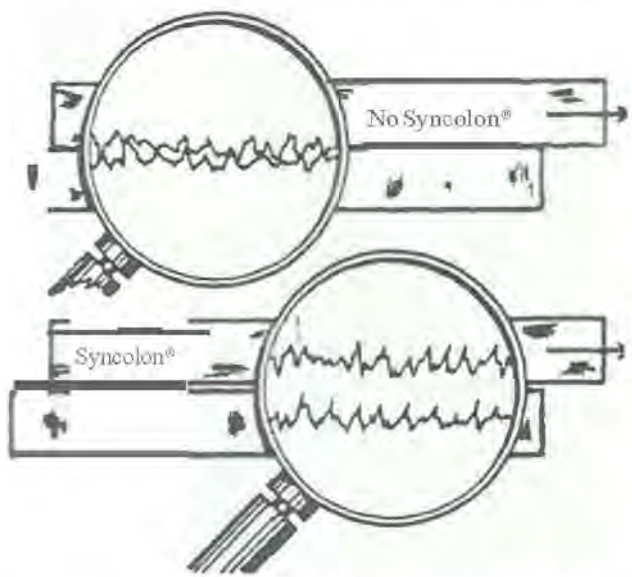
SUPER LUBE® UNIVERSITY
CLASS 101

SYNCOLON® (PTFE) FILLS IN MICROSCOPIC VOIDS

If we were to look at the surfaces of the steel under a powerful microscope, we would see that they actually contain minute peaks and valleys which interlock and prevent the blocks from sliding freely. When Syncolon® (PTFE) is present between the blocks, the blocks are separated and the small peaks and valleys can no longer interlock. The top block can then slide freely over the bottom block.

SYNCOLON® (PTFE) REDUCES FRICTION



This also explains the manner in which a lubricant reduces wear. If they were not lubricated, some of the small peaks would be broken off as one block moves over the other. Eventually, this would result in visible wear on the blocks. The peaks cannot contact each other with lubricant present and wear is reduced accordingly.

REDUCES WEAR

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REMOVES HEAT

- A certain amount of heat is always developed at the points of contact between rubbing parts, even though they are lubricated. Oil absorbs heat. The heat usually passes from the oil, through the sides of the oil reservoir, and into the air. Super Lube® is an excellent heat transfer agent.

PROTECTS FROM DIRT

- Proper use of Super Lube® can keep dirt from entering a bearing and damaging the smooth surfaces. Each time a new addition of grease is applied to the bearing, a supply of clean grease is forced out the ends to maintain a protective seal.

PREVENTS RUST

- Rust is a reaction with unprotected metal surfaces that come in contact with air and moisture. Super Lube® provides a protective barrier which blocks the air and moisture from contacting the bearing surfaces. Anti-rust and anti-corrosion additives in Super Lube® further enhance the protective qualities even under extreme conditions.

TRANSMITS POWER

- Hydraulic equipment uses oil as a medium for power transmittal. Super Lube® Lightweight Oil may be used very effectively in this application.

UNDERSTANDING MOVING PARTS OF MACHINES REQUIRING LUBRICATION

- We know that lubrication is necessary at all points at which one surface moves against another. This occurs in **bearings**, which support rotating shafts, in **gears**, which have meshing teeth, and between **pistons** and the cylinders in which they operate. A machine may be large and complex in design, but it still has three fundamental moving parts, the **bearings**, **gears** and **pistons**.

BEARINGS

- There are two main types of bearings, **plain** and **antifriction**

Plain bearings

- **Plain bearings** are usually made from bronze, Babbitt, plastic, or some other softer than steel material so that wear will be on the bearing rather than on the steel part rubbing against it. Plain bearings are further classified as journal or bushing, guide, and thrust bearings. Journals or bushings support or operate against a rotating shaft. Guide bearings hold reciprocating parts in proper position. Reciprocating parts move with a back and forth motion. Thrust bearings prevent shafts from moving end wise. Most plain bearings should be lubricated with Super Lube® Oil with PTFE.

Antifriction bearings

- **Antifriction bearings** have a series of rollers or balls interposed between the moving parts. These rollers or balls are enclosed between rings known as races. Since rolling takes place with very little friction, these bearings are called **antifriction bearings**.

- **Antifriction bearings** are further classified as **roller**, **ball**, **ball thrust**, or **needle bearings**.

Roller bearings

- **Roller bearings** are further categorized as **straight roller** if the axis of each roller is parallel to the axis of the bearing; and **tapered roller** if the bearing is used to not only support the rotating shaft, but also to prevent the shaft from moving endwise. In this respect, it acts as a thrust bearing also.




Ball Bearings

- **Ball Bearings** are as the name implies, a series of balls retained between the races by a cage. The bearings may be of the open design or shielded. Shielded bearings have rubber guards on the ends to protect the balls from contamination in dirty environments. Most shielded bearings are factory lubricated and are not serviced in the field.

- The **ball thrust bearing** is similar to the plain thrust bearing except that balls are placed between the two thrust race faces.

- The **needle bearing** differs from the others in that it has no inner race and no separator or cage, and its small rollers or needles are just slightly separated by the lubricant. The name comes from the fact that the length of each roller is so much greater than its thickness.

- In contrast to plain bearings, which are made of materials softer than steel, antifriction bearings are made of very hard steel. The roller or ball in an antifriction bearing must be very hard, since it must carry the entire load, whereas the load is spread over a much larger area in a plain bearing.

GEARS

- Serve to transmit motion from one shaft to another and to vary the turning speeds of the various shafts.

- A **spur gear** is a toothed wheel whose teeth parallel the shaft or axle. The smaller of the two meshing gears is usually called the pinion.

- **Helical gears** are similar in shape to spur gears, but their teeth are placed at an angle on the face of the gear. In meshing, more teeth are in contact at one time than in the case of spur gears, yielding a smoother operation.

- **Herringbone gears** are like having two helical gears side by side with teeth inclined in opposite directions. They are used when smooth operation is desired and to eliminate end thrust on a shaft that would be present if only a helical gear were used.

- A **rack and pinion** combination is used to produce reciprocating motion from rotary motion. Usually the rack moves back and forth as the pinion rotates one way or the other.

- **Bevel gears** are used to transmit motion between shafts that are at an angle to each other. The **straight bevel gear** has straight teeth on a slanted or beveled working surface. The **spiral bevel** gear has spiral teeth and produces smoother operation.

- In the **worm gear set**, the small element called the **worm** usually drives the large element known as the **wheel** or **gear**. The shaft of the worm is perpendicular to the shaft of the wheel.

- When gearboxes are enclosed or sealed by a housing, they are usually oil filled. When it is not practical or possible to seal the gear casings, then grease is used as a lubricant.

PISTONS

- Operate in a cylinder and convert the power of compressed air, or the combustion of fuel in the space above the piston, to drive it down causing a crankshaft to turn, or a linear mechanism to move. Lubricants help to provide a seal between the piston and the cylinder walls. Pistons are found in engines, compressors, air or hydraulic cylinders, pumps, and pneumatic tools. Pistons are usually oil lubricated, but it is becoming common now to see permanently lubricated air cylinders utilizing a grease.

METHODS OF APPLYING LUBRICANTS

OIL

- **Once-through-oiling** is so named because the oil passes through the bearing only once and is lost for further use. Methods of this type include hand oiling, drip feed oiling, wick feed oiling, misting and force feed lubricators.

- **Hand oiling** is the direct application of oil from a hand oilcan. It is the most common method and is used to lubricate electric motor bearings, circulator pumps, hinges and small bearings having little movement.

- **Drip-feed oiling** allows a more uniform supply of oil to be administered through the use of a shut off valve, adjustment, oil chamber, needle valve and sight glass. The dripping off of the oil is adjustable and visible through the sight glass. Air line lubricators are a good example of drip-feed oilers.

- **Wick-feed** oilers consist of an oil reservoir and a wool wick. The wick draws the oil from the reservoir and feeds it into an opening in the bearing or onto a shaft by direct contact with the oil-saturated wick.

- **Misting** utilizes compressed air to atomize oil from a reservoir and deliver it as a mist through pipes to the bearings or gears.

- **Reservoir oiling** uses the same oil over and over again. Dipping and carrying the oil from the reservoir to the shaft is accomplished by using a ring, or collar that rotates on the shaft and carries the oil from the sump to the top of the shaft where it flows along and around the shaft, lubricating the bearings.

- **Circulating Oil Systems** make use of pumps and piping to deliver oil under pressure, and often in large quantities, to moving parts. The internal combustion engine is an example of a circulating oil system.

GREASE

- Grease is a semisolid made by combining base lubricating oils with a thickening agent and performance enhancing additives. Oils flow of their own accord, but pressure must be applied to most greases to cause them to move or flow.

In general, grease is preferred to oil under the following conditions:

- When there is no way to retain oil for the parts being lubricated. Examples are open gears, conveyors, and open guide bearings.

- When the lubricant must act as a seal to prevent the entrance of dirt into a bearing.

- Where a lubricant is seldom added, as in shielded bearings.

- Where speeds are low and loads are high.

- Hand application of grease is most common. It can be applied with a brush to open gears or conveyors, or by means of a grease gun. The grease gun accepts a standard cartridge of grease or it can be filled from a bulk container. The grease gun mates to a special grease fitting located on the equipment to be lubricated. Grease is forced under high pressure into the fitting by pumping the grease gun handle.

- High-pressure application is also achieved by means of semi-automated pumping equipment. This is commonly found in automobile repair facilities. Air pressure is used to activate the grease pump instead of a hand pump.

- Automated assembly lines are often outfitted with special grease metering and dispersing heads connected through tubing and distribution manifolds to a centrally located grease pump. Either the assembly equipment itself, or the assembled parts, can then be lubricated on a continuous or timed interval basis.

LUBRICANT CHARACTERISTICS

OIL

- **Viscosity** is a measure of flow ability at defined temperatures. Low viscosity oils, or light oils, flow freely. High-viscosity or heavy oils, flow slowly. In general, heavy oils are used on parts moving at slow speeds under high pressure, since the heavy oil resists being squeezed out from between the rubbing parts. Light oils are used when higher speeds and lower loads are encountered, as they do not impose as much drag on high-speed parts.

- Low temperatures call for light oils and high temperatures are more apt to require heavier oils, because oils increase in viscosity as their temperatures become lower and decrease in viscosity as the temperature goes up.

- Viscosity is expressed in either Saybolt Universal Seconds (SUS) or in centistokes (cSt). SUS readings are usually referenced at a temperature of 100°F, and cSt readings at 100°C. In both methods, when comparing viscosities, a higher number indicates a thicker oil.

Pour Point

- **Pour Point** of oil is the lowest temperature at which it will pour, or flow, when chilled without disturbance. Even as water loses its fluidity and becomes solid at low temperatures, so does oil cease to flow. Synthetic oils flow at much lower temperatures than do mineral oils. Super Lube is a synthetic oil.

Oxidation Resistance

- **Oxidation Resistance** – oil is a complex mixture of compounds of hydrogen and carbon called hydrocarbons. When hydrocarbons are exposed to air and heat, they combine slowly with oxygen in the air and are chemically changed into materials unsuitable for use as lubricants. The slow combination of oil with oxygen is called oxidation. Oxidation is hastened in service by high temperatures. Anti-oxidants are added to lubricants to help retard oxidation. Super Lube utilizes antioxidants.

Extreme Pressure

- **Extreme Pressure** oils are used on gears and bearings that operate under extreme loads and pressures. With extreme shocks and pressures, moving steel parts may break through an ordinary oil film and establish steel-to-steel contact. The EP (extreme pressure) oils contain added ingredients that help prevent metal-to-metal contact even if the oil film itself should fail to maintain the necessary separation. Super Lube utilizes PTFE and other food grade additives to enhance the EP characteristics.

GREASE

- **Hardness**
- **Dropping Point**

Hardness

- **Hardness** sometimes known as consistency or penetration is a characteristic that is similar in concept to the viscosity of oils. Just as the soil in your garden is hard if a spade barely penetrates it, and soft if it spades easily, so grease hardness is determined and graded according to the depth to which a sharp, pointed cone will penetrate the grease when dropped from a certain height. Grease is graded by the National Lubricating Grease Institute (NLGI) from a grade “000” (very soft) to a grade “6” (like a bar of soap), with a grade “2” as the most common (consistency similar to Vaseline).

Dropping Point

- **Dropping Point** of a grease is the temperature at which it passes from a semi solid to a liquid. Most calcium soap greases melt in the 160 – 210°F range. Sodium soap greases melt in the 275 – 350°F range, and lithium soap greases melt in the 350 – 400 °F range. Super Lube has no dropping point. It does not melt. It is ideal for high temperature applications. In time, at high temperatures, Super Lube base oils will dry out and the lubricant will resemble a rubbery substance. The PTFE will provide continued lubrication, but the lubricant should be replenished.

OIL TESTS

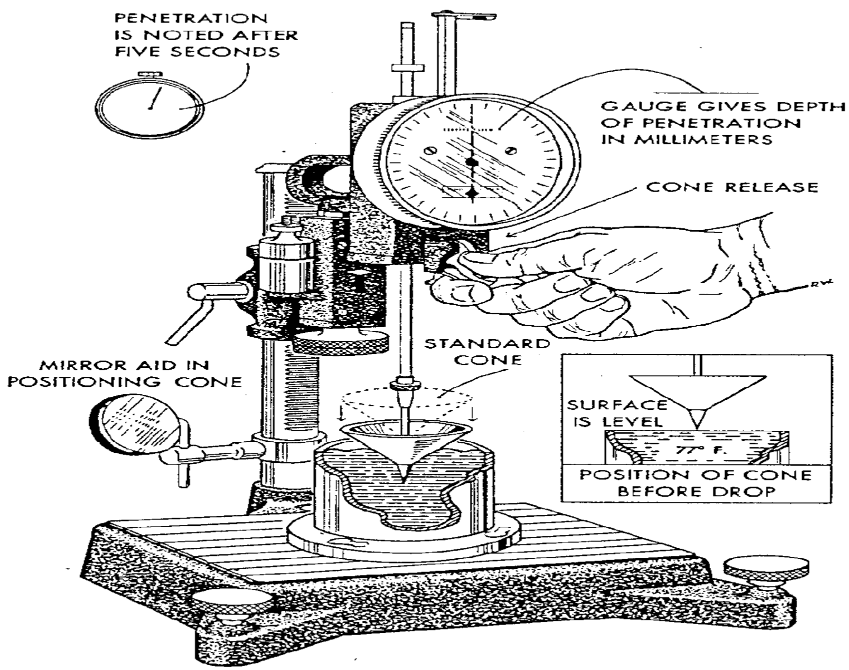
- Saybolt Universal Viscosity
- Cloud and Pour Points
- Flash and Fire Points
- Falex Lubricant Tester
- Measurement of Extreme Pressure Properties of Oils

GREASE TESTS

- Cone Penetration of Lubricating Grease
- Dropping Point of Grease
- Extreme Pressure Properties of Grease
- Water Washout Test

Cone Penetration of Lubricating Grease

ASTM D-217



WHAT IS PENETRATION?

Penetration, with respect to a lubricating grease, is the depth (in tenths of a millimeter) that a standard cone penetrates a sample of the grease under prescribed conditions of weight, time, and temperature.

WHY THE TEST?

Penetration is a measure of consistency of a grease to determine its plasticity.

HOW TO DETERMINE PENETRATION

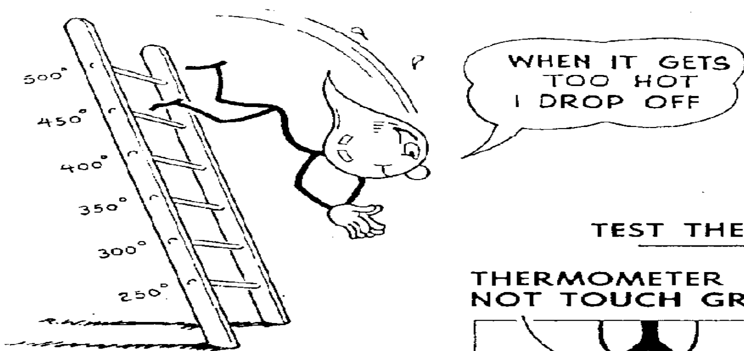
The grease is brought to a standard temperature in a container which is then placed directly below the cone tip. Release of the plunger permits the cone to drop into the grease. The depth of penetration in tenths of millimeters is read on the scale of the penetrometer.

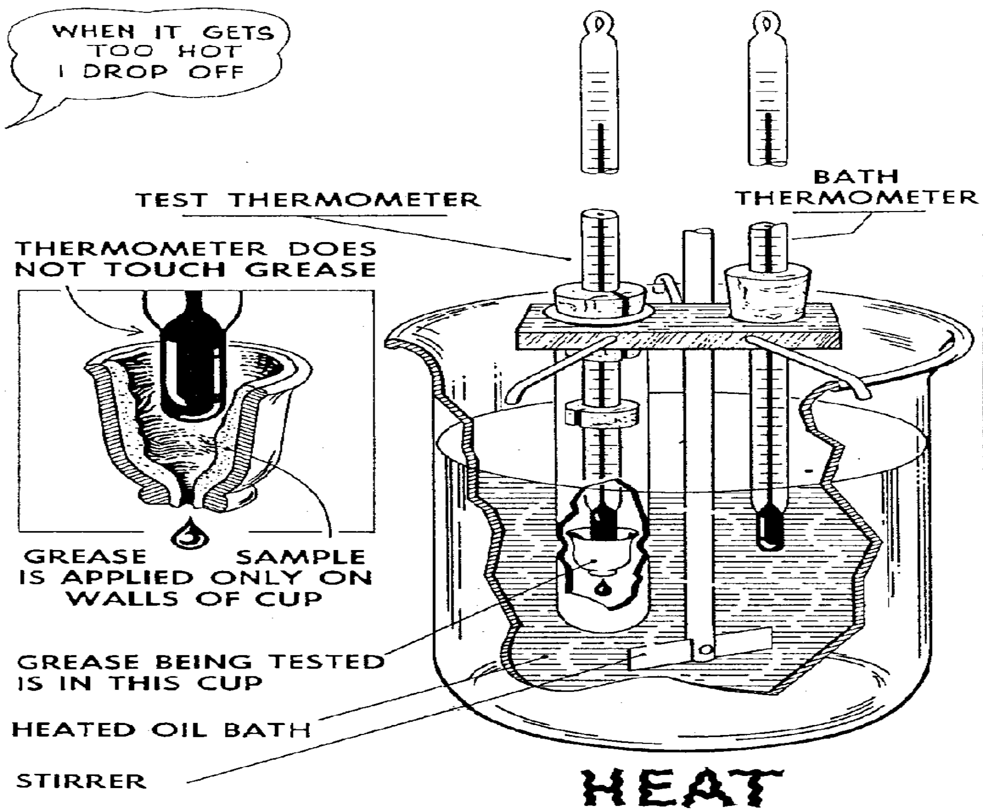
TYPICAL PENETRATION RESULTS

NLGI Grade	ASTM Penetration
0	355-385
1	310-340
2	265-295
3	220-250
4	175-205
5	130-160
6	85-115

Dropping Point of Grease

ASTM D-566





WHAT IS DROPPING POINT?

The dropping point of grease is that temperature at which grease passes from a semi-solid to a liquid state.

WHY THE TEST?

The dropping point is a qualitative indication of the heat resistance of grease on applications where a semisolid lubricant is required.

HOW TO DETERMINE DROPPING POINT

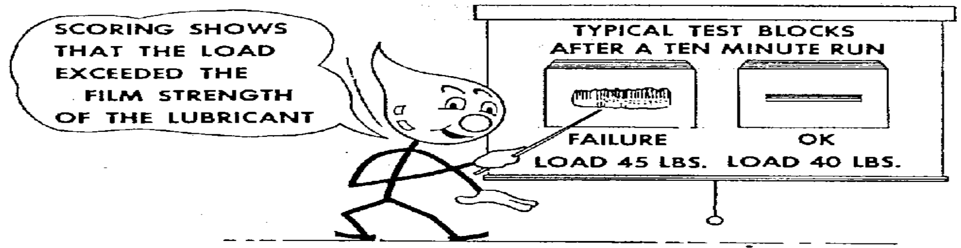
When the first drop of grease falls through the hole in the bottom of the cup, the average of the readings on the two thermometers is considered the dropping point of the grease.

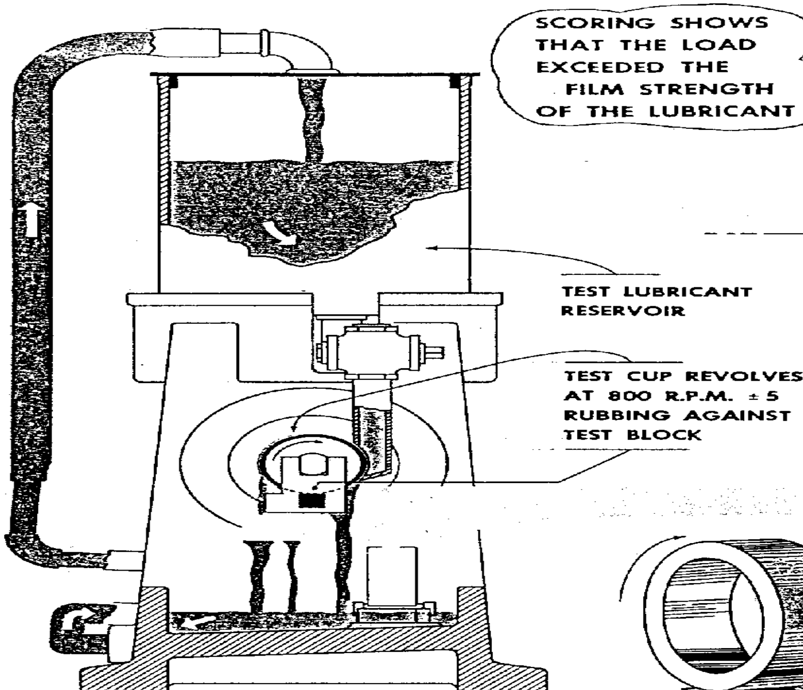
TYPICAL DROP POINT RANGES

Calcium Base grease (Hydrous)	160-210 F.
Sodium Base greases	275-350 F.
Lithium Base greases	350-400 F.
Bentone Base greases	over 500 F.
Silicone greases	over 500 F.

Extreme Pressure Properties of Greases

BY THE TIMKEN LUBRICANT TESTER
ASTM-D-2509

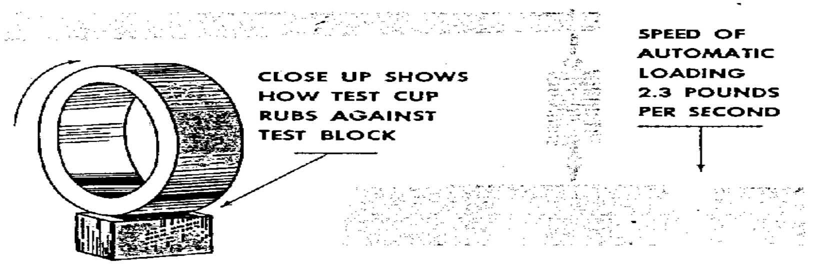




SCHEMATIC DRAWING OF TIMKEN TESTER
SECONDARY FRICTION ARM NOT SHOWN

WHAT IS EP TESTING?

The initials EP stand for extreme pressure. The EP testing simulates bearing and gear loads beyond the limits of non EP additive lubricants and measures this property in terms of lever-arm load.

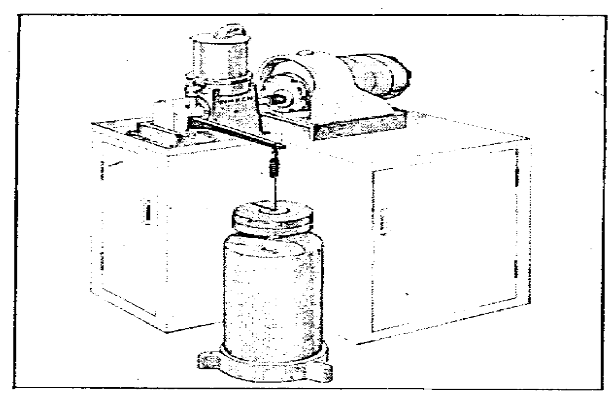


WHY THE TEST?

The test is conducted to determine the maximum load the lubricant will carry.

TEST PROCEDURE

The test is run for ten minutes at successively higher loads until maximum OK and failure loads are determined. The OK load is the maximum weight that can be applied without producing scoring on the test block.



Water Washout Test

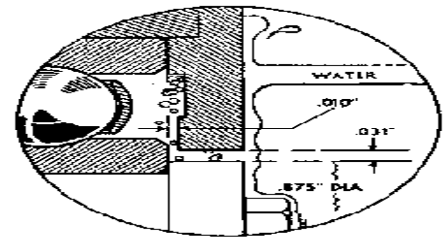
ASTM D-1264

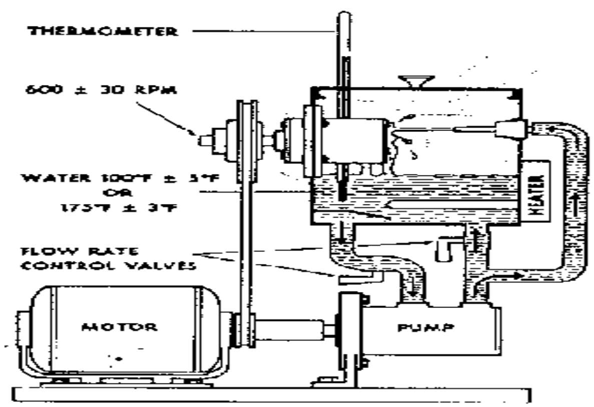
WHAT IS THE WATER WASHOUT TEST?

This test is a method for determining the water washout characteristics of lubricating greases from a bearing under prescribed laboratory conditions.

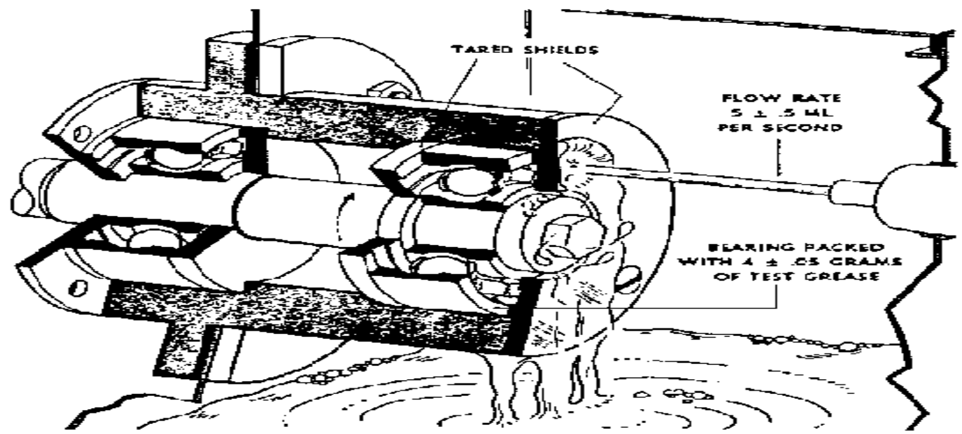
WHY THE TEST?

Water washout of grease from bearings is costly and harmful to efficient maintenance.





SCHEMATIC DRAWING OF WATER WASHOUT APPARATUS



CUTAWAY VIEW OF BEARING HOUSING

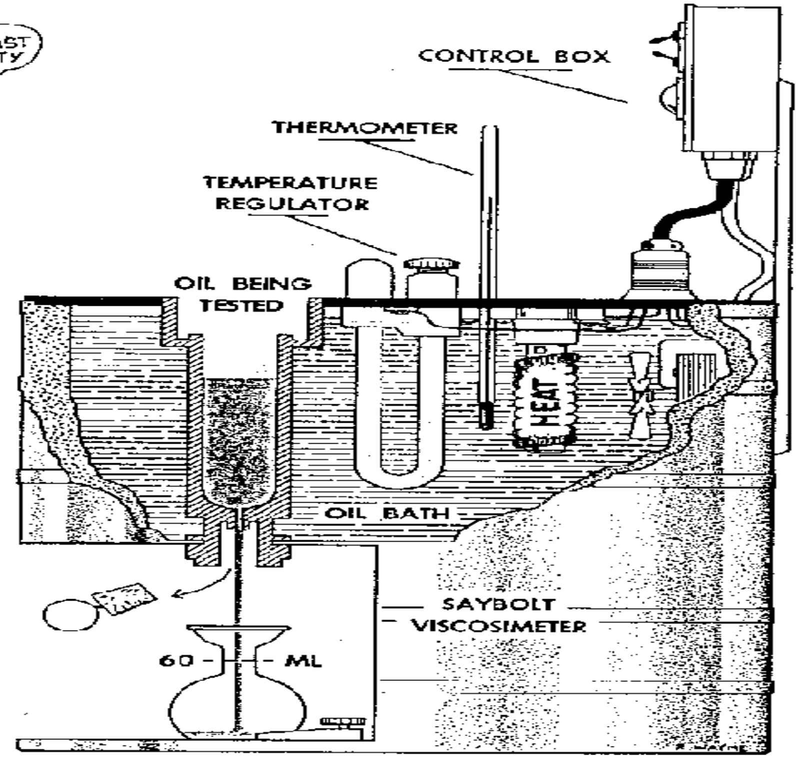
TEST PROCEDURE

A fixed amount of grease is packed in a tared ball bearing which is inserted in a housing with specified clearances and rotated at 600±30 rpm. Water controlled at a specified temperature of 100 F impinges on the bearing plate at 5±0.5 ml per second. The amount of grease washed out in one hour is a measure of the resistance of the grease to water washout. The test is repeated with a water temperature of 175 F.

WASHOUTS ARE COSTLY

Saybolt Universal Viscosity

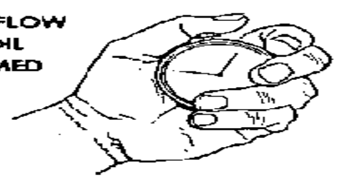
(SAYBOLT VISCOSIMETER) ASTM D-88

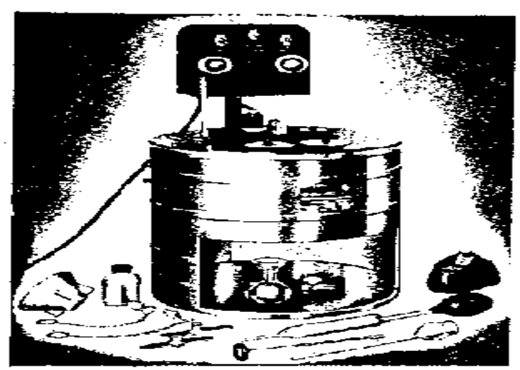


WHAT IS VISCOSITY?
Viscosity is a measure of "flow-ability" at definite temperatures.

WHY THE TEST?
At operating temperature it is viscosity that determines fluid friction (friction within the oil itself). Change in viscosity indicates contamination or oxidation instability.

THE FLOW OF OIL IS TIMED



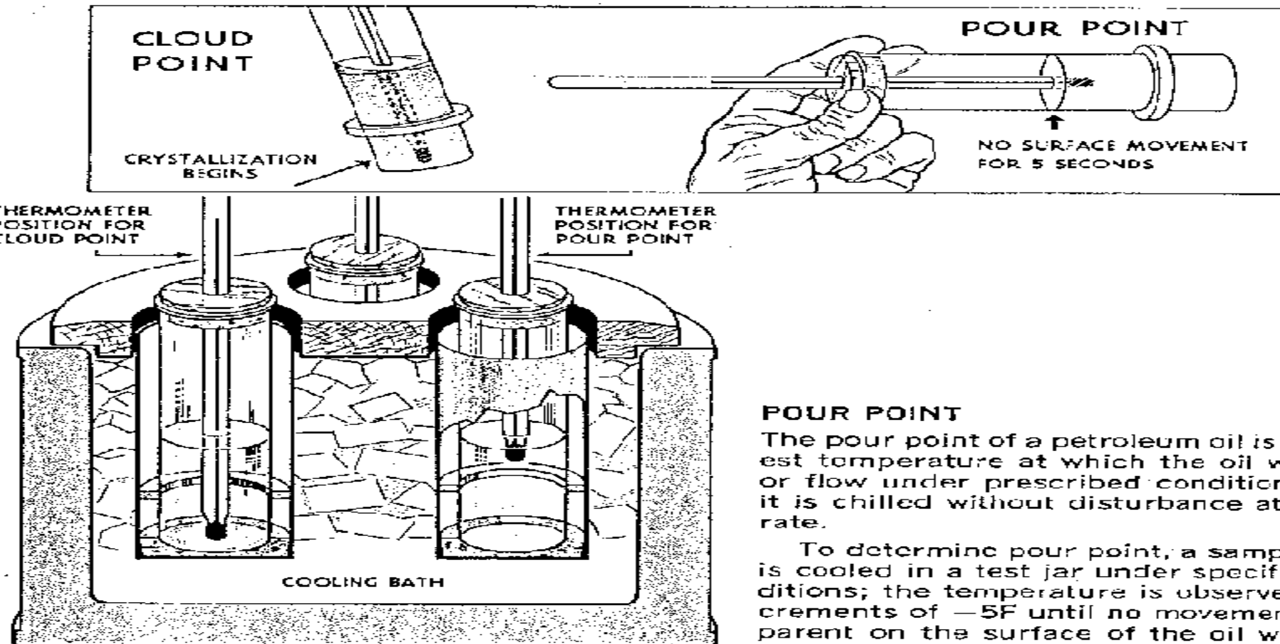


HOW TO DETERMINE VISCOSITY
The unit of measure is time in seconds required for 60 ml of the oil to flow through a standard orifice under a standard falling head and at a given temperature. 100F and 210F are common temperatures for reporting viscosity. Saybolt Furol Viscosity is obtained with the same instrument with a larger orifice, producing results approximately one-tenth those of the Universal orifice readings.

	SAE	at 100 F	at 210 F
Typical Viscosity	10W	202	48
(Saybolt Universal)	20W	323	57
For SAE	30	538	68
Automotive Ratings	40	850	84
	50	1174	100

Cloud and Pour Points

ASTM D-97



APPARATUS FOR CLOUD AND POUR TESTS

CLOUD POINT

The cloud point of a petroleum oil is the temperature at which paraffin wax, or other solidifiable compounds present in the oil, begins to crystallize or separate from solution when the oil is chilled under prescribed conditions. Oils that are nearly or quite wax-free, such as naphthenic types, show no cloud points.

To determine the cloud point, a sample of the oil free of all moisture is poured into a test jar and cooled in progressive steps. When inspection first reveals a distinct cloudiness or haze at the bottom of the test jar, the temperature is recorded as the cloud point. Cloud point is useful for estimating the temperature at which filter screens in the fuel intake system of diesel engines might become clogged because of wax separation. The type of wax, microcrystalline or amorphous, would have a definite bearing on filterability. The amorphous type would be of a sticky nature and would more easily clog filter screens.

POUR POINT

The pour point of a petroleum oil is the lowest temperature at which the oil will pour or flow under prescribed conditions when it is chilled without disturbance at a fixed rate.

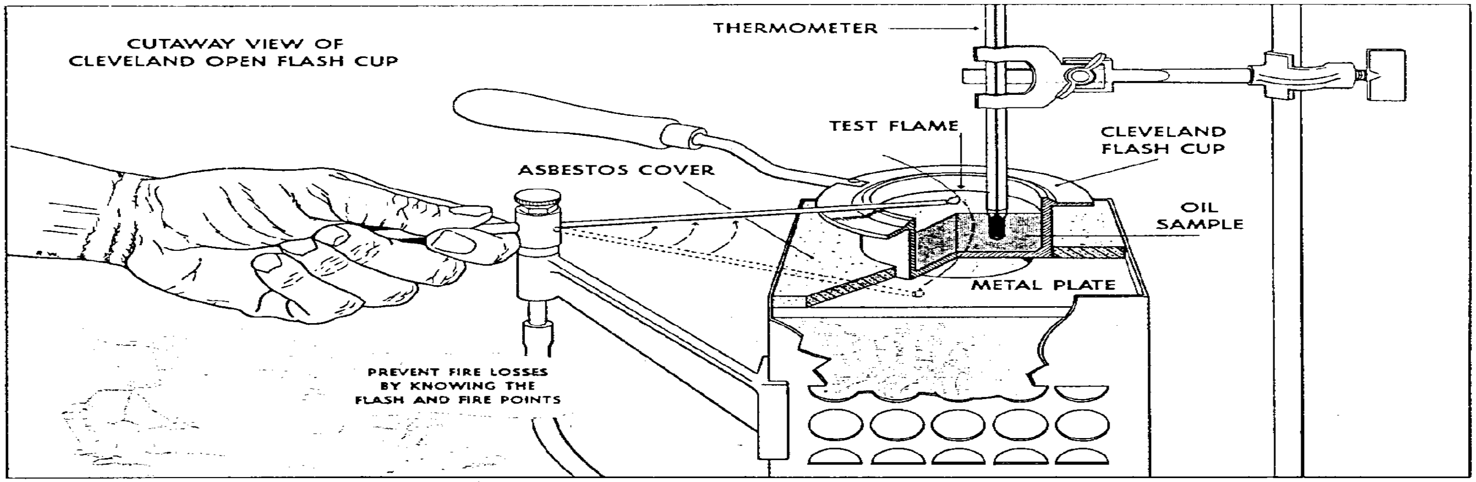
To determine pour point, a sample of oil is cooled in a test jar under specified conditions; the temperature is observed in increments of —5F until no movement is apparent on the surface of the oil when the test jar is held in a horizontal position for 5 seconds. This temperature is recorded as the solid point. By definition the pour point is 5F above this temperature.

Pour point is of importance in establishing the lowest temperature at which a diesel fuel is still sufficiently fluid to be pumped or transferred. However, many fuels can be pumped or transferred at temperatures below their pour points.

Low pour points may often be obtained by increasing the volatility of the fuel. This reflects itself in a lowering of the Btu value on a volume basis and possibly lowering the cetane number.

Flash and Fire Points

CLEVELAND OPEN CUP METHOD—ASTM D-92



WHAT ARE FLASH POINT AND FIRE POINT

The flash point of an oil is the lowest temperature at which it gives off vapors that will ignite when a small flame is periodically passed over the surface of the oil.
The fire point is the lowest temperature at which an oil ignites and continues to burn for at least 5 seconds.

WHY THE TEST?

Knowledge of flash and fire points in lubricating oil aids in precautionary measures against fire hazards. The flash point is also important in that it indicates a temperature above which evaporation losses occur.

TEST PROCEDURE

The Cleveland cup is filled with oil sample up to the specified filling mark. The bulb of the thermometer is immersed in the sample to ¼ inch from the bottom of the cup. The oil is then heated at a rate of 9 to 11F per minute. At every 5F rise in temperature a small flame is passed over the oil surface. When a flash occurs, the temperature reading is the FLASH POINT of the sample. The heating of the oil is continued. The test flame is applied again at every 5F rise in temperature. When the oil ignites, the temperature reading is recorded as the FIRE POINT. Fire points range from 10 to 70F higher than the flash points.

TYPICAL RESULTS

PETROLEUM PRODUCT	FLASH POINT	FIRE POINT
Lubricating Oils	175-450F	250-500F
Cylinder Oils	500-700F	540-750F

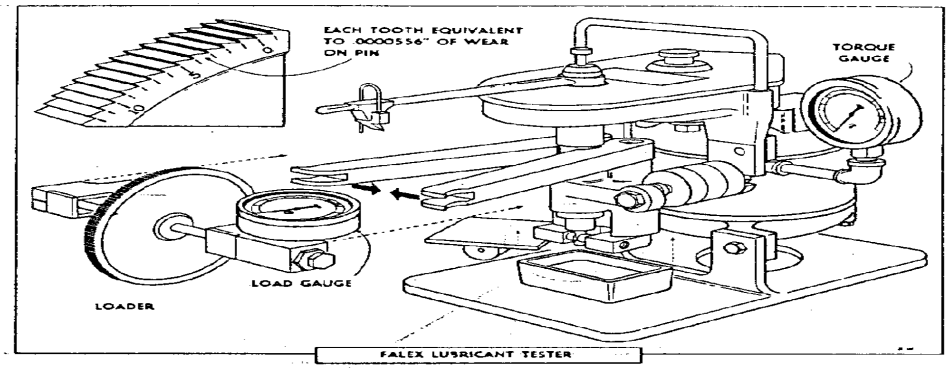
Falex Lubricant Tester

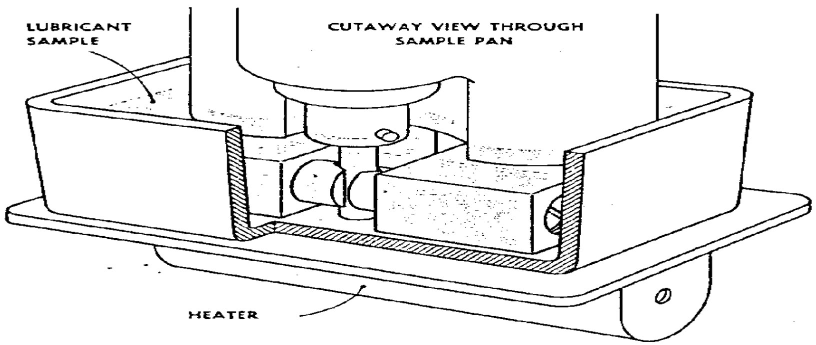
WHAT IS THE FALEX LUBRICANT TESTER?

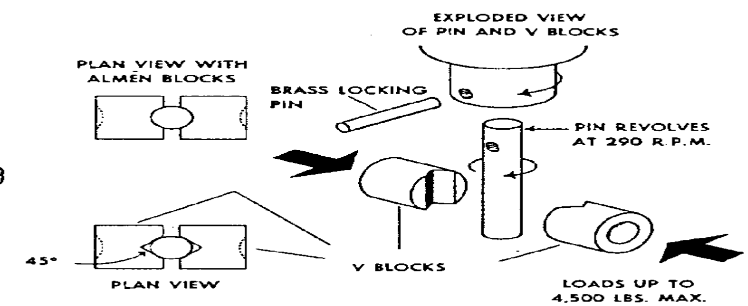
The Falex Lubricant Tester is a steel journal and bearing loaded by a spring-gage micrometer and driven by a 1/3-hp 290-rpm motor.

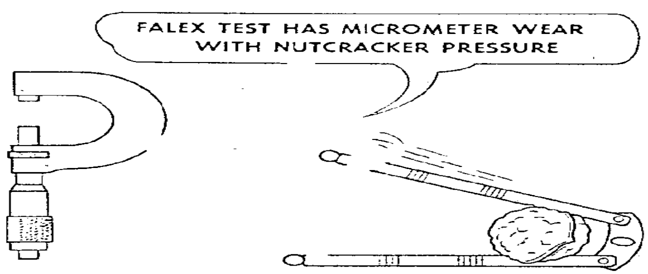
WHY THE TEST?

The test measures bearing load and resulting wear produced by extreme pressure forces under constant speed and temperature.









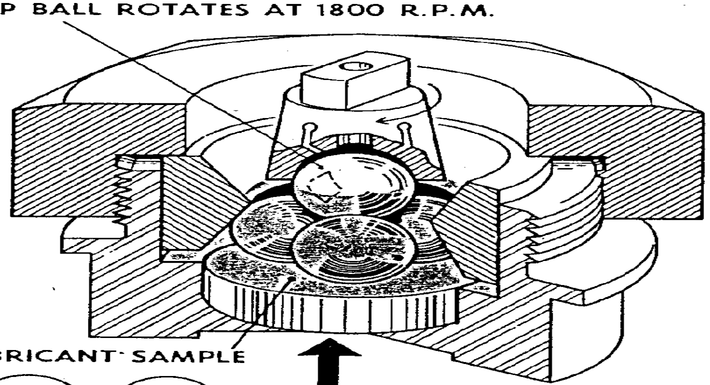
TEST PROCEDURE

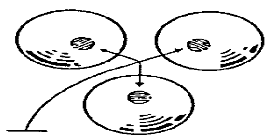
The test sample is placed in the lubricant pan and heated to the prescribed temperature. The test blocks are placed in the jaws and the journal pin held in the driving shaft by a brass shearing pin. The prescribed load is applied by an automatic ratchet mechanism allowing the wear to be recorded as the number of teeth advanced to maintain the jaw load during the prescribed time.

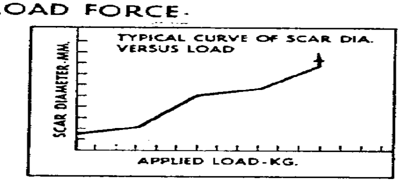
Measurement of Extreme Pressure Properties of Oils — Four Ball Method—ASTM D-2783

WHAT IS THE FOUR BALL EP TEST?

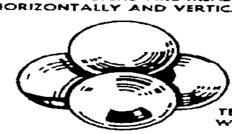
The determination of the load-carrying capacity of a lubricant in kilograms applied to a system of four steel balls in the form of a tetrahedron.







LOAD SCAR CURVE



TEST PROCEDURE

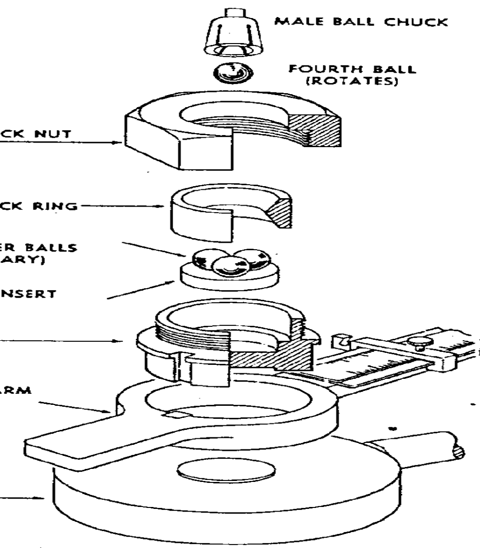
A series of 10-second runs is made at pre-selected and successively higher loads until welding of the four balls occurs.

Two measurements are made of the wear spots on each of the three lower balls, and the average scar diameter readings are plotted to establish the load-scar curve and the weld point.

The worksheet data collected from the determination of the load scar curve are used in calculations under the mean Hertz load formula for the determination of the EP value.

WHY THE TEST?

To evaluate the EP characteristic of lubricants by a load scar curve and weld point.



FOUR BALL E. P. WORKSHEET

SAMPLE__________ LAB. NO.______

Applied Load, kg	#1	#2	#3	Average Diameter, mm (X)	Factor DH Compensation Scar Diameter	Factor LDh	Correct Load $\frac{LDh}{X}$
6						0.95	
8						1.397	
10					.21	1.881	
13					.23	2.669	
16					.25	3.520	
20					.27	4.739	
24					.28	6.043	
32					.31	8.867	
40					.33	11.94	
50					.36	16.08	
63					.39	21.88	
80					.42	30.10	
100					.46	40.52	
126					.50	55.15	
160					.54	75.83	
200					.59	102.1	
250						137.4	
315						187.0	
						TOTAL A	
400						257.4	
500						345.7	
620						461.6	
800						648.5	
						AVERAGE B	

DH - Hertz Diameter is static indentation caused by deformation of the balls under load at start of the test

$LDH - DH = 8.73 \times 10^{-2} \sqrt[3]{P}$

DH - Hertz Diameter in Millimeters

P - Applied Load (L).

Thank You

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