Automatic dishwasher detergents

Raw materials and chemical additives

Local. Global. Integrated.

CONTENT

AUTOMATIC DISHWASHER GELS

General information

The most popular detergents on the market for **Automatic Dishwashing** are formulations in the form of tablets or pods, however dishwasher gels are quite common as well. Their application into dispenser is easy and quick. Those types of formulations are expected to wash the dishes well, leave them without streaks and deposits, not damage the cleaned surfaces and be universal for different types of surfaces and various types of dirt. The best detergents for automatic dishwashing, not only prevent redeposition of dirt, but also limit the accumulation of minerals and discoloration of the dishes.

Depending on the type of formulation, different ingredients are used, however, they usually contain the following components:

- **Sequestring/Dispersing agents** – responsible for scale build-up prevention as well as reducing calcium and magnesium ions by chelating or dispersing mechanism. Phosphates are characterized by the highest chelating effect, however nowadays, they are being replaced by the usage of environmentally friendly additives such as organic polymers (products form EXOlat serie).
- **Oxygen-based bleaches** – break up and bleach organic deposits. They are mainly found in tablets and liquids containing chlorine-based bleaching agents for professional usage.
- **Nonionic surfactants** – compounds that lower the surface tension of water, emulsify oil deposits and prevent the formation of stains on the vessel surfaces.
- **Enzymes** – hydrolyze dirt deposits based on proteins and polysaccharides.
- **Corrosion inhibitors** – decrease the corrosion rate of a material. The most often used compound is sodium metasilicate.

AUTOMATIC DISHWASHER GELS

Basic formulation of Dishwasher Gel

The example recipe of automatic dishwashing gel is presented below. One of the main function in this formulation is fulfilled by the:

- **ROKAnol L5P5**, low-foaming nonionic surfactant, which belongs to a group of alkoxylated natural alcohols. It exhibits excellent wetting and detergent properties for broadly understood cleaning, where low foaming profile is required. The product exhibits cleaning properties at the level of widely used lauryl alcohol ethoxylates, but it is characterized by several times lower foaming abilities. ROKAnol L5P5 is one of the most universal low-foaming surfactant from PCC EXOL SA offer used in ADW application.
- **EXOlat C40/EXOlat ZA**, organic polymers, which are capable of removing water hardness by dispersion of calcium and magnesium ions. They prevent the limescale deposition as well as enhance the detergent effect.

AUTOMATIC DISHWASHING GEL

INGREDIENT	FORMULATION 1 [%]	FORMULATION 2 [%]	FUNCTION
EXOlat C40 (homopolymer of acrylic acid)	–	**12.0**	**sequestrant**
EXOlat ZA (copolymer of acrylic acid and maleic anhydride)	**12.0**	–	**sequestrant**
ROKAnol L5P5	**5.0**	**5.0**	**cleaning and wetting agent**
Sodium polyacrylate, Mw=4000-6000, 40%	6.0	6.0	anti-redeposition agent
Sodium Citrate	4.0	4.0	chelating agent
Subtilisin, 40%	4.0	4.0	enzyme
Tetrasodium EDTA, 40%	4.0	4.0	chelating agent
Amylase, 40%	1.0	1.0	enzyme
Xanthan Gum	0.8	0.8	thickener
Citric Acid	0.5	0.5	pH adjuster
Water	up to 100	up to 100	solvent
Additives*	q.s.	q.s.	–

* Additives: preservatives, dyes, fragrances and other

Procedure:

1. Mix Xanthan Gum with water (50°C).
2. Add EXOlat C40/EXOlat ZA, ROKAnol L5P5, Tetrasodium EDTA, Sodium Citrate, Citric Acid, Sodium Polyacrylate and mix until all the ingredients are uniformly combined with each other.
3. Cool the mixture down to 20-25°C.
4. Add enzymes and mix until homogenous solution is obtained.

AUTOMATIC DISHWASHER GELS

Cleaning effect

The detergency measurements were conducted based on modified IKW method: *„Recommendations for the Quality Assessment of the Cleaning Performance of Dishwasher Detergents (Part B, Update 2015)"*. According to IKW method there are 8 types of dirt, which are divided into 4 classes. Corresponding to the composition of dishwashing detergents of bleach, alkali and various enzymes, at least one soil type from each of the four soil classes (bleachable, persistent/alkaline-sensitive, starch-containing amylase-sensitive and protein containing protease-sensitive) were used in testing.

Four types of dirt were selected, one from each class (table below). After washing cycle, a visual assessment was carried out, scoring from 0 to 9 or from 0 to 10, depending on the degree of cleaning and type of dirt. The higher the score the better the detergent effect.

Types of dirt and their scores are presented below.

SOIL CLASS	Bleachable	Persistent/ alkaline-sensitive	Starch-containing, amylase-sensitive	Protein-containing, protease-sensitive
SOIL TYPE	Black tea	Milk	Pasta	Egg yolks
SCORING	0 - 10	0 - 9	0 - 10	0 - 10

METHOD DESCRIPTION

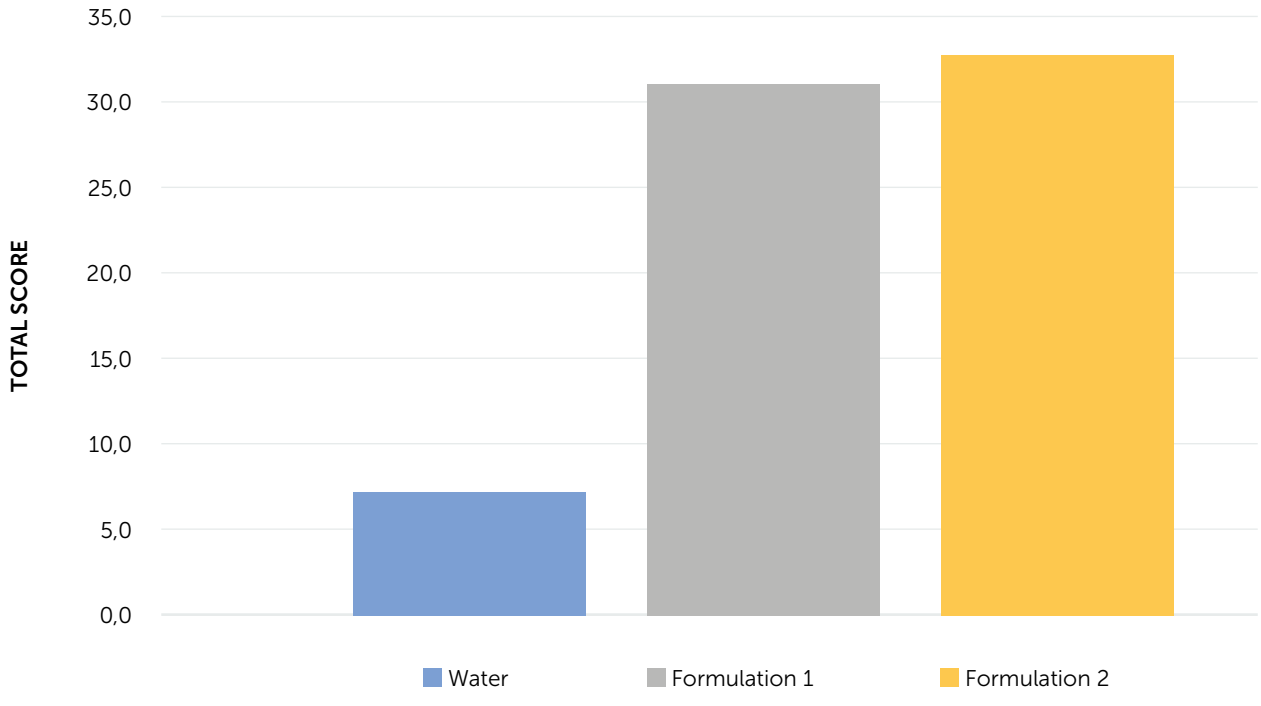
USED DISHES	3 x a glass of baked milk 3 x dirty plate with pasta 3 x cup soiled with tea 3 x metal plate soiled with egg yolk
DISHWASHER TYPE	BOSCH Silence Plus
WASHING METHOD	„ECO"*
WASHING CYCLE NUMBER	1
WATER TYPE	Tap water (13°dH)
FORMULATION DOSE	30 ml
MEASUREMENT METHOD	visual assessment - point scale

* Washing program: pre-wash, 50°C wash, intermediate rinse, rinse with 65°C polishing, drying

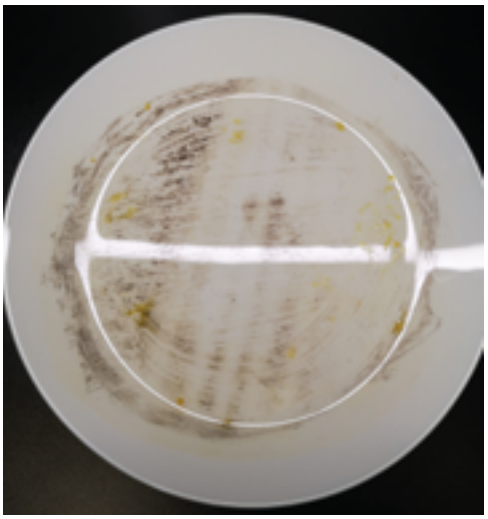
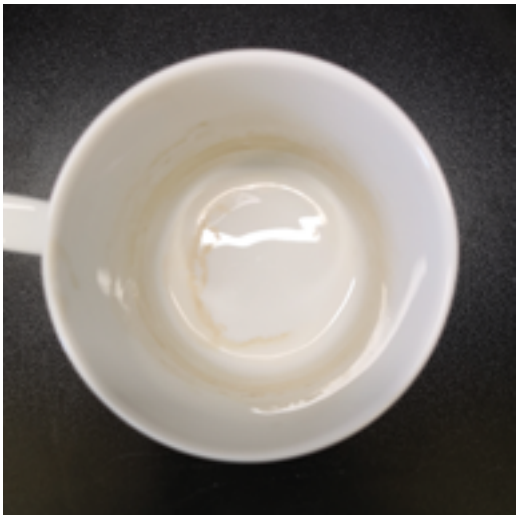
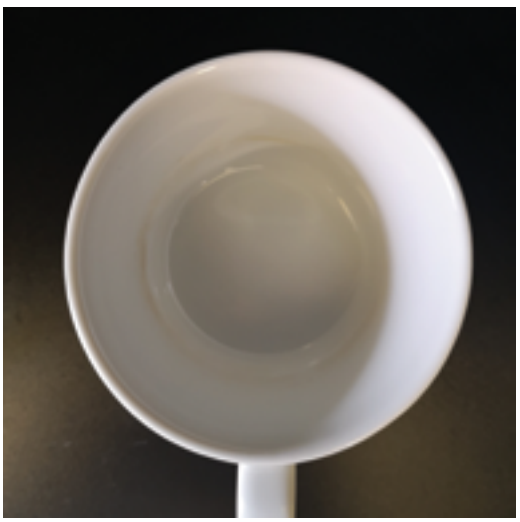
DETERGENCY RESULTS

	AVERAGE NUMBER OF POINTS				TOTAL POINTS
SOIL TYPE	Black tea	Milk	Pasta	Egg yolks	
WATER	0.3	3.3	1.3	2.0	6.9
FORMULATION 1	4.7	8.3	9.0	9.0	31.0
FORMULATION 2	5.7	8.0	9.0	10.0	32.7

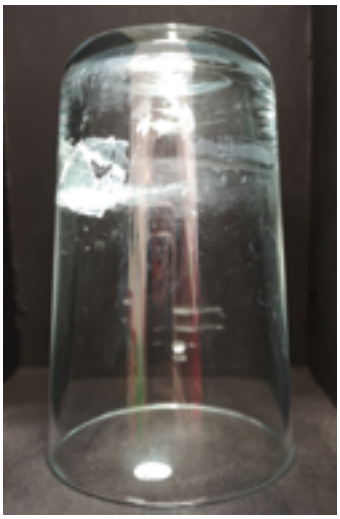
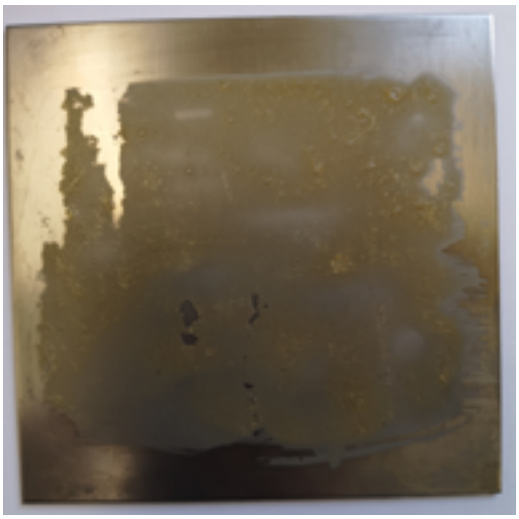
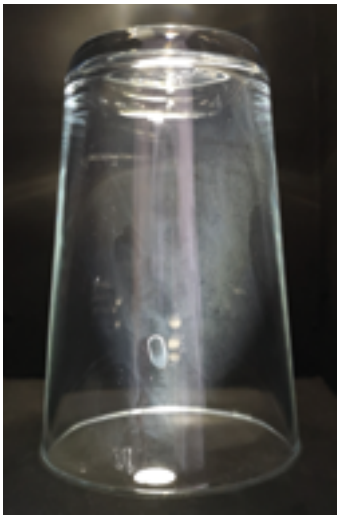
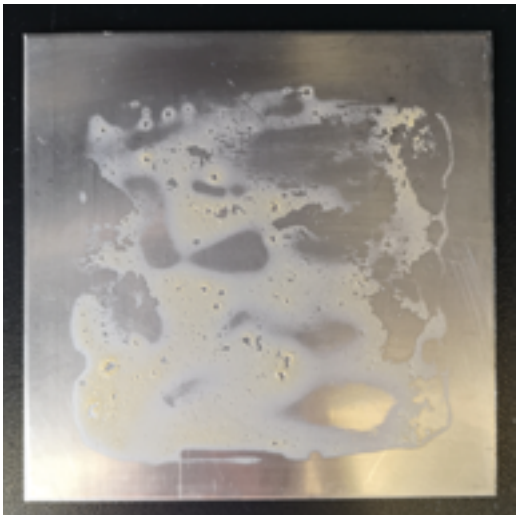
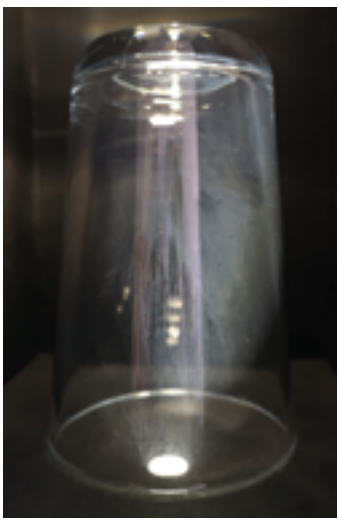
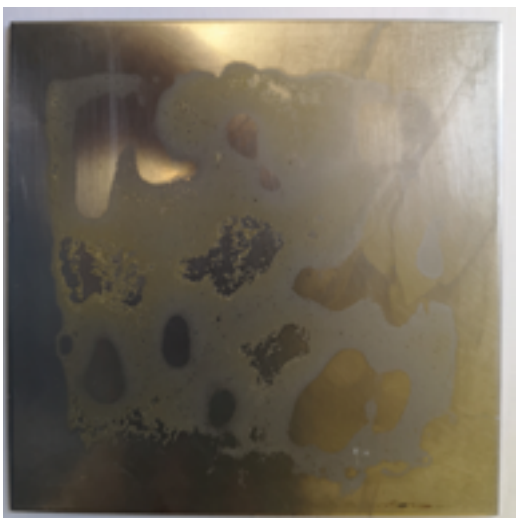
DETERGENCY RESULTS



DETERGENCY RESULTS – VISUAL ASSESSMENT

	BLACK TEA	PASTA
WATER		
FORMULATION 1		
FORMULATION 2		

DETERGENCY RESULTS – VISUAL ASSESSMENT

MILK	EGG YOLK	
		WATER
		FORMULATION 1
		FORMULATION 2

DISHWASHER RINSE AIDS

General information

Rinse aids are used in the final rinse cycle to minimize the deposition of residual water, soluble minerals and surface-active soil components on washed items. The main component of rinse aid formulations are low foaming nonionic surfactants from the group of ethoxylated and propoxylated fatty alcohols or EO/PO block copolymers.

The surfactant in rinse aid formulation contribute to decreasing of surface tension of water and improves the wetting on the hydrophobic surfaces. Improved wetting, reduces the tendency of the rinsing water to form drops on the vessel surfaces, which give rise to spots upon drying.

The other components in rinse aid detergents are complexing agents, such as citric acid and hydrotropes, such as tetrasodium cumenesulfonate. The complexing agent prevents scale build-up and it contributes to the brilliancy and shiny appearance on a glass surface. The hydrotropes are responsible for raising the cloud point of low foaming surfactants and keep the formulation clear.

DISHWASHER RINSE AIDS

Basic formulations of Dishwasher Rinse Aid

ECONOMIC RINSE AID FORMULATION

COMPONENT	CONCENTRATION [%]	FUNCTION
ROKAnol L7 (Laureth-7)	**5.5**	**wetting agent**
ROKAnol LP2500 (Alcohols, C12-C15, branched and linear, ethoxylated, propoxylated)	**3.5**	**wetting agent**
Sodium Cumenesulfonate, 40%	5.0	hydrotrope
Citric Acid, monohydrate	3.0	chelating agent / pH adjustor
Water	up to 100	solvent
Additives *	q.s.	–

* Additives: preservatives, dyes, perfumes and other

Procedure:

1. Mix non-ionic surfactants ROKAnol LP2500 and ROKAnol L7 with water.
2. Add Sodium Cumenesulfonate, Citric Acid and other additives.
3. Mix until a clear solution is obtained.

STANDARD RINSE AID FORMULATION

COMPONENT	CONCENTRATION [%]	FUNCTION
ROKAnol LP2500 (Alcohols, C12-C15, branched and linear, ethoxylated, propoxylated)	**9.0**	**wetting agent**
Sodium Cumenesulfonate, 40%	5.0	hydrotrope
Citric Acid, monohydrate	3.0	chelating agent / pH adjuster
Water	up to 100	solvent
Additives *	q.s.	–

* Additives: preservatives, dyes, perfumes and other

Procedure:

1. Mix ROKAnol LP2500 with water.
2. Add Sodium Cumenesulfonate, Citric Acid and other additives.
3. Mix until a clear solution is obtained.

RINSE AID METHOD DESCRIPTION

The rinse aid method is based on EN 50242/ EN 60436 *„Electric dishwashers for household use – Methods for measuring the performance"*. The test was performed on clean glasses and knives.

USED DISHES	6 x clean glasses 6 x clean knives
DISHWASHER TYPE	BOSCH Silence Plus
WASHING METHOD	„ECO"*
WASHING CYCLE NUMBER	6
WATER TYPE	Tap water (13°dH)
FORMULATION DOSE	10 ml
MEASUREMENT METHOD	STEP 1: counting spots STEP 2: assessing the shine level

* Washing program: pre-wash, 50°C wash, intermediate rinse, rinse with 65°C polishing, drying

The measurement method consists of 2 steps. The first one is counting spots on glasses and knives, the second one is assessing of shining level. Each step has its own scoring which is briefly described below.

STEP 1 [counting spots]: the scoring depends on the number of stains (glasses + knives). The maximum number of spots dishes is 60. The bigger number of spots on glasses and knives the worse effect. The highest score (7) is assigned to the smallest number of spots.

NUMBER OF SPOTS	0 – 8	9 – 16	17 – 24	25 – 32	33 – 40	41 – 49	50 – 59	60≤
SCORING	7	6	5	4	3	2	1	0

STEP 2 [assessing the shine level]: the score depends on the shine level. Evaluation has been made only on glasses due to the too small surface of knives. The higher the score the better the effect.

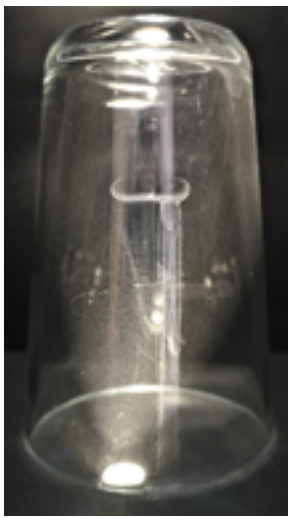
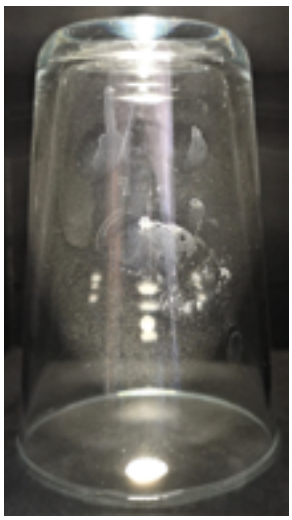
APPEARANCE	HIGH MATT EFFECT	MEDIUM MATT EFFECT	WEAK MATT EFFECT	SHINY EFFECT
SCORING	0	1	2	3

DISHWASHER RINSE AIDS

Rinse Aid test – results

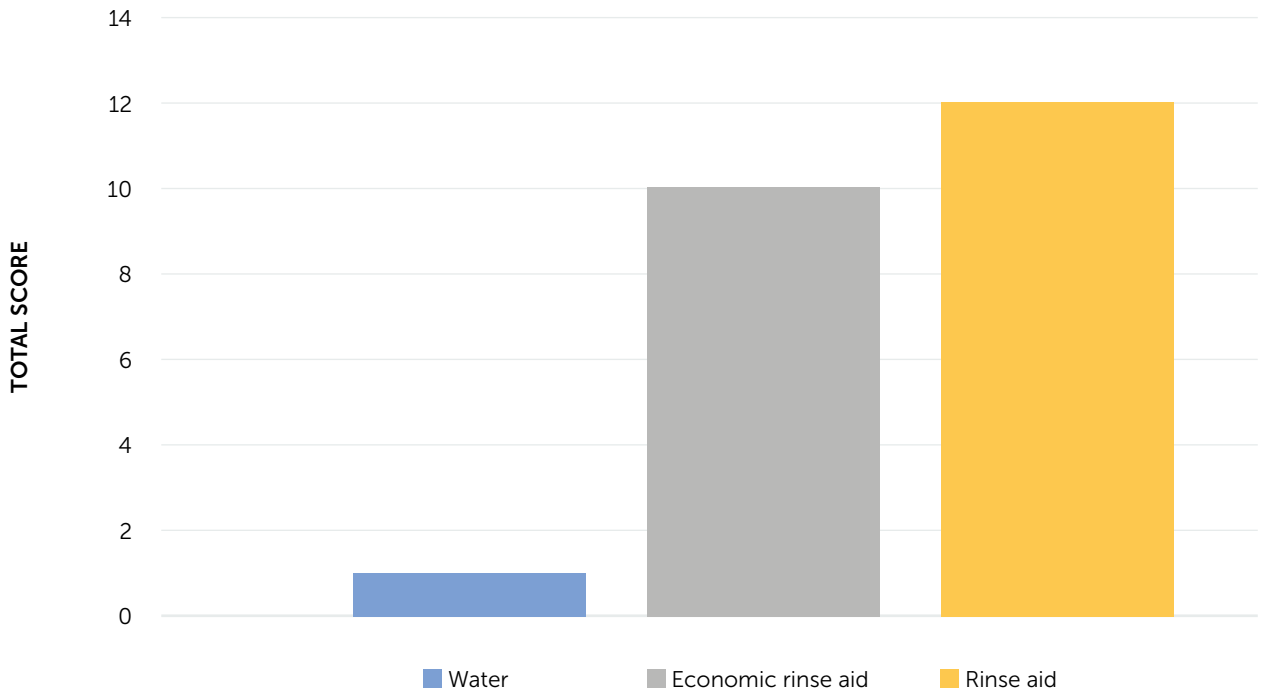
RINSE AID TEST – RESULTS

Appearance of dishes after 6 cycles of washing, using basic formulations presented above has been compared to dishes rinsed only with water.

	WATER	STANDARD RINSE AID FORMULATION	ECONOMIC RINSE AID FORMULATION
GLASSES			
KNIVES			

The rinsing effect is expressed as a total score of counted spots on glasses and knives and shining effect on glasses. The higher the score the better the rinsing effect.

RINSING EFFECT



DISHWASHER CLEANERS

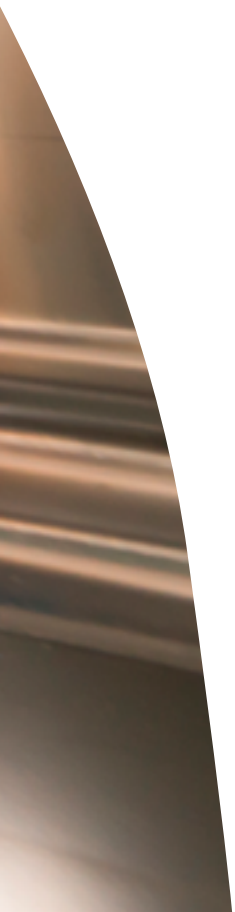
General information

Due to the growing awareness of consumers, more and more preparations for specialized applications can be found on store shelves such as liquid dishwasher cleaners. Dual layer product are becoming increasingly popular because it gives to the user a feeling of better and stronger action.

Dual layer formula cleans dishwasher by

- fighting grease,
- fighting limescale
- decreasing odour in the hidden parts of machine.

It works safely and effectively by breaking down and removing mineral build up which is inside the machine, including hard-to-reach parts like the heating element and sprayer arms.




Go Green

DISHWASHER CLEANERS

Basic formulations of Dual Layer Dishwasher Cleaners

ECONOMIC DUAL LAYER DISHWASHER CLEANER

COMPONENT	CONCENTRATION [%]	FUNCTION
ROKAnol GT3R (Alcohols, C9-C16, ethoxylated)	**7.0**	**wetting and degreasing agent**
Citric Acid, monohydrate	25.0	chelating agent
Water	up to 100	solvent
Additives *	q.s.	–

* Additives: preservatives, dyes, perfumes and other

Procedure:

1. Mix non-ionic surfactant ROKAnol GT3R, Citric Acid and other additives.
2. Mix until a clear solution is obtained.

STANDARD DUAL LAYER DISHWASHER CLEANER

COMPONENT	CONCENTRATION [%]	FUNCTION
ROKAnol IT3 (Isotrideceth-3)	**7.0**	**wetting and degreasing agent**
Citric Acid, monohydrate	25.0	chelating agent
Water	up to 100	solvent
Additives *	q.s.	–

* Additives: preservatives, dyes, perfumes and other

Procedure:

1. Mix non-ionic surfactant ROKAnol IT3, Citric Acid and other additives.
2. Mix until a clear solution is obtained.

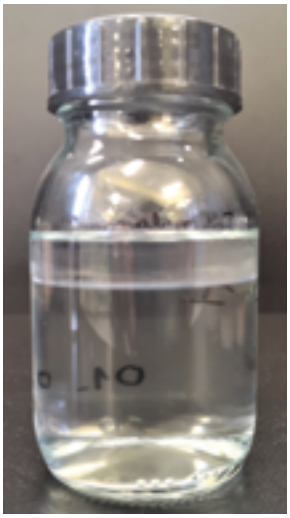
TWO PHASE DISHWASHER CLEANER

COMPONENT	CONCENTRATION [%]	FUNCTION
ROKAnol GA3 (PEG-3 Propylheptyl Ether)	**7.0**	**wetting and degreasing agent**
POLIkol 6000 (PEG-135)	**5.0**	**accelerates phase separation**
Citric Acid, monohydrate	25.0	chelating agent
Water	up to 100	solvent
Additives *	q.s.	–

* Additives: preservatives, dyes, perfumes and other

Procedure:

1. Mix non-ionic surfactant ROKAnol GA3 and POLIkol 6000, Citric Acid and other additives.
2. Mix until a clear solution is obtained.

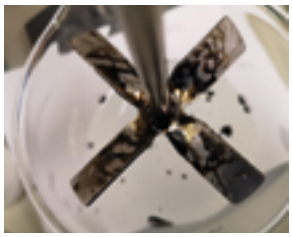
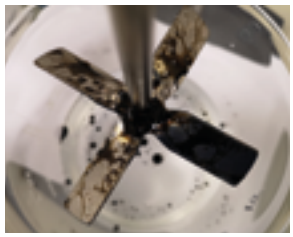
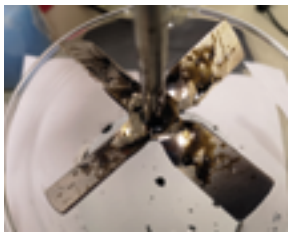
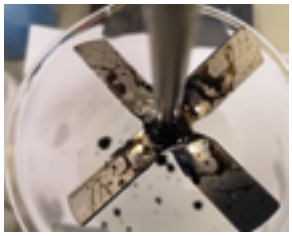
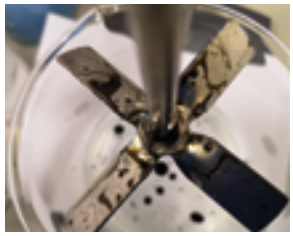
ECONOMIC DUAL LAYER DISHWASHER CLEANER	STANDARD DUAL LAYER DISHWASHER CLEANER	TWO PHASE DISHWASHER CLEANER
		

DISHWASHER CLEANERS

Degreasing Properties

Method of dynamic degreasing verifies the efficiency of degreasing a metal surface during mechanical mixing. For this purpose the tested surface is immersed for 5 minutes in the used oil and then is applied in 1 L of solution which contains 5 g/L of tested formulation. The mixing speed is 200 RPM. The degreasing effects are visually assessed after 2 and 5 minutes from starting the mixing process.

Appearance of metal surface after 2 and 5 minutes of stirring in solution of tested formulations

	ECONOMIC DUAL LAYER DISHWASHER CLEANER ROKAnol GT3R	STANDARD DUAL LAYER DISHWASHER CLEANER ROKAnol IT3	TWO PHASE DISHWASHER CLEANER
2 min.			
5 min.			

About Us

PCC Exol SA is a major player in the European surfactants market. In the eastern and central-eastern part of the continent, it is the undisputed leader in its industry. Most of the production facilities and the company's headquarters are located in Brzeg Dolny, Poland. Here we develop, test and manufacture a wide range of anionic, non-ionic and amphoteric surfactants and speciality industrial formulations. New products are continuously added to the portfolio in response to market trends and individual customer requirements. The surfactants produced at the plants have a very wide range of industrial applications.

They are used as wetting agents, emulsifiers, auxiliaries in paper, metallurgy and many other industries, as well as in household chemicals, personal care products and textiles. PCC EXOL pays special attention to the issue of sustainable development, which is one of the key elements of the company's strategy. In order to strengthen its competitive position in the surfactants market, the company is committed to promoting responsible production and consumption throughout the value chain. The concept of sustainable development is therefore a key aspect of all the company's management and operational processes.

PCC ROKITA SA
PCC PCG
OXYALKYLATES
IRPC

Polyols

- Polyether polyols
- Polyester polyols
- Prepolymers
- Polyurethane Systems

PCC
ROKITA SA

Chlorine

- Chlorine
- MCAA
- Other Chlorine Downstream Product

PCC
ROKITA SA

Phosphorus

- Phosphorus derivatives
- Naphthalene derivatives
- Polycarboxyethers (PCE)

PCC EXOL SA
PCC CHEMAX INC
PCC PCG OXYALKYLATES

Surfactants

- Anionic surfactants
- Cationic surfactants
- Nonionic surfactants
- Amphoteric surfactants (betaines)
- Chemical formulation

PCC
SYNTEZA

Alkylphenols

- Nonylphenol
- Dodecylphenol
- Tristyrylphenol

PCC CONSUMER PRODUCTS SA

Consumer Products

- Household & industrial Cleaners, Detergents and Personal Care Products

PCC
ROKITA SA

Energy

- Renewable Energy
- Conventional Energy

PCC
INTERMODAL SA

Logistics

- Intermodal transport
- Road Haulage
- Rail Transport

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Silicon

- Microsillica
- Silicon Metal

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Holding & Projects

- Portfolio Management
- Project Development

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