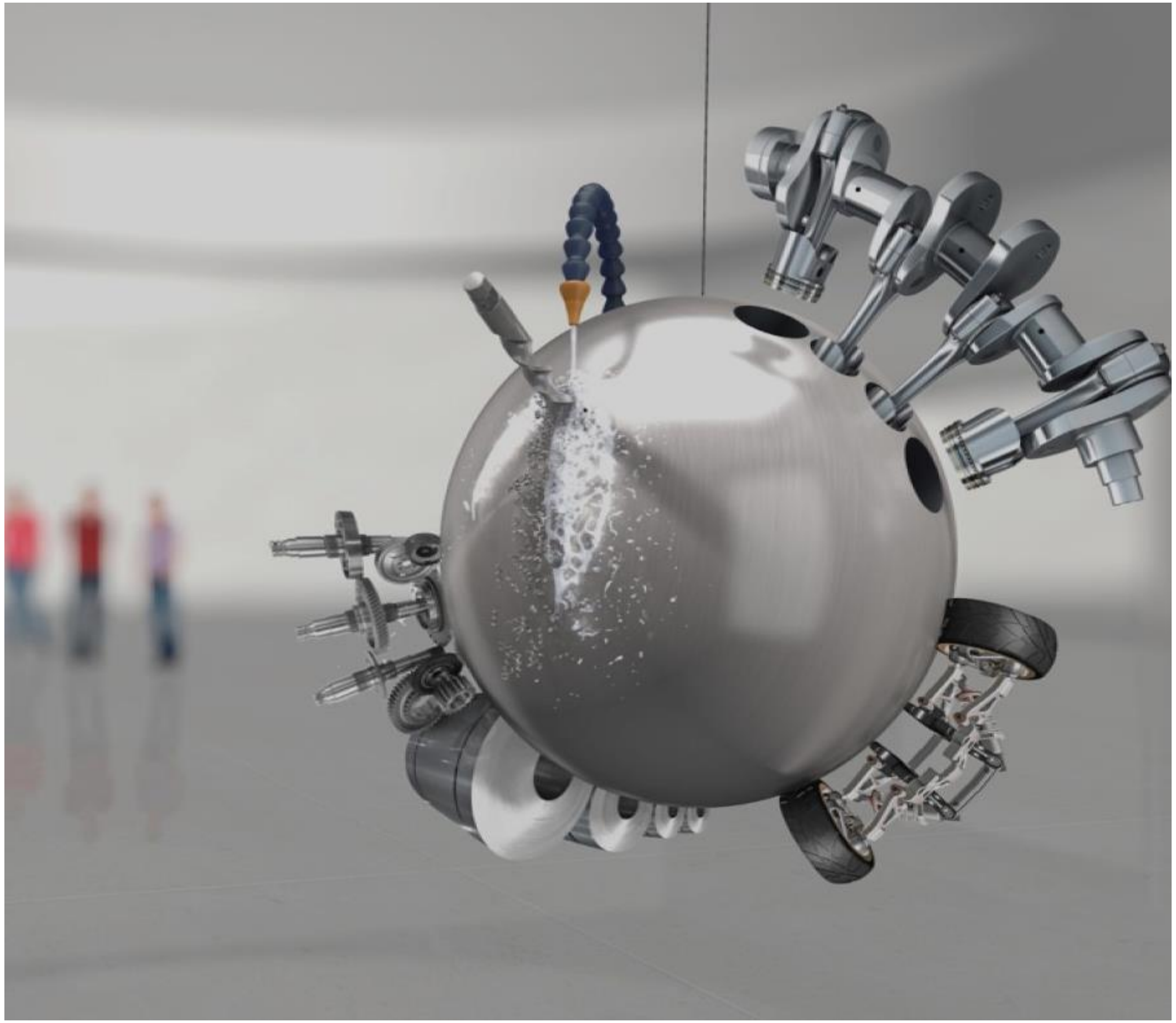
Corrosion Inhibitors for water-miscible Lubricants

Product Overview



Evonik Operations GmbH – Specialty Additives
Interface & Performance
August 2023

Corrosion Inhibitors for water-miscible Lubricants

- Evonik offers corrosion inhibitors for water-miscible lubricants that are based on primary amines
  - Monoethanolamine (MEA)
  - Diglycolamine (DGA)

- The use of secondary amines such as diethanolamine (DEA) in water-miscible metalworking fluids has been restricted in Germany for decades (regulated by TRGS 611)
  - We therefore do not provide corrosion inhibitors based on diethanolamine for use in European countries

- The portfolio also includes a phosphoric acid partial ester, which can be applied as a multifunctional additive to provide
  - excellent corrosion inhibiting properties on aluminum alloys and ferrous metals
  - lubricity enhancing and EP / AW characteristics in water-miscible and in non-water-miscible lubricants

Product Overview

Product	Application					Chemical Base	Remarks
	ferrous metals	zinc	aluminum	emulsifiable fluids	water soluble fluids		
REWOCOROS® O 3	○	○	○	●		Oleic acid amidoethanol polyethoxylate	▪ Co-emulsifier ▪ Lubricity enhancer ▪ Corrosion inhibitor if combined with fatty acids and appropriate amines
REWOCOROS® AC 101	●	●		●		Fatty acid polyglycol monoethanolamide, modified	▪ Co-emulsifier ▪ Lubricity enhancer
REWOCOROS® AC 261	●	●	●	●		Fatty acid diglycolamide, modified	▪ Co-emulsifier ▪ Lubricity enhancer ▪ Low foaming tendency
REWOCOROS® AL 200	●		●	●	●	Ethoxylated fatty alcohol phosphoric acid ester	▪ EP-/AW-additive ▪ Lubricity enhancer

● recommended ○ depending on fluid composition

REWOCOROS® O 3
Application Advantages

Composition
Oleic acid amidoethanol polyethoxylate

Physical Data
Water content: max. 0.3 %

Pour Point approx. 2 °C

pH Value 1 % Solution: 9.7 – 10.7

Colour to Gardner: max. 10.0

Application / Advantages
- Low foaming co-emulsifier for emulsifiable metalworking fluids (MWF)
- Acts as corrosion inhibitor if applied in combination with fatty acid amine soaps and appropriate amines
- Offers manifold possibilities in the formulation of tailor-made fluids for specific purposes
- The kind of amine that can be combined with REWOCOROS® O 3 depends on individual selection criteria which might be:
  - Odor
  - Volatility
  - Reserve alkalinity
  - Avoidance of copper or cobalt leaching
    - Instead of MEA, DEA or TEA (that should not be used), DGA should be the first choice

REWOCOROS® O 3
Further Application Advantages

Composition
Oleic acid amidoethanol polyethoxylate

Physical Data

Water content:
max. 0.3 %

Pour Point
approx. 2 °C

pH Value 1 % Solution:
9.7 – 10.7

Colour to Gardner:
max. 10.0

Application / Advantages (cont.)

- The kind of metal alloy:
  - MEA improves significantly corrosion inhibiting performance on ferrous metals and, especially, on cast iron
  - DGA will be the first choice if sensitive aluminum alloys should be protected
- The kind and amount of fatty acid or carboxylic acid that can be combined with REWOCOROS® O 3 influences
  - Corrosion inhibiting performance
  - Foaming tendency
  - Lime soap formation
- REWOCOROS® O 3 increases stability of water-mixed fluids and thereby enables reducing the total emulsifier amount
- Improves lubricating properties of water-based cooling emulsions and, as a result, decreases coefficient of friction between tool and work piece

REWOCOROS® O 3
Offers flexibility and allows customised formulations

Composition
Oleic acid amidoethanol polyethoxylate

Physical Data

Water content: max. 0.3 %

Pour Point approx. 2 °C

pH Value 1 % Solution: 9.7 – 10.7

Colour to Gardner: max. 10.0

Application / Advantages (cont.)

- Is, in comparison to most competitive products, liquid and facilitates the blending process in the manufacture of MWF / HFA concentrates
- Secondary amine free (complies with German TRGS 611)
- Is not known to show any detrimental effects on finished parts

The possibility of using a single base component instead of pre-formulated corrosion inhibitors offers our customers more flexibility and freedom to design customised MWF formulations

Recommended dosage

- We recommend a dosage of approx. 2 - 5 % of REWOCOROS® O 3 **within the emulsifiable lubricant concentrate**

REWOCOROS® AC 101
Application Advantages

Composition
Fatty acid polyglycol monoethanolamide, modified

Physical Data
Amine value
180 – 195 mg KOH/g

Acid value:
25 – 30 mg KOH/g

Water content:
max. 2 %

Colour do Gardner:
max. 12

Application / Advantages

- Corrosion inhibitor and co-emulsifier for soluble oils and semi synthetic fluids as well as for emulsifiable, fire-resistant hydraulic fluids (HFA)
- REWOCOROS® AC 101 is especially applicable as corrosion inhibitor for ferrous metals (steel and in particular cast iron) but can also be used for zinc coated metals (e.g. galvanized steel) to prevent formation of white rust
- Provides superior corrosion protection on ferrous metals such as steel and cast iron
- Protects zinc coated metals (e.g. galvanized steel) to prevent formation of white rust
- Allows high reserve alkalinity of water mixed MWF and thus excellent pH buffer capacity
- Increases stability of water mixed lubricants due to excellent co-emulsifying properties and thereby enables reducing the total emulsifier content while maintaining emulsion stability
- Improves lubricating properties of water-based cooling emulsions and, as a result, decreases coefficient of friction between tool and work piece
- Allows high reserve alkalinity of water-mixed fluids and thus excellent pH buffer capacity
- Enhances wetting / spreading and at the same time rinsing properties of water-mixed fluids

REWOCOROS® AC 101
Further Application Advantages & Dosage

Composition
Fatty acid polyglycol monoethanolamide, modified

Physical Data

Amine value
180 – 195 mg KOH/g

Acid value:
25 – 30 mg KOH/g

Water content:
max. 2 %

Colour do Gardner:
max. 12

Application / Advantages

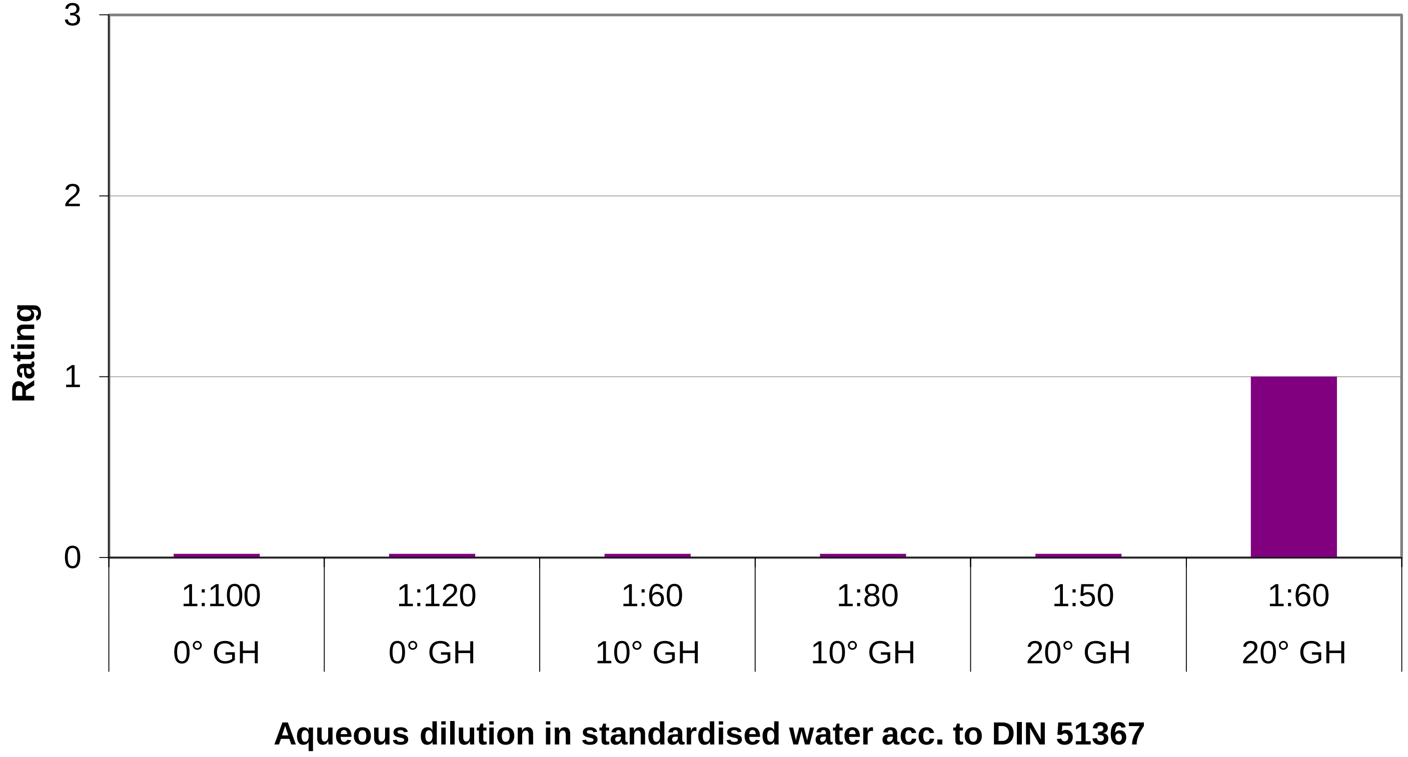
- Is, in comparison to most competitive products, liquid and facilitates the blending process in the manufacture of MWF / HFA concentrates
- Shows very low foaming tendency in hard water application
- Secondary amine free (complies with German TRGS 611)
- Non-corrosive to skin acc. to OECD 431
- Is not known to show any detrimental effects on finished parts

Recommended dosage

- To achieve sufficient corrosion protection, we recommend a dosage of 0.1 - 0.25 % REWOCOROS® AC 101 related to the water mixed fluid

REWOCOROS® AC 101 excellently inhibits Corrosion of Ferrous Metals, and even of the rust-sensitive Cast Iron

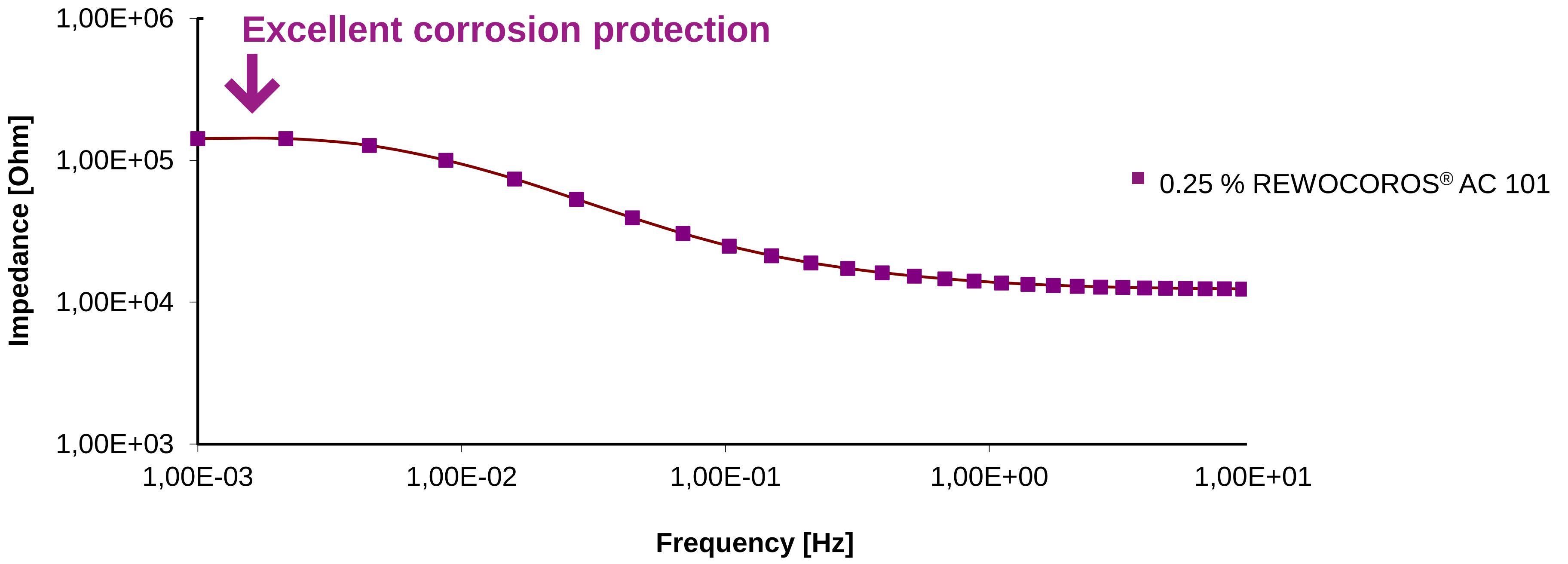
Corrosion prevention acc. to DIN 51360 – 2 (Chip/ filter paper method)



EVONIK
Leading Beyond Chemistry

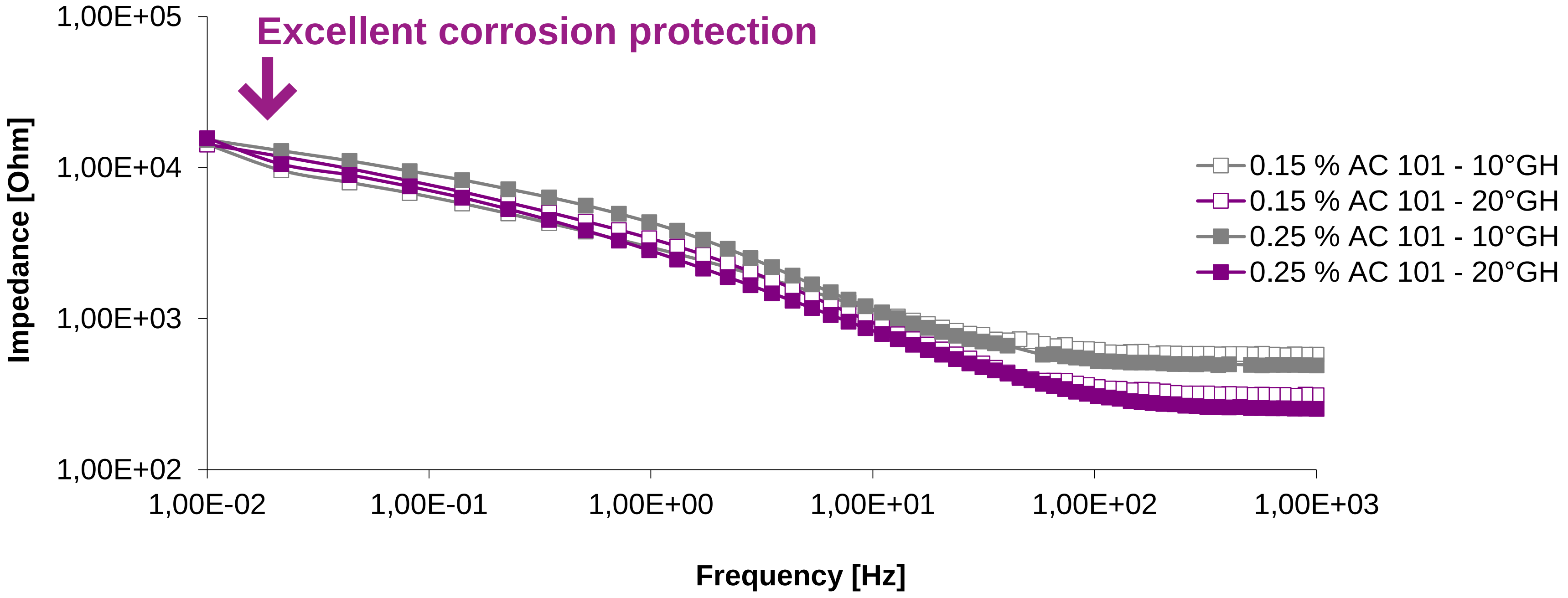
REWOCOROS® AC 101 inhibits Corrosion of Ferrous Metals

Impedance spectra of REWOCOROS® AC 101 diluted in water of 10 °GH (DIN 51367) on steel 37



REWOCOROS® AC 101
inhibits corrosion of zinc coated metals

Impedance spectra of REWOCOROS® AC 101 diluted in water of 10 °GH and 20 °GH (DIN 51367) on Zinc 99.6 % - Titanium 0.4 % - alloy



REWOCOROS® AC 261
Application Advantages

Composition
Fatty acid diglycolamine (DGA) condensation product, modified

Physical Data
Amine value:
115 – 130 mg KOH/g

Acid value:
27 – 33 mg KOH/g

Water content:
max. 2 %

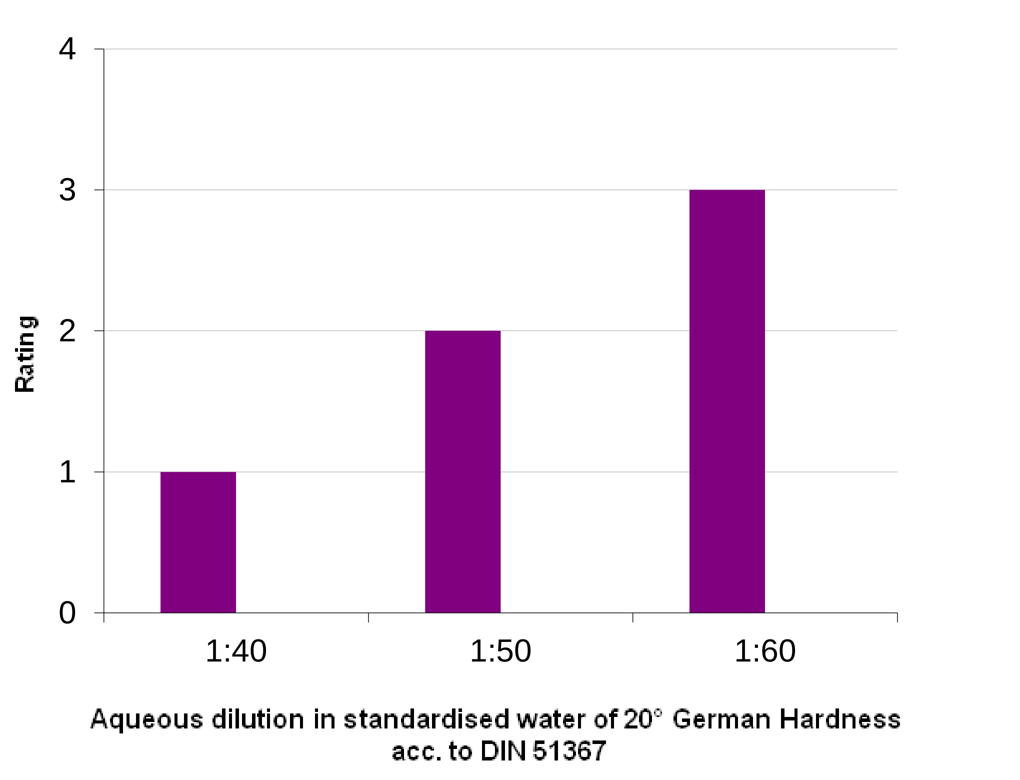
Application / Advantages

- Corrosion inhibitor for soluble oils and semi synthetic fluids as well as for emulsifiable, fire-resistant hydraulic fluids (HFA)
- Provides corrosion protection on:
  - aluminum alloys
  - ferrous metals
- Good co-emulsifying properties
- In order to prevent cobalt or copper leaching it is advisable to avoid the presence of certain commonly used metalworking amines such as monoethanolamine (MEA) or diethanolamine (DEA)
  - Due to the presence of DGA that shows a significantly lower tendency to dissolve cobalt or copper, REWOCOROS® AC 261 is particularly well-suited for its use in emulsifiable lubricants which are applied for processing of yellow metals or hardened metals (carbide)
- REWOCOROS® AC 261 increases stability of water mixed lubricants due to its excellent co-emulsifying properties and, thereby, enables reducing the total emulsifier content while maintaining emulsion stability
- Allows high reserve alkalinity of water mixed MWF and thus excellent pH buffer capacity
- Enhances wetting / spreading and at the same time rinsing properties of water-mixed fluids
- Is a clear liquid product that conduces to easy blending processes
- Shows in hard water applications a low foaming tendency
- Is secondary amine-free (complies with German TRGS 611)
- Is not known to show any detrimental effects on finished parts

EVONIK
Leading Beyond Chemistry

REWOCOROS® AC 261 inhibits corrosion of ferrous metals

Corrosion prevention acc. to DIN 51360 – 2 (Chip/ filter paper method)



Recommended dosage

- To achieve sufficient corrosion protection, we recommend a dosage of 0.1 - 0.25 % REWOCOROS® AC 261 **related to the water mixed fluid**

EVONIK Leading Beyond Chemistry

REWOCOROS® AL 200
Multifunctional Additive

Composition
Ethoxylated phosphoric acid ester, modified

Physical Data
Acid value:
140 – 160 mg KOH/g

pH value 10 % solids:
1.0 – 3.0

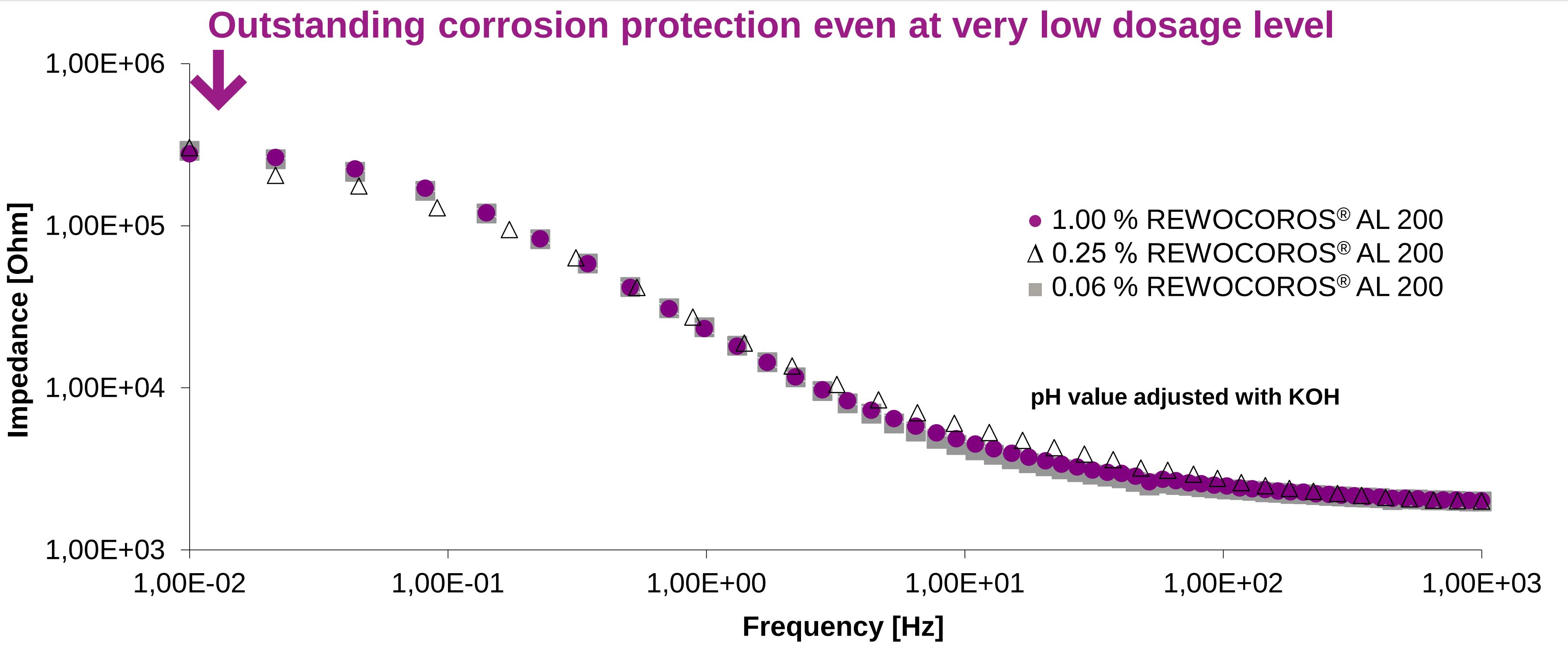
Water content:
max. 1.5 %

Phosphorous content:
approx. 5 %

Application / Advantages
- Provides excellent corrosion inhibition on:
  - aluminium and its alloys
  - ferrous metals
- Phosphorous content exhibits lubricity improving properties as well as EP / AW characteristics in water-mixed fluids (in its neutralized form) and in non-water-miscible lubricants (in its supplied form)
- Provides as alkali or ammonium salt in aqueous systems even at low pH (≥ pH 5) excellent corrosion inhibition on aluminum alloys and on ferrous metals
- To improve corrosion protection properties on aluminum alloys a combination of REWOCOROS® AL 200 with DGA or DGA / MEA is recommended
- A combination of REWOCOROS® AL 200 with preferably MEA is favorable for the corrosion protection of ferrous metals
- Enhances lubricity in neat rolling and drawing oils
- Improves wetting and at the same time rinsing properties of water-mixed fluids
- Is well soluble in metalworking fluid concentrates
- Is readily biodegradable (73 %, 28d, OECD 301 D)
- Is not known to show any detrimental effects on finished parts

REWOCOROS® AL 200 excellently inhibits Corrosion of even sensitive Aluminium Alloys in water-borne Systems

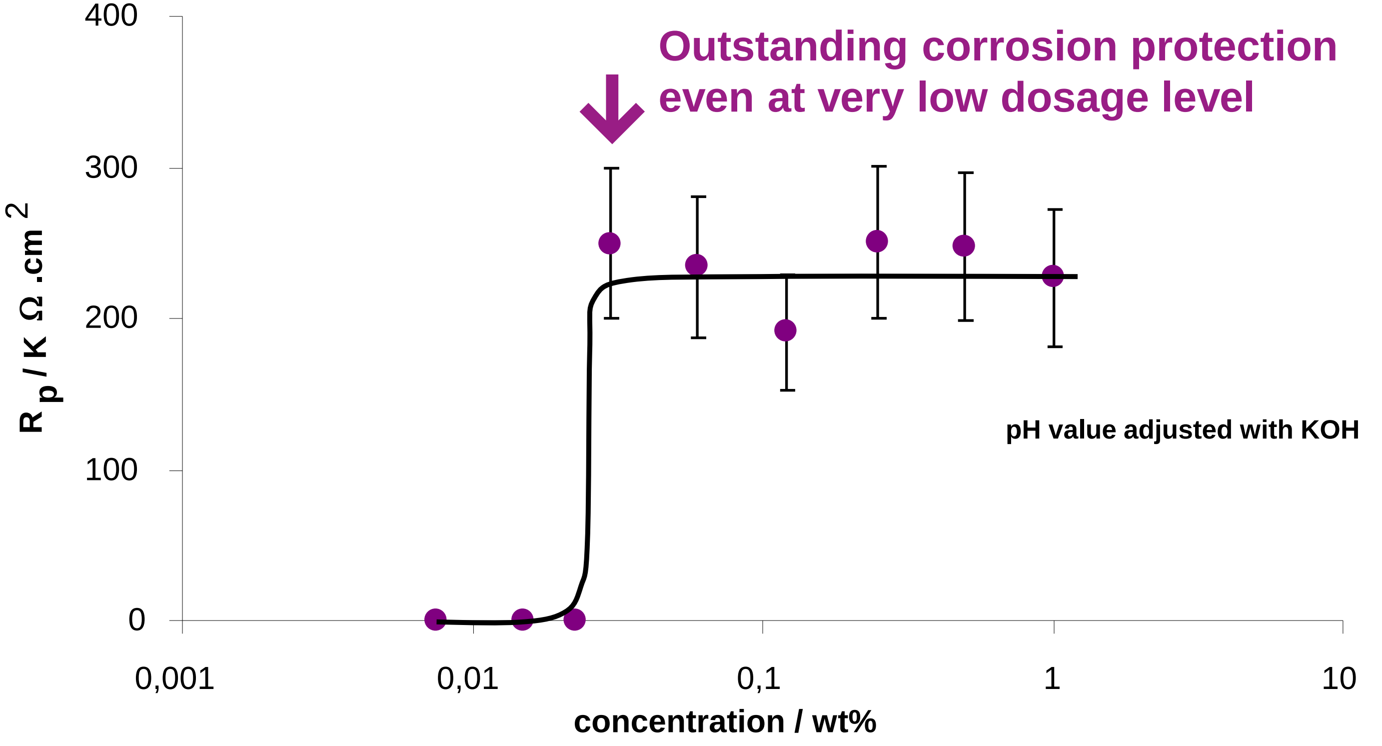
Impedance spectra of REWOCOROS® AL 200 diluted in water of 10 °GH (DIN 51367) at pH 9 on aluminum EN AW 7075



Leading Beyond Chemistry

REWOCOROS® AL 200 excellently inhibits Corrosion of even sensitive Aluminium Alloys in water-borne Systems already at very low Dosages

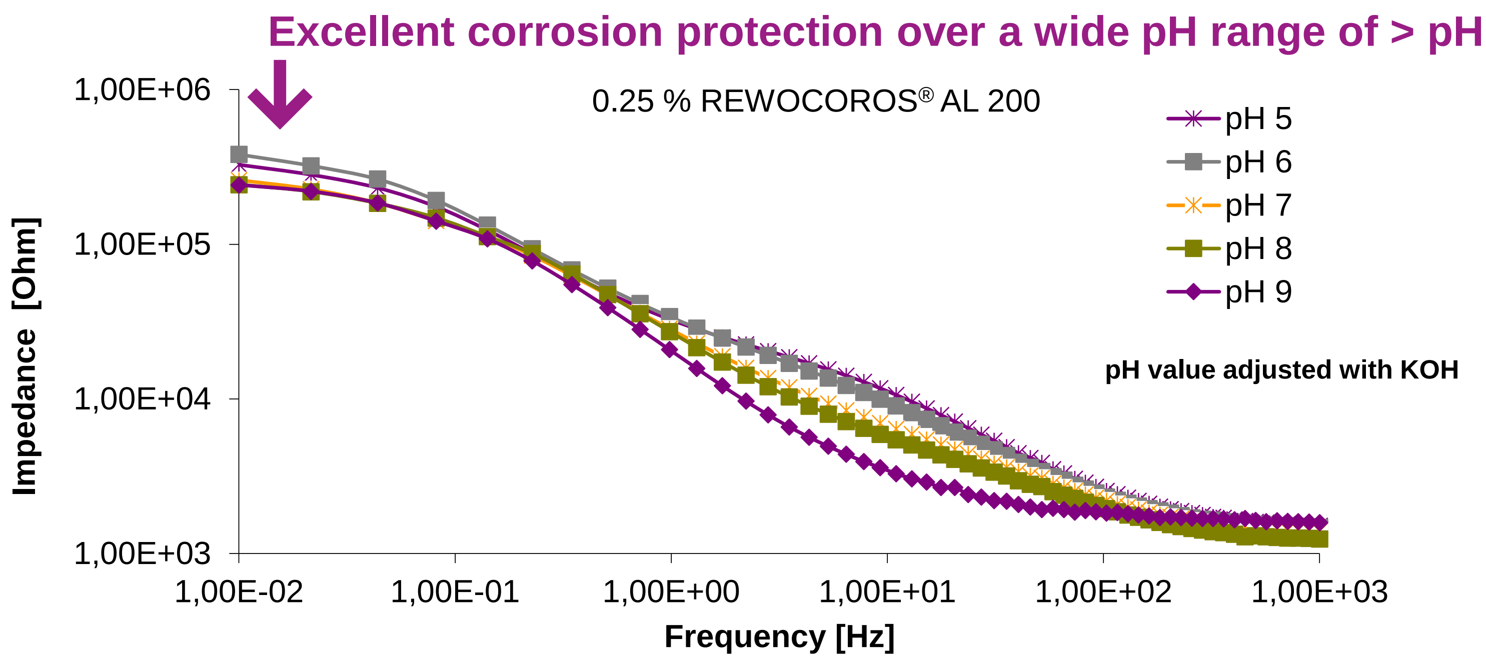
Impedance spectra of REWOCOROS® AL 200 diluted in water of 10 °GH (DIN 51367) at pH 9 on aluminum EN AW 7075



EVONIK Leading Beyond Chemistry

REWOCOROS® AL 200 excellently inhibits Corrosion of Aluminium Alloys even at low pH Values

Impedance spectra of REWOCOROS® AL 200 diluted in water of 10 °GH (DIN 51367) at different pH values on aluminum EN AW 7075



EVONIK
Leading Beyond Chemistry

REWOCOROS® AL 200 inhibits Corrosion of even sensitive Aluminium Alloys in water-borne Lubricants

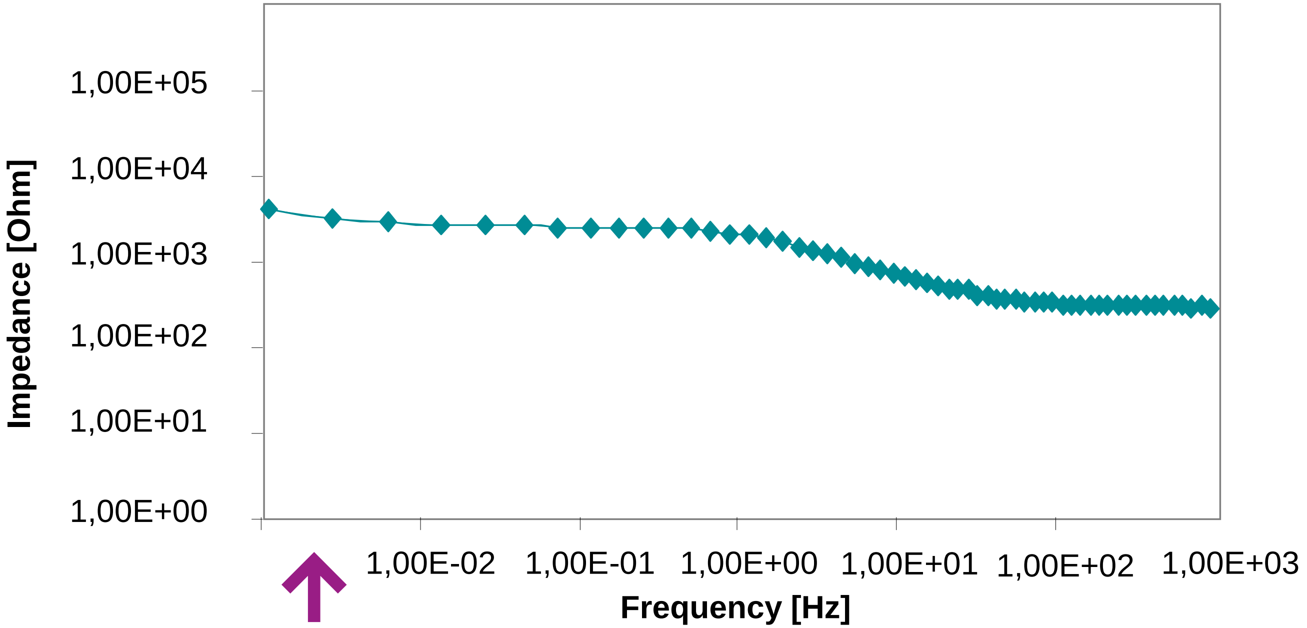
Test formulation to evaluate corrosion performance of REWOCOROS® AL 200 on aluminum EN AW 7075

50.0 %	Naphthenic oil (NYNAS T 22)
17.5 %	POE-5 Oleyl-/Cetyl alcohol
8.0 %	Tall oil fatty acid (low resin)
15.0 %	TEA
4.5 %	Butyldiglycol
5.0 %	**REWOCOROS® AL 200**

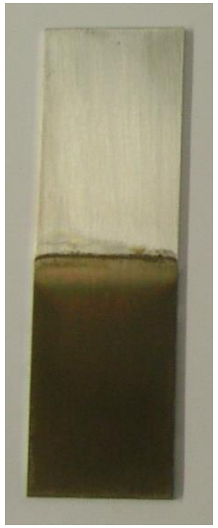
REWOCOROS® AL 200 inhibits Corrosion of even sensitive Aluminium Alloys in water-borne Lubricants

Test formulation without REWOCOROS® AL 200 (control) diluted to 5 % in water of 10 °GH (DIN 51367) on EN AW 7075

Impedance specta



Immersion test after 28 days

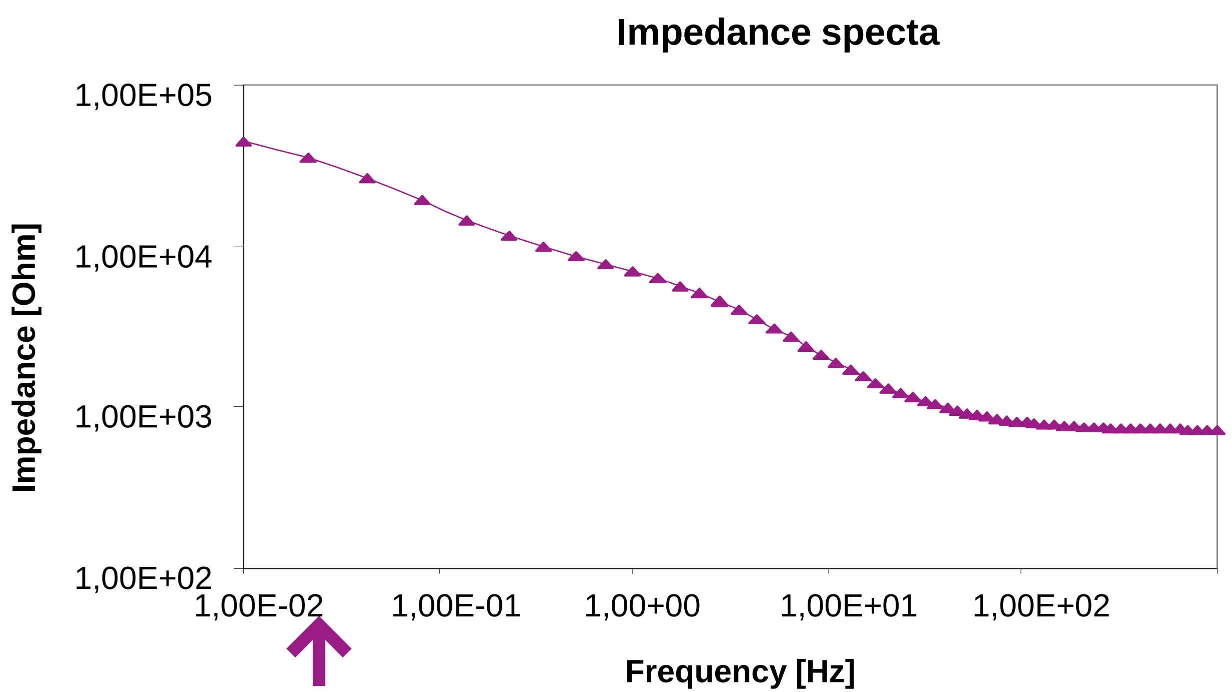


Insufficient corrosion protection of the water-mixed lubricant in absence of REWOCOROS® AL 200

EVONIK
Leading Beyond Chemistry

REWOCOROS® AL 200 inhibits Corrosion of even sensitive Aluminium Alloys in water-borne Lubricants

Test formulation with REWOCOROS® AL 200 diluted to 5 % in water of 10 °GH (DIN 51367) on EN AW 7075



Immersion test after 28 days

Excellent corrosion protection of the water-mixed lubricant due to the presence of REWOCOROS® AL 200

EVONIK
Leading Beyond Chemistry

EVONIK
Leading Beyond Chemistry