

Phosphate Esters for Industrial Lubricants

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Outline

- Overview
 - Phosphate Esters
 - Colonial's Phosphate Ester Product Line
- Selected Phosphate Esters for Industrial Lubricants
- Summary

Phosphate Esters: Chemistry

- Anionic surfactants
- Made from hydroxyl group-bearing substrates and phosphating agents
- Stable over a broad pH range
- Show good solubility
- General Composition
 - Di-phosphate esters (d-PE)
 - Mono-phosphate esters (m-PE)
 - Free phosphoric acid
 - Unreacted alcohols or alkoxyates

Substrates

- Alkanols
- Alkoxyates
- Fatty alkanolamides
- Carbohydrates
- Others

Phosphating Agents

- Five (5) available
- P_2O_5 and PPA dominate
- Directly impacts the product composition

Phosphate Esters: Properties & Performance

What Affects Properties of Phosphate Esters

- Type of substrates
- Phosphating agents
- Degree of ethoxylation of alcohols
- Phosphating process
- Mono/diester ratios
- Type of salts

What Can Phosphate Esters Do?

- Extreme pressure (EP) wear protection
- Corrosion Inhibition
- Boundary lubrication
- Emulsification
- Surface Wetting
- Dispersing
- Detergency
- Giving antistatic effects, esp. on synthetic fibers
- Fire retarding

Phosphate Esters: End Applications

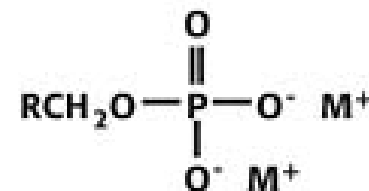
- Metalworking fluids
- Hydraulic fluids
- Paints and coatings
- Plasticizers
- Cleaners
- Fire retardants
- Agrochemical formulations
- Ink

Phosphate Esters: Global Market

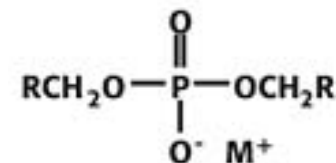
- The global phosphate ester market was valued at \$ 843.9 M in 2017
- Expected to be at \$1.2B by 2022 at a CAGR of 6.9% from 2017 to 2022.
- The growth driver is from
 - The Asia-Pacific region
 - Technological advancements in lubricants, surfactants, pesticides, fire retardants, hydraulic fluids, plasticizers, and paints and coatings for application-based end-use industries
- Mainly manufactured in the Asia Pacific region
 - NA and EU have stringent regulations regarding manufacturing as well as usage of phosphate ester.

Colonial Offers a Comprehensive Class of Specialty Phosphate Esters

- Substrates
 - Alkanol: 2-EHL, etc.
 - Phenol ethoxylates
 - Alkoxylates
 - Castor oil
 - Carbohydrates
 - Fatty alkanolamides
- Mono-ester or mix of mono- & di-esters
- Water or oil soluble
- Neutralized or free acid



Monoester



Diester

M = H, amines, or
metals (Na/K)

EP • Corrosion Inhibition • Lubricity • Emulsification • Surface Wetting • Detergency

Colonial Phosphate Esters

Cola[®]Cor THE

Cola[®]Cor ACI

Cola[®]Cor KAT

Cola[®]Lube 3404

Cola[®]Lube 3406

Cola[®]Lube 3407

Cola[®]Lube 3133

Cola[®]Fax 3374

Cola[®]Fax 3375

Cola[®]Fax 3376

Cola[®]Fax 3378

Cola[®]Fax 3383

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Corrosion Protection

Cola[®]Cor THE

Cola[®]Cor ACI

Cola[®]Cor KAT

Lubricity & EP Wear Protection

Cola[®]Lube 3133

Cola[®]Lube 3404

Cola[®]Lube 3406

Cola[®]Lube 3407

Cleaning

Cola[®]Fax 3373

Cola[®]Fax 3374

Cola[®]Fax 3375

Cola[®]Fax 3376

Cola[®]Fax 3377

Cola[®]Fax 3378

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Cola[®]Cor ACI (Aluminum Corrosion Inhibitor)

- Mono-phosphate esters
- Water soluble
- Generates low foam or inhibit foam formation
- Prevents Al staining at 0.1- 0.5% at pH up to 9.3
- Provides sufficient ferrous protection at 0.2 wt%
- Compatible with, and capable of boosting the corrosion performance of other corrosion inhibitors

Regulatory Listings

- TSCA (US)
- DSL (Canada)
- AICS (Australia)
- NZIoC (New Zealand)
- IECSC (China)

Applications

- Synthetic
- Semi-synthetic
- Soluble oil

Cola®Cor THE

- Alkyl phosphate esters
- Neutralized with oil-soluble amine
- Oil soluble
- Ashless
- Ideal for use in rust preventatives
- Of anti-wear properties and effective boundary lubrication.

Applications

- Steel mill applications
- Hydraulic oils
- Drawing compounds
- Rolling oils
- Other oil-based industrial lubricants.

Cola[®]Cor KAT (NEW)

- Blend of phosphate esters
- Neutralized with alkali metal hydroxide
- Water soluble
- Especially effective in alkaline environments for ferrous, non-ferrous (Al), and yellow metals (brass and copper)
- Compatible with virtually all kinds of ferrous corrosion inhibitors
- Highly-efficient antistatic agent for synthetic fibers.

Currently under evaluation & more to come... Stay tuned!

Cola[®]Lube 3404

- Alkyl phosphate esters
- Excellent lubricity and EP/AW protection
- Excellent corrosion protection of steel @ 1% active solution in 100 ppm hardness water
- Good inhibition of staining on aluminum
- Minimizes copper and cobalt leaching and helps protect cutting tools
- Hard-water stable
- Water-dispersible

Regulatory Listings

- US (TSCA)
- Canada (DSL)
- Australia (AICS);
- New Zealand (NZIoC)
- Philippines (PICCS)
- Korea (ECL)
- China (IECSC)

Cola®Lube 3404

Application

- Metal working fluids (emulsions, neat oil), rolling oils & emulsions
- Fire-resistant hydraulic fluids (HFD, HFD-U)
- Gear oils
- Oilfield
- Ink dispersants
- Alkaline cleaning agents
- dispersing agent in pigment pastes
 - In metal pigment pastes the ester acts as a corrosion inhibitor
- Surface treatment for the printing and coating industry

Cola®Lube 3406

Chemistry

- Phenol ethoxylate phosphate esters
- Mono-/di-phosphate esters
- Very low-foaming
- Good corrosion inhibition, lubricity and wetting properties.
- Useful in aqueous alkaline systems where zero foam is required

PERFORMANCE TESTING

RESULTS

Shake Foam Test

(1 g Test Material Into 50 ML DI water)

	Immediate	80 mm
	1 min.	0
	3 min.	0
	5 min.	0
	10 min.	0

Applications

- Synthetic metalworking fluids
 - especially grinding fluids
- Metal cleaning

Cola®Lube 3407

- Long-chain fatty alcohol ethoxylate phosphate ester
- Soluble in paraffinic and naphthenic oil
- Soluble in water upon neutralization
- Biodegradable and non-ecotoxic
- One of the most widely adopted phosphate esters in metalworking fluids

Regulatory Listings

- US (TSCA)
- Canada (DSL)
- Australia (AICS)
- New Zealand (NZIoC)
- Japan (MITI)
- Philippines (PICCS)
- Korea (ECL)
- China (IECSC)
- Taiwan (NECI)

Cola®Lube 3407

Performance Attributes

- Excellent extreme pressure wear protection and lubricity characteristics; one of the best of its kind
- Emulsification
- Dispersing
- Ferrous & nonferrous protection properties for metallurgies.
- Low foaming

PERFORMANCE TESTING RESULTS

Shake Foam Test

(1 g Test Material Into 50 ML DI water)

Immediate	95 mm
1 min.	20
3 min.	20
5 min.	20
10 min.	15

Cola®Lube 3407

Applications

- Metalworking fluids
 - Synthetic, semi-synthetic, and soluble oil
 - Cutting, grinding, rolling oils, liquid drawing compounds
- Glass cutting and polishing lubricants

Summary

Colonial's Phosphate Ester Platform

Corrosion Protection

- Cola[®]Cor THE
- Cola[®]Cor ACI
- Cola[®]Cor KAT

Lubricity & EP Wear Protection

- Cola[®]Lube 1500
- Cola[®]Lube 3133
- Cola[®]Lube 3404
- Cola[®]Lube 3406
- Cola[®]Lube 3407

Cleaning

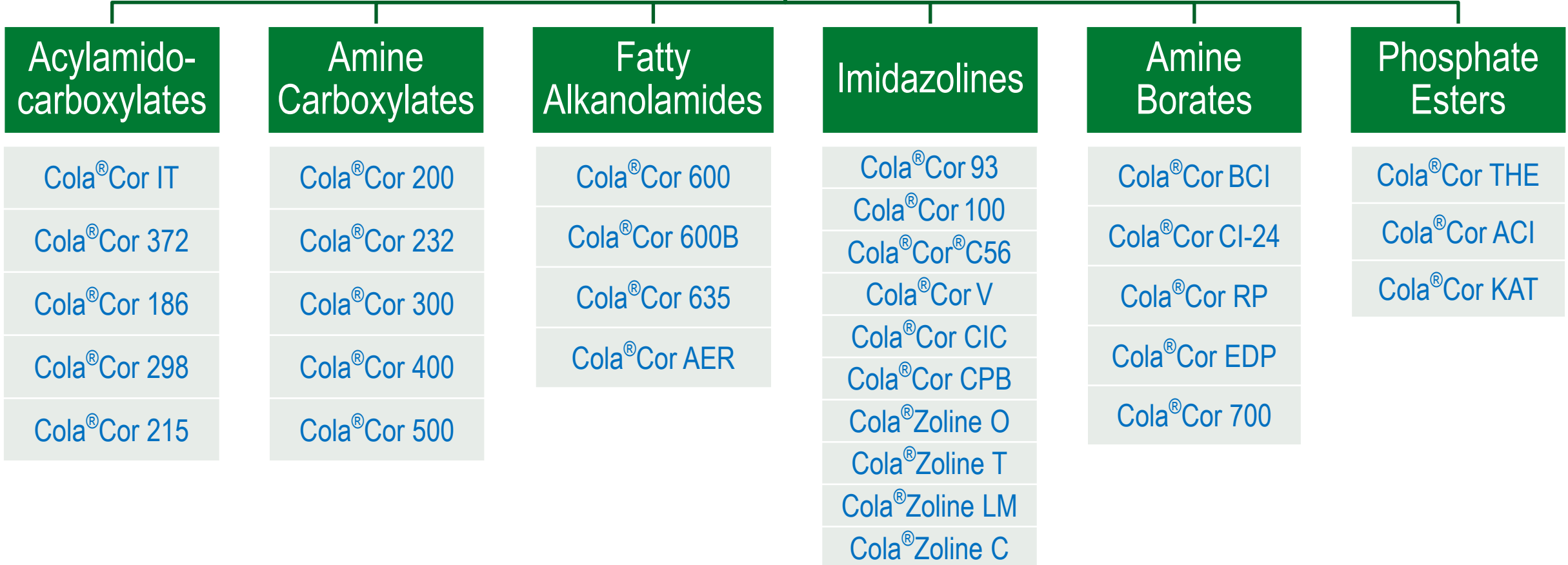
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Colonial offers a comprehensive class of phosphate ester products

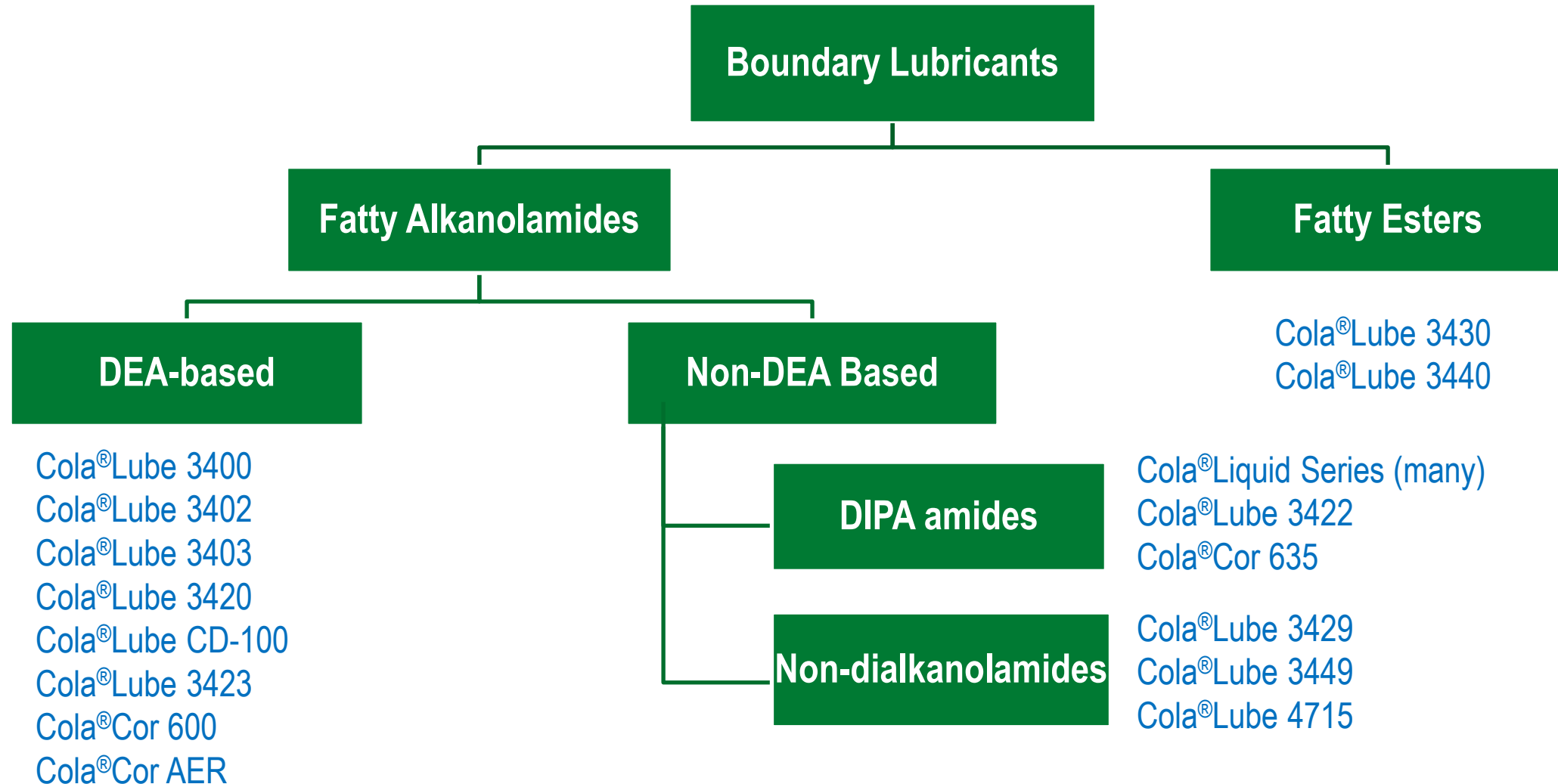
- Based on the wide variety of substrates
- Serving a wide selection of end applications

Corrosion Inhibitor Product Platform

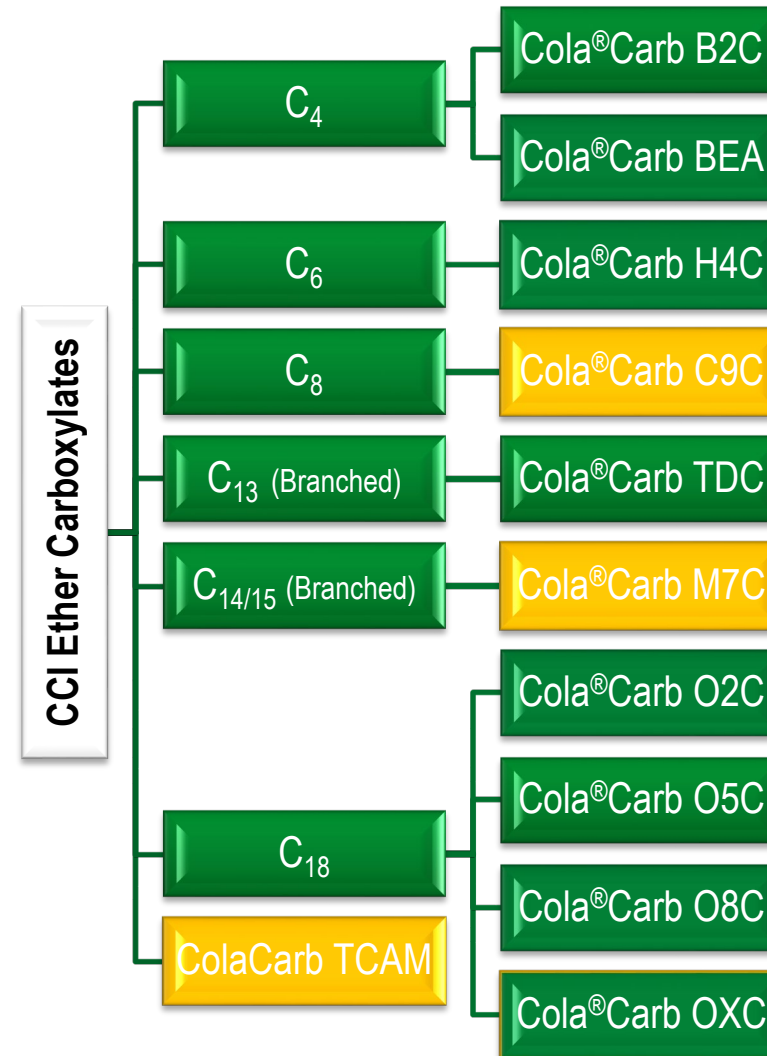
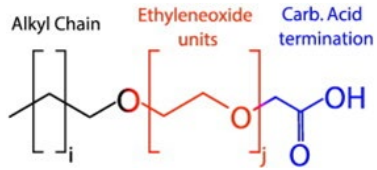
Corrosion Inhibitors



Boundary Lubricant Product Platform



Ether Carboxylate Product Platform



Thank You!

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