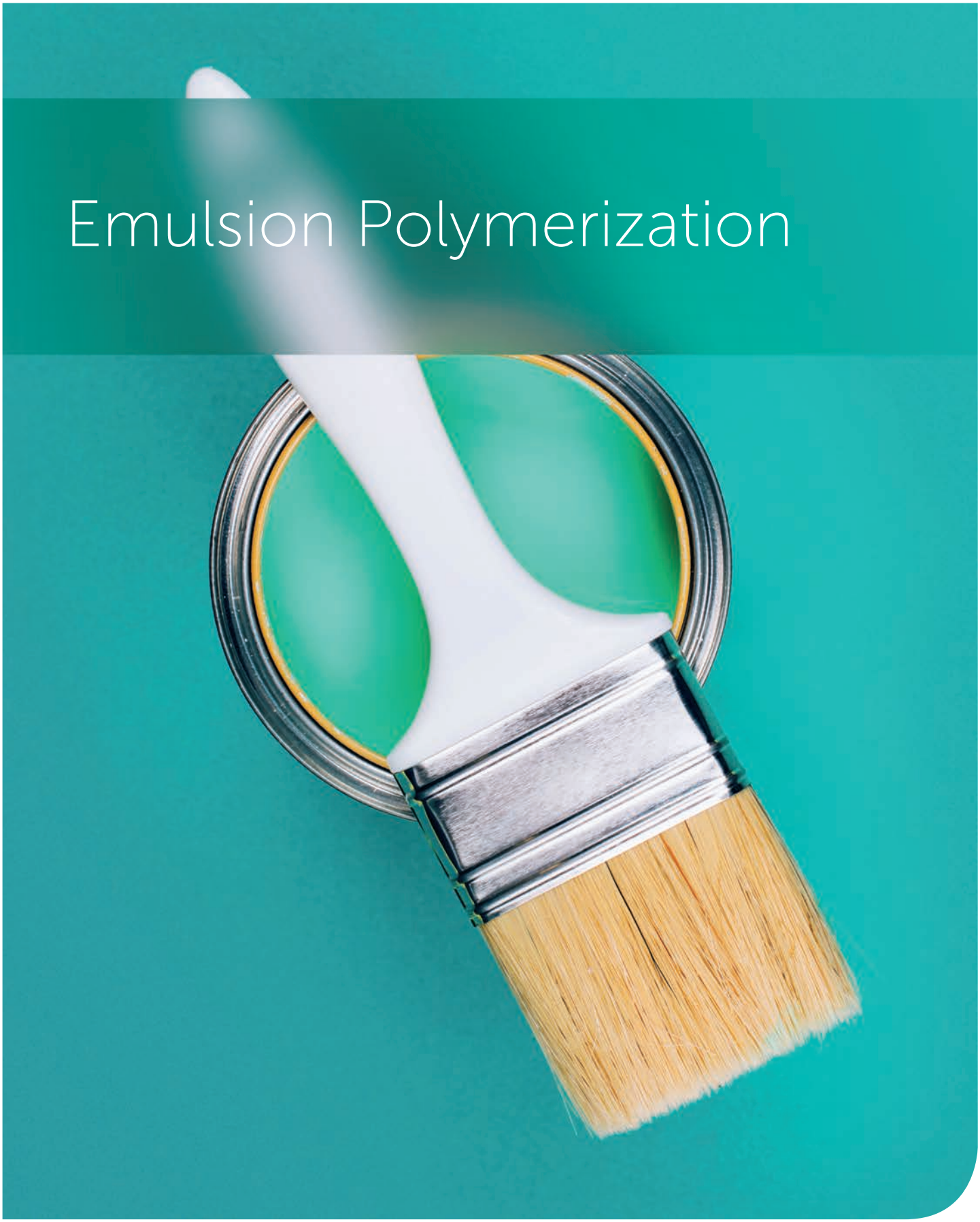
Emulsion Polymerization



pcc Exol

Introduction

Emulsion polymerization is a process used to manufacture polymer dispersions also called latexes for a wide variety of formulations including water-based paints, coatings for wood, nonwoven, adhesives, sealants, rubbers. All of these applications are often called CASE (Coatings, Adhesives, Sealants, Elastomers).

The big advantage of water-based products over solvent-borne is the reduction of environmental impact due to much lower level of VOC (volatile organic compounds) contained in formulations. Another significant advantage is easy to use and often no hazards labeling.

There are many process variations in emulsion polymerization. In the batch process the reaction is initiated when all portion of reagents present in the reactor. In the semi-continuous process - some reagents are added to the reactor at the beginning of the process and the remaining ingredients are dosed in controlled portions. Another process is the emulsion polymerization with pre-emulsion, where monomers, water and surfactants are mixed together to form an emulsion which is dosed during the synthesis. Seeded emulsion polymerization is a process where disperse a small amount of suspended fine particles of latex (seeds) is added to the reactor followed by feeding monomers, surfactants and initiators; the polymerization process starts in swelled latex particles. The seeds in latex suspension may be also prepared in situ as a first step of the emulsion polymerization.

The role of surfactants in emulsion polymerization

Anionic and nonionic surfactants are commonly used in emulsion polymerization as emulsifiers and latex stabilizers. Typical concentration of surfactants is in the range from a few tenth to 5%. Anionic surfactants may be used as a single emulsifier or often in combination with nonionic surfactants. Nonionic formulations are rarely used alone, mainly due to the tendency of forming solutions with greater particle sizes. Even if nonionic surfactant consists of primary emulsifier the small amount of anionic surfactant is often used to ensure lower particle size. The proper combination of nonionic and anionic emulsifiers is very important to provide good performance of the polymer dispersion. Anionic surfactants control particle size ensures good polymerization rate and electrostatic stability, whereas nonionic surfactants improve mechanical and electrolytic stability, ensuring also the resistance to freeze-thaw cycles.

Surfactants plays many roles in the emulsion polymerization process and are essential for latex manufacturing. Surfactants reduce the interfacial tension between insoluble monomers and water and form small monomer droplets in aqueous matrix. Surfactants have the tendency to form micelles which play an essential role during nucleation step of emulsion polymerization, as they create space where the polymerization occurs. As the reactions progresses the dimensions of micelles increase rapidly and when limit values are achieved, they break and form polymer particles. Each polymer particle is covered by surfactants to prevent their agglomeration. Using the mixture of anionic and nonionic surfactants is very common in emulsion polymerization as it helps to stabilize the formulation for specific applications and ensures polymer dispersion stability during transport and storage. Various types of latex stabilization by anionic and nonionic surfactants.

Various types of latex stabilization by anionic and nonionic surfactants.

Anionic surfactants are absorbed on polymer particles and surround them by electric charges. The electrostatic layer forms an energy barrier for other particles preventing their agglomeration. Anionic surfactants have the ability to stabilize small particles of dispersion by electrostatic repulsion thus they often used during nucleation process. The main disadvantage of anionic surfactants is their high sensitivity to the presence of electrolytes.

Nonionic surfactants ensure the latex stabilization by adsorption on polymer particles, covering them by long polyethylene glycol chains, forming a steric barrier between other polymer particles. The steric forces are not as strong as electrostatic, resulting in increased dimensions of particles. However steric stabilization is far less sensitive to electrolytes and freezing.

PCC EXOL performance surfactants

Anionic emulsifiers

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Sulfates and sulfonates

ROSULfan L and D

Sodium lauryl sulfate (SLS) based on alcohol C12-14
Sodium salt of decyl C10 alcohol sulfate

Sodium lauryl and decyl sulfates are derived from natural oleochemical feedstock. The SLS is a commonly used emulsifier in emulsion polymerization for most monomer systems - acrylic, styrene-acrylic, vinyl acetate, and, EVA. Products with different distribution of the alcohol carbon chain are also available.

ABSNa and ABS

Alkyl benzene sulfonate (sodium salt)

Alkyl benzene sulfonate surfactants are derived from linear C10-C13 alkylate feedstock with high 2-phenyl content. Linear alkylbenzene sulfonate shows excellent acid/alkali stability and quite good hard water stability. The acid form of product can be used as intermediate for various kind of salts. Product is compatible with many polymers like styrene-butadiene rubber, styrene-acrylic, polyvinyl chloride and polyvinylidene chloride, EVA.

Alkyl ether sulfates

SULFOROKAnol L Series

Alkyl ether sulfate; with the range 1-12 EO

We supply alkyl ether sulfates based on different alcohols: natural C12-C14, C12-C16 and synthetic C12-C15, with varying degrees of ethoxylation. The products are available as solutions and concentrated pastes. Products with a higher ethoxylation degree ensure better electrostatic and steric stabilization to latex particles, significantly improving colloidal stability. Alkyl ethers sulfates have a better hard water tolerance then fatty alcohol sulfates. They can be used as a sole emulsifier or with other anionic and nonionic surfactant systems for all acrylic, styrene-acrylic, vinyl-acrylic, EVA lattices.

Sulfosuccinates

Sulfosuccinate L3/40

Disodium lauryl sulfosuccinate

Monoester of ethoxylated (4EO) lauryl alcohol and sulfosuccinic acid, sodium salt is an efficient anionic surfactant for most monomer systems - acrylic, styrene-acrylic, vinyl acetate, EVA. It provides very good electrostatic stabilization and small sizes of dispersed particles. It can be used in combination with nonionic surfactants in order to improve mechanical stability and freeze-thaw and reduce particle size. Products based on different degree of ethoxylation and fatty alcohols feedstock are also available.

Sulfosuccinate DOSS

Dioctyl sulfosuccinate sodium salt sulfosuccinate (sodium salt)

Diester of 2-ethyl hexyl alcohol is an excellent wetting and leveling agent for binders and coating formulations. This product has a strong tendency to reduce the surface tension. DOSS used as a co-emulsifier in emulsion polymerization process provides also excellent emulsification capabilities for hydrophobic monomers like styrene, 2-ethylhext acrylate, butyl acrylate.

PRODUCT CHARACTERISTIC						PRODUCTS GROUP							
PRODUCT NAME	DESCRIPTION	CAS	APPEARANCE	HLB	ACTIVE	Vinyl acetate & copolymers	Styrene Acrylics	Acrylics	Styrene butadiene rubber	Polyvinyl chloride	Nitrile rubber	Chloroprene rubber	APE - free	Post-polymerization stability
ABSNa 30	Sodium Dodecylbenzenesulfonate	68411-30-3	Liquid	-	28-32	●	●	o	●	●	●	●	●	
ROSULfan A	Ammonium Lauryl Sulfate	931-558-1	Liquid	-	26-28	o	●	●	●	●			●	
ROSULfan L	Sodium Lauryl Sulfate	85586-07-8	Liquid	-	27.5-30	o	●	●	●	●			●	
SULFOROKAnol L225/1	Sodium Laureth Sulfate + 2 EO	68891-38-3	Liquid	-	26-28	o	●	●	●	●			●	
SULFOROKAnol L270/1	Sodium Laureth Sulfate + 2 EO	68891-38-3	Paste/Liquid gel	-	26-28	o	●	●	●	●			●	
SULFOROKAnol L327/1	Sodium Laureth Sulfate + 3 EO	13150-00-0	Liquid	-	27-29	o	●	●	●	●			●	
SULFOROKAnol L370/1	Sodium Laureth Sulfate + 3 EO	13150-00-0	Paste/Liquid gel	-	27-29	o	●	●	●	●			●	
SULFOROKAnol L1230/1A	Sodium Laureth Sulfate + 12 EO	9004-82-4	Liquid	-	29-31	●	●	●	●	o			●	o
Sulfosuccinate L3/40	Disodium Laureth Sulfosuccinate	68815-56-5	Liquid	-	min. 38	●	●	●	o				●	
Sulfosuccinate DOSS 70GP	Di (2ethylhexyl)sulfosuccinic acid, sodium salt	577-11-7	Liquid	-	min. 70	o	o	o	o	●	o	●	●	

● highly recommended o recommended

Nonionic emulsifiers

PCC Exol manufactures a broad range of nonionic products for emulsion polymerization. The product portfolio includes both commodity and special emulsifiers and latex additives. Our product range covers ethoxylates and alkoxylates of nonylphenol, fatty alcohols, acids and vegetable oils, fatty amines and amides and block copolymers of ethylene oxide and propylene oxide.

We manufacture our product based on alcohols derived from both - petrochemical and natural sources with extensive range of carbon chains distribution ranging from C9-C18. With the appropriate method of conducting the reaction with ethylene oxide, it is possible to obtain a range of products with various ethoxylation degrees. Products based on other oleochemical feedstock are available upon request.

Fatty alcohol ethoxylates and alkoxylates

ROKAnol L Series

Lauryl alcohol ethoxylates and alkoxylates

Products of ROKAnol L series are commonly used environmental friendly alternative for nonylphenol ethoxylates. They are available in various degree of ethoxylation and propoxylation ranging from 2 to 50. ROKAnol LI0/80 is recommended as a standard alternative for ethoxylated nonylphenol (10EO), providing good emulsification capability and latex performance of styrene-acrylic and full acrylic binders. Higher ethoxylates of lauryl alcohol e.g. ROKAnol L30A (30EO) can be used as latex post-stabilizers that improve stabilization of various kind of polymers lattices or as emulsifier for p-VAc. Typically, we recommend to use our ROKAnols in combination with various anionic surfactants.

ROKAnol T, K and O Series

C16-C18 unsaturated and saturated alcohol ethoxylates

Linear fatty alcohols with C16-C18 carbon chains distribution are excellent emulsifiers for emulsion polymerization. ROKAnol T18, K18, K21 and 020 are effective emulsifiers for polymerization of vinyl acetate and copolymer. The main difference between ROKAnols T, K and O is in the iodine value of oleochemical feedstock. ROKAnol T is completely saturated but products of K and O series are based on partly unsaturated fatty alcohols. The unsaturation degree influences slightly the HLB value and emulsification efficiency as well as viscosity of obtained polymer dispersions. ROKAnol K21 and K18 can be also used as post-additives to improve freeze-thaw stability. Other degree of ethoxylation is possible to obtain, based on this oleochemical feedstock.

ROKAnol ID and IT Series

Isodecyl and Iso-tridecyl alcohol ethoxylates

Ethoxylates of fully branched synthetic alcohols of isotridecanol and isodecanol are more soluble in water and possess lower foaming capacity and a higher cloud-point then linear type of ethoxylates. ROKAnol ITO and IT12 are suitable as an alternative for NPEs for most commonly used monomer systems including styrene and acrylates.

PRODUCT CHARACTERISTIC						PRODUCTS GROUP									
PRODUCT NAME	DESCRIPTION	CAS	APPEARANCE	HLB	ACTIVE	Vinyl acetate & copolymers	Styrene Acrylics	Acrylics	Styrene butadiene rubber	Polyvinyl chloride	Nitrile rubber	Chloroprene rubber	APE - free	Low foam	Post-polymerization stability
ROKAnol DB11W	Alcohols, C12-15 + 11 EO	68131-39-5	Oily liquid/ Paste	13.6	min. 90.0		•	o	o	o			•		
ROKAnol ID8	Alcohols, C10-Iso + 8 EO	68439-45-2	Liquid	13.8	min. 99.5		•	o	o	o			•		
ROKAnol IT8	Alcohols, C13, branched + 8 EO	69011-36-5	Liquid/Paste	12.8	min. 99.5		•	o	o	o			•		
ROKAnol IT9	Alcohols, C13, branched + 9 EO	69011-36-5	Oily liquid/ Paste	13.2	min. 99.0		•	o	o	o			•		
ROKAnol IT10	Alcohols, C13, branched + 10 EO	69011-36-5	Liquid	13.8	min. 99.5		•	o	o	o			•		
ROKAnol IT12	Alcohols, C13, branched + 12 EO	69011-36-5	Liquid/Paste	14.5	min. 99.0		•	o	o	o			•		
ROKAnol K14	Alcohols, C16-18 unsaturated + 14 EO	9005-04-3	Paste/Wax	14.0	min. 99.0		•	o	o	o			•		
ROKAnol K18	Alcohols, C16-18 unsaturated + 18 EO	9005-04-3	Paste/Wax	15.8	min. 99.0	•	•	•	o	o			•		•
ROKAnol K21	Alcohols, C16-18 unsaturated + 21 EO	9005-04-3	Paste/Wax	16.5	min. 99.5	•	•	•	o	o			•		•
ROKANOL L10/80	Alcohols, C12-14 + 10 EO	68551-12-2	Viscous liquid	13.8	min. 80.0		•	o	o	o			•		o
ROKAnol L22	Alcohols, C12-14 + 22 EO	68551-12-2	Wax	17.0	min. 99.7	o	•	•	o	o			•		o
ROKANOL L30A	Alcohols, C12-14 + 30 EO	68551-12-2	Wax	18.0	min. 99.7	•	•	•	o	o			•		•
ROKAnol L30A/65	Alcohols, C12-14 + 30 EO	68551-12-2	Viscous iquid	18.0	64-66	•	•	•	o	o			•		•
ROKAnol L80/50W	Alcohols, C12-14 + 10EO/PO	68551-12-2	Viscous liquid	17.6	47-51	•	•	•		o			•	o	o
ROKAnol O18	Alcohols, C16-18 unsaturated + 18 EO	9004-98-2	Paste	15.6	min. 99.0	•	•	•	o	o			•		•
ROKAnol O20	Alcohols, C16-18 unsaturated + 20 EO	9004-98-2	Paste	16.3	min. 99.0	•	•	•	o	o			•		•
ROKANOL T12	Alcohols, C16-18 + 12 EO	68439-49-6	Wax	13.5	min. 99.5		•	•	o	o			•		
ROKAnol T18	Alcohols, C16-18 + 18 EO	68439-49-6	Wax	15.8	min. 99.0	•	•	•	o	o			•		•

• highly recommended o recommended

Fatty acids and vegetable oils ethoxylates

ROKAcet R and S Series

Stearic acid and castor oil ethoxylates

Ethoxylates of stearic acid and castor oil are used as emulsifiers, stabilizers and dispersants for many water-based coatings formulations. As post-additives, they improve freeze-thaw stability and electrolyte tolerance. They also have very good emulsification capabilities for many types of solvents, fatty acids, waxes.

ROKAcet R and S series - product list

PRODUCT CHARACTERISTIC						PRODUCTS GROUP								
PRODUCT NAME	DESCRIPTION	CAS	APPEARANCE	HLB	ACTIVE	Vinyl acetate & copolymers	Styrene Acrylics	Acrylics	Styrene butadiene rubber	Polyvinyl chloride	Nitrile rubber	Chloroprene rubber	APE - free	Post-polymerization stability
ROKAcet S24	Stearate + 24EO	9004-99-3	Wax	15.8	min 99.0	•	•	o	o	o			•	o
ROKAcet R40	Castoroil + 40EO	61791-12-6	Paste	13.0	min 99.0		•	•	o	o			•	o
ROKACET R70	Castoroil +70EO	61791-12-6	Paste	15.4	min 99.0	•	•	•	o	o			•	•

Alkylphenol ethoxylates and alcoxylates

ROKAfenol N Series

Nonylphenol ethoxylates

Nonylphenol ethoxylates ensure excellent steric stabilization to the latex, improve resistance against freeze-thaw cycles, increase temperature stability and enhance hard water tolerance. ROKAfenols N can be used in combination with various anionic surfactants including ABSNa, ROSULfan L, Sulfosuccinate L3/40 and SULFOROKAnols L. Our nonylphenol ethoxylates are available in various degrees of ethoxylation, ranging from 4-40. The proper control of the production process ensures low PEG level and narrow ethoxylates distribution in our NPE products.

ROKAfenol N Series - product list

PRODUCT CHARACTERISTIC						PRODUCTS GROUP							
PRODUCT NAME	DESCRIPTION	CAS	APPEARANCE	HLB	ACTIVE	Vinyl acetate & copolymers	Styrene Acrylics	Acrylics	Styrene butadiene rubber	Polyvinyl chloride	Nitrile rubber	Chloroprene rubber	APE - free	Post-polymerization stability
ROKAfenol N10	Nonylphenol+10EO	127087-87-0	Oily liquid	13.3	min 99.0		●	o	o	o		●		
ROKAfenol N12	Nonylphenol+12EO	127087-87-0	Oily liquid	14.0	min 99.0		●	o	o	o		●		
ROKAfenol N14	Nonylphenol+14EO	127087-87-0	Oily liquid	15.0	min 99.0	o	●	o	o	o	o	●		
ROKAfenol N22	Nonylphenol+22EO	127087-87-0	Paste/Wax	16.2	min 99.0	●	●	●	o	o	●	●		
ROKAfenol N22/30	Nonylphenol+22EO	127087-87-0	Liquid	16.2	25-26.5	●	●	●	o	o	●	●		
ROKAfenol N40/70	Nonylphenol+30EO	127087-87-0	Wax	17.6	69-71	●	●	●	o	o	●	●		●
ROKAfenol N40	Nonylphenol+40EO	127087-87-0	Liquid	17.8	min 99.0	●	●	●	o	o	●	●		●

PEG/PPG block copolymers

ROKAmers

PEG/PPG block copolymers

Nonionic surfactants composed of 3-block segments of PEG/PPG/PEG have versatile properties and application performance depending on their molecular weight and ratio of ethylene oxide to propylene oxide in the molecule. Products with low EO contents (ROKAmer 2000) show anti-foaming properties, whereas products with higher EO content (ROKAmer 1010) act as emulsifiers and dispersants.

PEG/PPG block copolymers - product list

PRODUCT CHARACTERISTIC						PRODUCTS GROUP									
PRODUCT NAME	DESCRIPTION	CAS	APPEARANCE	HLB	ACTIVE	Vinyl acetate & copolymers	Styrene Acrylics	Acrylics	Styrene butadiene rubber	Polyvinyl chloride	Nitrile rubber	Chloroprene rubber	APE - free	Low foam	Post-polymerization stability
ROKAmer 2100	PEG/PPG Copolymer	9003-11-6	Clear liquid	3.4	min. 99	o	o	o	o	o			●	●	
ROKAmer 2330	PEG/PPG Copolymer	9003-11-6	Viscous liquid	4.9	min. 99	o	o	o	o	o			●	●	
ROKAmer 2950	PEG/PPG Copolymer	9003-11-6	Viscous liquid or semi-liquid paste	8.1	min. 99	o	o	o	o	o			●	●	
ROKAmer 1010	PEG/PPG Copolymer	9003-11-6	Wax	16.6	min. 99	o	●	●	o	o	o		●	●	
ROKAmer 1010/50	PEG/PPG Copolymer	9003-11-6	Viscous liquid	16.6	>50	o	●	●	o	o	o		●	●	
ROKAmer 2000	PEG/PPG Copolymer	9003-11-6	Clear or turbid liquid	2.4	min. 99	o	o	o	o	o			●	●	
ROKAmer 2600	PEG/PPG Copolymer	9003-11-6	Clear or turbid liquid	5.6	min. 99	o	o	o	o	o			●	●	

PCC Exol products in applications

Styrene/acrylic latex

The recipe shown below presents low MFFT styrene-acrylic dispersion that can be used as a binder for decorative paints. Sulfosuccinate L3/40 provides good pre-emulsion stability within the entire emulsion polymerization process and ensures small particles size of the final dispersion.
SULFOROKAnol LI 230/1A ensures both electrostatic and steric stabilization, providing higher particle sizes with their narrow distribution. Nonionic APEO-free surfactants - ROKAnol Land K Series ensures excellent electrolyte tolerance and can be used as alternatives for nonylphenol ethoxylates (APEO) emulsifiers. Particles size of the latex can be controlled by amount of Sulfosuccinate L3/40 or SULFOROKAnols in water, added as initial charge.

Reactor Charge	grams	% pphm
Initial charge		
Water	262.68	54.55
Sulfosuccinate L3/40	**optional**	**0-0.4**
Initiator solution I		
Water	3.95	0.82
Ammonium persulfate	0.25	0.05
Pre-emulsion		
Water	164.17	34.09
ROKAnol L10/80 (80%)	**8.41**	**1.4**
Sulfosuccinate L3/40	**11.98**	**1.0**
Styrene	190.44	39.55
Butyl acrylate	279.09	57.95
Acrylamide	7.22	1.5
Acrylic acid	4.79	1.0
Initiator solution II		
Water	35.52	7.38
Ammonium persulfate	2.28	0.47
Chaser		
Peroxan BHP-70	0.66	0.14
Water	8.17	1.7
Bruggolite FF6	0.47	0.1
Water	8.17	1.7
pH Adjustment		
NH_4OH Solution (25%)	6.07	1.26

Procedure

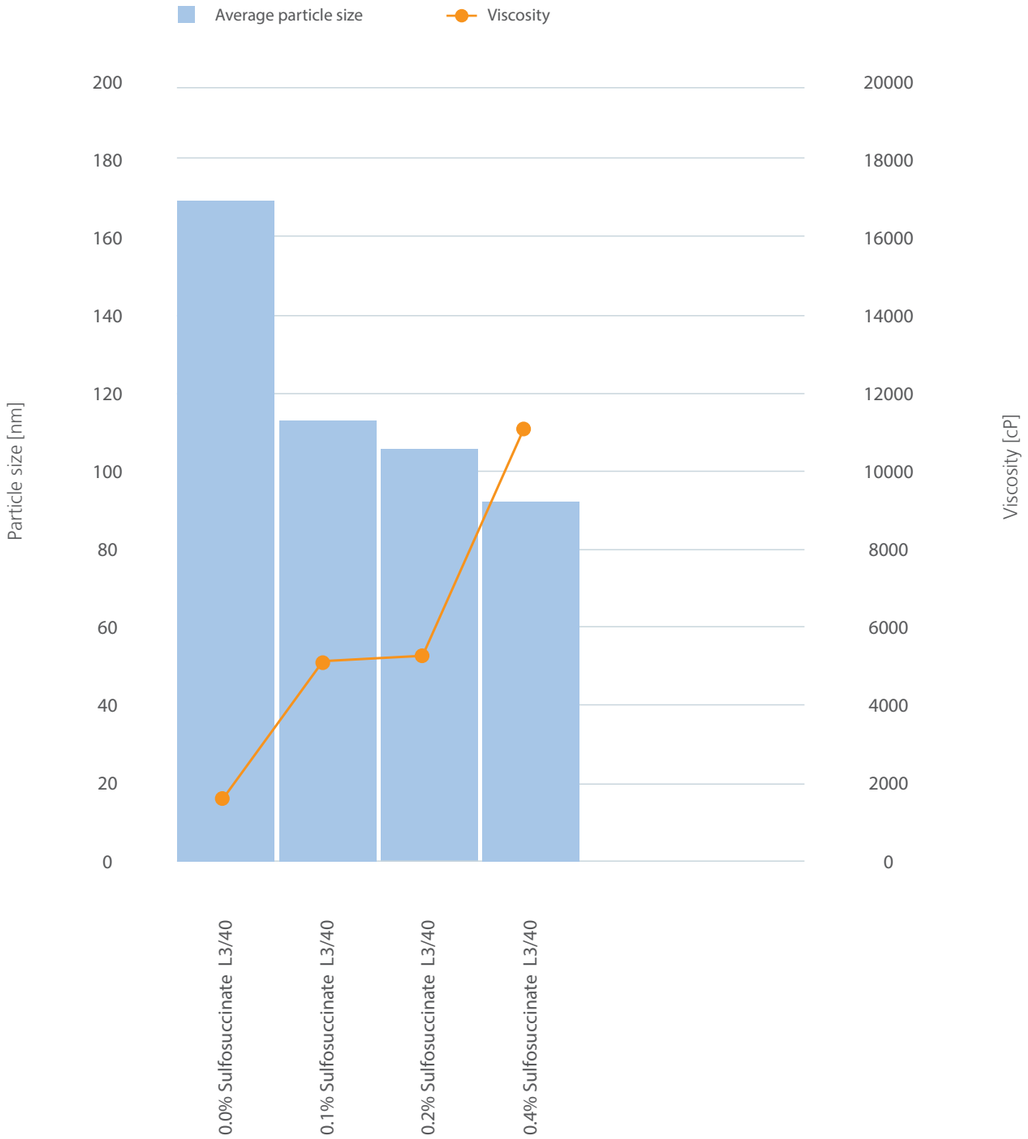
1. Add water to reaction flask and heat to 85°C.
2. Add initiator solution in one shot and charge 7% wt. of pre-emulsion.
3. Hold for 15 min at 85°C to prepare seed latex.
4. Start metering pre-emulsion and Initiator Solution II over 4 hours.
5. After addition hold for 90 min at 85°C.
6. Cool down to 55°C and start feed solution of Bruggolite FF6 and solution of Peroxan BHP-70 for 30 min.
7. Cool down to 30°C. adjust pH to 7-8 with ammonium hydroxide solution.

Latex properties

		Sulfosuccinate L3/40 in initial charge			
Properties	Units	0.0%	0.1%	0.2%	0.4%
pH		7.5	6.2	5.6	7.8
Solids	%	49.7	49.9	52.2	50.5%
Viscosity	cP	1812	5900	6100	11200
Wet coagulum 100 mesh	%	0.01	0.08	0.09	0.44
MTTF	°C	<1	<1	<1	<1
Average particle size	nm	172	115	106	95

Styrene/Acrylic latex

Particle sizes of Sulfosuccinate L3/40 - containing styrene-acrylic dispersion. The higher amount of anionic emulsifier in the reactor during the first step of seeded emulsion polymerization, contributes to lowering particle size of dispersion and rising viscosities. The properties of the final dispersion may be adjusted by changing the concentration of Sulfosuccinate L3/40 in emulsion polymerization process



APEO replacements in styrene-butyl acrylate dispersion

A series of nonionic surfactants was evaluated as nonylphenol alternatives in above styrene-acrylate recipe.

		APEO- FREE EMULSIFIERS					APEO EMULSIFIERS	
PROPERTIES	UNITS	ROKAnol L10/80	ROKAnol IT12	ROKAnol K21	ROKAnol L30A/65	SULFOROKAnol 1230/1A*	NPE-10	NPE-20
pH		7.5	8.7	8.7	7.8	8.7	8.4	7.8
Solids	%	49.7	50.9	49.8	49	50.7	49.9	50.0
Viscosity	cP	1812	3335	2040	1850	3250	1026	2850
Wet coagulum 100 mesh	%	0.01	0.02	0.3	0.07	0.09	0.02	0.13
MTTF	°C	<1	<1	<1	<1	<1	<1	<1
Average particle size	nm	172	148	158	144	267	161	152
Chemical stability								
10% $CaCl_2$		•	•	•	•	•	•	•
20% $CaCl_2$		○	○	○	•	•	○	•
30% $CaCl_2$		○	○	○	•	•	○	•
40% $CaCl_2$		○	○	○	○	○	○	○
Water resistance**		••	••	••	•••	••	••	••

• Excellent
○ Poor

* Instead of anionic surfactant - Sulfosuccinate L3/40

** Wet coatings at 200 microns thickness was dried for 96 hour s at 20°C and immersed into distilled water to evaluate the condition of whiting according to the following standard:

- • whitened in 30 minutes
- •• not whitened in 30 minutes but slightly whited during 2 hour
- ••• not whitened in 2 hours but slightly whited during 4 hours
- •••• not whitened in a 4-hour period

Dispersion of vinyl acetate/n-butyl acrylate

Anionic emulsifiers were compared in vinyl acetate/butyl acrylate dispersion. SULFOROKAnol LI 230/1A provides better water resistance than standard low-molecular SLES.

Reactor Charge	grams	% pphm
Initial charge		
Water	406.97	85.7
SULFOROKAnol L225/1	38.09	2.0
ROKAnol L30A/65	14.66	2.0
Mowiol 18-88	9.52	2.0
Sodium carbonate	1.43	0.3
Initiator solution I		
Water	34.28	7.2
Ammonium persulfate	3.17	0.7
Pre-emulsion		
Vinyl acetate	380	80.0
Butyl acrylate	95	20.0
Chaser		
Peroxan BHP-70	0.67	0.1
Water	7.94	1.7
Bruggolite FF6	0.6	0.1
Water	7.94	1.7

Procedure

1. Add water to reaction flask and heat to 65°C.
2. Add 25% solution of initiator (APS) and charge 10% wt. of monomer.
3. Hold for 15 min at 85°C to prepare seed latex.
4. Start metering preemulsion and Initiator Solution II over 4 hours.
5. After addition hold for 90 min. in 85°C.
6. Cool down to 55°C and start feed solution of Bruggolite FF6 and solution of Peroxan BHP-70 for 30 min.

Latex properties

Properties	Units	SULFOROKAnol L225	SULFOROKAnol L1230/1A
pH		3.5	3.7
Solids	%	50.4	49.6
Viscosity	cP	4853	760
Wet coagulum 100 mesh	%	0.5	0.1
Chemical stability			
10% $CaCl_2$		●	●
20% $CaCl_2$	● Excellent	●	●
30% $CaCl_2$	○ Poor	●	●
40% $CaCl_2$		●	●
Water resistance[2]		●	● ●

* Instead of anionic surfactant - Sulfosuccinate L3/40

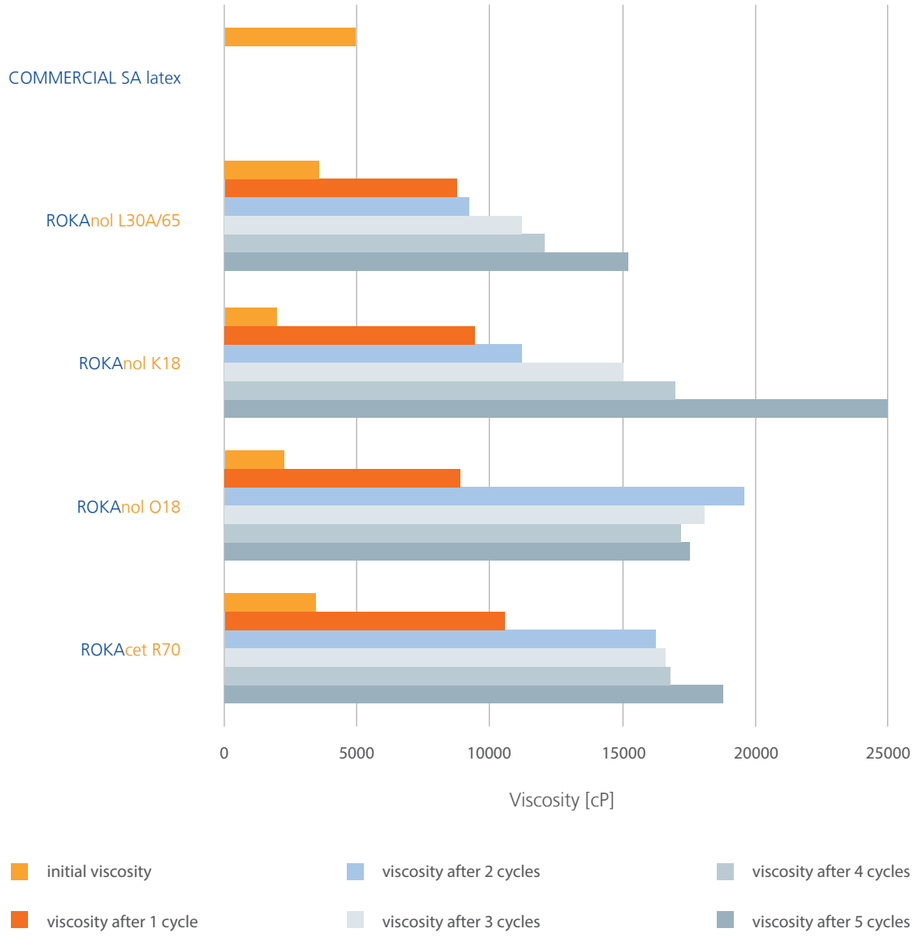
** Wet coatings at 200 microns thickness was dried for 96 hour s at 20°C and immersed into distilled water to evaluate the condition of whitening according to the following standard:

- ● whited in 30 minutes
- ● ● not whited in 30 minutes but slightly whited during 2 hour
- ● ● ● not whited in 2 hours but slightly whited during 4 hours
- ● ● ● ● not whited during 4 hour passed

Post-addition of surfactants to improve dispersion performance

Several surfactants have been added at a level of 1% pphm to the common styrene-butylacrylate dispersion. Such addition allows to improve colloidal stability against freezing. Viscosity changes, after every freeze-thaw cycle, are shown in the diagram below:

Latex viscosity after freeze-thaw cycles



Without the additive, latex was coagulated after first cycle. Addition of nonionic product prevents this negative effect, allowing to maintain appropriate application properties of dispersion. The best results (the lowest viscosities after every cycle) are ensured by using ROKAnol L30A/65. For this reason, the product is strongly recommended as a post-additive to improve freeze-thaw stability.

PCC EXOL SA
Sustainable technologies for new generations

PCC Exol SA combines the latest technologies with experience in production and distribution of surfactants. The company has its headquarters in Brzeg Dolny, Poland, where the manufacturing units of anionic, nonionic and amphoteric surfactants are located. Flexibility of production enables us to offer a wide range of surfactants adjusted to the current customers' needs. As one of the leading chemical products manufacturers, we continue to undertake investment activities based on sustainable development.

Our products have numerous industrial applications. Our surfactants are used as raw materials for various markets including household chemicals, textile, agrochemicals, metalworking, oilfield industries, construction industry, paints & coatings, pulp and paper, and many others. Over the years, PCC Exol SA has developed core expertise in manufacturing specialty surfactants. We meet our customers' needs with a unique and versatile product portfolio, a broad expertise in surfactants chemistry and a high degree of flexibility.

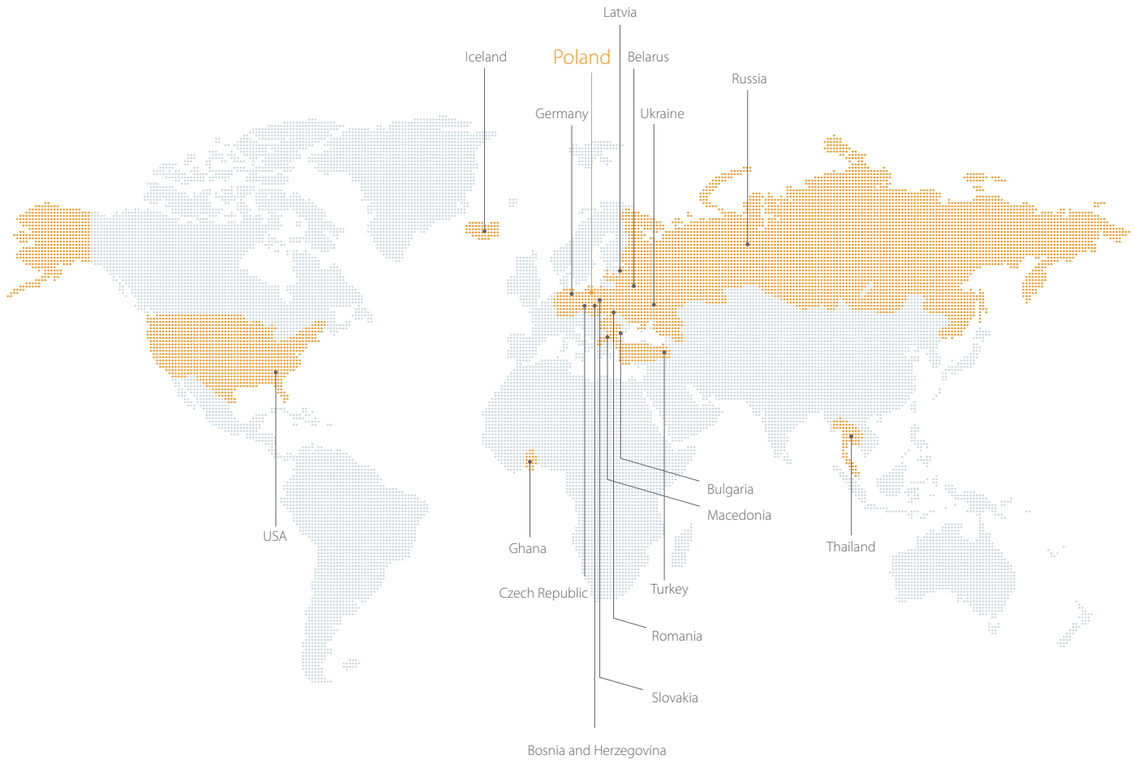
Through close customer relationships and by maximizing the synergy of customers' application experience combined with our knowledge of chemistry, we continuously strive to offer tailor-made products and system solutions that contribute to your success.

We are continuously expanding our product range with new surfactants, focusing on safe chemistry and being friendly to people and environment. We operate in full compliance with legal and other requirements, including environmental requirements. The design, production and sale of large volumes of specialist, often unique, chemical products for further processing requires the coordinated cooperation of many services at the Company's disposal.

A certified quality management system and environmental management system has proven to be very useful. Those two integrated systems help our employees to be aware of their roles in reaching quality and environmental goals.

Our specialists know that in the end, by carrying out their tasks in accordance with procedures applicable to their positions and other internal regulations, we provide our clients with exactly what they expect from us, acting in a reasonable manner and in compliance with legal requirements relating to the environment. Our strategic investor is the German company PCC SE, which operates internationally as three divisions: Chemical, Energy and Logistics.

PCC Group in the world



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