



## Formulating with Synergex™

Synergex products can extend coolant life and improve the performance of most water-based metalworking fluids.

Eastman's Synergex family of multi-functional amine additives can be used in combination with other amines or used by themselves in a concentrate, used tank side, or used to make corrosion inhibiting salts and amides. Synergex products can extend coolant life and improve the performance of most water-based metalworking fluids.

### Including Synergex in your coolant formulas can offer multiple benefits:

- Extended coolant life
- Improved pH control
- Greater emulsion stability
- Low volatility and low odor
- Good water solubility
- Compatability with other additives:
  - Biocides
  - Fungicides
  - Metal deactivators
  - Corrosion inhibitors
- Easy salt formation with:
  - Corfree® M1
  - Sebacic acid
  - Neodecanoic & isononanoic acid
  - Caprylic/capric acid
  - Boric acid

### Amine carboxylate with Synergex

One of the easiest ways to insert Synergex into synthetic and semi-synthetic formulations is to prepare a Synergex dicarboxylate salt rust inhibitor. The following example can easily be prepared by simple blending without the use of an outside source of heat:

Table 1		
Amine carboxylate salt	Lbs	Percent
Water	200.00	47.06%
Corfree® M1 *	108.00	25.41%
Synergex	117.00	27.53%
<b>Total</b>	<b>425.00</b>	<b>100.00%</b>

Start with water and blend in the Synergex, then add the Corfree® M1 until most of the granules are dissolved. Mix until clear.

**Note of caution:** some heat of solution will be generated during this process.

\* Corfree® is a registered trademark of INVISTA S.a.r.l.

The above formula makes 50 gallons of Synergex salt with the following properties:

Table 2	
Properties	Results
Color	Amber
Odor	Bland
Lbs/gal	8.6
Solids	50%

- pH = 6.91 @ 1.0/1.0 Synergex/Corfree M1 ratio
- pH = 7.58 @ 1.1/1.0 Synergex/Corfree M1 ratio
- pH = 8.55 @ 1.2/1.0 Synergex/Corfree M1 ratio
- pH = 9.02 @ 1.3/1.0 Synergex/Corfree M1 ratio (odor is shifting from soapy to more amine-like)
- pH = 9.38 @ 1.4/1.0 Synergex/Corfree M1 ratio
- pH = 9.56 @ 1.5/1.0 Synergex/Corfree M1 ratio

If this Synergex salt is used to make up 24% of the synthetic or semi-synthetic formulation, then the concentration of Synergex in the final concentrate will be 6%, ideal for optimizing all the benefits of a synergistic amine. The above Synergex salt will be replacing rust inhibitors that typically contain only 5% to 25% water so adjust your formula accordingly.

## Semi-synthetic testing

Here is a recommended semi-synthetic formula incorporating the Synergex™ Corfree® M1 acid salt:

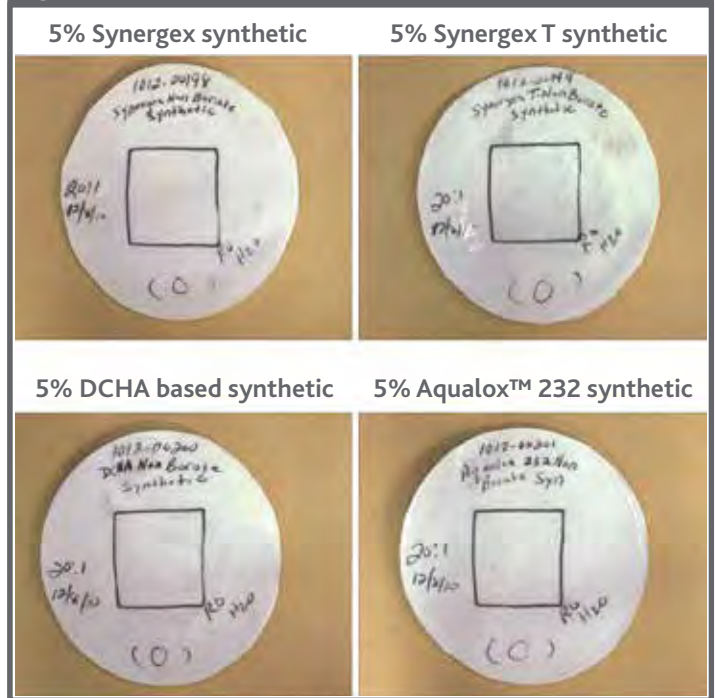
Ingredient	Weight percentage
1 Water	19.00%
2 Synergex	9.00%
3 Corfree® M1	8.00%
4 Anti-foam	00.15%
5 Sodium tolyltriazole 50%	00.10%
6 EDTA 40%	00.10%
7 DIPA oleamide 2/1 molar ratio	20.00%
8 Low rosin tall oil fatty acid	08.00%
9 Naphthenic oil 100 SUS	22.00%
10 High mol wt fatty ester	09.00%
11 PEG 600 monotallate	01.00%
12 4 mole ethoxylated alcohol	03.00%
13 Fungicide	0.65%
<b>Total</b>	<b>100.00%</b>

The semi-synthetic formula with a Synergex salt rust inhibitor was compared to a semi-synthetic formula made from DCHA and another semi-synthetic formula with a commercial TEA/primary amine based boramide. All three formulas showed no rust in distilled water at a 20:1 dilution in a typical cast iron chip on filter paper rust test.

The aluminum leaching results were very favorable to Synergex containing semi-synthetics as both the results and the pictures show. Also in the cobalt leach, the Synergex containing synthetics did very well. Lastly, the cast iron chip rust testing showed, as before, that at the concentrations necessary for long coolant life, 5% (20/1 dilution) there is no trace of rust.

To learn more about Synergex, visit  
[www.SynergexAmine.com](http://www.SynergexAmine.com)

Figure 1



*Aqualox™ is a trade mark of the Lubrizol corporation*

## Corrosion inhibition in synthetics

We compared the amine-carboxylate with Synergex salt rust inhibitor to a similar rust inhibitor made from DCHA, Synergex T and the commercial rust inhibitor Aqualox™ 232. The rust inhibitors were formulated at 20% with 20% diisopropanolamine and the usual additions of tolyl triazole, fungicide and anti-foam. All four formulas showed no rust in distilled water at a 20:1 dilution in a typical cast iron chip test on filter paper, see figure 1. This is not surprising in that the level of Corfree® M1 is the same for all four.

These synthetic formulas were also tested for aluminum corrosion. The aluminum stain test is run using Al 1100 H14 coupons placed in a jar covered with the sample and allowed to sit for 24 hours. The coupon is weighted before and after the test, and any staining is noted when the coupons are removed. ICP/emission was used to determine the dissolved metal concentration (measured in ppm) of aluminum which leached out of the coupon. All formulas were boric acid free and included Corfree® M1. Synergex T performed the best with 50% less loss of aluminum than DCHA and only 17% the mass loss of the typical TEA based corrosion inhibitor.

The potential for cobalt leaching was expected to be very low for synthetic coolants with long life amines, and test work done on the finished coolants confirmed this to be true. Only the commercial additive contains appreciable levels of TEA and all are fortified with the usual metal deactivator.

# **EASTMAN**

The results of insight™

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