

Solutions to Overcome Today's Formulation Hurdles for Light Metal and Multi-Metal Metalworking Fluids

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KAO Chemicals is a supplier of surfactant technology used in high-end technical applications such as metalworking. Its global metalworking competence center develops emulsifiers, co-emulsifiers, and solubilizers. Based on our application laboratory's latest findings, this article guides you through the KAO Metalworking Toolbox and the benefits of using KAO additives for light metal (non-ferrous) and multi-metal formulations, with a special focus on how AKYPO® (ether carboxylic acid) and FOSFODET (low-foaming phosphate ester) support corrosion and staining inhibition. All these findings share the

goal of achieving low-foaming, environmentally friendly and sustainable formulations.

KAO's metalworking expertise, which includes the production of specialty surfactants, has as its hub the global metalworking competence center at KAO Chemicals Germany, which is part of KAO Chemicals Europe.

KAO's focus on this segment is on industrial lubricants, which are available worldwide, with distribution in North America being handled by the Sea-Land Chemical Company.

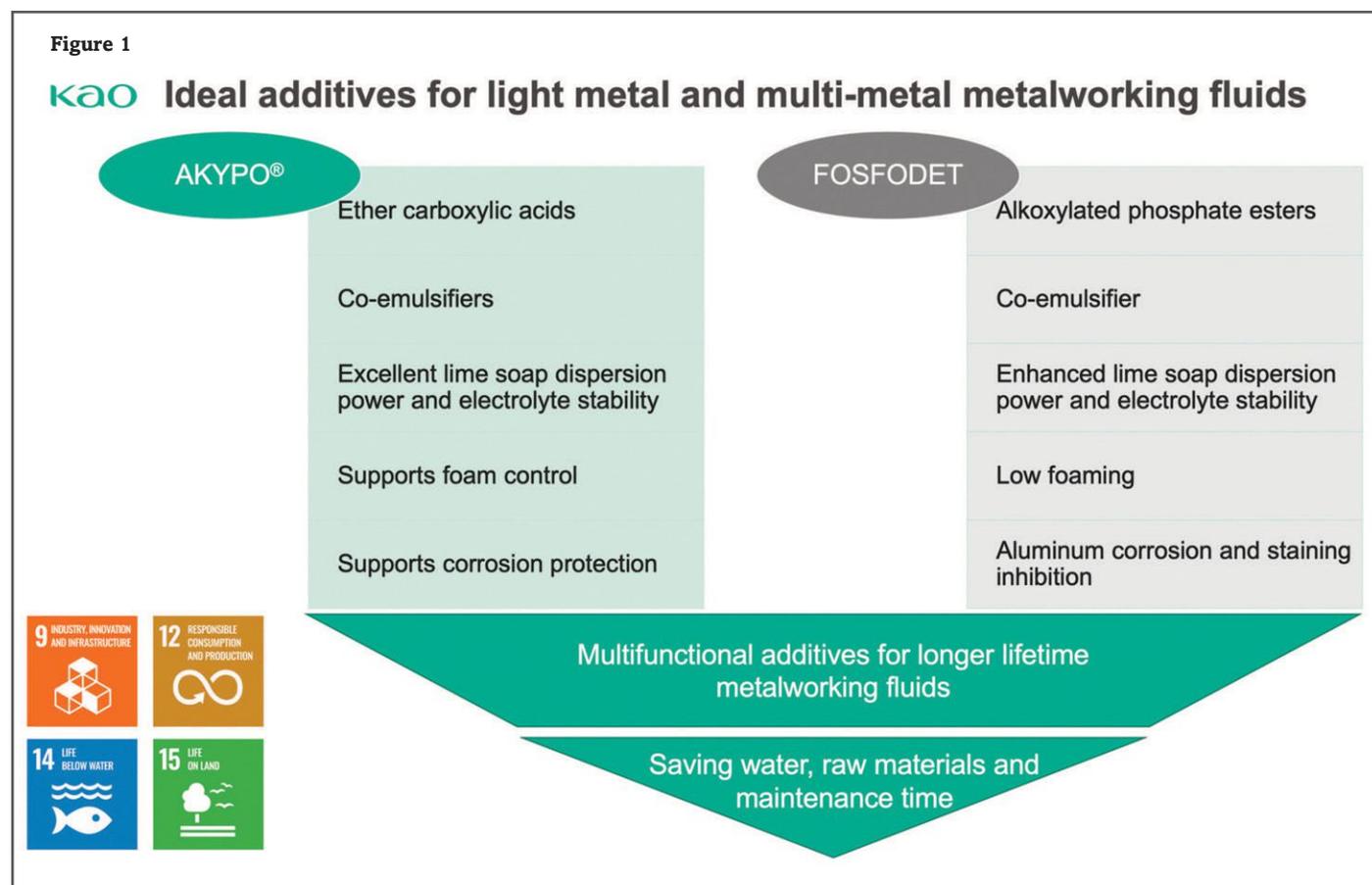
Surfactants, including emulsifiers, co-emul-

sifiers and solubilizers, have a great impact on formulations and their performance.

The challenges faced when formulating light metal (non-ferrous) and multi-metal metalworking fluids include emulsion stability, hard water tolerance, shrinking additive toolbox, supply chain issues, foam control, corrosion & staining protection, additive efficiency and sustainability requirements.

KAO produces two additive ranges for light metal (non-ferrous) and multi-metal metalworking fluids: AKYPO® and FOSFODET (see Figure 1).

These ranges are multifunctional addi-



tives for longer lifetime metalworking fluids. They both help save water, raw materials and maintenance time.

AKYPO® ether carboxylic acids are used as co-emulsifiers. They have excellent lime soap dispersion power and electrolyte stability, and they support foam control and corrosion protection.

FOSFODET products, meanwhile, are alkoxyated phosphate esters and are used as co-emulsifiers. Compared to other leading phosphate esters, FOSFODET products have enhanced lime soap dispersion power and electrolyte stability, as well as low foaming behavior. Of course, they also prevent aluminum corrosion and staining.

The AKYPO® RO range and AKYPO®TEC AM VG enhance the foam control of metalworking fluids by limited foam formation tendency and faster foam collapse rates when combined with fatty acids. This is illustrated in the circulation experiment in Figure 2, where the lower foaming profile also the ideal dispersion of aluminum soaps with AKYPO® is demonstrated.

The main properties of the AKYPO® RO range and AKYPO® TEC AM VG are the following:

Long alkyl chain (C16-18) ether carboxylic acid

- Co-emulsifier / stabilizer
- Outstanding lime soap dispersion power
- Liquid and easy to formulate
- Globally registered or listed

And its main benefits are:

- Hard water and electrolyte stability extends the lifetime of metalworking fluids.
- It especially improves the emulsion stability.
- It improves fluid cleanliness.
- It helps control foam in combination with fatty acids.
- It has synergistic effects with AKYPO LF and AKYPO ROX / KAO FINDET
- It enables sustainable and label-free end-formulations.

The new AKYPO® IN-0202 is a low-foaming multifunctional co-emulsifier for multi metal treatment due to its corrosion protection performance on light non-ferrous and ferrous metals (see Figure 3).

AKYPO® IN-0202 main properties are:

- Short alkyl chain (C9) PO-EO ether carboxylic acid
- Low foaming co-emulsifier
- Hydrotropic properties
- Liquid and easy to formulate

Its application benefits are:

- Increased hard water and electrolyte stability for extended fluid longevity
- Corrosion inhibiting properties on ferrous and light metals
- Stabilization of concentrate and emulsion
- Ideal for low foaming formulations

Another KAO product range, FOSFODET CS, provides a great combination of foam control and corrosion inhibition, making it perfect for light metal treatment.




Test conditions Pump-test Al³⁺
Metalworking emulsion was pumped 5 hours
In steps of 10° hardness the load of aluminum ions was increased to 100° hardness.

AKYPO® TEC AM VG

Low foaming co-emulsifier specialized for aluminum treatment

Focus: Initial foam and soap formation in low water hardness area...

without AKYPO®



with AKYPO®



Start 0°

10°

< 200 ppm Al³⁺

30°

40° ...

200-500 ppm Al³⁺

	without AKYPO®	with AKYPO®
Mineral oil	22.0	22.0
Deionized water	41.0	41.0
Amino alcohol mixture	6.0	6.0
Dicarboxylic acid	3.0	3.0
Tall oil fatty acid	3.0	3.0
Butyldiglycol	5.5	5.5
Sulfonate (MW 450)	12.5	10.0
KAO FINDET MB-212	3.5	3.5
FOSFODET CS-0602	3.5	3.5
AKYPO® TEC AM VG		2.5*

*Increasing emulsion stability also by using AKYPO® RO or our AKYPO® PO-EO range

Figure 2: Test conditions Pump-test with Al³⁺: Metalworking fluid emulsion was pumped for five hours. In steps of 170 ppm (10° gH) hardness, the load of aluminum ions was increased to 1700 ppm hardness.



Figure 3: Aluminum corrosion test with a 5% dilution of neutralized ether carboxylic acid with different amines to pH 9.4 in demineralized water. On the left AKYPO® IN-0202 ether carboxylic acid (EC) and on the right reference long-chain with high degree of ethoxylation EC. Staining is evaluated after 24 hours at 40°C.

FOSFODET CS (PO-EO) shows superior performance in lower foam profile and enhanced emulsion stability compared to standard phosphate esters (EO). Figure 4 shows a comparison of the chemical structure of

FOSFODET CS products vs. standard phosphate esters in combination with selected metalworking fluid test proofing the foaming profile as well as enhanced emulsion stability in formulation.

Benefits of FOSFODET CS:

- Ideal (co)-emulsification with enhanced foam control due to less foam formation and fast collapse of foam, as well as hard water and electrolyte stability.
- Corrosion inhibition, particularly aluminum staining inhibition.
- Anti-wear/extreme pressure performance.
- Typical applications include metalworking fluids, rolling oils, conveyer belt lubrication and hydraulic fluids.

The KAO Metalworking Toolbox is helping your way to cutting edge and sustainable metalworking fluids. Our multi-function and efficient additives improve emulsion stability and hard water and electrolyte tolerance, while enabling low-foaming formulation design, along with ideal corrosion and staining inhibition. KAO products are available worldwide and for the most part based on renewable raw materials, contributing to saving resources such as water due to enhanced fluid longevity.

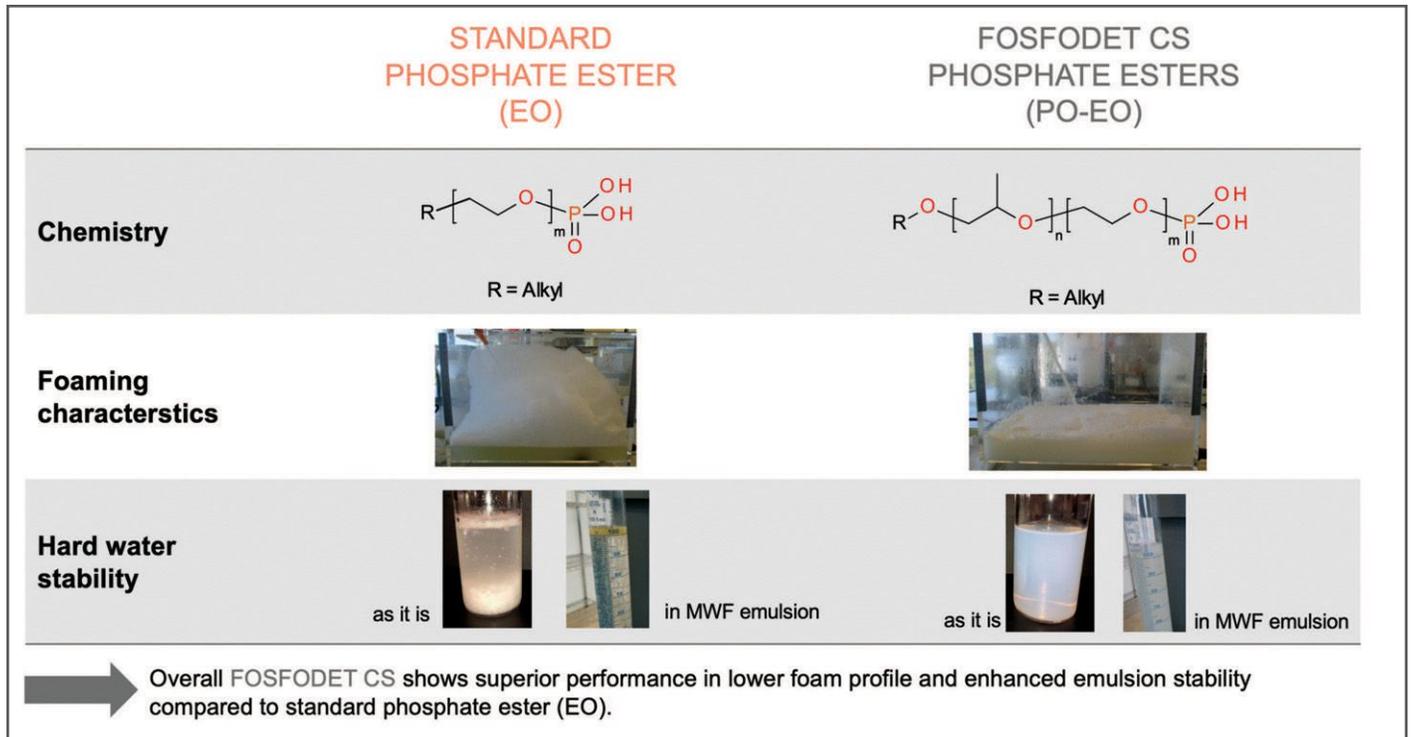


Figure 4: This table shows the superior performance of FOSFODET CS PO-EO phosphate esters compared to standard only ethoxylated (EO) phosphate esters due to their low foaming profile and enhanced emulsion stability in formulation.



METALWORKING ADDITIVES

AKYPO®
AKYPO® ROX
KAO FINDET
AMIDET®
FOSFODET

Essentials for
longer lifetime
metalworking fluids

The technology of Kao
surfactants in metalworking fluids



kaochemichals-eu.com

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