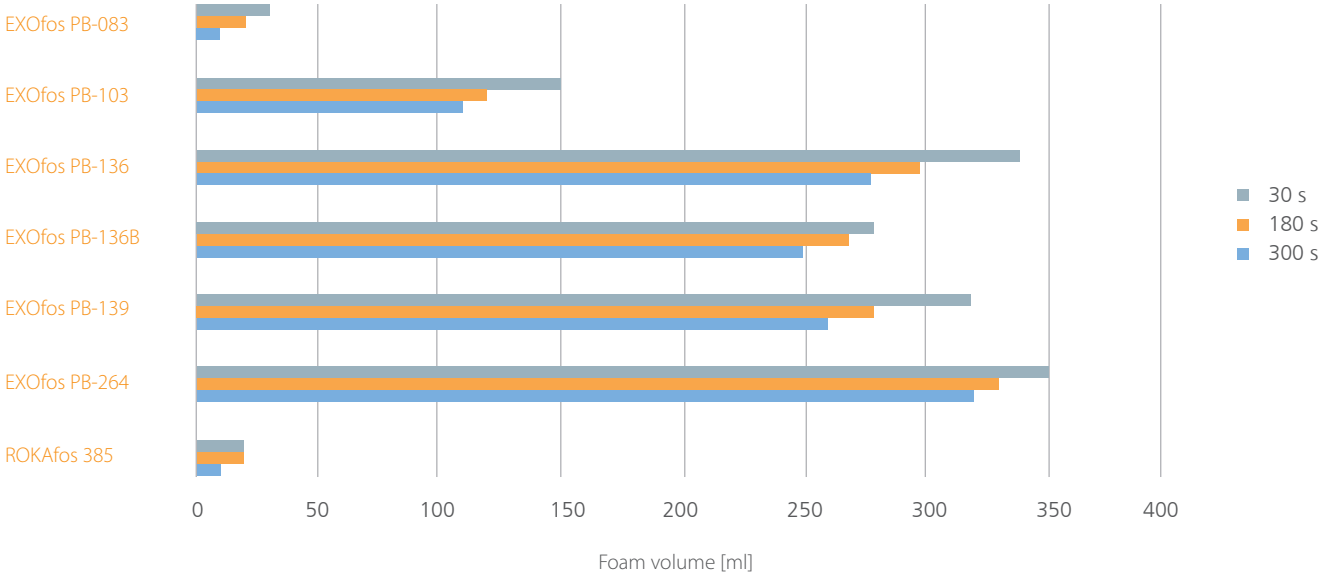




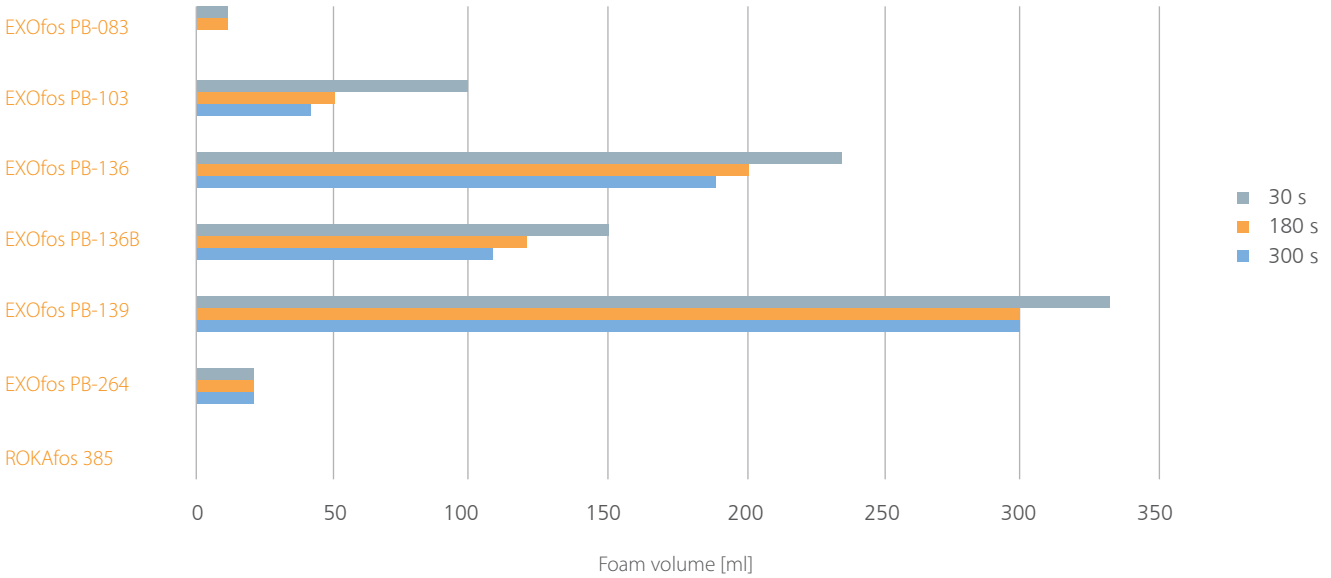
Foaming capability

Foam is a heterogeneous system in which the liquid is the continuous phase and the dispersed phase is gas. Foams, as well as emulsions, are thermodynamically unstable systems, so surfactant molecules on the interface are required to stabilize them. The ability of foaming is important in many industrial applications including detergents, where it prevents the surfaces from getting dirty again during washing or cleaning processes. The determination of the foaming capability was performed according to PN-ISO 696: 1994 Standard (the modified Ross-Miles method) at a temperature of 25°C, for a surfactant concentration of 1 g/l in both hard (17°d) and demineralized water.

Concentration of 1.0 g/l, demineralized water; temperature 25°C



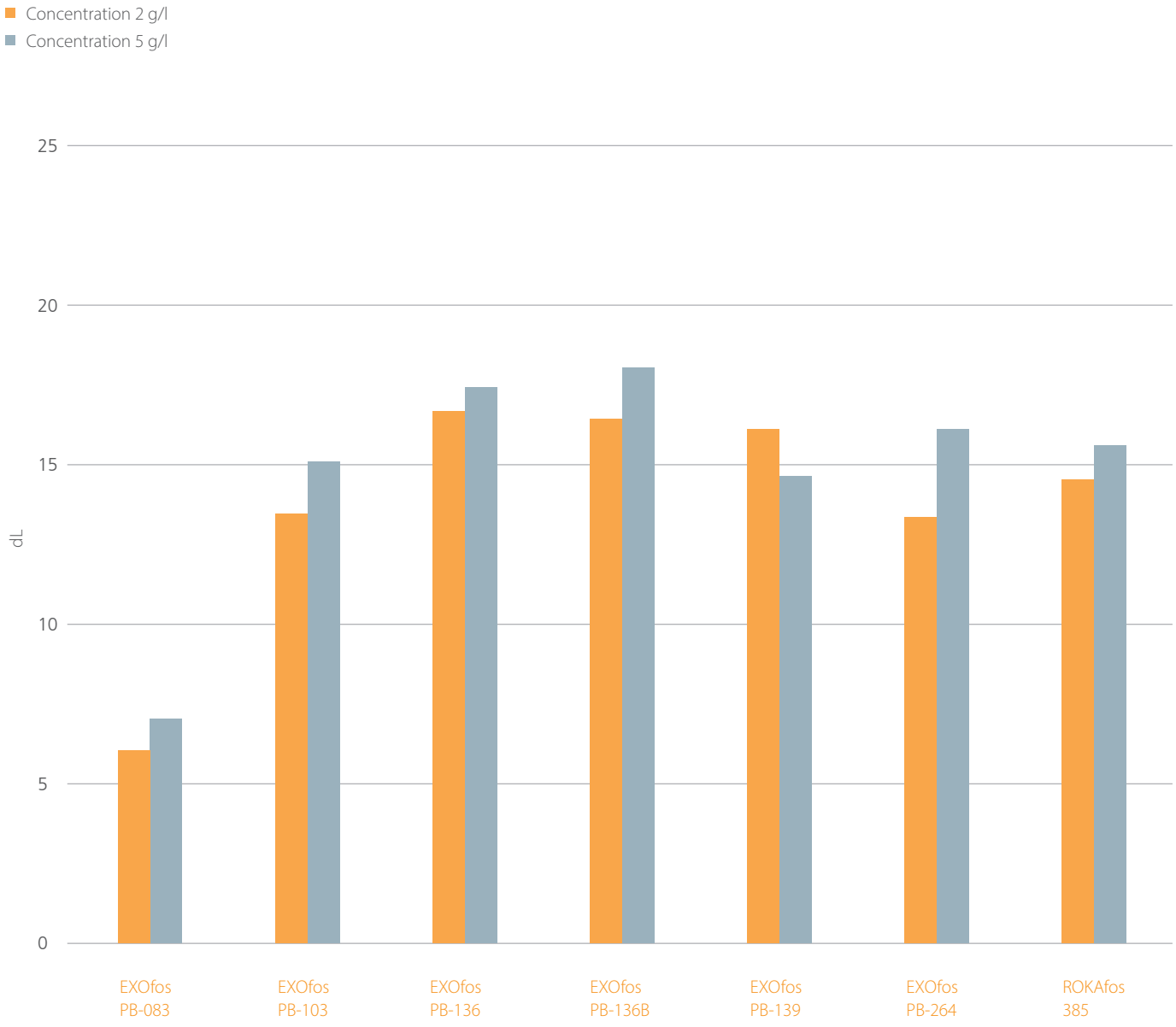
Concentration of 1.0 g/l, hard water; temperature 25°C



Detergency on a cotton fabric

Determination of detergency on a cotton fabric is tantamount to assessing the effectiveness of washing with the use of surfactants. Detergency tests were performed according to PCC EXOL S.A. own method, using EMPA 125 pieces of fabric (cotton), soiled with a mixture of oils and pigments that were washed in EXOfos Series and ROKAfos 385 solutions.

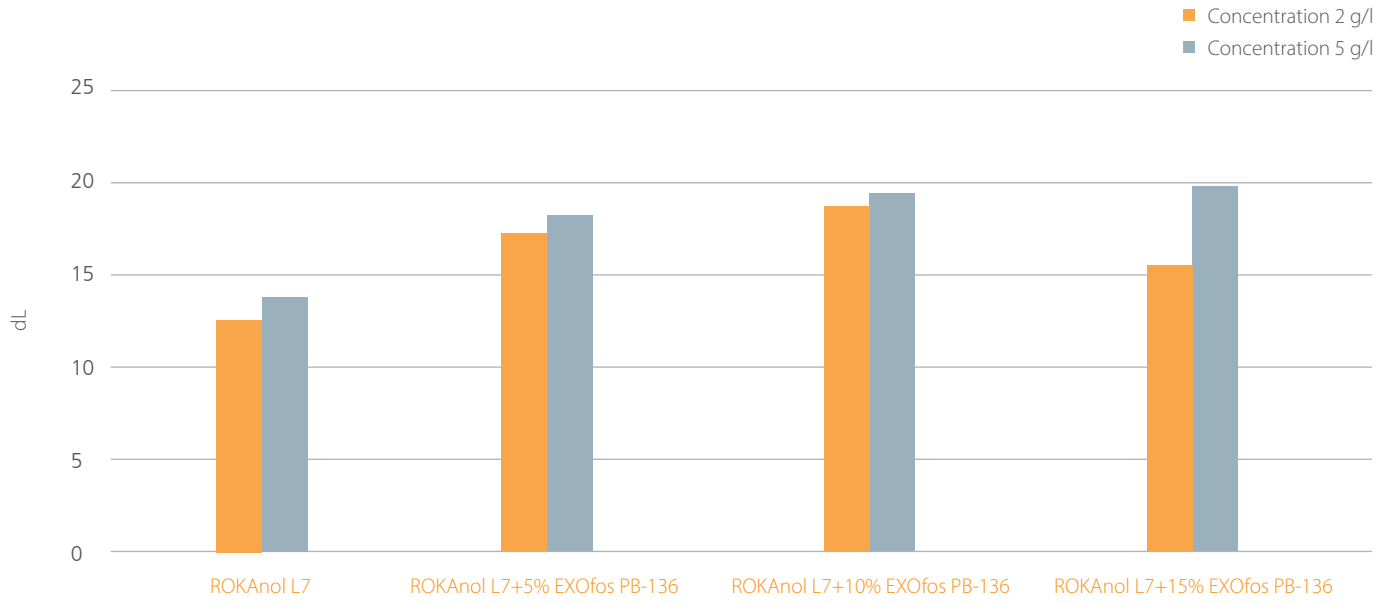
Cotton fabric detergency results in dL units



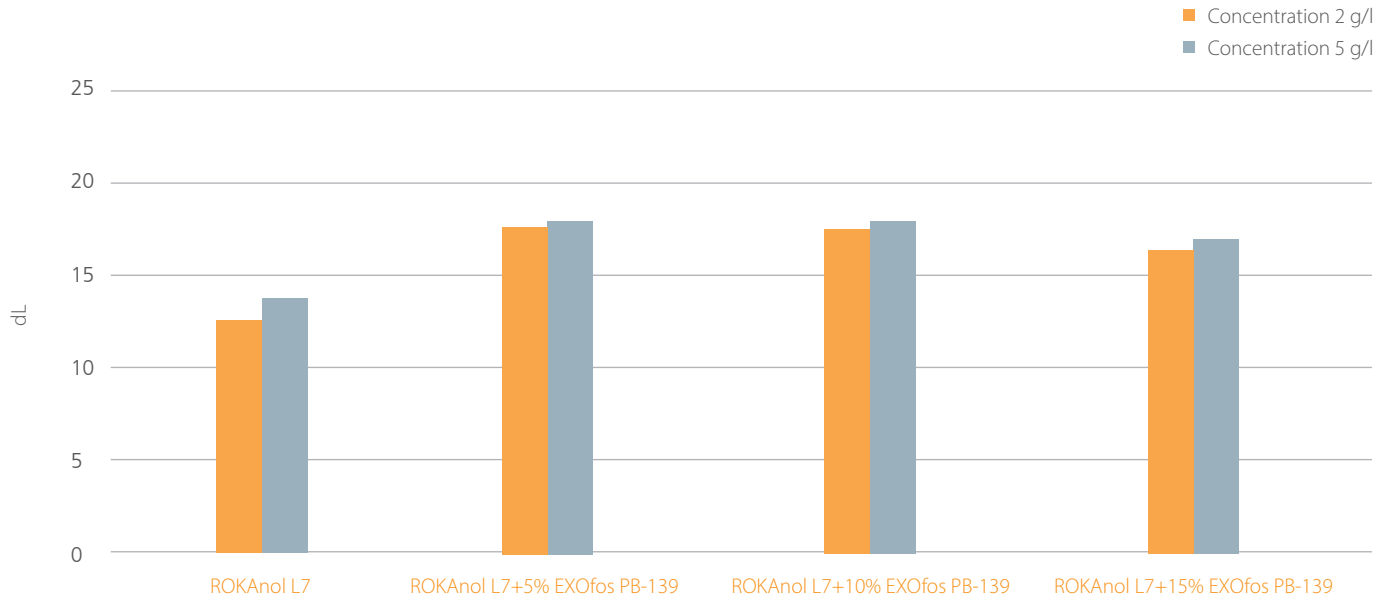
The cleaning process is described by the dL parameter in accordance with the CIE LAB method. The standard is the soiled fabric, so the higher the value of the dL parameter, the better the tested fabric is cleaned.

The effect of the additive EXOfos PB-136 and EXOfos PB-139 on the detergent cleaning properties of ROKAnol L7 - a standard nonionic surfactant used in laundry detergents - was also investigated. Three concentrations of EXOfos products were tested: 5%, 10% and 15%. In addition, these systems were tested at pH 8. It turns out that the addition of 5% of the EXOfos PB-136 or EXOfos PB-139 improves the detergent cleaning properties compared to ROKAnol L7. Increasing the pH of the tested mixtures also improves the effectiveness of the standard surfactant used in this application.

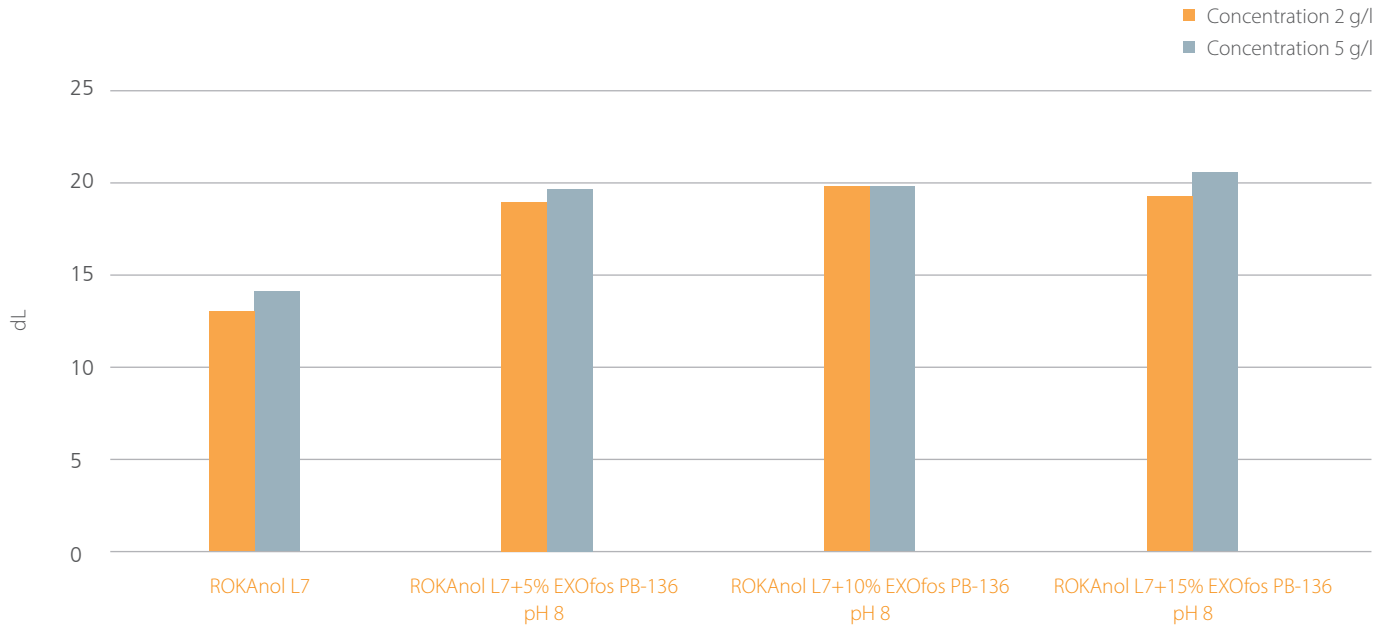
Cotton fabric detergency results for ROKAnol L7 (INCI: Laureth-7) with the addition of **EXOfos PB-136** (5%, 10% and 15%)



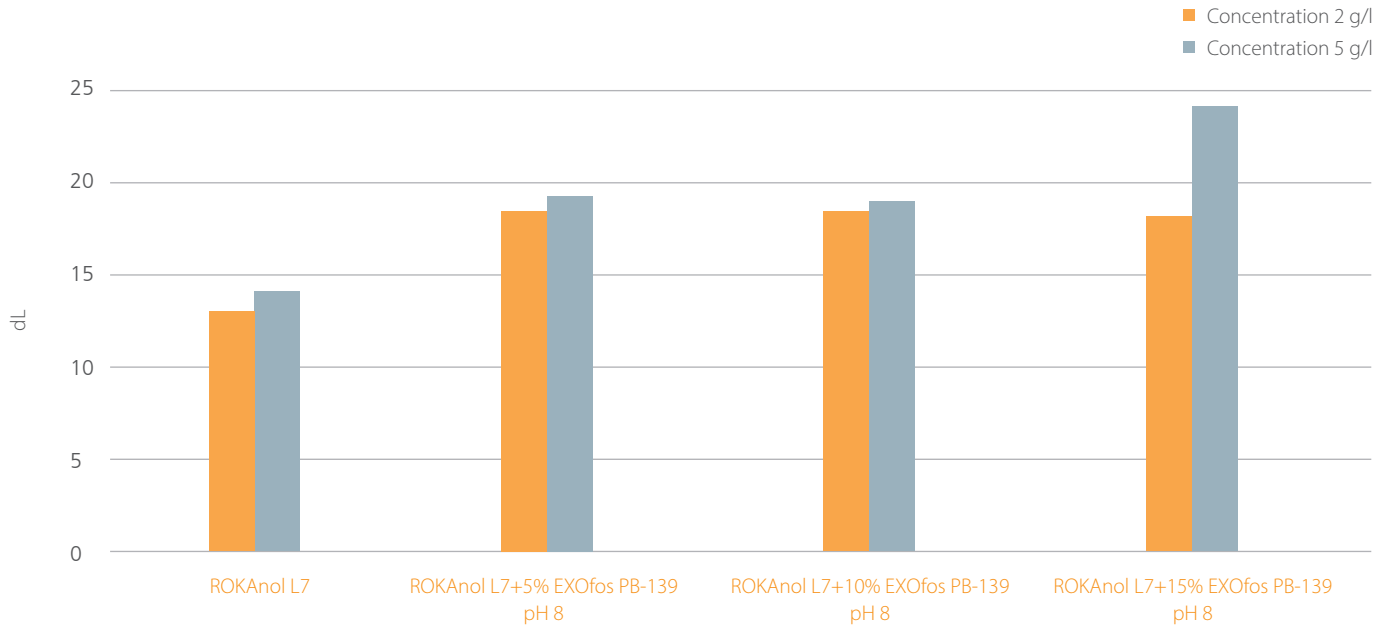
Cotton fabric detergency results for ROKAnol L7 (INCI: Laureth-7) with the addition of **EXOfos PB-139** (5%, 10% and 15%)



Cotton fabric detergency results for ROKAnol L7 (INCI: Laureth-7) with the addition of **EXOfos PB-136** (5%, 10% and 15%, pH 8)



Cotton fabric detergency results for ROKAnol L7 (INCI: Laureth-7) with the addition of **EXOfos PB-139** (5%, 10% and 15%, pH 8)



Alkali and acid resistance

Surfactants used in industrial cleaning have to be resistant to strong acids or alkalis. Acidic cleaning detergents are mainly used to remove mineral deposits from acid-resistant surfaces, while alkaline detergents are known primarily for their remarkable degreasing properties.

The analysis of this stability for EXOfos Series and ROKAfos 385 has been performed in accordance with the PN-EN 14712:2005 Standard.

NaOH CON. [g/l] PRODUCT NAME	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280
EXOfos PB-083	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o
EXOfos PB-103	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o	o	o	o	o
EXOfos PB-136	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o	o	o	o
EXOfos PB-136B	•	•	•	•	•	•	•	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
EXOfos PB-139	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o	o	o	o	o	o	o	o
EXOfos PB-264	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o	o	o	o	o	o	o	o	o	o
ROKAfos 385	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	o	o	o	o	o	o	o

º macroscopic phase separation
• homogeneous, cloudy solution
• clear, homogeneous solution
• homogeneous, opalescent solution

Acid resistance (Sulphuric acid); concentration of 1%; temperature 20°C

H_2SO_4 CON. [ml/l] PRODUCT NAME	1	10	40	60	100	105	140	225
EXOfos PB-083	o	o	o	o	o	o	o	o
EXOfos PB-103	o	o	o	o	o	o	o	o
EXOfos PB-136	o	o	o	o	o	o	o	o
EXOfos PB-136B	o	o	o	o	o	o	o	o
EXOfos PB-139	•	•	•	•	•	•	•	•
EXOfos PB-264	o	o	o	o	o	o	o	o
ROKAfos 385	o	o	o	o	o	o	o	o

º macroscopic phase separation
• homogeneous, cloudy solution
• clear, homogeneous solution
• homogeneous, opalescent solution

Acid resistance (Hydrochloric acid); concentration of 1%; temperature 20°C

HCl CON. [ml/l] PRODUCT NAME	1	10	40	60	120	140	225
EXOfos PB-083	o	o	o	o	o	o	o
EXOfos PB-103	o	o	o	o	o	o	o
EXOfos PB-136	o	o	o	o	o	o	•
EXOfos PB-136B	o	o	o	o	o	o	•
EXOfos PB-139	•	•	•	•	•	•	•
EXOfos PB-264	o	o	o	o	o	o	o
ROKAfos 385	o	o	o	o	o	o	o

º macroscopic phase separation
• homogeneous, cloudy solution
• clear, homogeneous solution
• homogeneous, opalescent solution

Solubilizing properties

The tests were performed for EXOfos PB-139. Three samples of hard surface cleaning formulations were prepared. Two of them were alkaline systems and one was an acidic. Initial formulations were cloudy. The addition of EXOfos PB-139 made the formulations clear.

Composition of the formulation		Appearance before adding EXOfos PB-139	Appearance after adding EXOfos PB-139
ACIDIC FORMULATION			
SULFOBURSZTYNIAN DOSS70GP	2 g		
ROKAnol NL6	3 g		
Phosphoric acid (75%)	10 g		
Water	85 g		
+ EXOfos PB-139	10 g		
ALKALINE FORMULATION I			
ROKAnol IT9	5 g		
Tetrapotassium pyrophosphate	10 g		
Water	85 g		
+ EXOfos PB-139	5 g		
ALKALINE FORMULATION II			
ROKAnol L5P5	1,5 g		
NaOH (50%)	20 g		
Water	78,5 g		
+ EXOfos PB-139	10 g		

Formulations

ALLUMINIUM CLEANER

Brand name	Content [%]	Function
EXOfos PB-136	5 ÷12	Cleaner / wetting agent
ROKAnol DB7	3 ÷7	Cleaner / wetting agent / degreaser
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	2 ÷ 3
cloud point, °C	none
solidification point, °C	0
clarification temperature, °C	+4

Procedure:

1. Mix EXOfos PB-136 with water until dissolved.
2. Add ROKAnol DB7.
3. Mix until a homogenous solution is obtained.
4. Add other additives.

ALLUMINIUM /STAINLESS STEEL CLEANER

Brand name	Content [%]	Function
EXOfos PB-136 / EXOfos PB-139	10	Cleaner / wetting agent / degreaser
ROKAmina K30	5	Foaming agent / foam stabilizer
ROKAnol DB7	2	Cleaner / wetting agent / degreaser
Butyl glycol	5	Solvent
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	2 ÷ 3
cloud point, °C	none
solidification point, °C	0
clarification temperature, °C	+2

Procedure:

1. Mix ROKAnol DB7 with water until dissolved.
2. Then add ROKAmina K30 and mix.
3. Add EXOfos PB-136 or EXOfos PB-139 and butyl glycol.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

Formulations

RINSE AID FOR AUTOMATIC DISHWASHERS

Brand name	Content [%]	Function
EXOfos PB-139	2.5	Cleaner / wetting agent / degreaser
ROKAnol LP700	9	Cleaner / wetting agent
Citric acid, monohydrate	3	Chelator
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	2 ÷ 3
cloud point, °C	54 ÷ 61

Procedure:

1. Mix citric acid with water until dissolved.
2. Then add EXOfos PB-139 and ROKAnol LP700 - mix.
3. Mix until a homogenous solution is obtained.
4. Add other additives.

ECONOMIC RINSE AID FOR AUTOMATIC DISHWASHERS

Brand name	Content [%]	Function
EXOfos PB-139	2.5	Cleaner / wetting agent / degreaser
ROKAnol L7	5.5	Cleaner / wetting agent
ROKAnol L5P5	3.5	Cleaner / wetting agent / degreaser
Citric acid, monohydrate	3	Chelator
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	2 ÷ 3
cloud point, °C	60 ÷ 64

Procedure:

1. Mix citric acid with water until dissolved.
2. Then add EXOfos PB-139 and ROKAnol L7 and ROKAnol L5P5 - mix.
3. Mix until a homogenous solution is obtained.
4. Add other additives.

Formulations

BOTTLE WASH DETERGENT

Brand name	Content [%]	Function
EXOfos PB-083 / ROKAfos 385	5	Cleaner / wetting agent / degreaser
ROKAnol LP3135 / ROKAnol L5P5	1 ÷ 3	Cleaner / wetting agent
NaOH solid	5	pH regulator
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	13 ÷ 14
cloud point, °C	none
solidification point, °C	-4
clarification temperature, °C	-2

Procedure:

1. Mix NaOH with water until dissolved.
2. Then add EXOfos PB-083 or ROKafos 385 and mix.
3. Add non-ionic surfactant ROKAnol LP3135 or ROKAnol L5P5.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

HARD SURFACE CLEANER

Brand name	Content [%]	Function
EXOfos PB-139	2	Cleaner / wetting agent
ABSNa 30	5	Cleaner / wetting agent / degreaser
$Na_2SiO_3 \cdot 5H_2O$	0.5	pH regulator / active filler
Butyl glycol	3	Solvent
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	8 ÷ 9
cloud point, °C	none
solidification point, °C	+2
clarification temperature, °C	0

Procedure:

1. Mix Na_2SiO_3 with water until dissolved.
2. Then add EXOfos PB-139 and ABSNa 30 - mix.
3. Add solvent – butyl glycol.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

Formulations

HEAVY DUTY CLEANER

Brand name	Content [%]	Function
EXOfos PB-139	5	Cleaner / wetting agent
ROKAnol NL6	2	Cleaner / wetting agent / degreaser
EXOlat C40	1	Sequestrant
$Na_2SiO_3 \cdot 5H_2O$	0.5	pH regulator / active filler
NaOH solid	2	pH regulator
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	5 ÷ 7
cloud point, °C	none
solidification point, °C	+1
clarification temperature, °C	+3

Procedure:

1. Mix NaOH and Na_2SiO_3 with water until dissolved.
2. Then add EXOfos PB-139 and ROKAnol NL6 - mix.
3. Add EXOlat C40.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

LOW FOAM FLOOR CLEANER

Brand name	Content [%]	Function
EXOfos PB-139	6	Cleaner / wetting agent
ROKAnol GT8	2	Cleaner / wetting agent / degreaser
STPP, sodium tripolyphosphate	0.5	pH regulator / active filler
$Na_2SiO_3 \cdot 5H_2O$	0.5	pH regulator / active filler
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	4 ÷ 5
cloud point, °C	none
solidification point, °C	+1
clarification temperature, °C	+4

Procedure

1. Mix STPP with Na_2SiO_3 water until dissolved.
2. Then add EXOfos PB-139 and mix.
3. Add nonionic surfactant ROKAnol GT8.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

Formulations

LOW FOAM CARPET CLEANER

Brand name	Content [%]	Function
EXOfos PB-139	4	Cleaner / wetting agent
EXOsoft PC35	2	Cleaner / wetting agent / degreaser
ROKAnol L5P5	2	Sequestrant
Water & additives	up to 100%	Solvent and additives

Chemical properties

appearance at 20-25°C	clear liquid
pH at 25°C	3 ÷ 4
cloud point, °C	none
solidification point, °C	0
clarification temperature, °C	+21

Procedure:

1. Mix EXOfos PB-139 with water until dissolved.
2. Then add EXOsoft PC35 and mix.
3. Add ROKAnol L5P5.
4. Mix until a homogenous solution is obtained.
5. Add other additives.

PCC EXOL S.A.
Sustainable technologies for new generations

PCC EXOL S.A. is a company that combines cutting-edge technologies with rich experience in production of surfactants (surface active agents). The company is located in Brzeg Dolny (Poland), where anionic, nonionic and amphoteric surfactant production plants have been launched. Due to the flexible production processes, the company offers a wide spectrum of surfactants and industrial formulations, which are often suited for the individual customers operating in plenty of various industry sectors. As one of the leading surfactant manufacturers, PCC EXOL S.A. carries out new investment projects and implements innovative technologies based on the global sustainability trends.

PCC EXOL S.A. portfolio includes surfactants with a broad range of applications. Besides of the mass production for personal care and detregents industry, the substances produced by PCC EXOL S.A. also include specialized products used in various branches, such as textile, agrochemical, metal cleaning, oil drilling, building & construction, paints & coatings, paper industry, extraction & drilling, and many others.

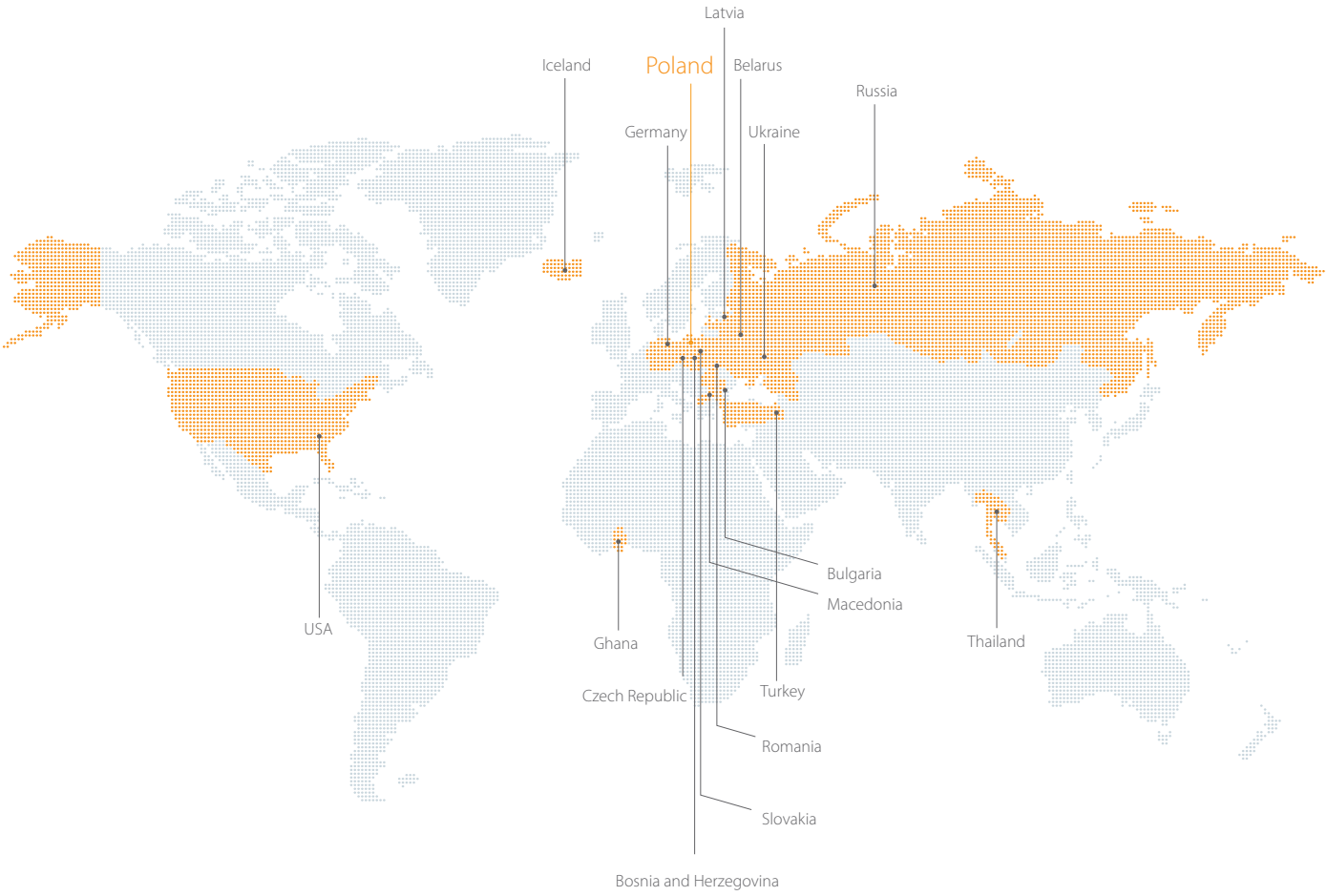
The company comprehensive portfolio is continuously enriched with new innovative products, which meet even the strictest market requirements and adapt to the individual needs of customers. This is possible due to the dynamic development of the research facili-

PCC EXOL S.A. combines innovative technologies with experience in designing, producing and selling surfactants and chemical formulations

ties, flexible production, knowledge as well as experienced personnel.

PCC EXOL S.A. has the key competence necessary for a worldwide production of surfactants. The ongoing projects will soon bring the new opportunities for the company's further development and expansion into new markets. The company offers not only a wide portfolio and professional servicing but most of all flexible production and comprehensive system solutions that meet individual customer demands. The strategic PCC EXOL S.A. investor is PCC SE, operating on international markets of the chemical raw materials, transport, energy, coal, coke, petrol, plastics and metallurgy. PCC SE includes 82 companies operating in 41 different locations in 18 countries.

PCC Group in the world



PCC Rokita S.A.

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