

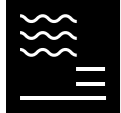
# METALWORKING ADDITIVES

AKYPO®  
AKYPO® ROX  
KAO FINDET  
AMIDET®  
FOSFODET

**Essentials for longer  
lifetime metalworking fluids**

Emulsion stability  
Lime soap dispersion  
Hard water stability  
Foam control  
Corrosion inhibition  
Extreme pressure and anti-wear  
Rinsing and cleaning





# METALWORKING APPLICATION

Kao Chemicals Europe provides key surfactant technology for modern metalworking formulations that are particularly indispensable for water miscible fluids. Our additive brands AKYPO®, AKYPO® ROX, KAO FINDET, AMIDET® and FOSFODET feature these primary properties:

- Stable emulsions for various degrees of water hardness and a wide variety of conditions.
- Foam controlling emulsifiers, co-emulsifiers and solubilizers.
- Multifunctional stabilizers (highlighted in Kao Metalworking Toolbox summary of application benefits).
- Easy handling and formulating.
- Environmentally friendly.

These properties enable your formulations to successfully meet the increasing demands of your customers:

- Increased fluid lifetimes.
- Lower maintenance costs and increased productivity thanks to clean fluids.
- Formulations for high pressure and high speed machining.
- Improved lubricity and extreme pressure/anti-wear (EP/AW) performance for increased tool lifetime.
- Mild labeling and environmentally friendly metal-working fluids.

PRODUCT GRUPS	CHEMICAL DESCRIPTION	Water hardness tolerance						
		Hard water stability	Electrolyte stability	Foam control	Emulsifier efficiency	Corrosion inhibition	Rinsing and cleaning	Extreme pressure/anti-wear
AKYPO® LF	C <sub>4-8</sub> alkyl ether carboxylic acids	●	●	●	●	●	○	○
AKYPO® RLM/RO	C <sub>12-18</sub> alkyl ether carboxylic acids with a low degree of ethoxylation	●	●	●	●	●	○	●
AKYPO® RO	C <sub>16-18</sub> alkyl ether carboxylic acids with a moderate to high degree of ethoxylation	●	●	●	●	●	○	●
AKYPO® PO-EO	C <sub>16-18</sub> alkyl PO-EO ether carboxylic acids	●	●	●	●	●	○	●
AKYPO® RA	Alkyl amide ether carboxylic acids	●	●	●	●	●	○	●
FOSFODET	C <sub>16-18</sub> alkyl PO-EO ether phosphate esters	●	●	●	●	●	●	●
AMIDET®	Ethoxylated alkyl amides	●	●	○	●	●	○	●
AKYPO® ROX KAO FINDET	C <sub>16-18</sub> alkyl PO-EO alkoxyates	●	●	●	●	●	○	●

Summary of the application benefits for the Kao Metalworking Toolbox product groups, highlighting the most relevant properties of our surfactants and their multifunctionality.

- Specially designed for respective performance
- High   ● Medium   ● Low   ○ Not relevant

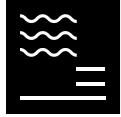
Range of products:

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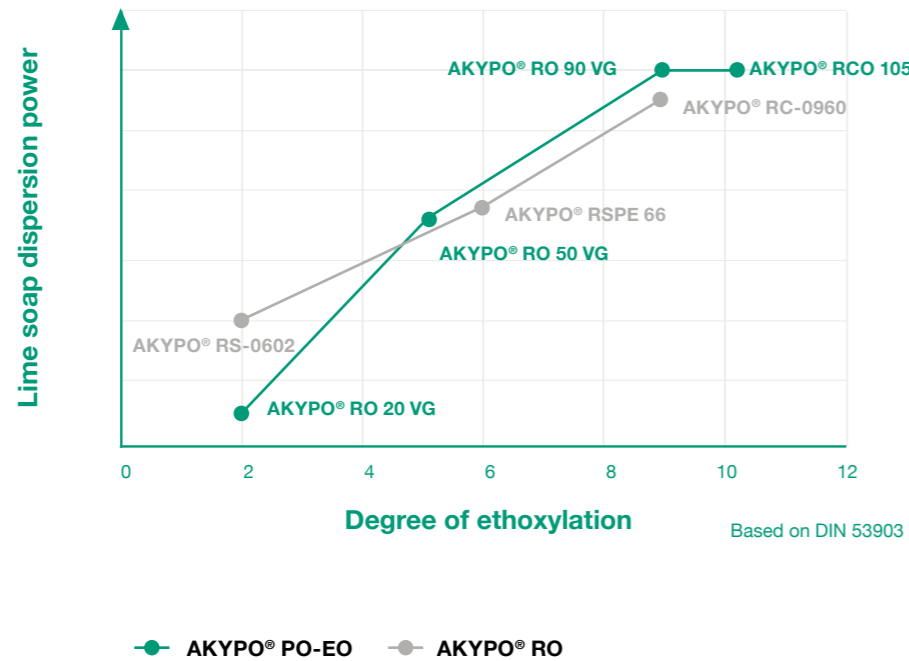




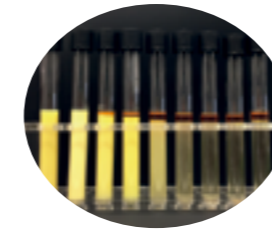
# ELECTROLYTE STABILITY

## Selecting the ideal AKYPO®

The lime soap dispersion power of AKYPO® increases with its degree of ethoxylation and this corresponds directly to the achievable hard water resistance. This parameter thus indicates which AKYPO® is the best choice for achieving the desired level of calcium and magnesium dispersion for the fluid.

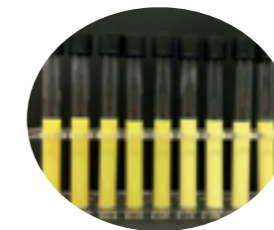


Without AKYPO®



Mg<sup>2+</sup> concentration

With AKYPO® RO 90 VG



Mg<sup>2+</sup> concentration

Electrolyte scan with 10% metalworking formulation (colored) starting with demineralized water (0 ppm) and an increasing concentration of magnesium.

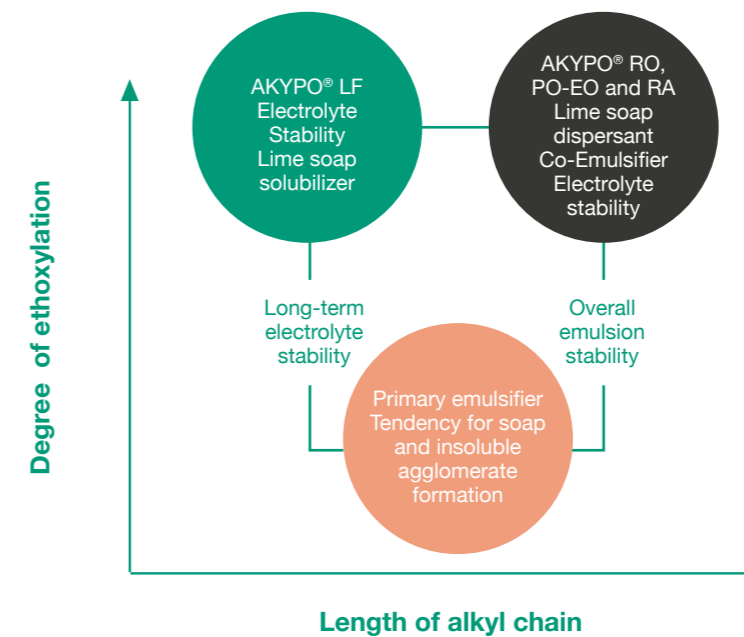
## Light metal treatment

The global goals of saving energy and conserving resources are fueling demand for the treatment of light metal alloys. This treatment in particular leads to the formation of aggressive soaps.

The best resistance against the formation of magnesium in soaps is attained by adding AKYPO® RO 90 VG.

## Electrolyte stability and solubilization

AKYPO® LF products will further enhance the electrolyte stability of your formulation and are beneficial for the solubilization of lime soaps.





# FOAM CONTROL

## Emerging need for foam control

Today's metalworking industry is moving toward using greater operating pressures and pumping rates, which leads to the increased formation of foam. Due to additional regulations and limits on biocides, the industry has turned to alternatives such as using highly concentrated fluids. This approach enables maintenance of resistance to microbial growth, but usually leads to increased foaming. These trends make foam control a central issue, particular in modern metalworking fluid technology. The Kao Metalworking Toolbox offers a broad range of low foaming AKYPO® and AKYPO® ROX / KAO FINDET products that enable enhanced foam control.

More information:

Explore

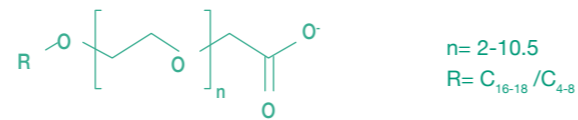
## Foam control in soft water

Foam formation is a well-known problem, especially with low levels of water hardness. The addition of short alkyl chain AKYPO® LF permits foaming reduction under soft water conditions.

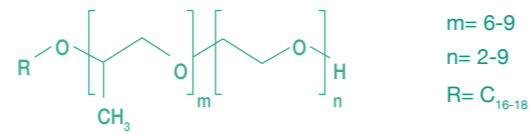
AKYPO® LF 4 shows the most limited foam formation tendency combined with the fastest

foam collapse rate, specifically when used in combination with AKYPO® RO 90 VG. We recommend using the combination of both products to increase the fluid's longevity. To simplify the formulation process, we offer AKYPO® TEC AM VG, a blend of AKYPO® RO 90 VG and LF 4.

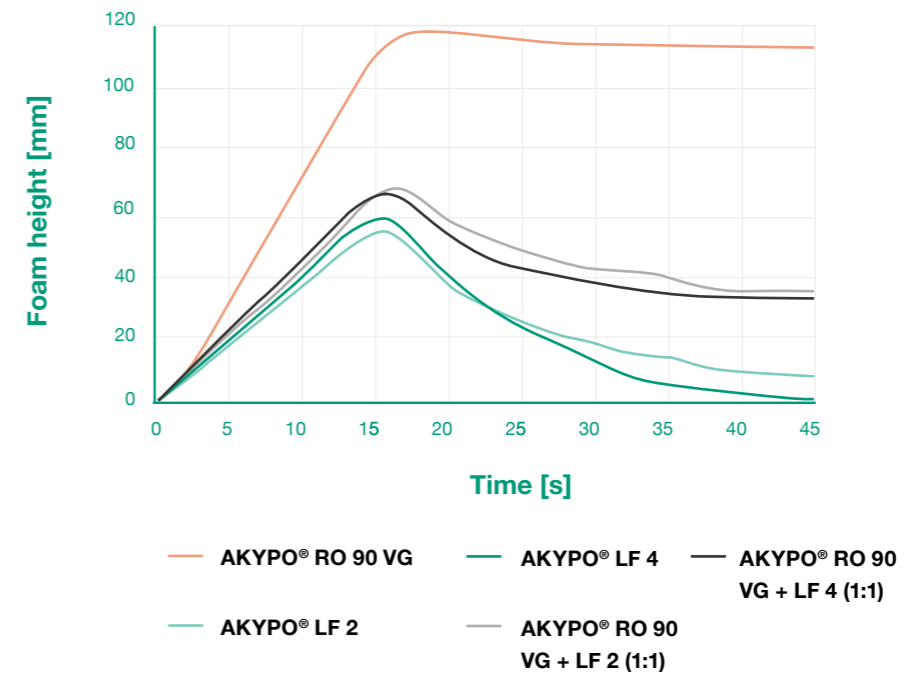
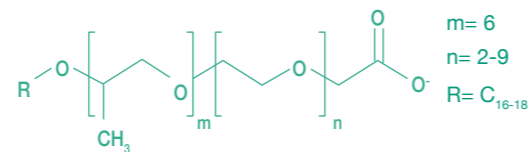
### AKYPO® RO / AKYPO® LF



### AKYPO® ROX / KAO FINDET



### AKYPO® PO-EO



The foaming behavior of a 5% metalworking fluid emulsion was tested at < 90 ppm (5 °dH) with a Krüss DFA100 Dynamic Foam Analyzer. The formulations included 2% AKYPO®.



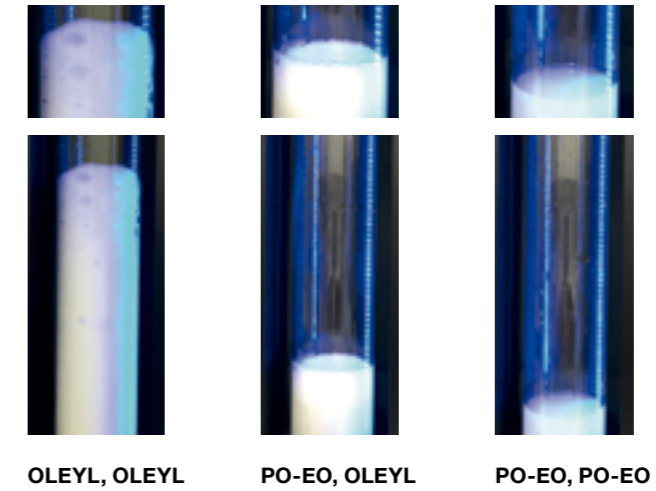


## Enhanced foam control with moderate water hardness

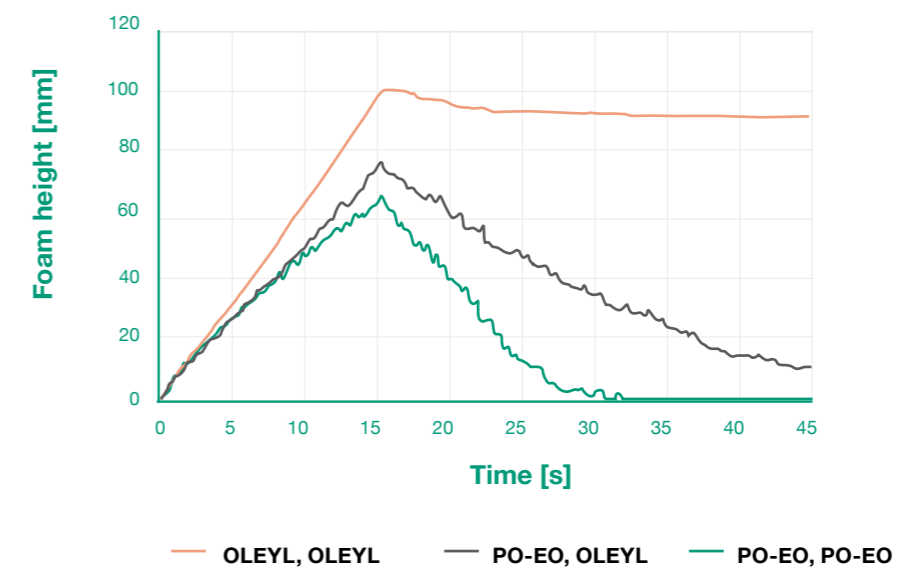
Emulsifiers based on saturated fatty alcohols, instead of unsaturated oleyl alcohol, and additionally modified by the insertion of a propylene oxide building block (PO) between the hydrophobic tail and the hydrophilic head have significantly-reduced foam stability. These PO-EO emulsifiers represent an ideal combination of emulsification power and low foaming characteristics. Accordingly they offer

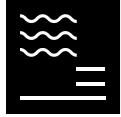
formulators a powerful alternative to standard emulsifier chemistries. The best foam control in combination with hard water stability is achieved through synergistic effects when nonionic and anionic PO-EO (co-)emulsifiers are used together. By way of illustration, this superior foam control performance is shown by modifying the emulsifier chemistry of a commercial formulation.

FORMULATION	NONIONIC (3%)	ANIONIC (2%)
Oleyl, Oleyl	Cetyl/Oleyl alcohol ethoxylate (5 EO)	AKYPO® RO 90 VG
PO-EO, Oleyl	AKYPO® ROX RS-0606N	AKYPO® RO 90 VG
PO-EO, PO-EO	AKYPO® ROX RS-0606N	AKYPO® RSPE 66



The images above show how fluid appears after exposure to 15 seconds of severe foam formation conditions followed by 15 seconds of foam collapse. The foaming behavior of a 5% metalworking fluid emulsion was tested at 200 ppm (11°dH) with a Krüss DFA100 Dynamic Foam Analyzer.





# CORROSION INHIBITION

## AKYPO® supports anti-corrosive properties

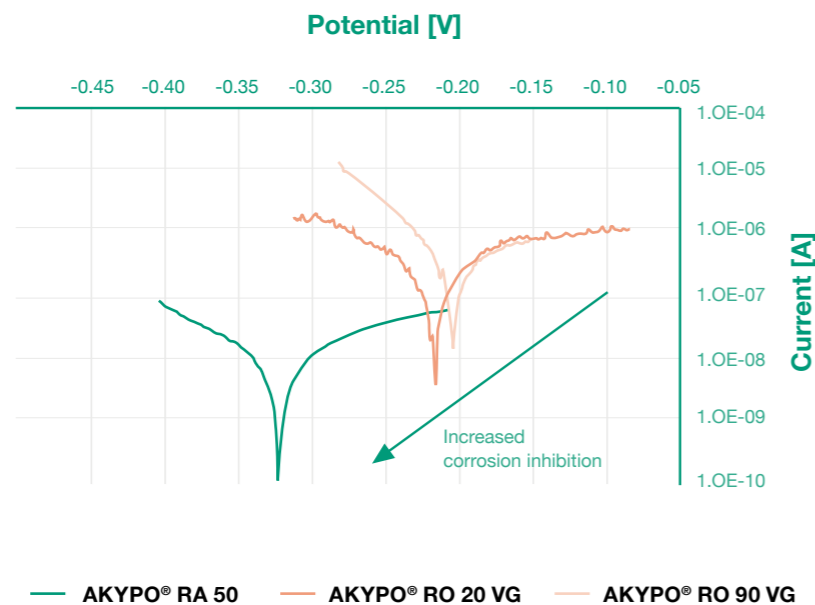
AKYPOs® ether carboxylic acid products are multifunctional. In particular, AKYPO® RO 20 VG, with its low degree of ethoxylation, supports anti-corrosion properties when used in combination with common corrosion inhibitors such as fatty acid alkanol amines.

### Protecting iron

Since corrosion is an electrochemical issue, electrochemical test methods provide a powerful alternative to chip/filter paper tests. Linear sweep voltammetry (LSV) measurements allow direct, quantitative determination of corrosion rates by measuring corrosion currents. The formation of a hydrophobic layer on the metal surface

inhibits corrosion reactions and is reflected in a decreased corrosion current. Due to its amide functionality, AKYPO® RA 50 shows the best corrosion inhibition on steel. This is depicted in the LSV analysis of steel (St 37-2), which ranks the various AKYPOs® as follows:

AKYPO® RO 90 VG < AKYPO® RO 20 VG << AKYPO® RA 50



### Protecting light metals

When it comes to staining, aluminum alloys present a different challenge in comparison with steel and other ferrous metals. Phosphorus chemicals such as alkylphosphonic acids or ethoxylated phosphate esters protect aluminum against corrosion but exhibit certain disadvantages for metalworking applications. This includes having limited hard water tolerance and a tendency to foam. Our newly developed FOSFODET solutions overcome these disadvantages. These products combine an excellent light metal inhibition with significant low foaming characteristics and reasonable hard water tolerance.



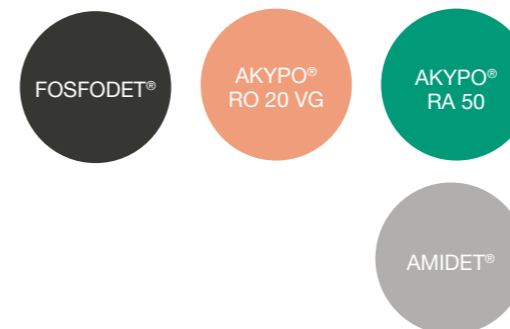
More information about FOSFODET CS series:

[Explore](#)

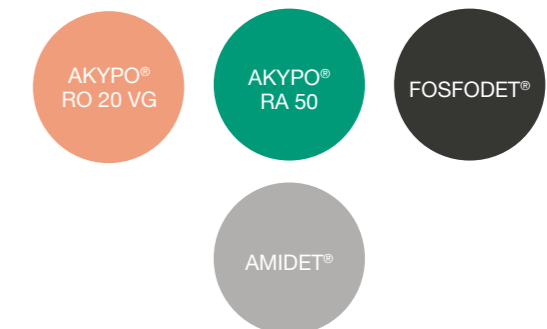
### Selecting the ideal anti-corrosion additive

This summary of the Kao Metalworking Toolbox's anti-corrosive properties provides guidance for selecting the best product to achieve the optimal level of corrosion control that can be provided by a given metalworking formulation.

#### Corrosion inhibition of iron

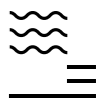


#### Corrosion inhibition of aluminium



More information about AMIDET TEC N:

[Explore](#)



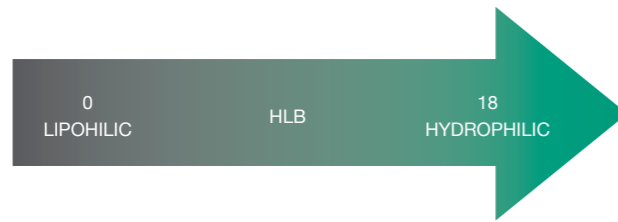




# SURFACTANT PROPERTIES

## Emulsifier efficiency

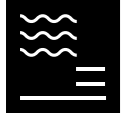
Hydrophilic-lipophilic balance (HLB) indicates emulsifier efficiency and is a concept that is often applied to formulations. Lipophilic products with low HLB values stabilize fluid concentrates, while hydrophilic products with increased HLB values are designed to stabilize the fluid emulsion. If desired, customers can also combine our products to achieve exceptional stability while dealing with a wide range of conditions.



The synergistic effects of AKYPO® ROX and KAO FINDET emulsifiers with AKYPO® PO-EO in particular improve lubricity and foam control properties, thanks to the polypropylene oxide building block placed between the alkyl and the polyethylene oxide chain.







## Wettability

Emulsifiers with low contact angles and surface tensions have the best wettability. Good wetting properties facilitate quick adhesion of performance additives to the metal surface, thus enabling improved lubricity and corrosion control in metal treatment. Solubilizing AKYPO® LF products, especially AKYPO® LF 4, are wettability modifiers. AKYPO® LF can strongly adjust drip off behavior, support washing and rinsing, and improve the removal of metal chips and fluid residues on metal. This also makes AKYPO® LF an excellent additive for metal cleaning applications.



NONIONIC	HLB LUMiFuge® (in-house method)	CONTACT ANGLE on steel (DC048) 0.1% in 1% NaOH	SURFACE TENSION [mN/m] 0.1% in 1% NaOH (static ring)	SOLUBILITY IN WATER neutralized	CLOUD POINT [°C] Hoffmann 5g in 25g BDG
<b>AMIDET®</b>					
AMIDET® TEC N	9–11	28.3	29.4	n.s	57
AMIDET® TEC-111	9–11	33.1	29.9	n.s	>95
<b>AKYPO® ROX / KAO FINDET</b>					
KAO FINDET MB-212	5	n.s	n.s	n.s	40
AKYPO® ROX RS-0606N	8	45.5	33.2	n.s	59
AKYPO® ROX RC-0960N	11	38.8	31.8	s	68

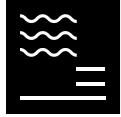
ANIONIC	HLB LUMiFuge® (in-house method)	CONTACT ANGLE on steel (DC048) 0.1% in 1% NaOH	SURFACE TENSION [mN/m] 0.1% in 1% NaOH (static ring)	SOLUBILITY IN WATER neutralized	CLOUD POINT [°C] Hoffmann 5g in 25g BDG
<b>AKYPO® RLM/RO</b>					
AKYPO® RLM 25	5.5	29.1	28.3	n.s	36°C
AKYPO® RO 20 VG	5	49.2	24.4	n.s	34°C
<b>AKYPO® RO</b>					
AKYPO® RO 50 VG	9	46.9	30.7	s	56°C
AKYPO® RO 90 VG	11	55.6	35.2	s	68°C
AKYPO® RCO 105	11	50.6	35.3	s	72°C
<b>AKYPO® PO-EO</b>					
AKYPO® RS-0602	5	44.5	32.9	n.s	30°C
AKYPO® RSPE 66	9	47.6	34.3	s	52°C
AKYPO® RC-0960	10	50.5	32.8	s	62°C
<b>AKYPO® LF</b>					
AKYPO® LF 1	11–14	53.5	34.8	s	54°C
AKYPO® LF 2	13–16	57.4	36.7	s	67°C
AKYPO® LF 4	12–15	65.7	45.3	s	63°C
AKYPO® LF 6	14–15	66.6	42.3	s	57°C
AKYPO® LF 10	15	66	42.6	s	65°C
<b>AKYPO® specialities and others</b>					
AKYPO® TEC AM VG	12	52.0	35.5	s	64°C
AKYPO® RA 50	13	55.5	35.1	s	62°C
AKYPO® IN-0202	9–12	19.2	30.0	s	37°C
AKYPO® TD-70	12	36.1	27.7	s	60°C
<b>FOSFODET</b>					
FOSFODET CS-0602	5	51.1	31.6	s	55°C
FOSFODET CS-0606	8	54.2	33.4	s	70°C
FOSFODET CS-0609	9	53.7	34.8	s	> 80°C

n.a. = not applicable; n.s. = not soluble; s = soluble

\*Please contact us for further technical information about the products. This data is provided as guidance. It does not represent the product specifications, which are presented in the technical data sheets. Additional information is also available in the product safety data sheets.

\*\*HLB values stated in the table are measured as non-neutralized; neutralized anionic (co)-emulsifiers show generally higher HLB values.





# TECHNICAL EXPERTISE

## Evaluating quality and performance

In addition to standard chemical wet analyses, our company's analytical department uses various chromatographic methods, including HPLC, GPC, and GC-MS as well as spectroscopic measurements such as FTIR and UV-VIS. Our metalworking competence center in Emmerich, Germany, carries out the following tests for developing and improving our metalworking additive portfolio:

### FOAMING

- CNOMO foam test D655212.
- Blender test Waring® Xtreme.
- Krüss DFA100 Dynamic Foam Analyzer.
- Shaking cylinder test.
- Aquarium stone test (in-house method).

### EMULSION AND EMULSION STABILITY

- LUMIFuge®
- Dynamic light scattering, zeta potential.
- Hach Lange transmission.
- Electrolyte scan (in-house method).
- Stability of metalworking fluid in hard water (DIN 51367/8).
- Temperature stability test.
- Phase inversion temperature.
- Turbiscan TOWER.

### CORROSION

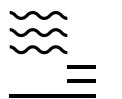
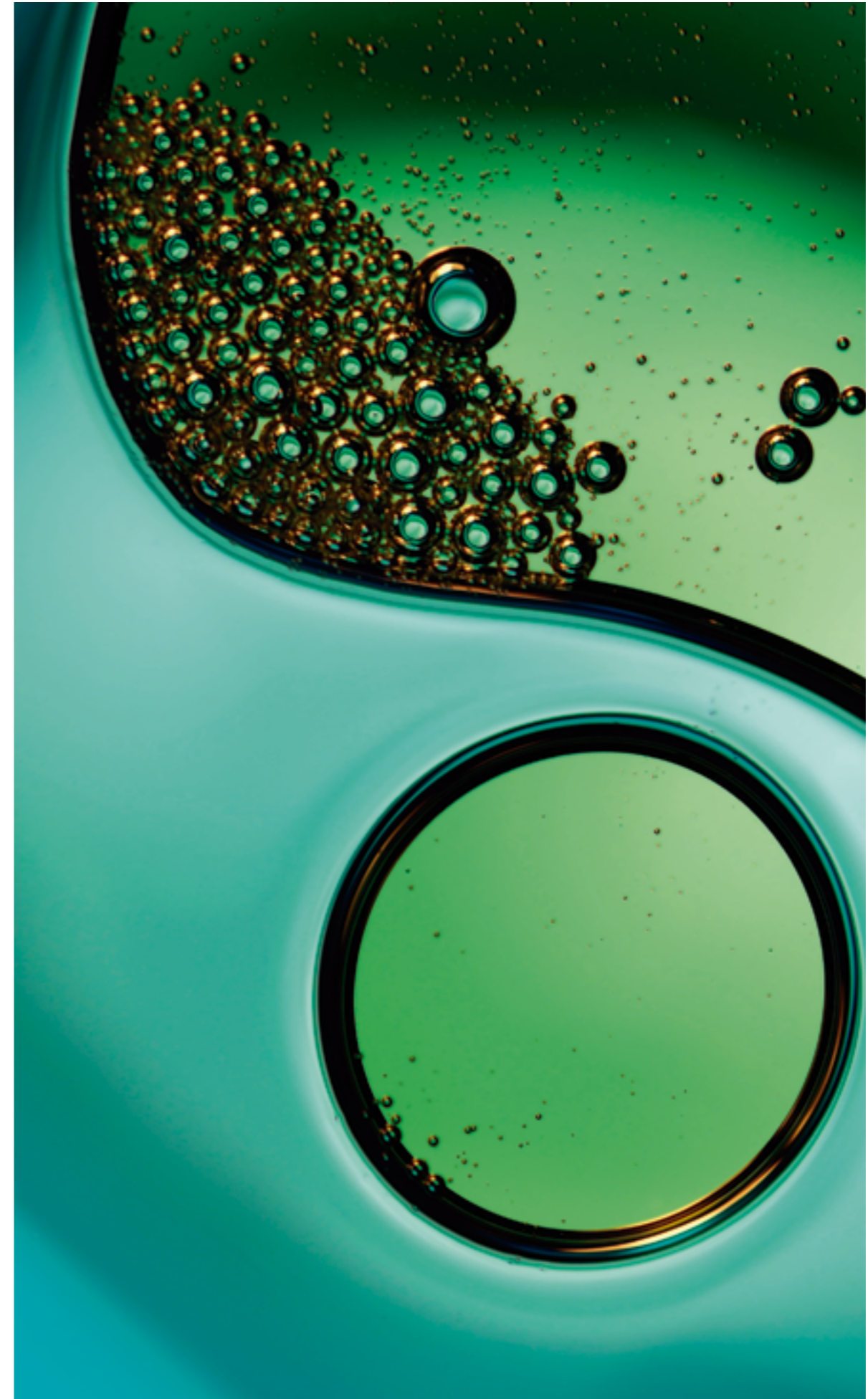
- Chip/filter paper method (DIN 51360-2).
- Light metal test, immersion test.

### LUBRICATION

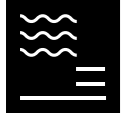
- Rheometer Anton Paar MCR 302 Tribocell.
- Tapping Torque Microtap Megatap II.
- Mahr Surf SD26 roughness measurement.
- Hund WETZLAR T100 microscope.

### BASIC SURFACTANT AND EMULSIFIER TESTS

- Krüss K100 Force Tensiometer (static surface tension, CMC, contact angle).
- Bubble pressure tensiometer (dynamic surface tension).
- Lime soap dispersing power (DIN 53903-1).
- Phase inversion temperature.
- HLB - Hydrophilic-Lipophilic Balance.







# FORMULATION GUIDE

## Collaborative innovation

Kao Chemicals Europe is more than just a metalworking additive supplier! Our desire is to provide the very best in support and joint development to formulate excellent innovative metalworking fluids. We draw on decades of experience and our comprehensive technical expertise to develop multifunctional products

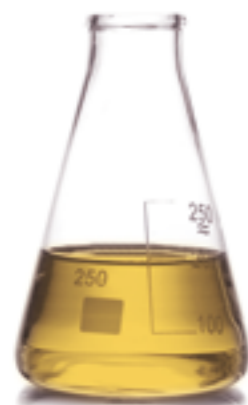
that add value to our customer's metalworking fluids.

Our metalworking guideline formulations range from classic boric acid based formulations to modern boron-free semi synthetic fluids.

## Classic metalworking fluid formulation

EXCELLENT HARD WATER STABILITY		% w/w
Mineral oil		49.1
Deionized water		5.5
Triethanolamine		18.4
Monoethanolamine		3.6
Boric acid		4.9
Tall oil fatty acid		4.3
Butyldiglycol		3.6
Cetyl/Oleyl alcohol ethoxylate (2 EO)		5.0
Cetyl/Oleyl alcohol ethoxylate (5 EO)		3.7
AKYPO® RO 90 VG		2.0

LOW FOAM AND HIGH HARD WATER STABILITY		% w/w
Mineral oil		48.4
Deionized water		5.4
Triethanolamine		18.1
Monoethanolamine		3.6
Boric acid		4.8
Tall oil fatty acid		4.3
Butyldiglycol		3.6
AKYPO® ROX RS-0606N		9.9
AKYPO® RSPE 66		2.0



## Guideline formulations

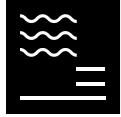
All companies that prepare metalworking fluids rely on their own know-how to develop their own formulations. The guidelines provided here are intended to serve as examples for various kinds of metalworking fluids that would benefit from the addition of AKYPO® and AKYPO® ROX / KAO FINDET. These formulations provide a framework for reformulation or as a starting point for new formulations. All formulations use

an emulsifier package consisting of fatty alcohol ethoxylates (for example, AKYPO® ROX / KAO FINDET) and AKYPO®. The various combinations will provide you with an idea about how to achieve the ideal formulation for specific performance requirements (extreme hard water stability, low foam, boron-free, etc.).

## Boron-free formulations

SOLUBLE OIL (BORON-FREE)		% w/w
Deionized water		1.0
Amino alcohol	Triethanolamine, monoethanolamine, other standards used in metalworking	4.6–5.3
Mineral oil		74.6–77.5
Tall oil fatty acid		9.5
Butoxypropanol		2.4–2.8
AKYPO® ROX PO-EO	Fatty alcohol alkoxyates	3.3–4.5
AKYPO® RO or AKYPO® PO-EO		1.7–2.3

SEMI SYNTHETIC (BORON-FREE)		% w/w
Deionized water		43.8
Amino alcohol	Triethanolamine, monoethanolamine, other standards used in metalworking	7.4
Mineral oil		21.1
Tall oil fatty acid		4.2
Butoxypropanol		3.2
AKYPO® ROX RS-0606N		12.1
AKYPO® RSPE 66		2.6
Dodecanedioic acid		3.2
Oleyl alcohol ethoxylated phosphate ester		2.5



## KAO CORPORATION

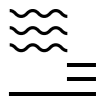
Founded in 1887, Kao Corporation is a Japanese company with a long history of innovation. Today, more than 33,000 employees worldwide are satisfying customer needs around the globe.

## SUSTAINABLE, COLLABORATIVE DEVELOPMENT

Inspired by our corporate philosophy, the Kao Way, and the Yoki-Monozukuri concept that lies at its heart, we are committed to providing excellent products to our customers.

Our close relationship with our customers inspires us to integrate their needs into the concepts and extensive technical knowledge of our Research & Development and Marketing & Sales teams. Guided by the Kao Sustainability Statement, we aspire to design and distribute non-toxic and environmentally friendly products using renewable resources.

These principles are reflected in our standard product range, the Kao Metalworking Toolbox, as well as in the customized solutions we offer.





Requests and further  
inquiries about our products:

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