Formulating Semi-Synthetic Metalworking Fluids

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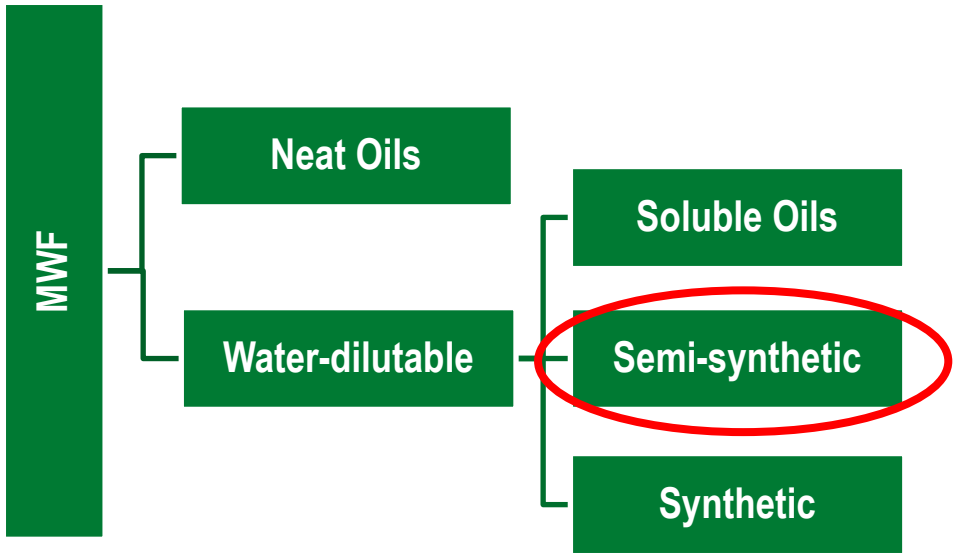
Semi-Synthetic Metalworking Fluids

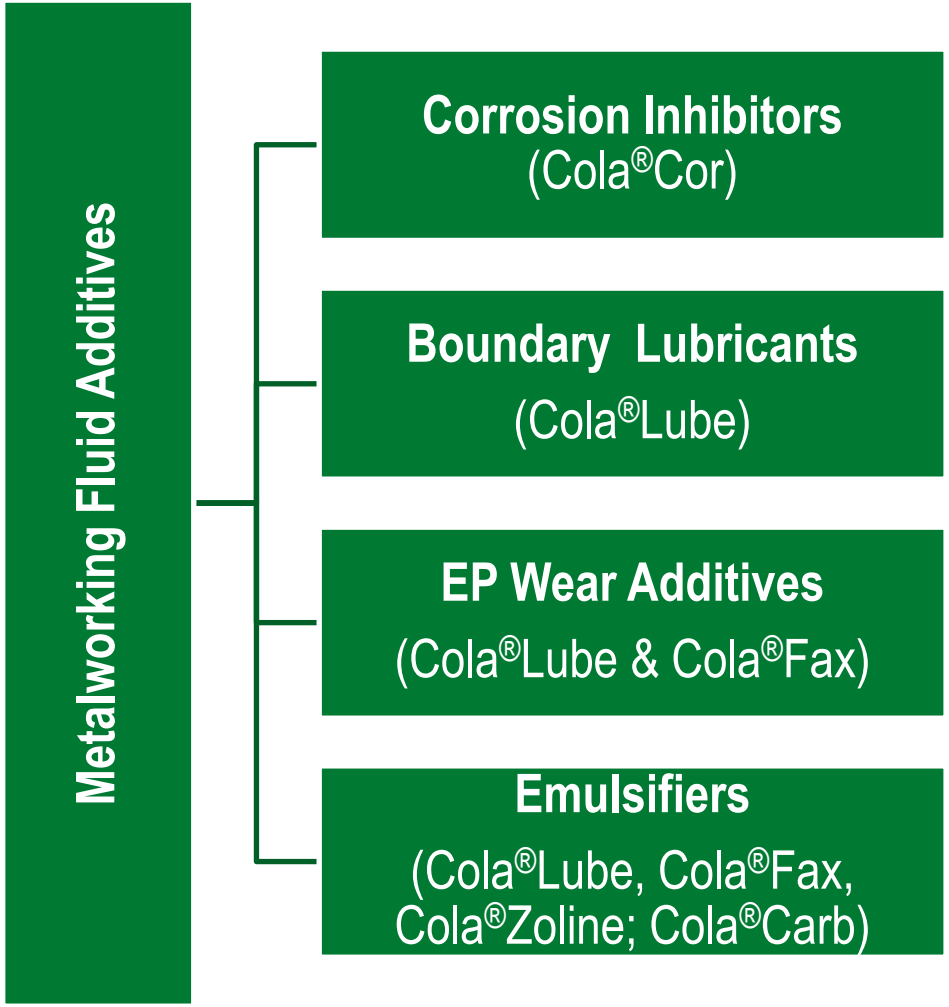


- Contains base oil & water
- Dilute with water at use
- Formulated to be bio-stable
- Combines both lubricity of soluble oil with cleanliness of synthetics to form a unique working fluid
- Applicable for all metalworking processes
- Light to Heavy Machining
- Standard waste treatment processes

Metalworking Fluid Additives

Additive Type	Function	Additive Chemistries
Boundary Lubricity Additives	Lubricate the interface between workpieces and tools	Fatty esters, Polymers, alkanolamides
Corrosion Inhibitors/Metal Deactivators	Corrosion protection for workpieces and tools during and after working process (ferrous and non-ferrous)	Triazoles, Amine carboxylates, amine borates, Imidazolines, phosphate esters, pyridinium compounds
Antiwear/Extreme Pressure Agents	Wear protection under normal and extreme conditions (T & P)	Chlorinated paraffins; sulfurized oils, phosphate esters (PEs)
Emulsifiers	Emulsify oil & water	sodium petroleum sulfonates, salts of fatty acids, alkoxylates, alkanolamides, PEs; ether carboxylates
Dispersants	Disperse particulates & soaps	Ether carboxylates, PIB-Based chemistry, etc.
Reserve Alkalinity Boosters	Maintain the basicity (pH) of working fluids; built-in or tankside	Reserve Alkalinity Boosters
Wetting agents	Whet surfaces	Alkoxylates and derivatives, phosphate esters, etc.
Coupling Agents	Stabilize concentrates to prevent phase separation and facilitate emulsion formation.	Glycols, glycol ethers
Colorants/Dyes	Color the working fluids as markers	(Manufacturer specific)
Antifoamers/Defoamers	Prevent foam (Antifoamers, built-in) and decrease foam (Defoamers; tankside)	High molecular weight polymers; polyalkylsiloxanes
Antioxidants	Prevent oil oxidation in neat oils	Aminics, phenolics, sulfurized oil, thiocarbamates; etc.
Antimist Agents (tankside addition)	Prevent mist formation (tankside addition)	High molecular weight polymers; polyisobutylene polymer
Antimicrobial Pesticides (biocides)	Prevent microbial growth	triazine compounds, oxazolidine compounds
Fragrances	Mask odors	Pine Oil, Almond Extract etc.

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%
- 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
ColaLube 3449	AMP Amides: emulsifier, boundary lubricants, biostability
High rosin tall oil fatty acids	Tall oil fatty acids: emulsifier, corrosion inhibitor,
ColaLube 3440	Poly(ricinoleic acid): boundary lubricity additives, emulsion stabilizer, beneficial for Al
ColaLube 3430	Polymerized polyol esters: boundary lubricity additives, emulsion stabilizer
ColaDol 91-6	EO-Based Alkoxylates: emulsifier, coupling agent
Colonial A225	EO-PO based alkoxylates: emulsifier, coupling agent
ColaCarb OXC	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
ColaCarb O5C	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
Fungicide	Microbial control (Fungicide)
Triethanolamine	Alkanolamine: Alkalinity booster
ColaCor 300	Amine carboxylates: corrosion inhibitors for ferrous metal
ColaCor IT	Acylamidocarboxylates: corrosion inhibitors for ferrous
ColaCor RP	Amine Borates: non-foaming Corrosion inhibitor
ColaLube 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
ColaLube 3430	6.0		6.0
TMPTO		6.0	
ColaLube 3449	6.5	6.5	
Alkoxylate Emulsifiers			6.5
ColaLube 3440	5.0	5.0	5.0
High rosin tall oil fatty acids (Altapyne M28B)	3.0	3.0	3.0
ColaCarb O5C	2.0	2.0	2.0
Colonial A225	4.0	4.0	4.0
ColaCor IT	1.5	1.5	1.5
ColaLube 3407	2.5	2.5	2.5
Propylene Glycol	2.0	2.0	2.0
ColaCor 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
  - ColaLube 3430 (A): polymerized polyol esters
  - TMPTO (B): trimethylolpropane Trioleate
- Emulsifiers
  - ColaLube 3449 (A): AMP amide
  - Alkoxylates Emulsifier (C): long-chain ethoxylates
- Blend order: from top to bottom

Concentrate Stability @ 0 °C and 60 °C

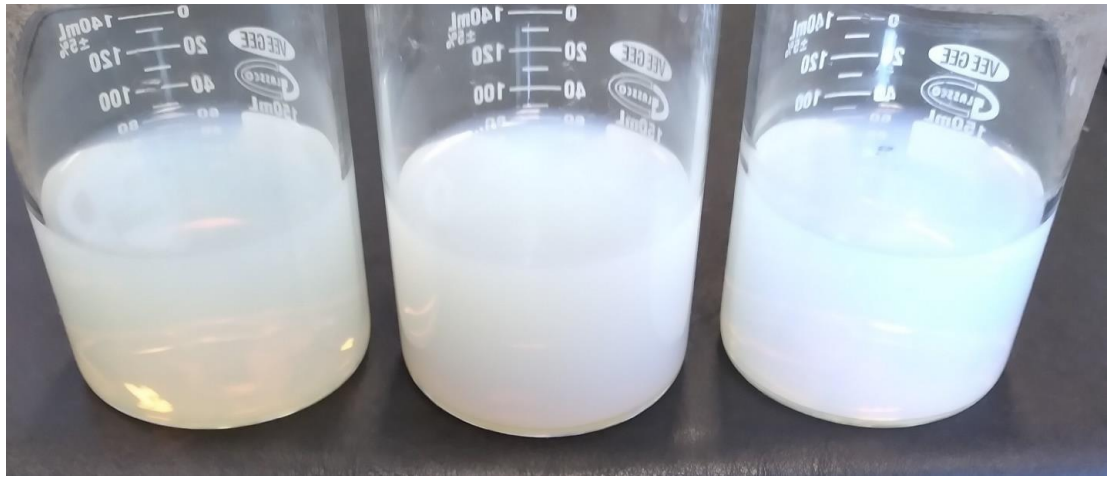
24 hours at 0 °C

A B C

Concentrate Stability

- At 0 °C for 24 hours
  - ColaLube 3430 (A) offers better concentrate stability than TMPTO (B)
  - ColaLube 3449 (A) ≈ ethoxylates emulsifer (C)
- At 60 °C
  - All equivalent on concentrate stability

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

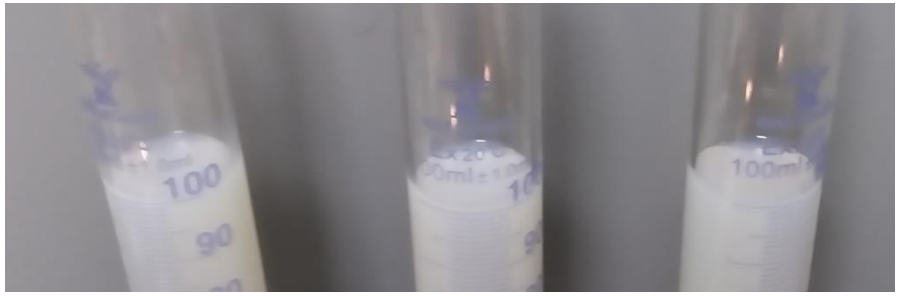


A B C

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

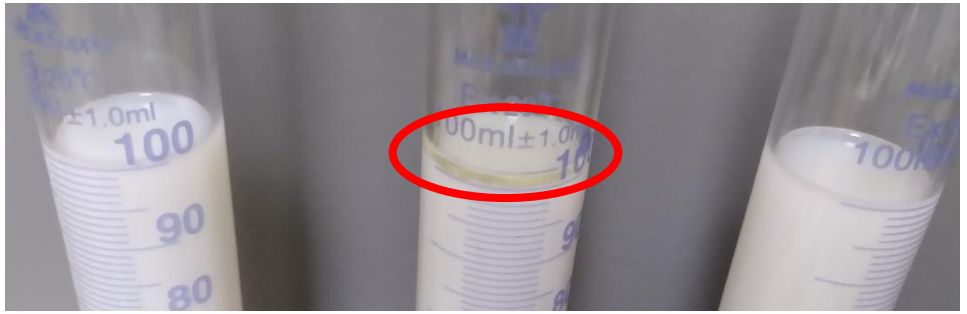
Emulsion Stability: 1000 ppm Water Hardness @ Ambient Temperature

Day 0



A B C

Day 7



A B C

- The oil/water split observed in the emulsion containing TMPTO.
- ColaLube 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

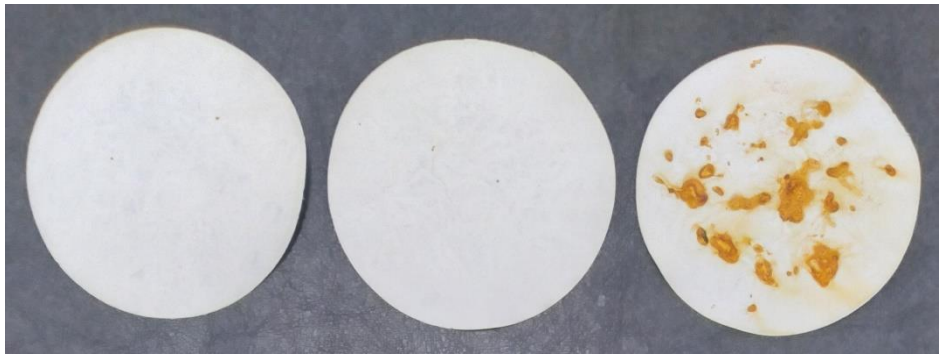
2 min after agitation

A **B** **C**

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

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

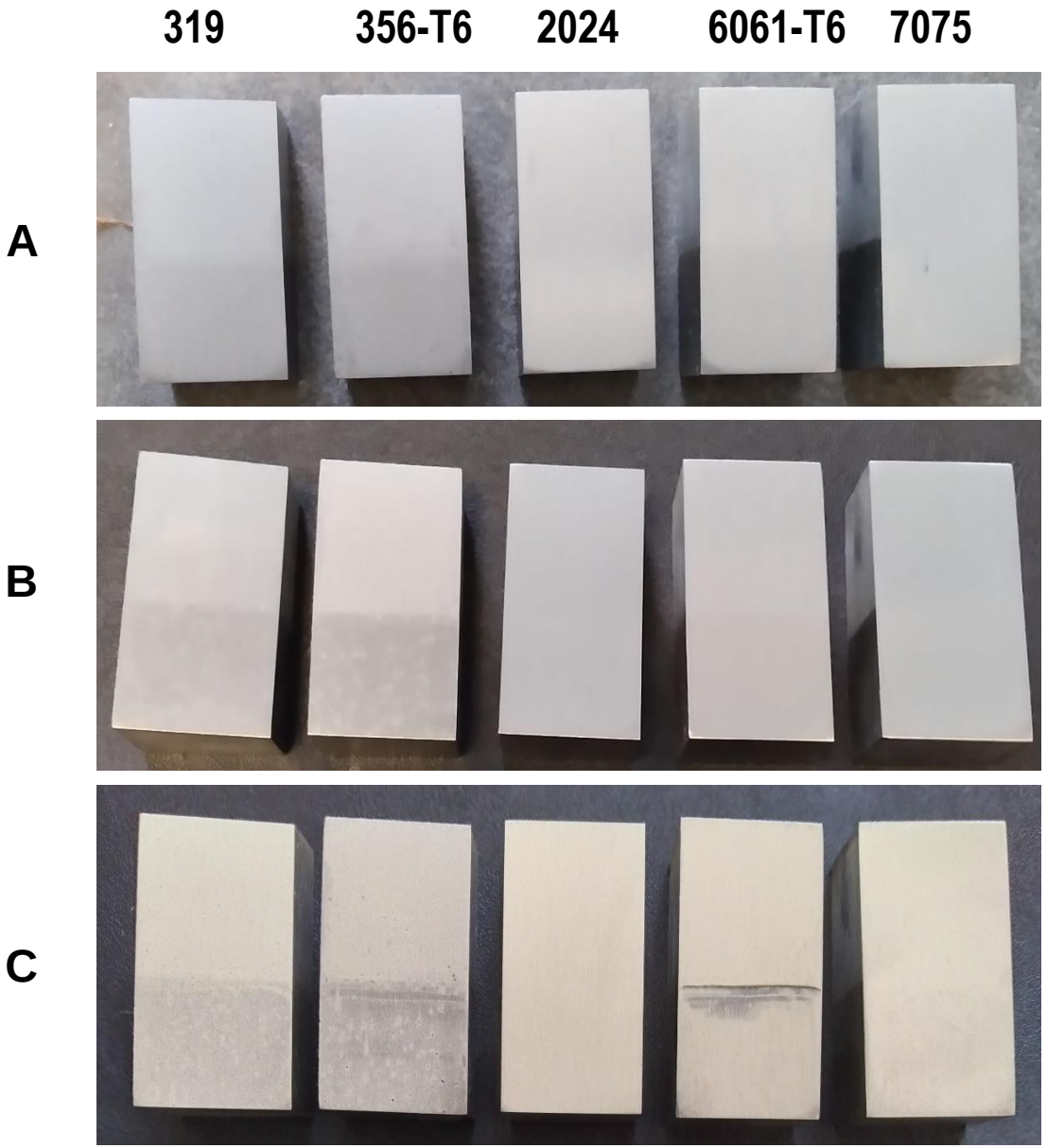
Cast Iron Chip Testing; 3% @ 150 ppm, 24 hours



A B C

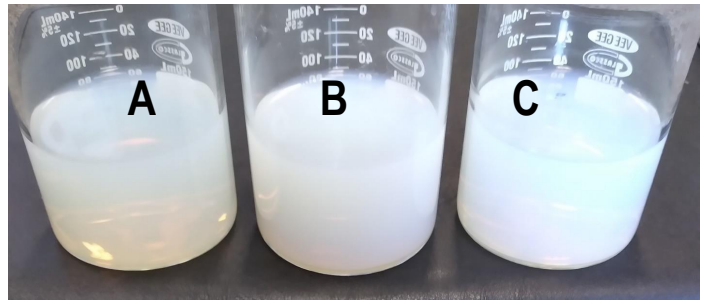
- Tested under a modified ASTM D4627 protocol
- 3.0% in 150ppm water
- ColaLube 3449, present in both samples A and B, enhances corrosion protection of the formulation.

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



- Formula A containing ColaLube 3430 and 3449 shows satisfactory performance in stain prevention
- ColaLube 3430 ≥ TMPTO in preventing staining.
- ColaLube 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
- ColaLube 3430 > TMPTO on steel
- ColaLube 3449 > ethoxylates

- The data on Al reverses the lubricity ranking
  - TMPTO > ColaLube 3430
  - Ethoxylates > ColaLube 3449
- Many factors contribute to the observations
- Emulsion particle size casts a direct effect on the lubricity profile on aluminum.

Summary

- Lubricity Additives: **ColaLube 3430** *vs.* **TMPTO**
  - ColaLube 3430 is better in
    - Stabilizing concentrates and emulsions.
    - Loaming profile.
  - On steel, ColaLube 3430 delivers better lubricity than TMPTO
  - ColaLube 3430 selected over TMPTO as lubricity additive for the guide formula

- Emulsifiers: **ColaLube 3449** *vs.* **Ethoxylate Emulsifier**
  - ColaLube 3449 delivers about the same emulsification power as ethoxylate
  - ColaLube 3449 delivers
    - Better ferrous corrosion protection
    - Lower foaming tendency.
    - Better in aluminum staining prevention.
  - ColaLube 3449 delivers better lubricity
  - ColaLube 3449 selected over ethoxylate as emulsifier for the guide formula.

Guide Formula: High Oil, Semi-synthetic Fluid

Ingredient	Wt%
100 SUS naphthenic oil (Hygold 100)	48.0
ColaLube 3449	6.5
ColaLube 3430	6.0
ColaLube 3440	5.0
High rosin tall oil fatty acids (Altapyne M28B)	3.0
ColaCarb O5C	2.0
Colonial A225	4.0
ColaCor IT	1.5
ColaLube 3407	2.5
Propylene Glycol	2.0
ColaCor 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 **ColaCor KAT** or **ColaCor 215**

Guide Formula: Low Oil, Semi-synthetic Fluid

Ingredient	Wt%
100 SUS naphthenic oil (Hygold 100)	20.0
ColaLube 3449	5.0
High rosin tall oil fatty acids (Altapyne M28B)	2.0
ColaLube 3440	3.0
ColaLube 3430	4.0
ColaDol 91-6	2.0
ColaCarb OXC	2.0
Fungicide (Polyphase FX-40)	1.0
Triethanolamine 99-LFG	3.5
ColaCor 300	4.0
ColaCor IT	6.0
ColaCor 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
  - **ColaLube 3407** to enable the extreme pressure wear protection
  - **ColaCor KAT** or **ColaCor 215** for aluminum stain prevention

Guide Formula for Low- and High – Oil Semi-synthetic

Additive	Low-oil Semi-synthetic	High-Oil Semi-Synthetic	Performance Attributes
100 SUS naphthenic oil (Hygold 100)	20.0	48.0	Base oils
ColaLube 3449	5.0	6.5	AMP Amides: emulsifier, boundary lubricants, biostability
High rosin tall oil fatty acids (Altapyne M28B)	2.0	3.0	Tall oil fatty acids: emulsifier, corrosion inhibitor
ColaLube 3440	3.0	5.0	Poly(ricinoleic acid): boundary lubricity additives, emulsion stabilizer, beneficial for Al
ColaLube 3430	4.0	6.0	Polymerized polyol esters: boundary lubricity additives, emulsion stabilizer
ColaDol 91-6	2.0	--	EO-Based Alkoxylates: emulsifier, coupling agent
Colonial A225	--	4.0	EO-PO based alkoxylates: emulsifier, coupling agent
ColaCarb OXC	2.0	--	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
ColaCarb O5C	--	2.0	Ether carboxylates: emulsifier, lime-soap dispersing agent, hard-water tolerance improver
Fungicide (Polyphase FX-40)	1.0	--	Fungicide: microbial control
Triethanolamine 99-LFG	3.5	4.5	Alkalinity booster
JEFFADD MW-781	--	1.0	Jeffamine: Alkalinity booster; coupling agent
ColaCor 300	4.0	--	Amine carboxylates: corrosion inhibitors for ferrous metal
ColaCor IT	6.0	1.5	Acylamidocarboxylates: corrosion inhibitors for ferrous
ColaCor RP	5.0	6.5	Amine Borates: non-foaming Corrosion inhibitor
Propylene Glycol	--	2.0	Coupling agent
ColaLube 3407	--	2.5	Long alkyl chain ethoxylate phosphate esters: EP wear, emulsifier, aluminum corrosion inhibitors
Corrguard EXT	0.75	--	Specialty amine: alkalinity booster to extend sump life
Deionized water	39.75	6.45	DI water: fluid carrier
: Sodium Tolytriazole 50%	--	0.6	Yellow metal deactivator
Densil DG-45	--	0.35	Fungicide for microbial control
Deformer (Foam Ban HP-940)	--	0.1	Anti-foaming agent
Bactericide (Triazine)	2.0	--	Bactericide: microbial control

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 ColaCor KAT or ColaCor 215

- To directly retrieve product info
  - ColaLube 3449
  - ColaLube 3430
  - ColaLube 3440
  - ColaDol 91-6
  - Colonial A225
  - ColaCarb OXC
  - ColaCarb O5C
  - ColaCor IT
  - ColaCor 300
  - ColaCor RP
  - ColaLube 3407
  - ColaCor KAT
  - ColaCor 215

Regulatory Status

- All **Colonial Additives** have confirmed global regulatory landscapes

- REACH Compliance
  - **ColaCarb O5C & OXC** and **ColaLube 3407** are REACH compliant

  - **ColaLube 3430:** the REACH-registration of currently underway and approaching the completion of the registration process.

  - If warranted, other **Colonial Additives** can be brought to be REACH-compliant

Thank You!

For further info on the involved products, please visit: https://colonialchem.com/products/

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