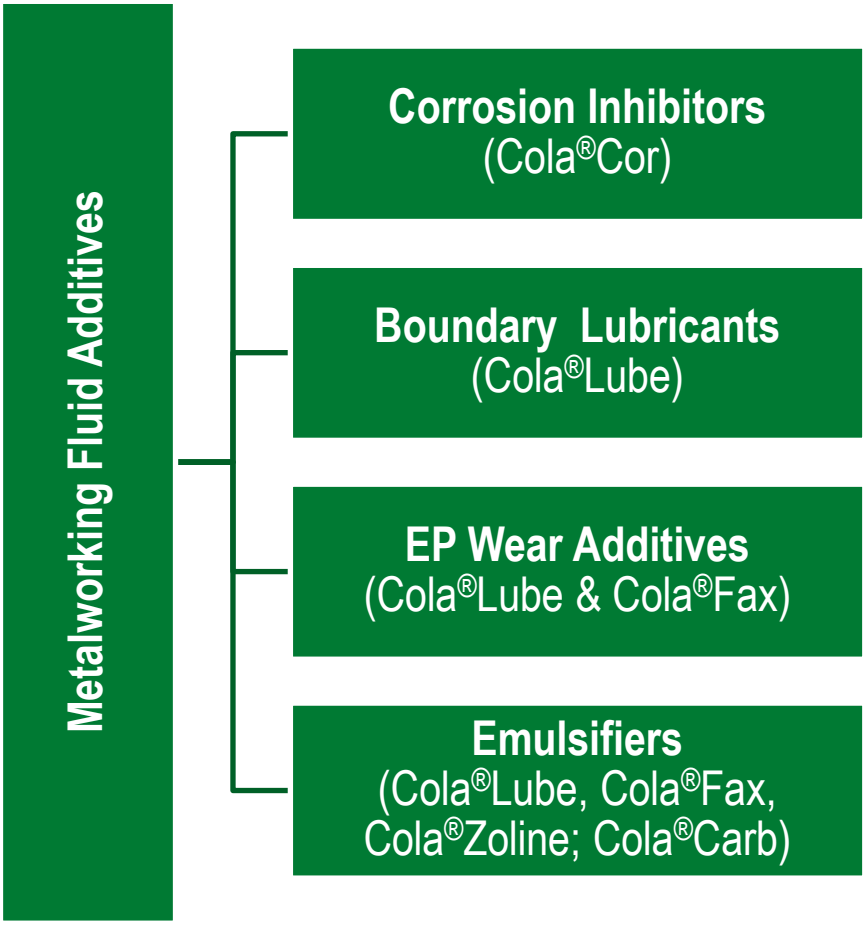
Formulating Semi-Synthetic Metalworking Fluids

Colonial Chemical

Colonial's Additive Portfolio for Metalworking Fluids



Capable of extending performance coverages as

- Wetting agents
- Dispersants
- Coupling agents
- Alkalinity Boosters

Design of the Semi-Synthetic Fluid

- Oil Levels (0 – 50%)
  - Low-Oil: ca. 20%
  - High Oil: ca. 50%
- Targeted dilution: 5%
- Targeted for low-, medium-, and heavy-duty processes
- Suitable for multimetal working processes: ferrous and aluminum
- Targeted metalworking processes
  - Cutting: grinding, cutting, milling, drilling, tapping, etc.
  - Forming: stamping etc.

Selected Additives

Additives in BOLD GREEN are from Colonial Chemical Inc.

Ingredient	Chemistry & Performance Attributes
100 SUS naphthenic oil	Base oils
Cola®Lube 3449	AMP Amides: emulsifier, boundary lubricants, biostability
High rosin tall oil fatty acids	Tall oil fatty acids: emulsifier, corrosion inhibitor,
Cola®Lube 3440	Poly(ricinoleic acid): boundary lubricity additives, emulsion stabilizer, beneficial for Al
Cola®Lube 3430	Polymerized polyol esters: boundary lubricity additives, emulsion stabilizer
Cola®Dol 91-6	EO-Based Alkoxylates: emulsifier, coupling agent
Colonial A225	EO-PO based alkoxylates: emulsifier, coupling agent
Cola®Carb OXC	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
Cola®Carb O5C	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
Fungicide	Microbial control (Fungicide)
Triethanolamine	Alkanolamine: Alkalinity booster
Cola®Cor 300	Amine carboxylates: corrosion inhibitors for ferrous metal
Cola®Cor IT	Acylamidocarboxylates: corrosion inhibitors for ferrous
Cola®Cor RP	Amine Borates: non-foaming Corrosion inhibitor
Cola®Lube 3407	Long alkyl chain ethoxylate phosphate esters: EP wear, emulsifier, aluminum corrosion inhibitors
Corrguard EXT	Specialty amine: alkalinity booster extending sump life
Deionized water	DI Water: Fluid carrier
Bactericide	Bactericide: microbial control

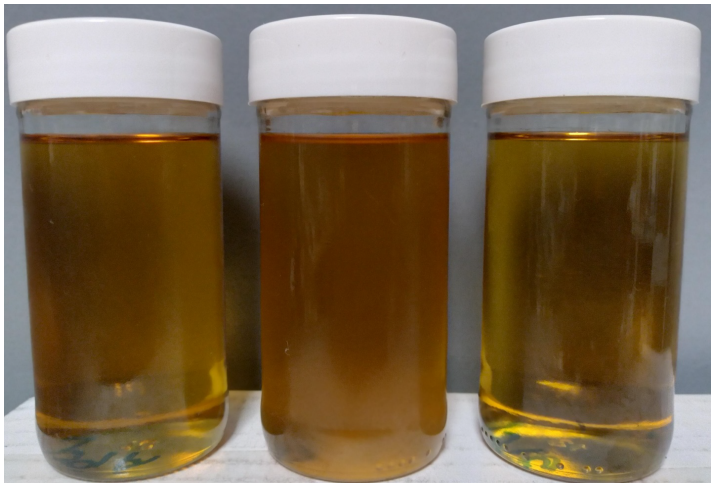
High Oil, Semi-synthetic Fluids

Ingredient	A	B	C
100 SUS naphthenic oil (Hygold 100)	48.0	48.0	48.0
Cola®Lube 3430	6.0		6.0
TMPTO		6.0	
Cola®Lube 3449	6.5	6.5	
Alkoxylate Emulsifiers			6.5
Cola®Lube 3440	5.0	5.0	5.0
High rosin tall oil fatty acids (Altapyne M28B)	3.0	3.0	3.0
Cola®Carb O5C	2.0	2.0	2.0
Colonial A225	4.0	4.0	4.0
Cola®Cor IT	1.5	1.5	1.5
Cola®Lube 3407	2.5	2.5	2.5
Propylene Glycol	2.0	2.0	2.0
Cola®Cor RP	6.5	6.5	6.5
Triethanolamine 99-LFG	4.5	4.5	4.5
JEFFADD MW-781	1.0	1.0	1.0
Deionized water	6.45	6.45	6.45
Sodium tolytriazole 50%	0.6	0.6	0.6
Densil DG-45	0.35	0.35	0.35
Deformer	0.10	0.10	0.10
Total	100	100	100

- Lubricity Additives
  - Cola®Lube 3430 (A): polymerized polyol esters
  - TMPTO (B): trimethylolpropane Trioleate
- Emulsifiers
  - Cola®Lube 3449 (A): AMP amide
  - Alkoxylates Emulsifier (C): long-chain ethoxylates
- Blend order: from top to bottom

Concentrate Stability @ 0°C and 60°C

24 hours at 0 °C



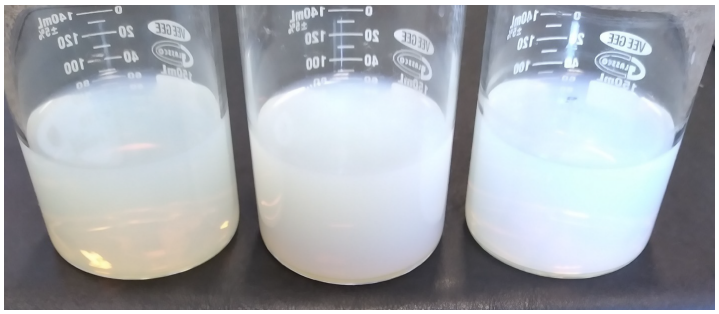
A **B** **C**

Concentrate Stability

- At 0 °C for 24 hours
  - **Cola®Lube 3430** (A) offers better concentrate stability than TMPTO (B)
  - **Cola®Lube 3449** (A) ≈ ethoxylates emulsifer (C)

- At 60 °C
  - All equivalent on concentrate stability

Emulsion Stability @ 5% in Tap Water (150 ppm)

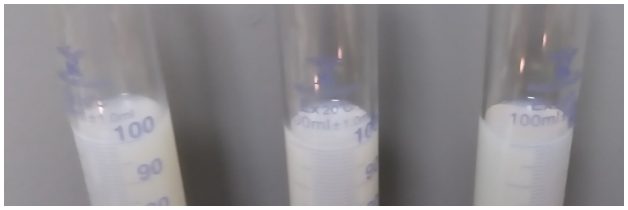


A B C

- 5% dilution with tap water at ~ 150ppm.
- Milkiness as an indicator of emulsion stability
- Cola®Lube 3430 (A) performs better than TMPTO (B) in stabilizing emulsions.
- Cola®Lube 3449 (A) arguably betters the ethoxylate emulsifier (C) in emulsification.

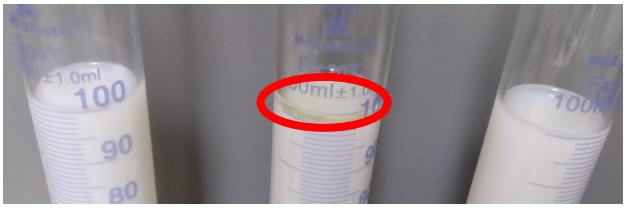
Emulsion Stability: 1000 ppm Water Hardness @ Ambient Temperature

Day 0



A **B** **C**

Day 7

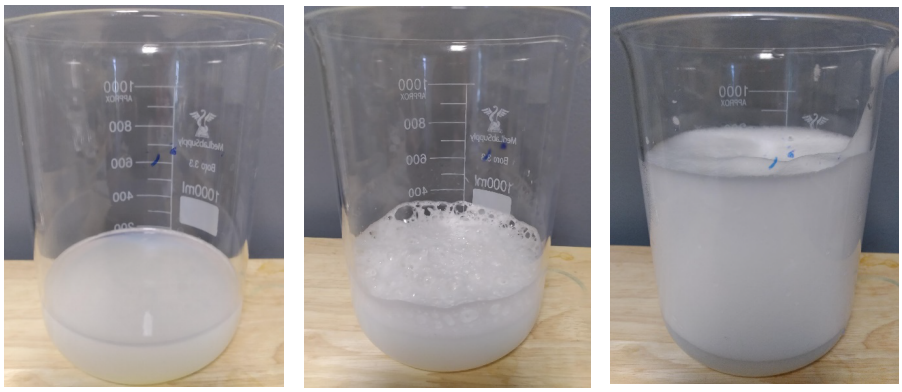


A **B** **C**

- The oil/water split observed in the emulsion containing TMPTO.
- Cola®Lube 3430 (A) performs better than TMPTO (B) in stabilizing emulsions at high water hardness.
  - Likely attributed to the better/stronger emulsification capability.

Foaming Tendency (w/o AF): 5% in 150 ppm Water Hardness

2 min after agitation

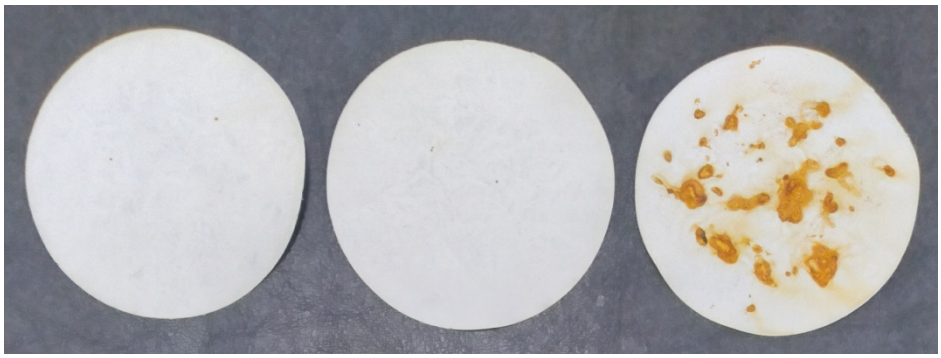


A **B** **C**

	Seconds (for foam break)
A	50
B	120
C	>300

- No anti-foaming agents were added.
- Tested at 5% dilution with tap water at ~ 150ppm.
- Cola®Lube 3430 (A) shows better foam performance than TMPTO (B).
- Unequivocally, as an emulsifier, Cola®Lube 3449 (A) delivers much better foam performance than ethoxylate.

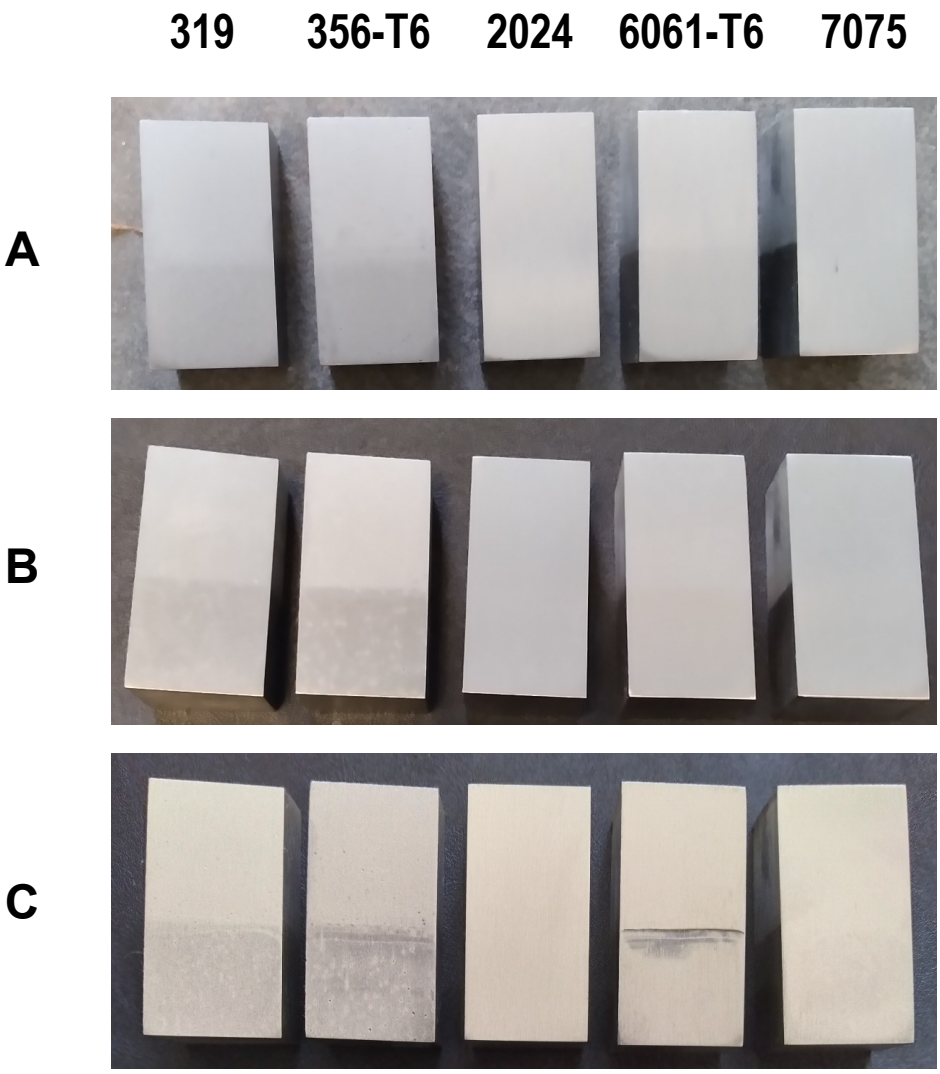
Cast Iron Chip Testing; 3% @ 150 ppm, 24 hours



A B C

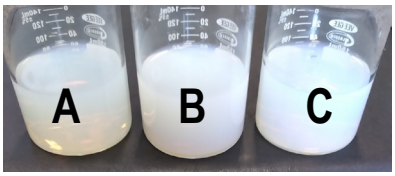
- Tested under a modified ASTM D4627 protocol
- 3.0% in 150ppm water
- Cola®Lube 3449, present in both samples A and B, enhances corrosion protection of the formulation.

Aluminum Staining Tests: 5%, 150ppm Water Hardness, RT, 24 hours



- Formula A containing Cola®Lube 3430 and 3449 shows satisfactory performance in stain prevention
- Cola®Lube 3430 ≥ TMPTO in preventing staining.
- Cola®Lube 3449 > ethoxylates in stain prevention.

Tapping Torque Test (TTT): Candidate Fluids A, B, & C *vs.* Industry Benchmark



Steel

Fluid	Max (Ncm)	Mean (Ncm)	STD (Ncm)
A	180.00	143.96	13.83
B	190.00	147.25	15.28
C	188.00	145.62	16.93
Benchmark	188.00	147.55	17.93

Aluminum

Fluid	Max (Ncm)	Mean (Ncm)	STD (Ncm)
A	150.00	129.03	6.06
B	143.00	125.75	5.47
C	146.00	130.21	5.86
Benchmark	125.00	112.19	5.34

- The benchmark is an industry reference for semi-synthetic MWF
- Fluid A gives the best lubricity on steel
- Cola®Lube 3430 > TMPTO on steel
- Cola®Lube 3449 > ethoxylates

- The data on Al reverses the lubricity ranking
  - TMPTO > Cola®Lube 3430
- Many factors contribute to the observations
- Emulsion particle size casts a direct effect on the lubricity profile on aluminum.

Guide Formula: High Oil, Semi-synthetic Fluid

Ingredient	Wt%
100 SUS naphthenic oil (Hygold 100)	48.0
Cola®Lube 3449	6.5
Cola®Lube 3430	6.0
Cola®Lube 3440	5.0
High rosin tall oil fatty acids (Altapyne M28B)	3.0
Cola®Carb O5C	2.0
Colonial A225	4.0
Cola®Cor IT	1.5
Cola®Lube 3407	2.5
Propylene Glycol	2.0
Cola®Cor RP	6.5
Triethanolamine 99-LFG	4.5
JEFFADD MW-781	1.0
Deionized water	6.45
Sodium tolytriazole 50%	0.6
Densil DG-45	0.35
Deformer	0.10
Total	100

- Ingredients in **BOLD GREEN** are from Colonial
- Blend from top to bottom
- Suggested dilution: 5%
  - Milk-like
  - *ca.* pH = 9 for the work fluid

- Suitable for
  - Medium- to heavy- duty machining processes
  - Provides ferrous, aluminum, and yellow metal corrosion protection
  - Cutting, milling, drilling, tapping, etc.

- For enhanced aluminum and yellow metal protection
  - Use **Cola®Cor KAT** or **Cola®Cor 215**

Guide Formula: Low Oil, Semi-synthetic Fluid

Ingredient	Wt%
100 SUS naphthenic oil (Hygold 100)	20.0
Cola®Lube 3449	5.0
High rosin tall oil fatty acids (Altapyne M28B)	2.0
Cola®Lube 3440	3.0
Cola®Lube 3430	4.0
Cola®Dol 91-6	2.0
Cola®Carb OXC	2.0
Fungicide (Polyphase FX-40)	1.0
Triethanolamine 99-LFG	3.5
Cola®Cor 300	4.0
Cola®Cor IT	6.0
Cola®Cor RP	5.0
Corrguard EXT	0.75
Deionized water	39.75
Bactericide (Triazine)	2.0

- Ingredients in **BOLD GREEN** are from Colonial
- Blend from top to bottom
- Suggested dilution: 5%
  - Milk-like fluid
  - *ca.* pH = 9 for the work fluid
- Suitable for
  - Low- to medium- duty machining processes
  - Ferrous machining process
  - Applications in general milling & drilling processes
- Further Performance Enhancement
  - **Cola®Lube 3407** to enable the extreme pressure wear protection
  - **Cola®Cor KAT** or **Cola®Cor 215** for aluminum stain prevention

Recommendations of Use

- Blend the prototypes by following the blend order in the guide formula from top to bottom
- Test per your designed performance criteria starting with a 5% dilution
- Customize the formula per actual performance needs
  - Reducing or increasing the treat rates for additives
  - Introducing new additives to compensate or enhance certain performance attributes
  - Making coarser emulsions for better TTT results on aluminum
- For enhanced aluminum and yellow metal protection, use Cola®Cor KAT or Cola®Cor 215

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One of our customer service representatives or technical advisors will be happy to help you locate the right product you need with specifications, formulations and product samples upon request.

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