

Metal Removal Neat Product Line Training



**Metal Removal Neat
Distributor Training**
John Harris Nov, 2025

Agenda

1. Product Line Chemistry
2. Troubleshooting
3. Product Line Details
4. Machining Applications
5. Workpiece Materials
6. Laboratory Testing

Product Line Chemistry

Base Oil & Additives

Basics – Job of Cutting Oils & Fluids

What are neat cutting oils?

- Fluids based on Mineral oils, Esters or Fatty alcohols combined with advanced additives to enhance cutting performance, corrosion protection properties, oil life etc.
- Used as supplied without further dilution.
- Can be used for applications from light Machining, Grinding to heavy-duty operations.
- They are applied by spraying or flooding on the parts/tools

What do they do?

- Reduce Friction
- Reduce Heat
- Carry Away metal chips and fines
- Corrosion protection

Rough composition of NCO

Neat oils consist of

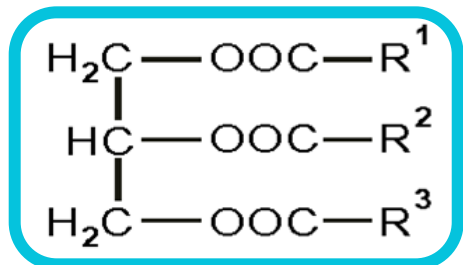
Base Oil: highly refined paraffinic mineral oils, hydro-crack oils, PAO or ester

Additives: to enhance cutting performance, corrosion protection properties, oil life etc.

API BASE OIL CATEGORIES					
Base Oil Category		Sulfur (%)		Saturates (%)	Viscosity Index
Mineral	Group I (solvent refined)	>0.03	and/or	<90	80 to 120
	Group II (hydrotreated)	<0.03	and	>90	80 to 120
	Group III (hydrocracked)	<0.03	and	>90	>120
Synthetic	Group IV	PAO Synthetic Lubricants			
	Group V	All other base oils not included in Groups I, II, III or IV			

Component	Percentage %	
Base oil / base oil mix	50 – 100 %	Base
Natural or synthetic ester	0 – 50 %	Primary Performance Additives
Anti-wear additive (phosphorous type)	0 – 2 %	
Chlorinated paraffin	0 – 50 %	
Active sulfur	0 – 5 %	
Sulfurized fat (inactive sulfur)	0 – 15 %	
PEP Additive (sulphonate)	0 – 20 %	Secondary Supportive Additives
Anti-mist additive	0 – 2 %	
Anti-foam additive	0 – 2 %	
Anti-oxidant / anti-ageing additive	0 – 2 %	
Anti-corrosion additive	0 – 2 %	
Copper inhibitor	0 – 2 %	
Pourpoint depressant	0 – 1 %	

Polar Additives / Esters



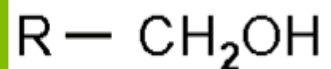
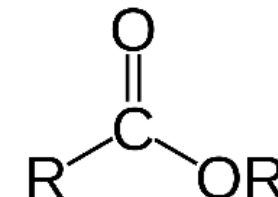
Triglycerides: Vegetable Oil

Natural: $\text{R}^1, \text{R}^2, \text{R}^3$ different

e.g. Rapeseed oil, olive oil, castor oil

Synthetic: $\text{R}^1, \text{R}^2, \text{R}^3$ can be identical

Properties can be controlled



Fatty alcohols



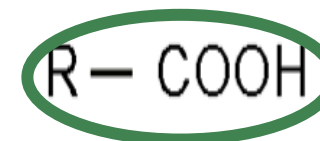
Carbionic esters

Mostly synthetic



Metal soaps

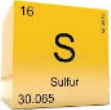
Salt of fatty acids



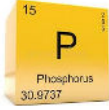
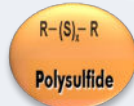
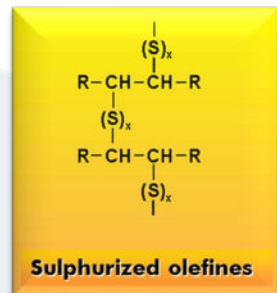
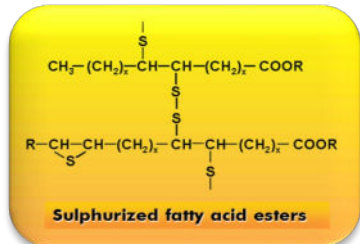
Fatty acids

Natural or synthetic

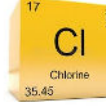
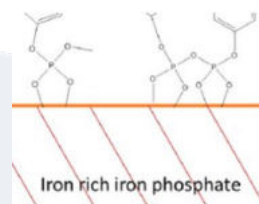
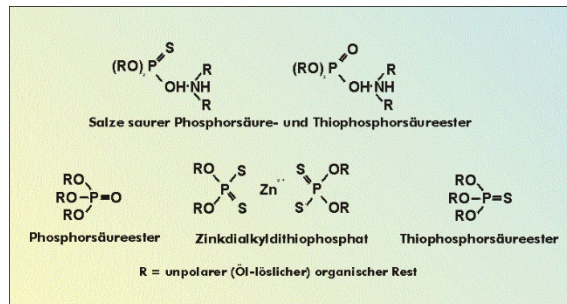
Extreme-pressure / Anti-wear additives



Sulfur molecules which are reacting at a certain temperature with the metal surface to metal sulfide.



Phosphorous molecules creating an highly lubricating shift to prevent wear.
One typical AW additive is ZDTP (Zinc-diaryl-alcyl-dithiophosphate) but more and more restricted for environmental reasons.



Chlorinated molecules react at a certain temperature with the metal surface to metal chloride.

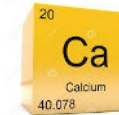
$\text{C}_{24}\text{H}_{44}\text{Cl}_6$ LCCP Long Chain Chlorinated Paraffin

$\text{C}_{15}\text{H}_{26}\text{Cl}_6$ MCCP Medium Chain Chlorinated Paraffin

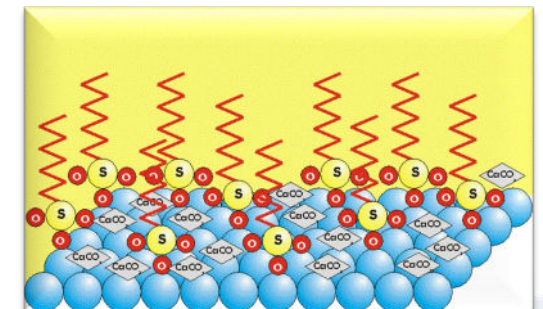
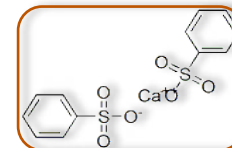
$\text{C}_{12}\text{H}_{19}\text{Cl}_7$ SCCP Short Chain Chlorinated Paraffin

- SCCP are prohibited due to risk of cancer
- MCCP and LCCP are still in use in metalworking for severe and relatively slow machining processes
- LCCP are preferred because they are not labelled

Chlorinated paraffins have different percentage of Chlorine from 35 ~ 70%



Overbased sulfonates creating a layer of solid lubricity molecules on the work piece surface as e.g. Calcium or Sodium carbonates CaCO_2 . That's why these additives type are called **PEP = Passive EP**



Active vs. Inactive Sulfur

Active sulfur will react with Copper, Brass and Bronze (yellow metals) turning it black in the process.

Inactive sulfur will not react with yellow metals

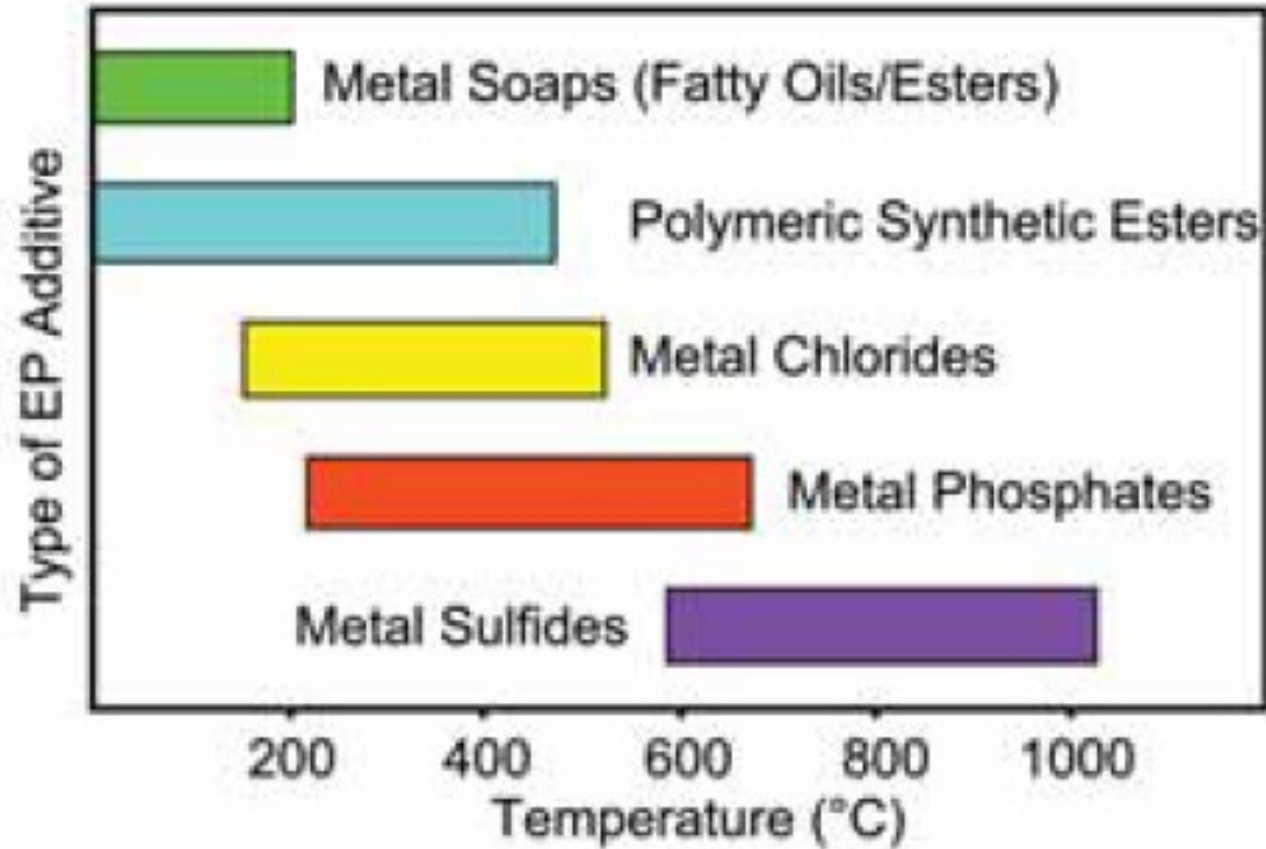
DO NOT use active sulfur on the lube side.

ASTM D130 test is used to differentiate active and inactive sulfur. If it is active sulfur at 100C it will stain copper. If it is inactive sulfur, it will not stain copper.



Extreme Pressure Additives

Activation Temperatures



(Courtesy of The Lubrizol Corp.)

Secondary Additives

Anti-Mist Additive: Long chain polymers which increase the size of the oil drops created by the rotating tools / work pieces.

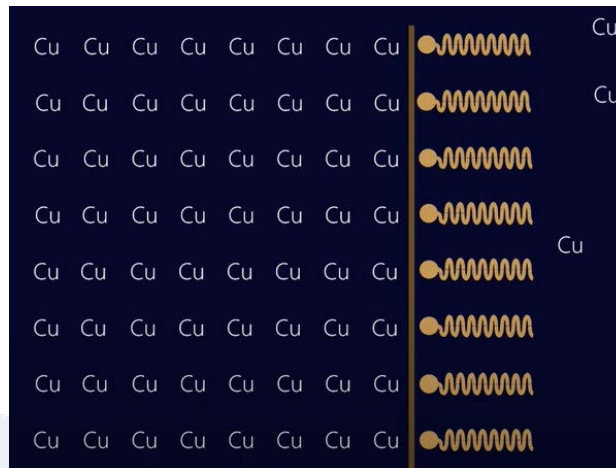
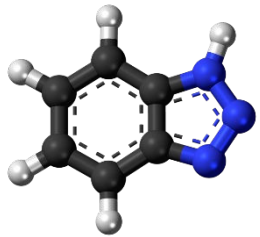
Anti-Oxidant Additive: Prevent the ageing of oil, which leads to increase in viscosity, higher acidity, stickiness and bad smell of an oil.

Anti-Foam Additive: Generally insoluble in the foaming medium and has surface active properties

Copper Inhibitor: Corrosion inhibitor for copper and its alloys by preventing undesirable surface reactions.

Anti-Stain Copper Inhibitor

- Benzotriazole is an effective corrosion inhibitor for copper and its alloys by preventing undesirable surface reactions.
- It is known that a passive layer, consisting of a complex between copper and benzotriazole, is formed when copper is immersed in a solution containing benzotriazole.



Troubleshooting

Neat Oil Troubleshooting

If your customer calls you because of a trouble in his machine:

- **Rule 1:**
 - Don't be nervous, we have excellent products and most of the issues are home made.
- **Rule 2:**
 - Take the customer serious and visit him as fast as possible.
- **Rule 3:**
 - Follow the directions below the fishbone diagram

☐ Foam

☐ Fume / Smoke

☐ Mist

☐ Tool Life

☐ Corrosion / Rust

☐ Smell / Oil Discoloration

☐ Tramp Oil

☐ Copper Discoloration

☐ Other

Foam Trouble

Possible Reason	Possible Solution
Not enough oil in the tank (visible)	Fill up
Not enough oil in the tank (invisible, e.g. high level of debris on the tank bottom)	Check with a meter / rod to see how far you come down. Clean sump.
Pump is sucking air	Check pump
Flow back is too high	Install tube or hose to flow the oil under oil level.
System too small	System should have 8 – 10 x the pump volume per minute.
Contamination with tramp oil, emulsion or cleaner	Check visual, take sample min. 1 ltr., investigate with operator <u>Add anti foam additive</u>

Fume/Smoke Trouble

Possible Reason	Possible Solution
Wrong positioning of the nozzle	Adjust
Not enough oil supplied	Check pump, open valves
Additive level too low for the application / material	Upgrade product, add service additive
Cutting speed too high	Reduce speed, upgrade product
Viscosity too high or too low	Change product
Oil temperature too high	Check chiller / cooler & sump level

Oil Mist / Vapor Trouble

Possible Reason	Possible Solution
Open tanks and gutters	Cover where ever possible, replace grids by sheets
Not enough oil supplied	Check pump, open valves
Oil mist collector does not work	Check collector, clean it
Viscosity to low	Change product
Oil temperature to high	Check chiller / cooler and sump level
Wrong product	Use oil with anti-mist additives

Tool Life Trouble

Possible Reason	Possible Solution
Cleanliness of oil is not good	Check filters, improve with magnetic filters
Not enough oil supplied	Check pump, open valves
Contamination with tramp oil	Take min. 250 ml sample and send to lab
Viscosity too low	Change product to higher viscous one
Oil temperature too high	Check chiller / cooler and sump level
Wrong product	Upgrade to higher level oil or add service additive
Additive level low	Check if chip centrifuge & other oil squeezers are used, take 250 ml sample

Rust / Corrosion Trouble

Possible Reason	Possible Solution
Cleanliness of oil is not good, contact corrosion	Check filters, improve with magnetic filters
Water in the oil	Check with crackle test, take min. 250 ml sample & send to lab
Contamination with chemicals	Take min. 250 ml sample & send to lab
Oxidation / ageing of the oil	Check smell, stickyness, take min. 250 ml sample an send to lab

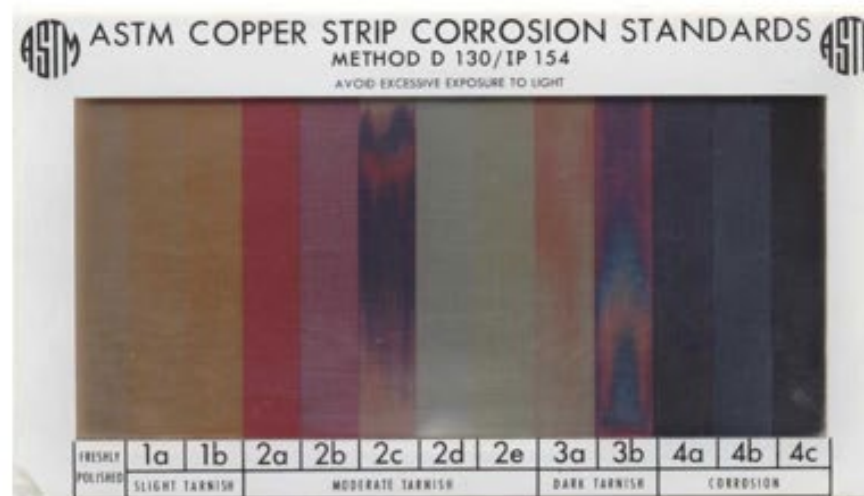
Smell / Oil Discoloration Trouble

Possible Reason	Possible Solution
Oxidation / ageing of the oil	Check smell, stickyness, take min. 250 ml sample and send to lab
Contamination with tramp oil	Take min. 250 ml sample & send to lab
Oil temperature too high	Check chiller, cooler, & sump level
Oil overheated & stressed	Upgrade to higher level oil or add service additive
Additive level low	Check if chip centrifuge & other oil squeezers are used, take 250 ml sample

Tramp Oil Trouble

Possible Reason	Possible Solution
Damage of machine seals	Check with maintenance people, e.g. hydraulic oil consumption. Take sample
Contamination during top up	
a) With mineral oil	Take min. 250 ml sample and send to lab, adjust with service additive
b) With soluble concentrate	Drain the sump, wash with water and system cleaner, drain, flush with HLPD hydraulic oil, drain, clean and fill new.
Machines tend to leak	Use Tri-purpose oils for cutting, hydraulic and lubrication

Copper Discoloration Color



Possible Reason	Possible Solution
Oil contains Active Sulfur	Wash parts directly after machining
	Add copper inhibitor to the oil
Contamination with tramp oil	Take min. 250 ml sample & send to lab
Wrong product	Change to product with inactive Sulfur or Sulfur free

PRODUCTS

MACRON 2425 S-14 US

- **BETTER – CORE Product**
- **Several Approvals**
- **High performance grinding oil – specializes in flute grinding**
- **Can be used on ceramic, diamond, or boron nitride grinding wheels**
- **Also be used for grinding of spiral toothed bevel gears and flat or cylindrical grinding processes**
- **Chlorine & Heavy metal free**
- **Low mist and vapor**

Similar Products:

- **Grinding**
 - **DASCOLENE 617 US – (Best-Core)**
 - Several Approval (Reishauer, Kapp)
 - Multi – Applications
 - Chlorine & HM free – Active Sulfur
 - **QUAKERCUT 010 ES – (Good-Core)**
 - Medium to Heavy duty
 - Unique chemistry allows for easy cleaning
- **Honing**
 - **MACRON 2405 M-4 US – (Best-Core)**
 - Chlorine, Sulfur, & HM Free
 - Transor Approval
 - **QUAKERCUT 004 PE – (Better-Core)**
 - Several Customers & Corporate approvals
 - Unique combination of film strength, friction reduction and extreme pressure lubrication assures optimum stone life, surface finish
 - Can be used as a Lapping Oil

PROCUT 65

- **BEST – CORE Product**
- **Heavy Duty Chlorine Free**
- **Unique product can do multiple applications. Currently performing Grinding, deep hole drilling, & Broaching**
- **Free of Heavy metals**
- **Active Sulfur – However, can be used on all non-yellow metals**
- **High flushing power and detergency**
- **Unique Ester Technology**

Similar Products: Not 1 Mineral based product can do as many applications.

- **Deep Hole Drilling:**
 - WC 75 (Good – not on Core) contains MCCP & Active Sulfur
 - CUT-MAX 634-8 (Best–CORE) MCCP free
- **Broaching:**
 - CUT-MAX 570 (Best-Core) high vis, MCCP, Active Sulfur
 - DASCOLENE 140 (Better-Core) MCCP free, Active Sulfur
- **Grinding:** Several products already discussed

QUAKERCUT 010 EP

- **BEST – CORE Product**
- **Multi Metal & Multi Application**
- **Sourced from renewable resource base oils**
- **Extensive experience in European market**
- **Higher flashpoints than typical mineral oil & some ester technology**
- **Longer shelf life, lower TAN,**
- **Lower consumption rates & mist compared to mineral oil**
- **QUAKERCUT XP & EP do not require the GHS Aspiration Hazard Classification**

Similar Products:

- **Quakercut 005 EP**
 - Best - Core
- **Quakercut 020 EP:**
 - Best - Core



CASE STUDY: QUAKEERCUT 010 EP

CASE STUDY - GRINDING WITH QUAKEERCUT® 010 XP

- » Application: Grinding of transmissions for heavy-duty vehicles
- » Machine: Junker Quickpoint 5002
- » Material: Steel, hardened high-alloy

Customer Benefits using QUAKEERCUT® 010 XP:

- » No oil change for 12 years
- » Lower consumption (-66 %)
- » Oil mist down from $> 1\text{mg/m}^3$ to $< 0.05\text{ mg/m}^3$
- » No reports of skin or respiratory irritation anymore
- » Filter cleaning prolonged from once every fortnight to once every three months
- » Total cost saving : \$5,800 USD per year per machine

WOCOCUT SM-165

- **Best – CORE Product**
- **Dual/Tri Purpose Oil**
 - Single purpose contained any additive including active Sulfur it could or couldn't contain anti-oxidant
 - Dual Purpose contains inactive sulfur (if at) & needed to contain anti-oxidant
 - Tri Purpose contains inactive sulfur (if at) & anti-oxidant, and anti-wear. agree
- **General Purpose Oil**
- **Chlorine & Heavy metal free**
- **Great Oxidation Stability**
- **Low Mist and Foam**
- **Non-staining to yellow metals**

Similar Products:

- **Dual/Tri Purpose (general purpose)**
 - MACRON 221 CM-32 (Better-Core)
 - Contains Chlorine
 - Top 10 2024 product
 - WOCOCUT SM-150 (Good-NOT Core)
 - Contains Chlorine
 - Medium Duty
- **General Purpose**
 - PROCUT SS (Best-Core)
 - HD containing Chlorine
 - Top 25 2024 product
 - Multi Metal & Multi Application
 - Garia 405 M-22 (Good-Core)
 - Medium Duty
 - Chlorine & Heavy Metals Free
 - Multi Metal and Multi Application including Magnesium
 - Also used as a Grinding fluid

EDM 244

- **Better – CORE Product**
- **EDM Applications**
- **Utilized to produce very fine and intricate cuts and profiles**
- **Works very well when machining graphite electrodes**
- **Transor Approved**
- **ONA Filtration Approved**
- **Approved for use in nuclear facilities**
- **Some Grinding & Honing**

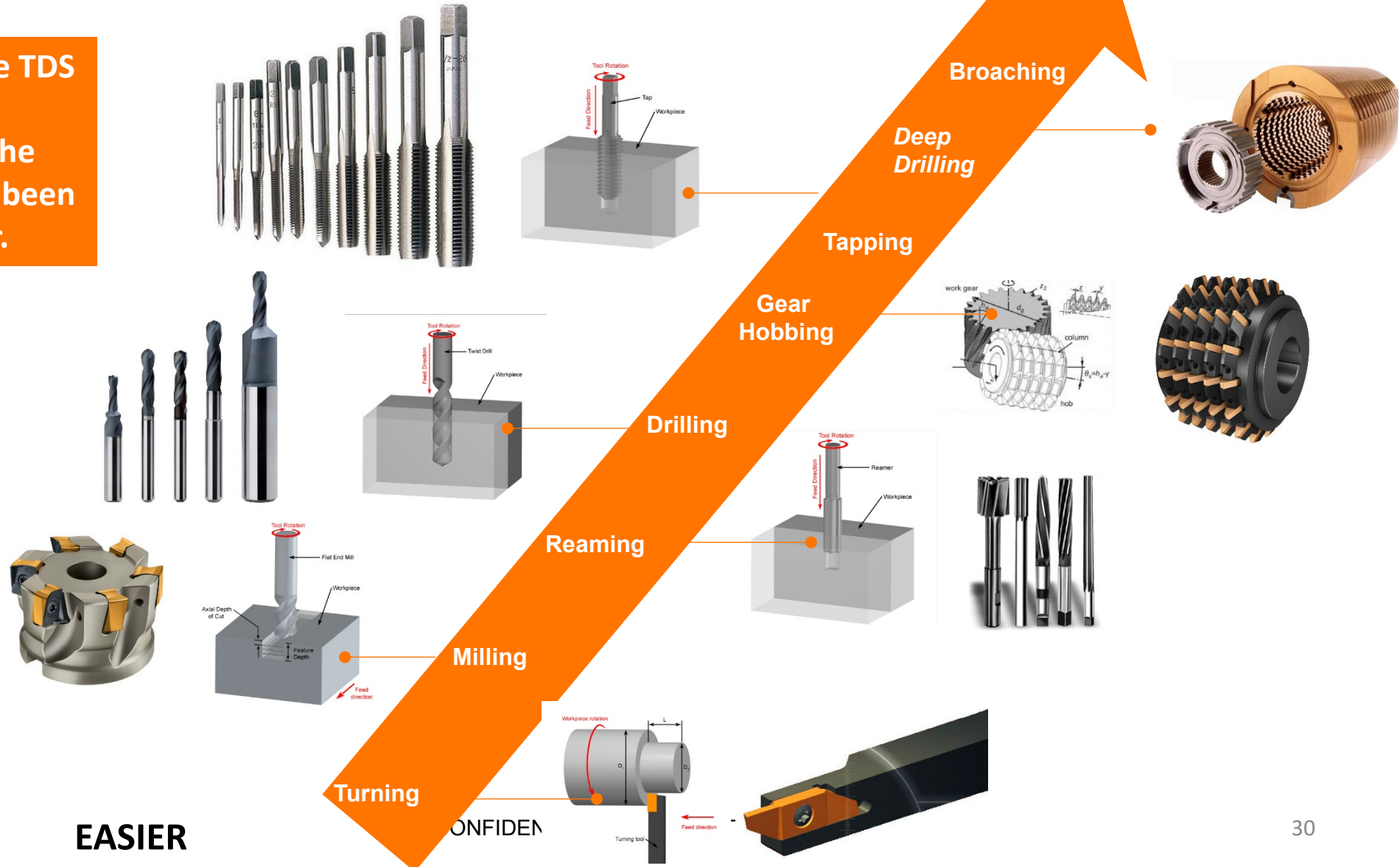
Similar Products:

- **EDM Super Supreme (Best-Core)**
 - HD Synthetic Di-Electric Fluid has been specially developed for modern EDM Machine
 - Provides faster Machines, shorter delivery times, tighter tolerances
 - Transor Approved
- **ONA Filtration Approved**
- **Dasco Spark (Good – Not Core)**
 - PR

MACHINING APPLICATIONS

Machining Operations

Check on the TDS for which operations the product has been designed for.



CONFIDEN

Machining

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process; otherwise known as “*subtractive manufacturing*”.

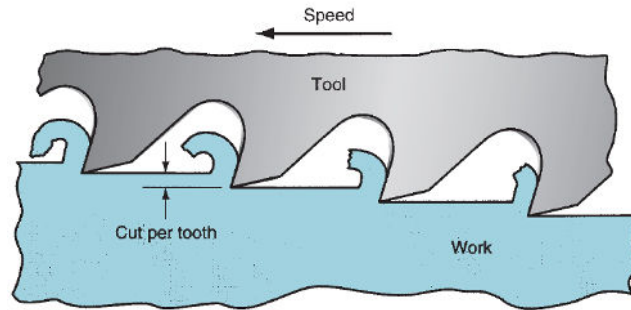
Principle machining processes:

- Turning
- Drilling (Deep Drilling)
- Milling
- Others: shaping, boring, broaching, sawing, threading, tapping



Materials: Cast iron, Easy steel, Moderate steel, Heavy duty steel, Stainless steel, Easy Al, Difficult Al, Aerospace Al, Titanium, Nickel, Inconel, Yellow/Red metals (copper, brass, bronze), CGI (compacted graphite iron), Titanium-carbon fiber

Broaching

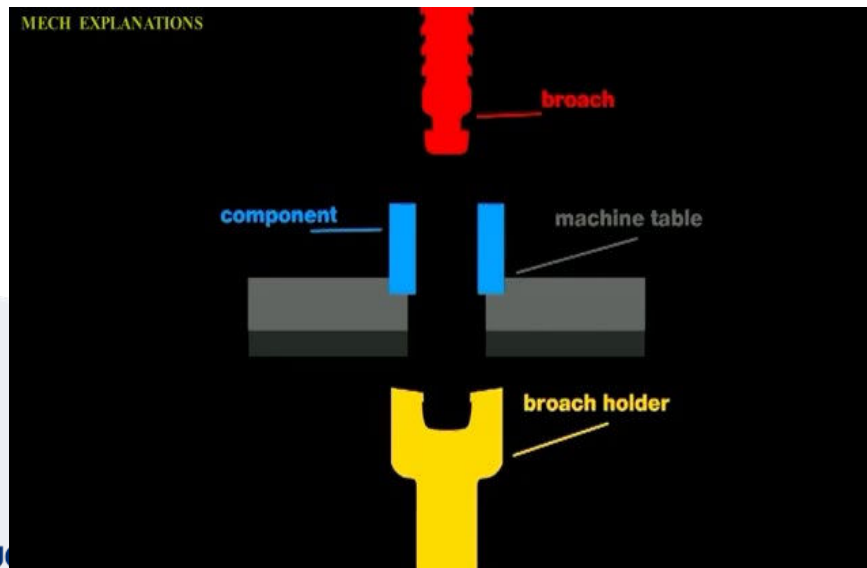


Broaching is a severe cutting operation where accurate sizing and finishing of surface or shape is achieved by a single slow pass of a multipoint cutter (the broach).

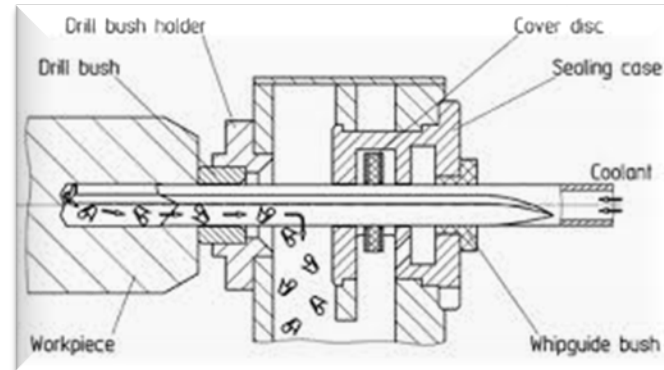
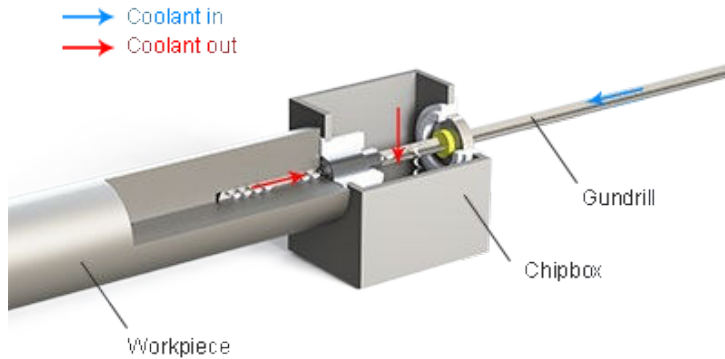
The stock removal of the broach is built into the tool by having each successive tooth cut deeper into the material. Thus, both roughing and finishing cuts may be built into the same tool.

Process Characteristics

- Requires high EP and medium to high viscosity
- Produces close tolerances and good surface finish
- Uses a multipoint cutting tool (broach)
- Has the roughing and finishing teeth on the same tool
- Machine surfaces are parallel to axis of tool motion



Deep Drilling (Gun Drill)



Gun drilling is a deep hole drilling process that uses a long, thin cutting tool to produce holes in metal at high depth-to-diameter ratios. Gun drilling is effective in diameters from approx. 0.8mm to 30 mm. The length of a hole can be 1500x the diameter.

A gun drill tool differs from a conventional twist drill by its unique head geometry; a standard gun drill has a single effective cutting edge that removes chips as it advances into a metal workpiece.

The gun drilling process is able to drill deep holes beyond what is possible with conventional machinery and tooling such as twist drills, by using high pressure coolant for clean chip exhaust, even at extreme depths.

The cutting oil is pressed through little channels in the tool. Oil and chips flow out through the tools flute.

The oil pressure can be up to 160 bar for small diameters.



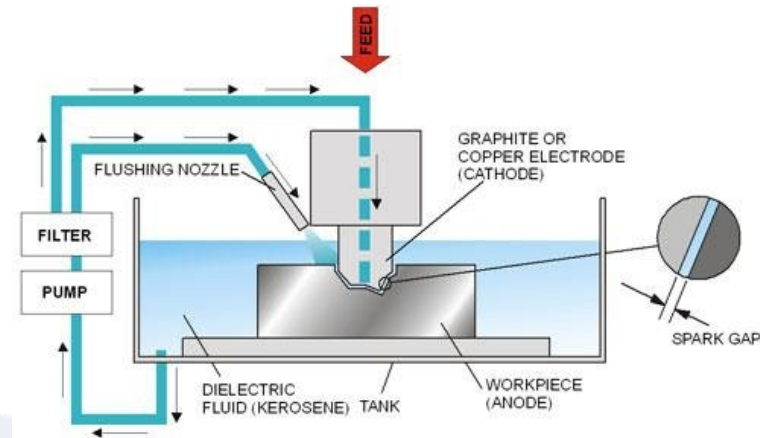
Electro Discharge Machining



EDM – Electro Discharge Machining is a machining process performed by the action of electric sparks eroding a work piece surface.

A current is applied between an electrode and component, through an insulating fluid to create a discharge which then converts the current to heat.

The surface of the component gets extremely hot (molten) at this point of discharge, and the fluid displaces metal particulates and gas to create a crater in the surface of the metal (electrode wear also results).



Minimum Quantity Lubrication

- MQL are CLEANER than Coolants
 - MQL lubricants are mostly consumed in the cutting process
 - The friction and heat in the interface vaporizes the small amount of lubricant and leaves cutting tools, parts, equipment, and floors dry and clean
 - Contamination from bacteria, tramp oil, and swarf are major concerns
 - Machines, floors, and finished parts are often left wet from coolant, causing potential slip hazards and often requiring part cleaning before secondary operations can take place
- MQL is SAFER than Coolants
 - Highly refined bio-based plants that are completely safe for skin contact
 - Some coolants have been shown to cause dermatitis and to be carcinogenic with long-term exposure to coolant vapor
 - No need for special disposal
- MQL is much GREENER
 - Since they are mostly coming from highly refined bio-based plants renewable, environmentally-friendly material

Workpiece Materials

Workpiece Materials

Points to consider when selecting a Neat Cutting Fluid depend on the metal:

- Material physical properties : **lubricity needed** to machine them
- Chemical compatibility with neat oils: **staining** on non-ferrous metals



Quick Guide to Machinability

Ferrous Materials

Material	Machinability
Free Cutting Steels	Free cutting & ductile due to high lead content
Carbon Steel	Machinability decreases as carbon content increases
Alloy Steel	Elements used: Cr, Mo, V decrease machinability
Stainless Steel	Machinability decreases as alloy level increases
Cast Iron	Relatively easy to machine due to graphite but swarf is very aggressive and requires fluid of exceptional stability

Quick Guide to Machinability

Non- Ferrous Materials

Material	Machinability
Aerospace Aluminum	Very soft but easy machining. Needs special inhibitors to prevent staining.
Automotive Aluminum	Can be soft or hard. Difficult applications are prone to BUE and poor finish. Needs high lubricity product.
Copper Alloys	Easy to cut but needs special formulas to prevent staining and discoloration.
Nickel Alloys	Prone to work hardening and very abrasive. Requires extreme pressure performance.
Titanium	High frictional heat plus with poor thermal promotes tool wear and BUE. Good cooling and antiwear required.

Magnesium (Mg)

- **Magnesium (Mg) is used in die-casting industries**
- **It is very easy to machine**
- **Magnesium alloys with a Mg content higher than 80% must be handled very carefully due to the risk of fire.**
- **Magnesium has a strong oxidising character and can create Hydrogen gas**
- **Requires special coolants or preferably a neat cutting oil to reduce fire risk**
- **Special coolants also need to be used to cope with dissolved Magnesium in the emulsion**

Laboratory Testing Testing Apparatus

Neat Oil Test Equipment

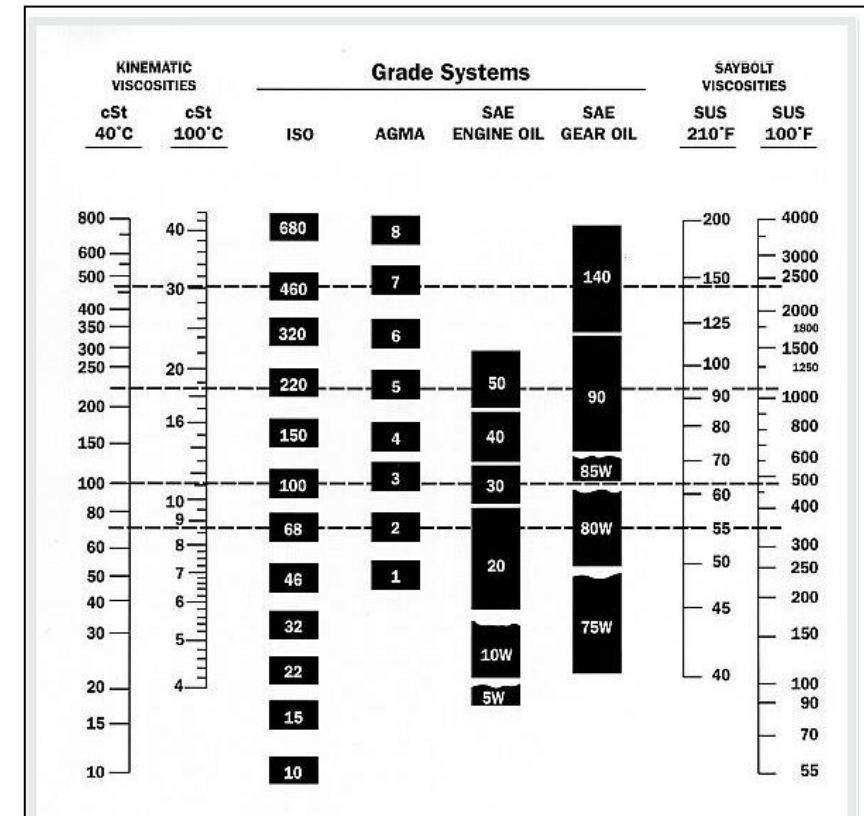
Quaker Houghton has well equipped labs with a wide range of analytical and mechanical test equipment.

This equipment is on one hand used for trouble shooting if something with the oil is wrong but also for benchmarking with competitors products and to make first tests for new developed products.

- ☐ Taking Sample
- ☐ Brugger Machine
- ☐ 4ball Machine
- ☐ SRV Machine
- ☐ Reichert Machine
- ☐ Micro Tap Machine
- ☐ Foam Test
- ☐ Corrosion Test
- ☐ Various Analytical Equipment

Viscosity

Kinematic viscosity is the time required for a fixed amount of an oil to flow through a capillary tube under the force of gravity.



Neutralization Number

TAN: Total Acid Number

The total acid number (TAN) is a measurement of the acidity in oil or fat, determined by the amount of potassium hydroxide (KOH) needed to neutralize the acids in one gram of sample.

A high TAN can indicate that the oil is degrading due to oxidation, contamination, or additive depletion, and this can lead to equipment corrosion, wear, and premature failure.

Monitoring TAN is crucial for predictive maintenance, as it helps determine when to change oil and prevents costly damage.

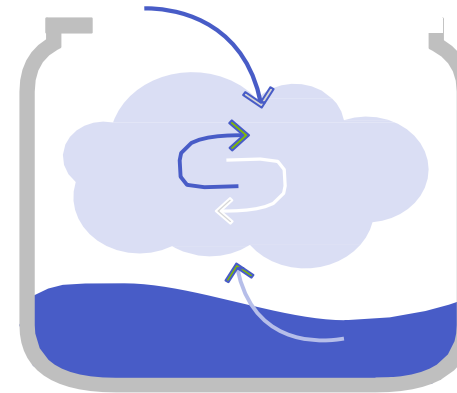
Flashpoint

The flash point of a volatile material is the lowest temperature at which it can vaporize to form an ignitable mixture in air. Measuring a flash point requires an ignition source. At the flash point, the vapor may cease to burn when the source of ignition is removed.

The Cleveland equipment increase automatically the temp (5°C min)

Base oil type	Gr I	Gr III	Ester
Viscosity at 40°C	10	10	10
Flash Point °C	160	200	220

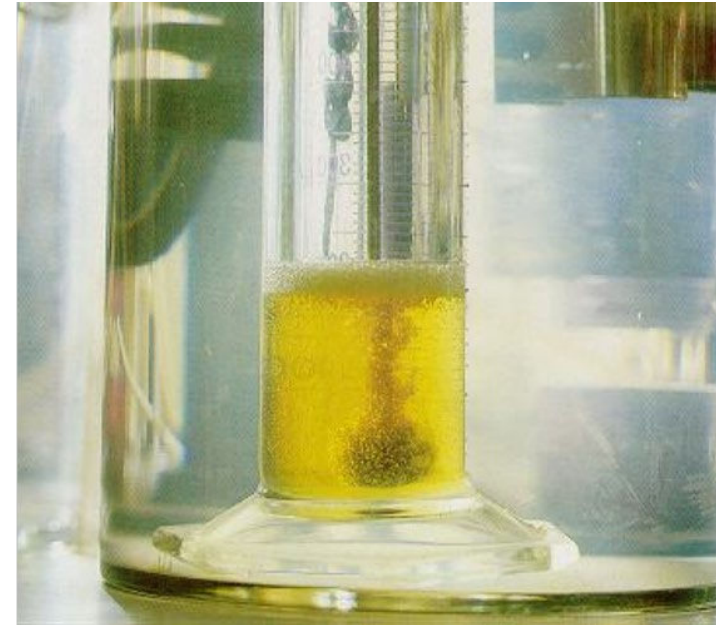
Picture shows equipment
for Flashpoint COC ASTM D 92



Foam Control

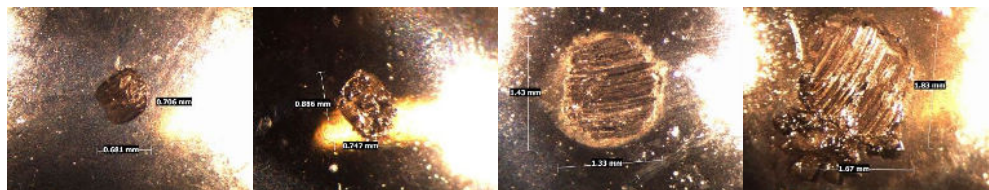
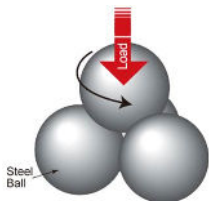
Purpose

The method shows how much foam is formed when air bubbles rise to the surface in oil at rest and the duration of the foam. From this, the behavior during use can be estimated. **Oils which produce a lot of foam or very persistent foam are not suitable for some applications.**



DIN	ASTM	IP
-	D-892	146

4 ball Instrument

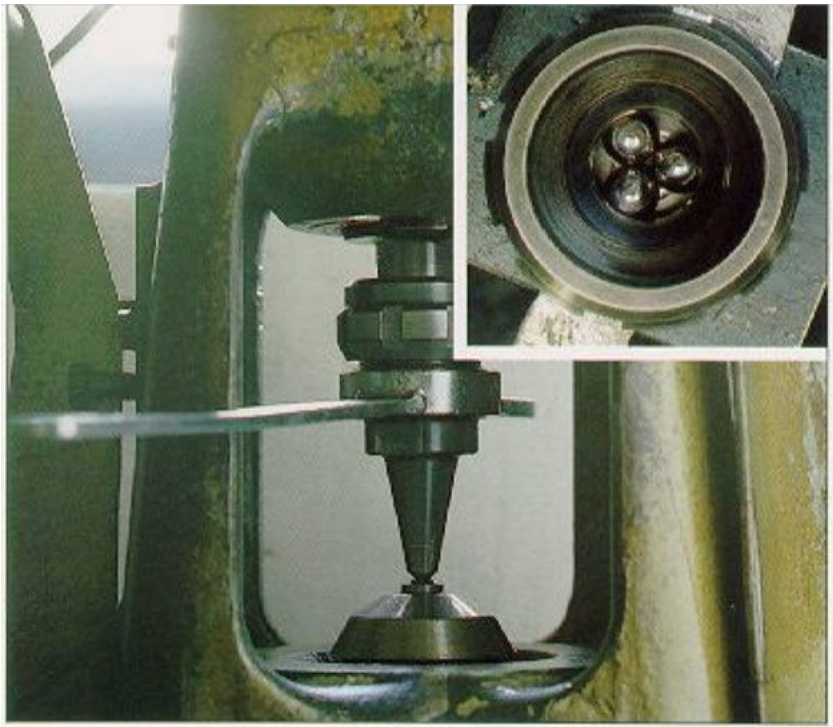


Purpose

The methods in accordance with this standard are intended to determine the characteristic values of lubricants with additives which should allow high surface pressure in the mixed friction area between surfaces moved in relation to each other.

Brief description of the method

The lubricant is tested in a four-ball system, which consists of a rotating ball (running ball), which slides on three balls which are identical to it (stationary balls). The test loads may either be increased gradually until the four-ball system seizes up or the ball imprint diameters of the three stationary balls shall be measured with constant test load after a set test period.



DIN	ASTM	IP
51350 Part 2 (weld load, fluids)	D-2783 (weld load, fluids)	239
51350 Part 3 (wear, fluids)	D-4172 (wear, fluids)	
51350 Part 4 (weld load, greases)	D-2596 (weld load, greases)	
51350 Part 5 (wear, greases)	D-2266 (wear, greases)	

Micro Tap Torque Instrument

- Was developed to compare the friction of different metalworking oils during the tapping process and the torque forces
- There are test panels with the bores according to the tap diameter
- These panels are from different materials like stainless steel, aluminium or plain carbon steels
- It is also possible to run at different RPM.



FTIR Spectrometer

Purpose

Quality control and structure elucidation of mineral oil additives

Brief description of the method

The (FT-IR) spectrometer is composed basically of the following parts: infrared source, Michelson interferometer, sample compartment and detector. The infrared radiation passes first through the interferometer, then through the sample. During the passage, characteristic signals are measured and stored digitally in the computer. The desired IR spectrum is obtained by a conversion (Fourier transformation) of these data.



ICP / AES (Inductively coupled plasma / atomic emission spectroscopy)

Purpose

Quantitative determination of elements: ZN, Ca, Ba, Mg, Mo, Pb, Na, U and P in mineral oil additives. Following DIN 51431.

Brief description of the method

The sample is sucked into a gas ionised in a high-frequency electromagnetic field. The stream of ionised gas is passed through a coil attached to a high-frequency generator. Argon is used as the plasma gas as it is relatively easy to ionise. The light energy emitted by each element is passed by a polychromator an a photoelectric multipler as the detector to the electronics and processed in the microprocessor. Finally, the content of each element present is calculated by system software.

Element (ppm)	SAV79979
Aluminium	0
Barium	0
Boron	4
Cadmium	0
Calcium	83
Chromium	0
Cobalt	0
Copper	0
Iron	262
Lead	1
Lithium	0
Magnesium	4
Manganese	10
Molybdenum	0
Nickel	0
Phosphorus	15
Potassium	462
Silicon	11
Silver	0
Sodium	127
Sulphur	123
Tin	3
Titanium	1
Vanadium	0
Zinc	9
Hardness	
Ca/Mg	225
Ca only	208



Questions?

Thank You!