Synergex™

CASE STUDY

Synergex™ LA amine additive in a semisynthetic metalworking fluid formulation

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Introduction

This case study was conducted to compare Synergex™ LA amine additive and Amietol™ M12 (MDEA, CAS 105-59-9) to a more conventional amine combination. The formulations were as similar as possible to allow for a fair comparison.

Table 1. Formulations

Raw material	Description	Formulation 405A	Formulation 405B
Ergon HyGold 100	100 SUS naphthenic oil	40.0	40.0
Polartech® EA 700	Polymeric emulsifier	7.0	7.0
Altapyne® M-28B	High-rosin tall oil fatty acids	2.0	2.0
Polartech® LA™ 8005	Polymerized ricinoleic acid	3.0	3.0
ACC EM-8	Nonionic emulsifier	4.0	4.0
ACC AE-43	EO/PO alcohol	3.0	3.0
AKYPO® TEC AM	Ether carboxylate	1.5	1.5
Rhodafac® AS 010	Aluminum stain inhibitor	0.75	0.75
OPP 40%	Bactericide/fungicide; 40% in glycol	3.75	3.75
MIPA	Amine	2	—
TEA 99 LFG	Triethanolamine	5.0	—
Amietol M12	Amine	—	5.0
Synergex LA	Specialty amine	—	3.0
Cola®Cor 232	Corrosion inhibitor blend	4.0	4.0
Cola®Cor RP	Amine borate complex	4.0	4.0
DI water	Deionized water	18.45	17.45
TT50	Sodium tolyltriazole 50%	0.50	0.50
Foam Ban® HV-810G	Defoamer	0.05	0.05
Coupler			
Propylene glycol	—	1.0	—
EO alcohol	High-HLB emulsifier	—	1.0

Figure 1. The prototype concentrates

405A 405B

Both samples show the same color and stability in concentrate form. No defoamers were used to better differentiate the foaming performance or gauge sample stability. The goal was to perform basic testing to indicate the performance benefits that can be achieved using Synergex LA.

Foam testing

Foam testing was performed by preparing 5% dilutions in water with 100 ppm hardness and blending with a kitchen mixer for five minutes. For the foam to break completely, the lapse times were:

- 405A: 19 seconds
- 405B: 105 seconds

Figure 2. Samples after the completion of the foam testing

The lower foam break times associated with sample 405A correspond to less emulsion stability. A closer look at the top of these emulsions shows the instability of sample 405A.

Cast iron chip testing

Cast iron chip corrosion testing was performed on both samples at 2%, 3%, and 4% in 200 ppm water. In the test, 2.5 grams of cast iron chips were added to a plastic Petri dish that contained a piece of filter paper. The chips were covered with the test fluid for five minutes and then drained. The Petri dishes remained covered for 24 hours and then were allowed to dry.

Figure 3. Cast iron chips after corrosion testing (top row is 405A and the bottom row is 405B)

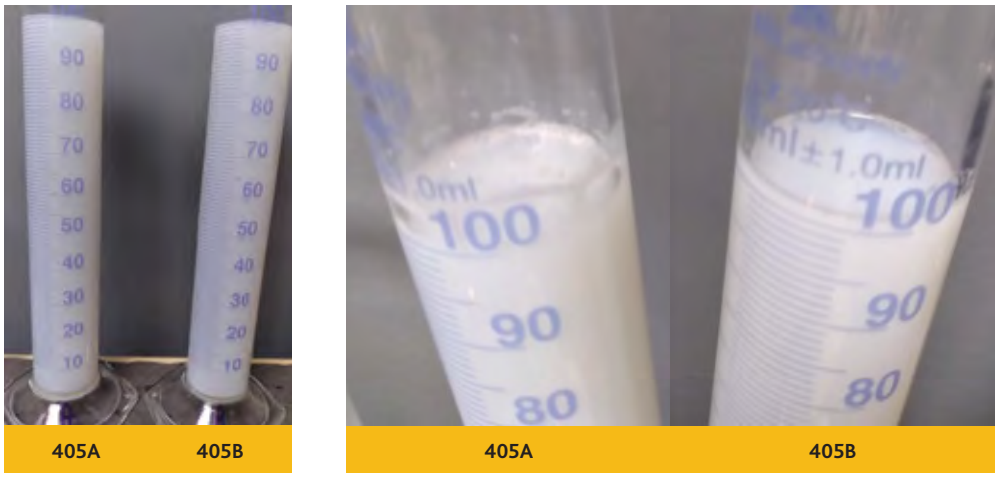
2% 3% 4%

All three concentrations displayed improved cast iron chip corrosion resistance in sample 405B. This indicates that the amine combination in sample 405B (Amietol M12 and Synergex LA) provides better protection than the combination used in sample 405A (MIPA and TEA).

Emulsion stability

Emulsion stability testing was performed by preparing emulsions at 5% in water with 650 ppm hardness and allowing them to sit for 24 hours.

Figure 4. Emulsions after stability testing



405A 405B 405A 405B

A closer inspection of the top of these emulsions shows more instability in sample 405A than in 405B.

Aluminum stain testing

Aluminum stain testing was done by soaking five different aluminum specimens (319, 356-T6, 2024, 6061-T6, and 7075) for 24 hours in emulsions of the prototypes prepared at 5% in water with 200 ppm.

There appeared to be little difference in how the different combinations affected the amount of stain observed. The aluminum stain profile did not get worse, even with the improvement in cast iron chip corrosion performance.

Figure 5. **Aluminum specimens after stain testing**

Microbial resistance

Both samples were submitted to Biosan Laboratories for ASTM E686 testing to determine their resistance to bacteria and fungal growth. In addition to the gathered data, it was noted that sample 405A turned a light brown color during testing, whereas sample 405B did not.

Table 2. **Aerobic bacteria and fungi levels**

	16881-1 GMA-405A at 7%			16881-2 GMA-405B at 7%		
	Bacteria/mL	Fungi/mL	pH	Bacteria/mL	Fungi/mL	pH
Time 0*	1×10^7	4×10^5	9.53	9.5×10^6	1.5×10^6	9.51
Week 6	< 2	< 2	9.31	52	< 2	9.36

**After inoculation*

pH stability

Testing was performed on 5% emulsions of both samples to determine pH stability over time. The testing involved preparing 500 mL of a 5% emulsion of each sample in DI water and allowing the emulsions to sit uncovered for two weeks. The pH was measured daily on both fluids. Sample 405B displayed slightly better pH stability than sample 405A. The pH data from the Biosan Laboratories report coincide with these data.

Table 3. pH levels

	405A	405B
Day 1	9.46	9.48
Day 2	9.43	9.48
Day 5	9.44	9.48
Day 6	9.38	9.39
Day 7	9.36	9.38
Day 8	9.35	9.38
Day 9	9.34	9.38
Day 12	9.34	9.38
Day 13	9.34	9.38
Day 14	9.34	9.38
Day 15	9.33	9.38

Results and conclusion

The purpose of this case study was to determine if improvements in biological resistance could be shown using Synergex LA. It also was meant to reveal any other tangible benefits. While significant improvement in microbial resistance in the Synergex LA/Amietol M12 formulation (405B) over the MIPA/TEA formulation (405A) was not reported, the data does show that excellent microbial control can be achieved with relatively modest levels of 1.5% *ortho*-phenylphenol (OPP) in combination with Synergex LA.

The formulation utilizing Synergex LA and Amietol M12 displayed emulsion stability enhancement along with better ferrous corrosion resistance and a reduction in the aluminum stain. Furthermore, a slight improvement in pH stability existed in sample 405B (Synergex LA/Amietol M12) over 405A (MIPA/TEA).

For more information on Synergex multifunctional amine additives, visit **eastman.com/Synergex** or contact your Eastman representative or your authorized Eastman distributor.

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