



Metalworking Fluids

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CLS, CLGS, MLA-I, MLT-I, OMA-I

Presenter



- **Joined CITGO Petroleum Company in Lubricants Technology as a Product Specialist in 2022**
- Hydrotex, Division Partner (2021 – 2022)
- Petro-Canada Lubricants, Sr. Technical Services Advisor (2010 – 2021)
- Plains All-American Pipeline, Technical Services Engineer (2007 - 2010)
- Independent Construction Contractor (2002 - 2007)
- Polaris Laboratories, Service and Sales Rep (2001 - 2002)
- Conoco, Lubrication Engineer (1993 - 2001)
- Conoco, Refinery Engineer (1990 - 1993)
- Aerojet General, Liquid Fueled Rocket Combustion Analyst (1988 - 1990)

- Bachelor of Science in Mechanical Engineering from Prairie View A&M University (1988)

- Certified Lubrication Specialist (CLS), Oil Monitoring Analyst (OMA), Machinery Lubrication Analyst (MLA), Machinery Lubrication Technician (MLT), Certified Lubricating Grease Specialist (CLGS), and CRC Engine Rater

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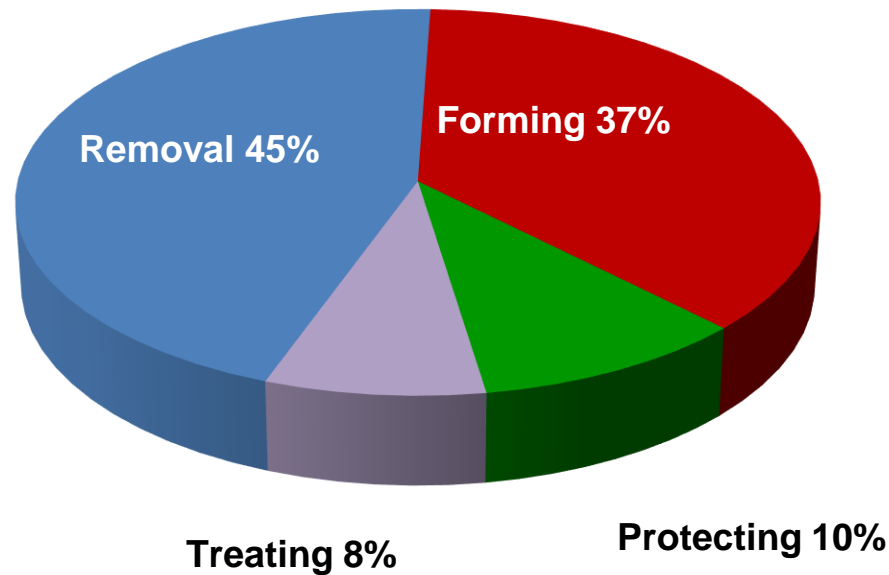


Content

- Metalworking Fluid Trends, Competition and Applications
- Metal Removal Products, Selection, and Applications
- Spindle Oil Options and Applications
- Slideway Oils and Applications
- Quench Oils and Applications
- Rust Preventatives and Applications

North American MWF Market

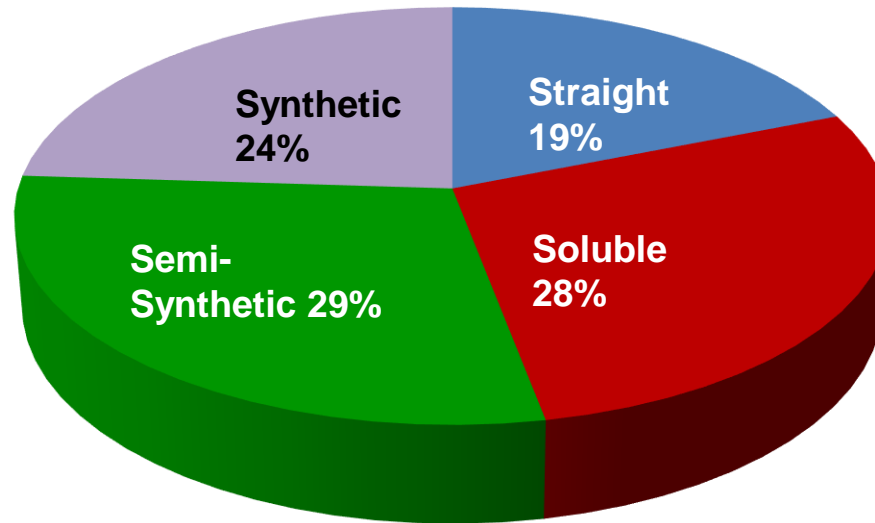
Estimated NA consumption of metalworking fluids by fluid category – 198,700,000 Gallons



Source: 2019 Kline and Company, Inc.

North American MWF Market

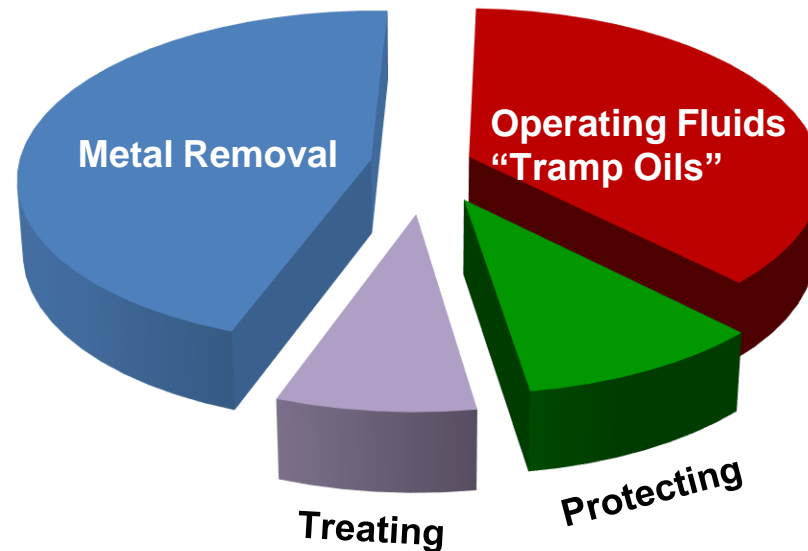
Estimated NA consumption of removal fluids by fluid type – 89,800,000 gallons



Source: 2019 Kline and Company, Inc.

CITGO Offers to the North American MWF Market

- **A comprehensive selection of fluids for a small to mid-size machine shop**
- **Specialty and operating fluids for a variety of industries – regardless of size**

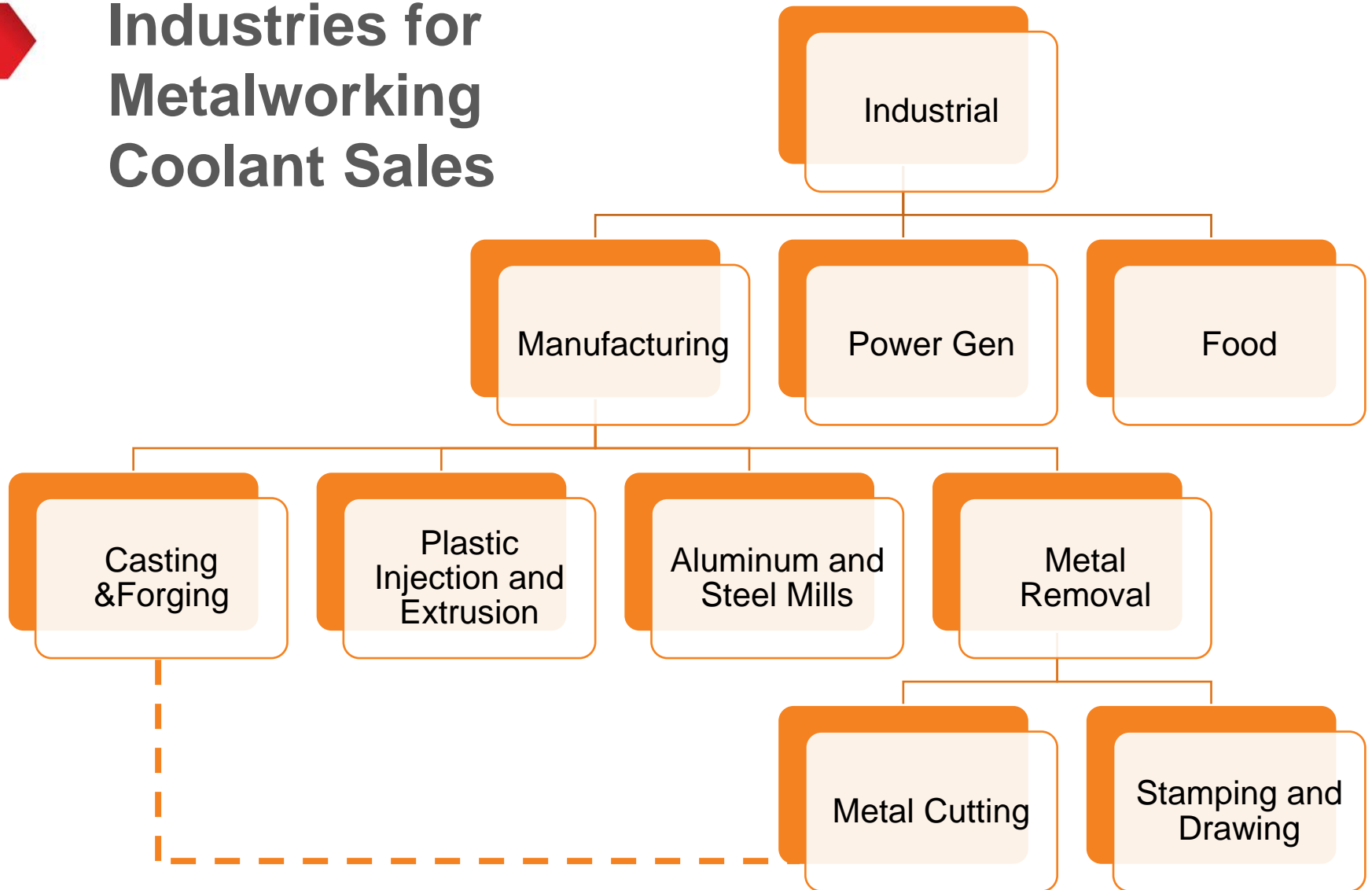




Fluids and Greases Used in a Machine Shop

Product	Application
Metalworking Fluid	Tool and worked piece coolant
Way Lubricants	Machine sliding surfaces
Hydraulic Fluids	Machine component movement
Gear Oils	Machine gearboxes
Spindle Oils	Headstock
Spindle Greases	Headstock
Chuck Greases	Chucks for tools and worked piece
Compressor Fluids	Plant air compressors

Industries for Metalworking Coolant Sales



Fragmented Market

- 300 MWF Manufacturers in US
- 15 largest have 65% of the total sales
- Two are majors oil companies
 - BP/Castrol- 15 million gallons
 - ExxonMobil – 7.0 million gallons
- Remainder are Specialty Chemical Companies



Market Competition



Hocut 795-B



Tech Cool
35052CF



S-787



Ecocool 711



Blasocut 2000CF



585 XT

Manual Metalworking Machines

Lathe



Milling Machine

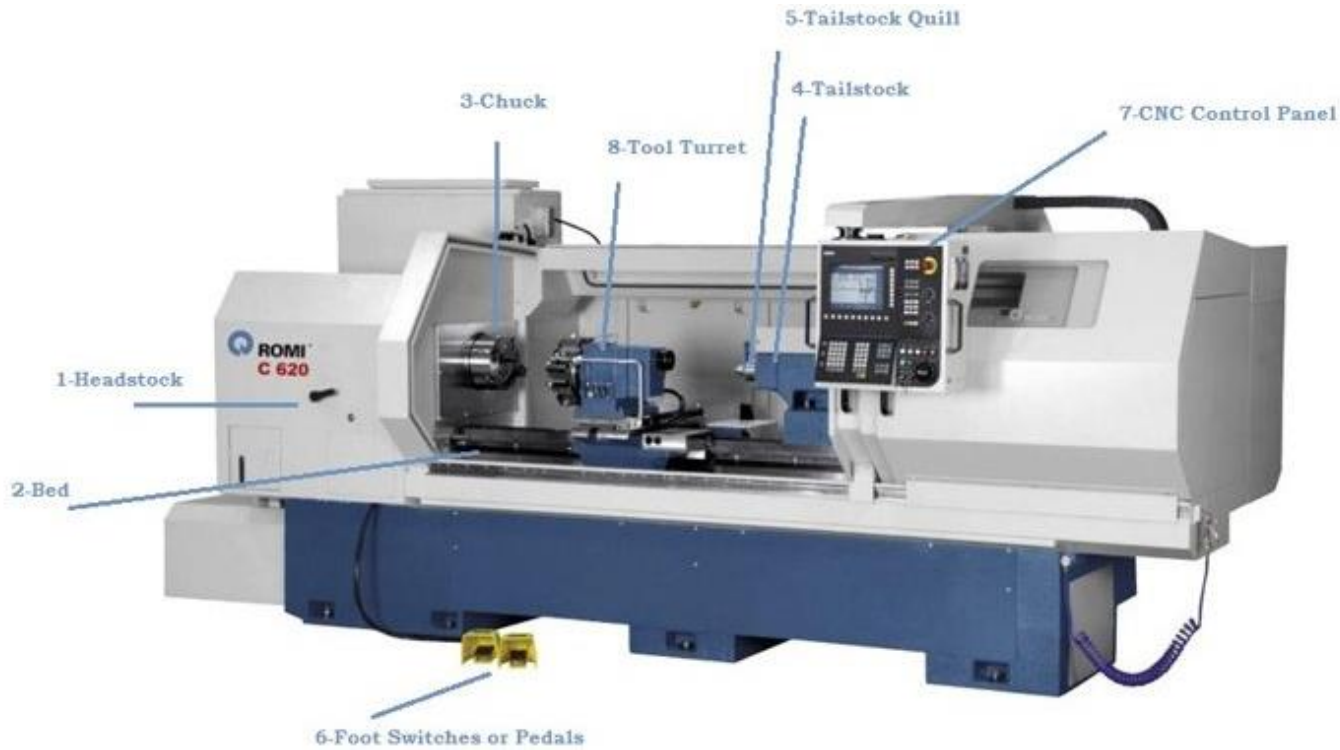


Drill Press



Grinding Machine

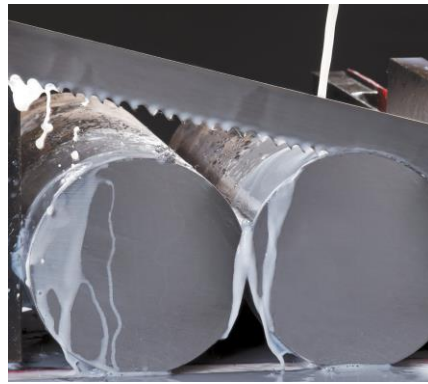
What's Inside a Computer Numerical Control (CNC) Machine?



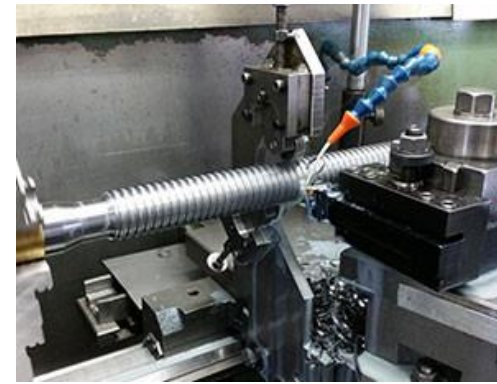
Metalworking Operations



Milling



Sawing



Threading

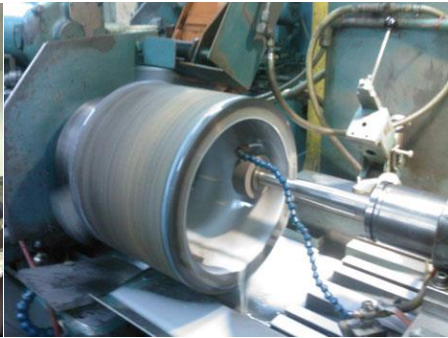


Drilling

Metalworking Operations



Honing



ID Grinding



Surface Grinding



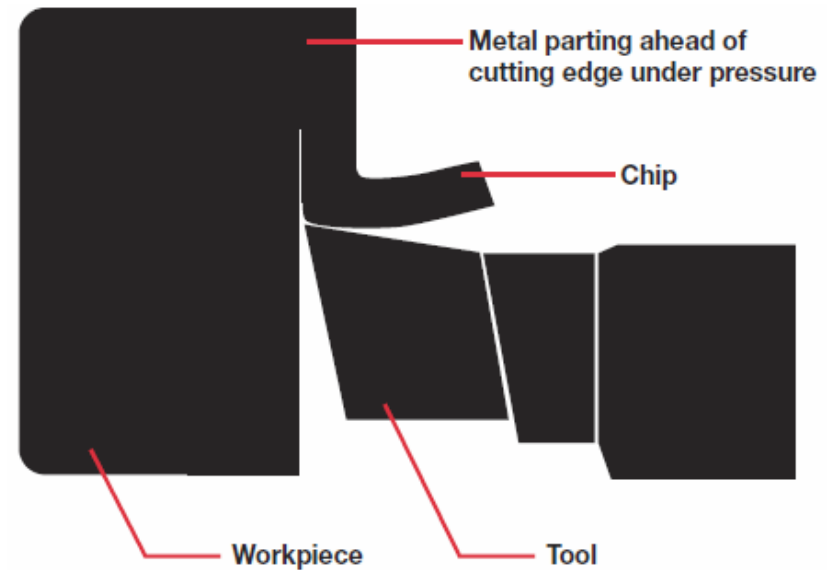
OD grinding

MWF Machine Manufactures



Metal Machining

- Primary function of metal machining: Removal of metal
- Metal removal by use of power to force cutting tool and worked piece
- Cutting tool is relatively blunt
- Metal chips removed by way of shearing action (high temperature plastic flow)

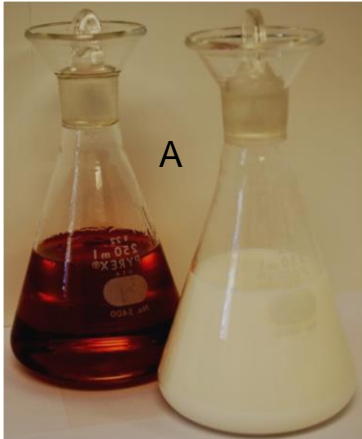




Primary Functions of a Cutting Oil (Fluid)

- **Lubricate** tool/workpiece interface
- **Cool** the tool and workpiece
- **Reduce wear** of tool
- **Dimensional accuracy** of workpiece
- **Flush** metal chips and fines
- **Corrosion protection** for tool and workpiece

Types of Metal Removal Fluids

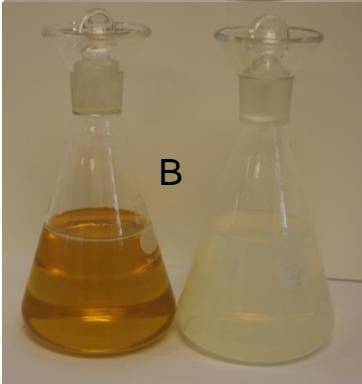


Neat Cutting Oil

- 100% Mineral Oil
- No water dilution

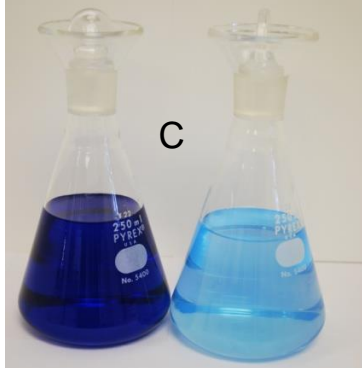
A. Soluble Oils

- >30% Mineral Oil
- Dilutions are Milky



B. Semi-Synthetics

- <30% Mineral Oil
- Dilutions are Translucent



C. Synthetics

- No Mineral Oil Content
- Dilutions are Transparent



5% Dilutions



Biostable Fluids

- Metalworking fluids are subjected to degradation by microbes (bacteria and fungus)
- Microbes “eat” components of the fluid, leading to odor problems, destabilization of the fluid, reduced machining performance, corrosion on machinery and parts, and plugged filters
- If left unattended, fluid with microbes would fail and shut down production
- Biostable fluids are designed to resist microbial degradation thus extending fluid life, reducing the need for biocides and minimizing downtime

Coolant Quality Management

How you win business!





General Procedures

- Fluids are diluted with water to create a mix of 5-10%
- O.I.L. should be added to water
 - Oil In Last
- Make-up should be added daily (**never just water**)
- **Concentrations should be checked frequently**



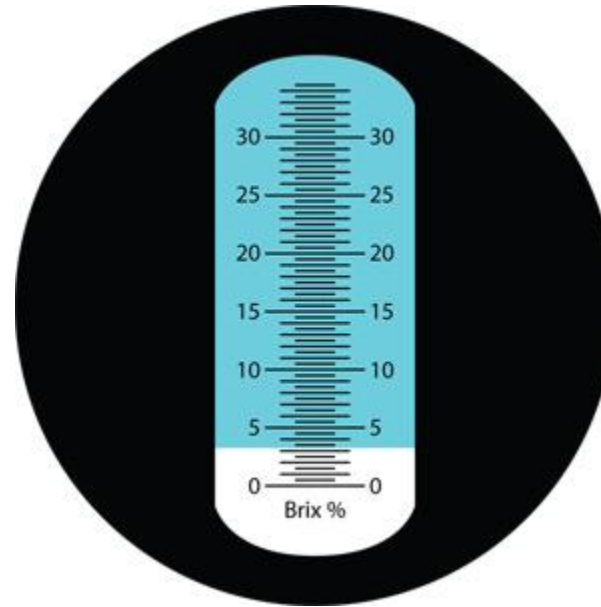
Importance of Concentration Control

90% of problems are related to concentration

What's the concentration?



Refractometer



Only for water containing products

Refractive Index

- Number you multiple refractometer reading by to get approx. concentration
- Soluble oils-generally 1
- Semi-Synthetics- generally 1-2
- Synthetics 1.5-7
- Be Careful to do the math





How will you win the business?

Solve The
Customer's
Problem

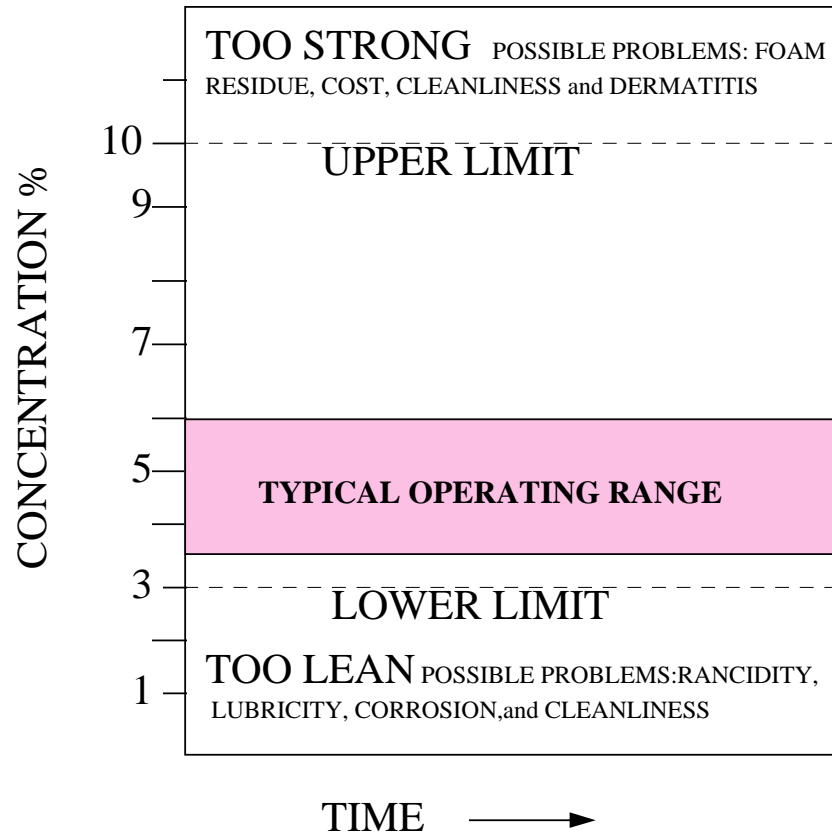
Identify the problem

- What one thing would you change about the MWF?
 - Common answers
 - Smells
 - Sump life
 - Foam
 - Avoids selling on price
 - Makes you look like an expert


NO PROBLEM

NO SALE!

How to fix the problem



What tests predict fluid failure?

Concentration  Residue, Foam, Dermatitis, Cost

Concentration  Corrosion, Lubrication, Rancidity

pH  Contamination

pH  Rancidity, Corrosion



What symptoms predict fluid failure?

Tramp oil



Cleanliness, Rancidity

Dirt



Cleanliness, Part Quality

Bacteria/Mold



Rancidity, Odor, Performance

Conductivity
Control



Mix Stability, Corrosion

Water Minerals



Mix Stability, Residue,
Corrosion Control



Make the fluid work for you

- Control the concentration to solve your customers problems
- Bad maintenance will cause even the best fluids to fail
- Arm the operators with the knowledge they control your success
- Check with customer 2-4 days after new product in sump
- Check concentration every-time you stop in

CITGO Straight Oils



Autokut AS Series

Material Compatibility

	Recommended	Highly Recommended
P - Steels	Blue	Blue
M - Stainless Steel	Yellow	Yellow
K - Cast Iron	Red	Red

- Active sulfur
- Free of chlorinated components
- Recommended for alloyed, stainless and chrome steels
- Formulated for severe operations such as broaching, threading and tapping
- Contain a mist suppressant to aid in meeting OSHA requirements
- Non-staining
- Available in four viscosity grades – ISO 15, 32, 46, and 68

Autokut IS Series

- In-active sulfur
- Free of chlorinated components
- Recommended for non-ferrous and many ferrous metals
- Formulated for a wide-range of applications
- Contain a mist suppressant to aid in meeting OSHA requirements
- Non-staining
- Available in two viscosity grades – ISO 15 and 46

	Recommended	Highly Recommended
P - Steels	Yes	Yes
M - Stainless Steel	Yes	Yes
K - Cast Iron	Yes	Yes
N - Non-ferrous	Yes	Yes

Autokut Tri-Purpose Cutting Oil

	Recommended	Highly Recommended
P - Steels	Blue	Blue
M - Stainless Steel	Yellow	Yellow
K - Cast Iron	Red	Red
N - Non-ferrous	Green	Green

- Transparent, multi-purpose cutting oil
- Effective for cutting and for lubrication of various machine tools
- Recommended for non-ferrous and ferrous metals
- Contains a mist suppressant to aid in meeting OSHA requirements
- Provides premium rust and oxidation protection for versatility in gear and hydraulic applications
- Recommended for use in automatic screw machines and in similar equipment for drilling, reaming, tapping, stamping, etc.

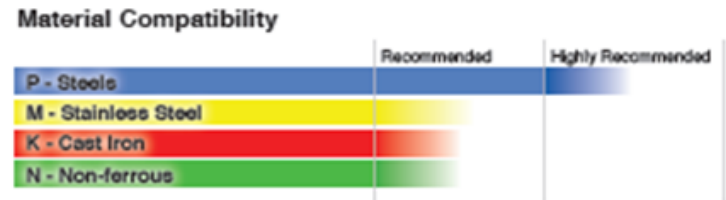
CITGO Water Diluted Products



Trukut Series-Soluble Oil

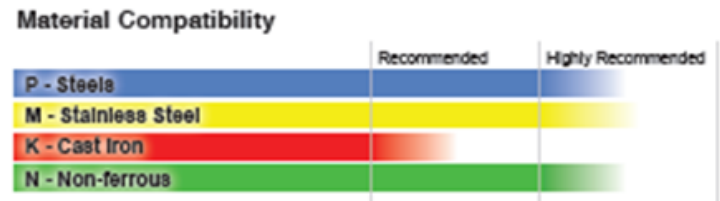
- **CITGO Trukut GP 205**

- General purpose emulsifiable (soluble) oil
- No biocide or fungicide
- Refract factor 1.0



- **CITGO Trukut HD 220**

- Heavy duty emulsifiable (soluble) oil
- EP properties
- Contains biocide and fungicide
- Refract factor 1.0



CITCOOL SS-HD Semi Synthetic

- **CITGO CITCOOL SS-HD**
 - Heavy Duty Semi-Synthetic
 - General Purpose Semi Synthetic
 - Multi-Metals
 - Exhibits low foaming tendencies
 - Improved hard water stability
 - Recommended for Ferrous and Al Alloys
 - Refract factor 1.5

Material Compatibility

	Recommended	Highly Recommended
P - Steels	Recommended	Highly Recommended
M - Stainless Steel	Recommended	Highly Recommended
K - Cast Iron	Recommended	Highly Recommended
N - Non-ferrous ^a	Recommended	Highly Recommended

CITCOOL 33 Synthetic

- Heavy Duty Synthetic Fluid
- Dyed green
- Exceptional Cooling
- Refractometer factor 2.6



Concentrate Diluted
with Water

Material Compatibility

	Recommended	Highly Recommended
P - Steels	Compatible	Compatible
M - Stainless Steel	Compatible	Compatible

*Not recommended for aluminum, magnesium and their alloys due to possible staining.

CITGO Metal Removal Fluid Applications



Metals Machinability Ratings

Non-Ferrous (rating >100%)	Ferrous (rating 100-70%)	Ferrous (rating 70-50%)	Ferrous (rating 50-40%)	Ferrous (rating <40%)	Non-Ferrous (rating <100%)
Most Wrought Aluminums	1112*	1020 – 1070	13xx, 2330, 2340	Most Stainless Steels	Titanium
Most Cast Aluminums	1016 - 1030	2317, 31xx, 41xx	2512, 3310	2515, 3310	Ti-5Al-2.5Sn
Leaded Brass	1109-1144	4027 – 4047	3240, 4340, 48xx	50100, 51100, 52100	Ti-6Al-4V
Magnesium Alloys	4023, 4024, 5120	43xx, 46xx, 51xx	61xx, 8645, 8650	9315	Ti-6Al-6V-2Sn
Zinc	Cast Steel	86xx, 87xx	8750, 9445	Tool Steel	Ti-8Al-1Mo-1V
Silicon Bronze	Cast Iron	91xx, 98xx	1008, 1010, 1015		Ti-8Mn
Brass	Stainless Iron	Ductile Iron	1050, 1070		Ti-13V-11Cr-3Al
			3310, 18-8		Nickel
			Wrought Iron		Copper

*Machinability rating is determined by normal cutting speed, surface finish, and tool life. Ratings are normalized to the machinability of 1112 steel, which has been benchmarked as 100% by the American Iron and Steel Institute. Metals with a rating lower than 100% are less machinable than 1112; metals with a rating greater than 100% are more machinable than 1112.

Metal Removal Fluid Application Overview

Product Type	CITGO Products	Typical Applications
Straight oils	Autokut IS	Multiple metals
	Autokut AS	Ferrous alloys
	Autokut Tri-Purpose	Screw Machine
Soluble Oils	Trukut GP 205	Multiple metals*
	Trukut HD 220	Multiple metals
Semi-Synthetic	CITCOOL SS-HD	Multiple metals*
Synthetic	CITCOOL 33	Ferrous applications

*Use Trukut HD 220 or Autokut IS for 2000 & 7000 series aluminum, as these grades are susceptible to staining.

Metal Removal Fluid Application Guide – Straight (Neat) Oils

Materials		Operation						
		Screw Machine Operations	Swiss Machining Operations	Deep Hole / Gun Drilling	Thread Forming	Gear Hobbing	Gear Shaping	Grinding
P Steels	Plain Steels	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
	Low Alloy	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
	High Alloy	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
	Steel Castings	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
M Stainless Steels		AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
K Cast Iron		AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
N Non Ferrous	Aluminum Alloys, Copper Alloys	AUTOKUT Tri-Purpose	AUTOKUT IS Series	AUTOKUT IS Series	AUTOKUT IS Series	AUTOKUT IS Series	AUTOKUT IS Series	AUTOKUT IS 15
S HRSA	Heat Resistance Super Alloys (nickel based)	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15
H Hard Metals	High Hardness Alloys, Work Hardening Alloys	AUTOKUT Tri-Purpose	AUTOKUT AS Series	AUTOKU AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT AS Series	AUTOKUT IS 15

The product recommendations on this chart are general guidelines. Consult the CITGO Product Answer Line with details of your specific operation and metallurgy. CITGO **never** recommends mixing competitive metalworking products with CITGO metalworking products. Some product changes may require sampling of the existing fluid and thorough cleaning and flushing of the system.

Metal Removal Fluid Application Guide - Water Miscible Products

Materials		Operation										
		Indexable Tooling	HSS Drilling	Deep Hole Drilling	Cut Tap	Form Tap	End Milling	Reaming	Hobbing	Sawing	Grinding	
P Steels	Plain Steels	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
	Low Alloy	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
	High Alloy	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
	Steel Castings	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
M Stainless Steels		CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
K Cast Iron		CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	CITCOOL SS-HD	TRUKUT GP 205
N Non Ferrous	Aluminum Alloys, Copper Alloys	TRUKUT HD 220 TRUKUT GP 205	TRUKUT HD 220	TRUKUT HD 220	TRUKUT HD 220	TRUKUT HD 220	TRUKUT HD 220 TRUKUT GP 205	TRUKUT HD 220	TRUKUT HD 220	TRUKUT HD 220 TRUKUT GP 205	TRUKUT GP 205	
S HRSA	Heat Resistance Super Alloys (nickel based)	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	TRUKUT GP 205
H Hard Metals	High Hardness Alloys, Work Hardening Alloys	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	CITCOOL 33 CITCOOL SS-HD	TRUKUT GP 205

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Spindle Oils

What are Spindles in a machine shop?

- A rotating axis/shaft of the machine, which has high speed bearings and anything attached to it (chuck, etc.)

What is a Spindle Oil?

- Highly stable base oil
- R&O Oil
- CNC machine viscosity range (2 to 15 cSt)
- Manual machines (32 cSt)

Spindle Oil Applications

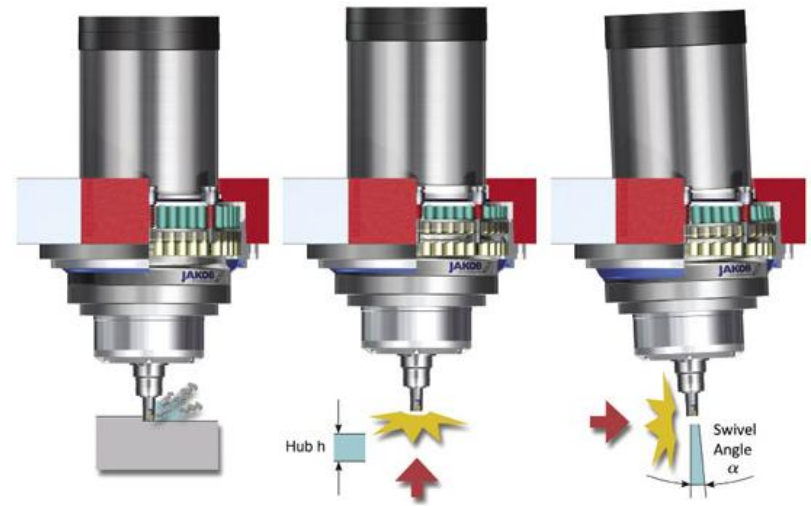
- CNC Machines
- Cutting tool drive heads



CITGO Spindle Oil Options

CITGO spindle oil options (cSt @ 40C)

- Mystik Twin Disc Fluid (2.5)
- CLARION SynBar Fluid 5 (5.5)
- CLARION FG White Mineral Oil 70 (12.6)
- CLARION ClariPac 70 (12.6)
- CITGO Sentry Oil 15 (15.7)



Slideway Oils

What are Slideways?

- Linear plain bearing in a machine tool

How Slideway Oils Work?

- Facilitate constant motion without a stick-slip affect
 - Stick-Slip: Bearing alternates between static and dynamic friction
- Improves machining accuracy

Where are Slideway oils used?

- Lathes
- Drill Press
- Honing Machine
- Grinder
- CNC Machine





CITGO Slideway Oils

SlideRite Oil 32, 68, 220, 320, 460

- Protect against the occurrence of stick-slip
- ISO VG 32, 68, and 220 have been formulated to meet requirements of the Fives Group (formerly Cincinnati Machine) specifications covering machine tool way lubricants.

<u>Grade</u>	<u>Fives Cincinnati Specification</u>
CITGO SlideRite 32	P-53*
CITGO SlideRite 68	P-47
CITGO SlideRite 220	P-50

*NOTE: Fives Group Specification P-53 is a combination hydraulic and way oil specification.

CITGO SlideRite Oil Applications

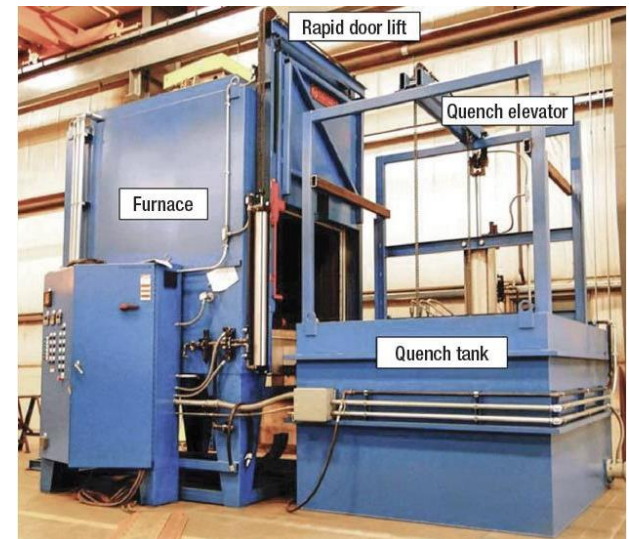
CITGO SlideRite Grade	Application (follow OEM Spec)
32	Hydraulic/Slideway common reservoir
68	Light to medium loaded horizontal ways
220	Medium to heavy loaded vertical and horizontal ways
320	Heavy loaded horizontal and vertical ways
460	Heavy loaded horizontal and vertical ways



How Quench Oils Work

Two primary functions:

- Harden the component by controlling heat loss.
- Enhance the wetting (coating) of the component to minimize distortions and cracking.



How Quench Oils Work

Three Stages of Quenching:

1. Vapor Stage

- Occurs when a component is first submerged into quenching oil.
- The component becomes surrounded by a vapor blanket.
- The cooling is slow in this stage.
- Heat is only removed via radiation through the layer of vapor.
- Responsible for many of the resulting soft spots during quenching
- Make vapor stage as short as possible by dispersing the vapor.



2. Boiling Stage

- When cooled, the vapor blanket dissipates, resulting in nucleate boiling.
- Heat transfer is the fastest in this stage.
- The timing and the exact rate of transfer depend on the oil's molecular composition.

3. Convective Stage

- Component-oil interface temperature drops below the oil's boiling point.
- Heat transfer is dependent on the oil's viscosity and degree of decomposition.
- Heat transfer rate is inversely proportional to oil viscosity.
- Viscosity is directly proportional to decomposition.

Quenchol Series

Quench Oil Customers

- Steel casting plants
- Heat treating facilities

CITGO Quenchol Series

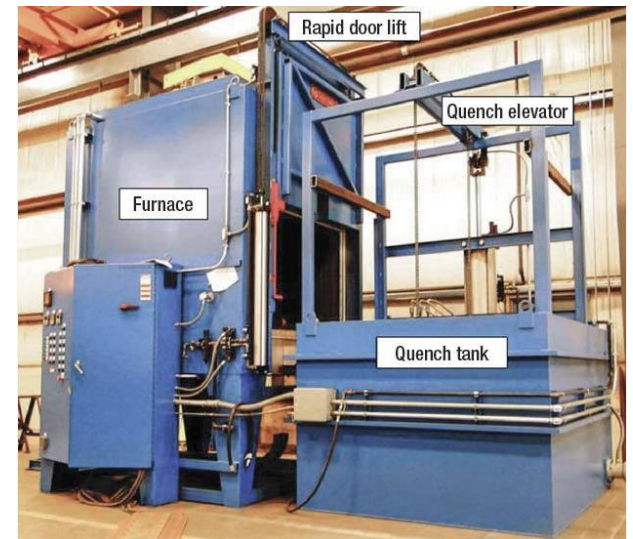
- Designed for the heat treatment of steel in a variety of quenching operations.
- Good oxidation resistance to extend life of fluid
- Uniform heat dissipation for quality hardened steel production.
- Excellent wetting and cooling capability
- Medium to fast quench rate

CITGO Quenchol 521

- Typical 40°C viscosity is 23 cSt
- Fast quench rate

CITGO Quenchol 624

- Typical 40°C viscosity is 52 cSt
- Medium quench rate



How Rust Preventatives Work

Prevent corrosion by forming a thin layer of protective film over the surface of the metal. This blocks electrolytes like water and salts from contacting the surface and thus delays the oxidation process.





Rust-O-Lene Series

- **CITGO Rust-O-Lene Oils**

- Rust preventative oils for temporary protection of metal parts during manufacturing and storage
- Application by dipping, spraying or brushing
- Prevents corrosion from fingerprints and perspiration
- Displaces water after machining with aqueous cutting fluids

- **CITGO Rust-O-Lene ST**

- Rust inhibitor with base oil in a high flash solvent
- Provides a protective film after solvent evaporation
- Short-Term application

- **CITGO Rust-O-Lene LT**

- Rust inhibitor with base oil
- No Solvent
- Long-term application



AR Slushing Oil

- Rust preventative coating oil for protection of steel stored for intermediate periods under cover
- Application by dipping, spraying or brushing
- Light colored
- Low viscosity (18 cSt @ 40°C)
- No solvent
- Economical
- Often used in steel mills



Metalworking Fluids

Questions?