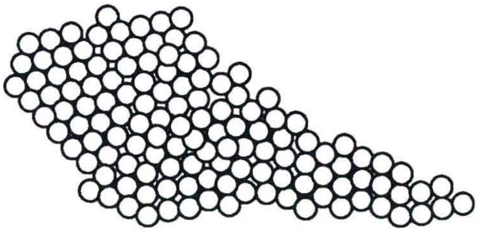
CHAPTER 3

Petroleum Base Hydraulic Fluid

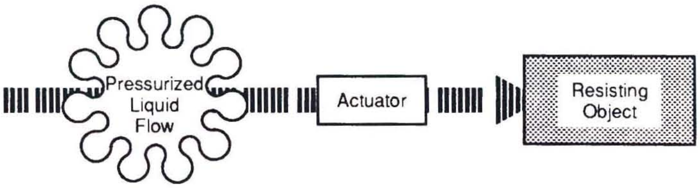
A common fluid for a hydraulic system consists of paraffinic and naphthalenic petroleum oils which are blended for characteristics that make it suitable for use in a hydraulic system.



As was pointed out previously, hydraulic fluid is the substance used for transmitting energy from pump to actuator in a hydraulic system. The intent of this lesson is to concentrate on some characteristics of petroleum base fluid.

At the outset, the lesson is concerned with petroleum base fluid as a lubricant. Then it deals with the effects on a system of a petroleum base fluid's viscosity. Finally, we see some problems of a petroleum base fluid in service and some maintenance considerations with respect to hydraulic oil.

Besides acting as a medium for energy transmission, the second most important function of a petroleum base fluid is to act as a lubricant. The lesson begins by describing lubrication.



lubrication

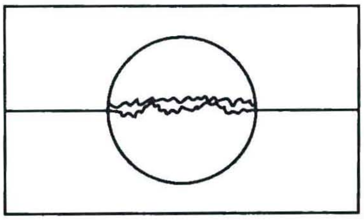
Lubrication is the process of reducing friction between relatively moving surfaces which are in contact.

Lubrication is a very important function of hydraulic fluid. Without lubrication, friction would cause system components to wear excessively and excessive heat to be generated.

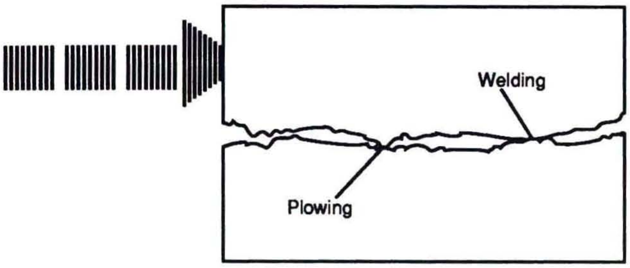
friction

Friction is a force which can stop or retard the motion of a moving object.

Assume that one surface of a clean, dry steel block is at rest on a similar surface. Any attempt to slide the block across the contacting surface would be resisted by a frictional force. Friction occurs because of surface roughness and welding of minute metal surfaces.



If an apparently smooth surface of a typical component were magnified, it would appear to be quite irregular; even the best machining methods cannot eliminate these irregularities completely. As surfaces are rubbed together, material is plowed, ripped, and worn away at a considerable rate. The rougher the surface and the greater the sliding force, the more friction will be developed.



Friction can also be related to the infinitely small welds which commonly occur between contacting metal. As a force is applied to mating surfaces, high points of a metal are deformed until they acquire a large enough base to support a force. This action tends to bond the material at the contacting points. In moving the surfaces across one another, these tiny bonds must be ruptured, which action contributes to friction.

Previously, we saw that a liquid consisted of continuously-moving molecules which could take the shape of its container. We also learned that a liquid had a resistance to flow known as viscosity. In the following section, we shall see how a petroleum oil's capability of adhering to a surface and viscosity contribute to develop a lubricating film.

fluid film

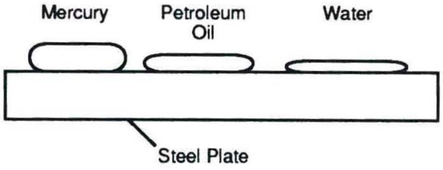
Interaction between metal surfaces can be greatly reduced by introducing a lubricating film between them. Not having a lubricating film between moving parts is similar to rowing a boat on land.

Any liquid will form a lubricating film, but some do a better job than others. Water, for example, was the first hydraulic fluid, but it was a poor industrial lubricant because its fluid film is not durable. Petroleum oil is a good lubricant because it forms a durable fluid film.

lubricity

Lubricity refers to a liquid's ability to form a durable fluid film between contacting surfaces. This ability is directly related to:

1. a fluid's natural film thickness
2. a fluid's tendency to adhere to a surface.



Petroleum oil has good lubricity. If at room temperature, a petroleum base hydraulic oil were poured on a steel plate, it would appear to wet, or adhere to the surface with a substantial fluid film. If water were likewise poured on the unprotected metal, it would appear to wet the surface, but its fluid film would be thin and therefore easily penetrated. For this reason, water has poor lubricity.

If the same procedure were followed with mer- cury, a thick fluid film would form, but it woulc show relatively little tendency to adhere to thε steel. As a matter of fact, the mercury could bε broken up into little balls or beads. Even thougł mercury does form a thick fluid film, it also has poor lubricity because it does not tend to stick tc the steel (ferrous) surface.

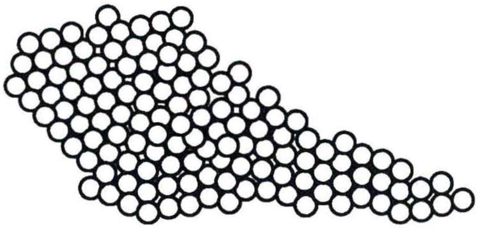
A liquid with good lubricity adheres to a surface and also develops a substantial fluid film. Of the fluids used in a hydraulic system, petroleum oil has been found to exhibit the best lubricity.

viscosity affects a system

Up to this time, we have seen that a petroleum base hydraulic fluid has two important functions:

1. to act as a medium for energy transmission
2. to lubricate internal moving parts of a system.

Both of these functions, and consequently hydraulic systems in general, are influenced by fluid viscosity which is probably one of the most significant characteristics of a petroleum base fluid. At this point we would like to review the characteristics of viscosity and then show how it can distinctively affect a system.



In the following section, we will redefine viscosity, see in what manner it is measured, and then determine how viscosity affects heat generation, lubricity, hydrodynamic lubrication, and clearance flow. The starting point for our review is at the molecular level.

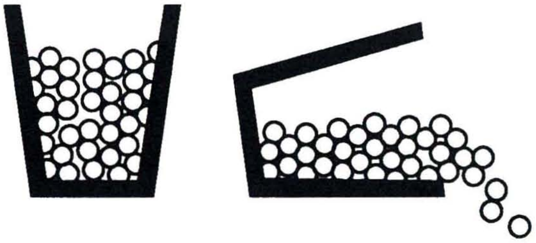
liquid molecules

Just as all liquids, petroleum base hydraulic fluid is made up of molecules which are attracted to one another. This attraction is much greater than the molecules of a gas, but is less strong than the molecules of a solid, which are in a relatively fixed position.

Liquid molecules are free to slide past each other, and, as a matter of fact, they are continuously moving.

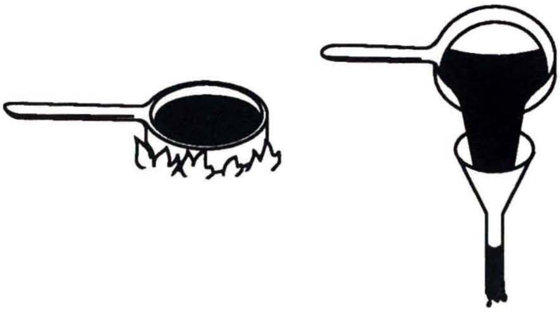
viscosity

Viscosity is the resistance of a liquid's molecules to flow or slide past each other; it is sort of an internal friction. An example of a high viscosity liquid is honey or molasses; water or cooking oil is an example of a low viscosity liquid.



viscosity affected by temperature

As was indicated, a liquid is made up of molecules which are attracted to each other and continuously moving. Some experts feel that the more slowly molecules move, the greater are attractive forces resulting in an increased resistant to flow.



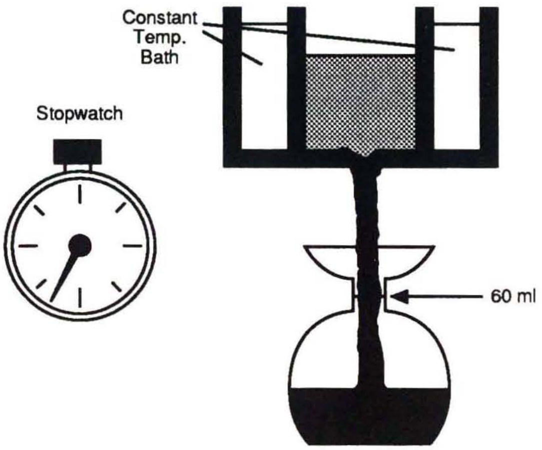
A bottle of molasses taken from a refrigerator consists of very slowly moving molecules which have large attractive forces; cold molasses has a high resistance to flow. Trying to pour this liquid through a funnel would be a time-consuming task.

Heating the molasses in a sauce pan adds energy to the molecules; molecular speed increases reducing attraction between molecules. With less of a resistance to flow, a reduced viscosity, heated molasses can more easily flow through the funnel.

Generally, as temperature increases, viscosity of a liquid decreases.

saybolt universal second

One measure of liquid viscosity is the Saybolt Universal Second (abbreviated SUS or SSU). The SI unit of viscosity is the centistoke (CST).



The Saybolt Universal Second is named in honor of George M. Saybolt who in 1919 offered to the United States Bureau of Standards his Saybolt Viscosimeter - a device which measured viscosity.

The use of the Saybolt Viscosimeter consisted of filling the apparatus with a liquid and heating the liquid to a specified temperature. With the liquid heated, a cork was pulled from the chamber bottom at the same time a stopwatch was started. The liquid then drained through an opening of a specific size until 60 milliliter (about 2 fluid ounces) was in the flask.

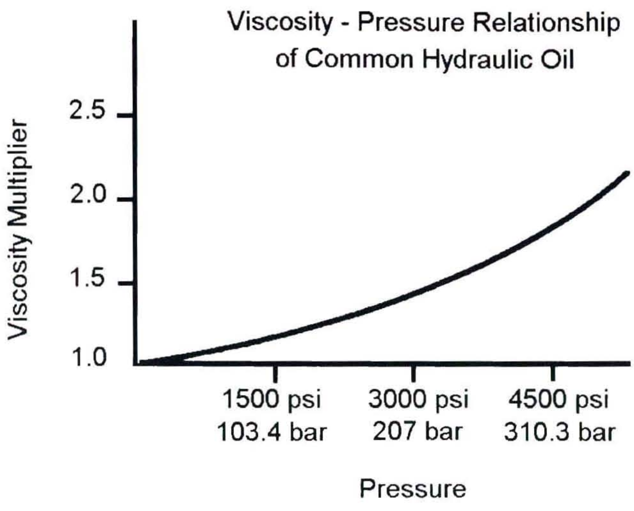
The stopwatch timed how long the liquid took to fill the flask. The result was a measure of viscosity in Saybolt Universal Seconds.

If an oil heated to a temperature of 100°F (37.7°C) took 143 seconds to fill the flask, its viscosity would be 143 SUS @ 100°F (37.7°C). If the same oil took 82 seconds to fill the flask when heated to 130°F (54.4°C), its viscosity would be 82 SUS (17.7 CST) @ 130°F (54.4°C). Viscosity is always associated with a temperature. Yet, it is common to hear someone say he is using "150 SUS (32 CST) @ 100°F (37.7°C)." The 100°F (37.7°C) temperature is assumed.

viscosity affected by pressure

Viscosity is affected by system pressure. As pressure in a system increases, viscosity also increases. This is pointed out by the illustrated graph.

The graph shows that for a common industrial hydraulic oil, viscosity increases 40% as pressure increases from zero to 3000 psi (207 bar).



viscosity affects heat generation

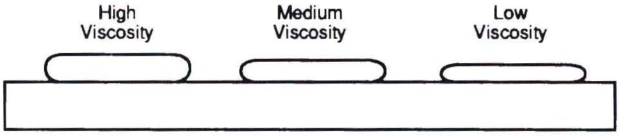
Viscosity of a petroleum base hydraulic fluid affects heat generation. We saw previously that this, along with friction and changing direction, was one of the liquid's resistance to pump flow.

A high viscosity liquid of 500 SUS (107.9 CST), having more internal resistance to flow, will cause more heat to be generated in a system than a low viscosity liquid of 150 SUS (32 CST).

In many hydraulic systems, viscosity of an oil is 150-250 SUS (32-53.9 CST) @ 100°F (37.7°C).

viscosity affects lubricity

Since it is a resistance, viscosity may not at first appear to be a desirable characteristic. But, viscosity is a very important and desirable fluid characteristic since it affects lubricity.

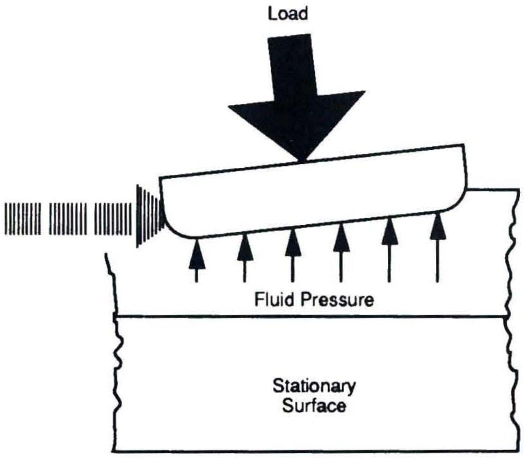


It was illustrated that lubricity was dependent on an oil adhering to a metal surface and developing a substantial fluid film; viscosity affects fluid film. The higher the viscosity, the thicker will be the fluid film. Of course, the fluid must be capable of readily flowing so determination of an appropriate viscosity for a system is a compromise between its ability to form a fluid film and its ability to flow.

viscosity affects hydrodynamic lubrication

The ability to form a durable fluid film is an important characteristic of petroleum base fluid. We referred to this ability as lubricity.

One may feel that a fluid film would be difficult to maintain between moving parts since any rapid movement would tend to scrape a surface clean. But once parts begin to move, liquid viscosity does not usually allow this to happen.



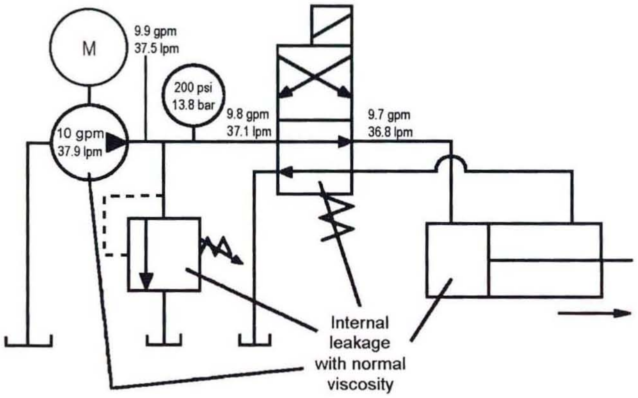
A metal block immersed in oil and at rest on a stationary metal surface is separated by the oil's fluid film. As a force moves the block, the leading edge rises because the oil resists getting out of its way (viscosity). This action forms a fluid wedge under the block which floats it along like a boat planing on water. As long as pressure on the moving block does not become excessive, the fluid wedge would ward off normal attempts at penetration. This is known as hydrodynamic lubrication.

A low viscosity liquid like water would get out of the way too easily under low speed and high load conditions. The wedge would not fully form, resulting in a fluid film which could more easily be penetrated.

When system components are moving, they are lubricated by the hydrodynamic process. However, at start-up or when excessive pressure pushes a moving part through a hydrodynamic wedge, a liquid's ability to form a durable fluid film (lubricity) becomes very important.

viscosity affects clearance flow

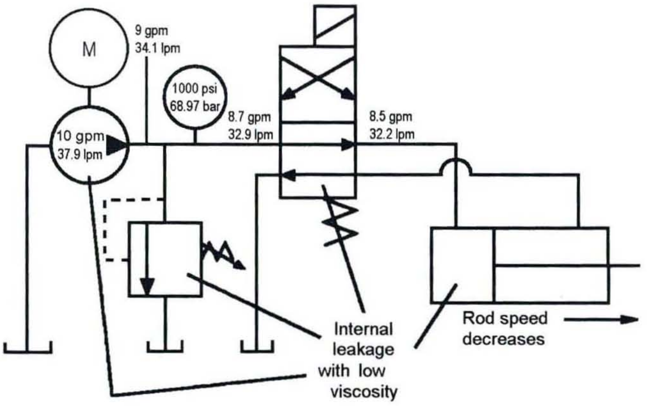
Another important effect of viscosity is its ability to help reduce leakage between clearances of close-fitting moving parts.



Many components of a hydraulic system do not have a zero-leakage seal between internal moving parts. Frequently, the seal is metal-to-metal through which a small portion of fluid is continuously flowing and lubricating. Examples of metal-to-metal seals could be found in piston pumps between pistons and piston bore; gear pumps between gears and housing; vane pumps between vane tip and cam ring; cylinders between piston rings and cylinder bore; and control valves between spool and valve body.

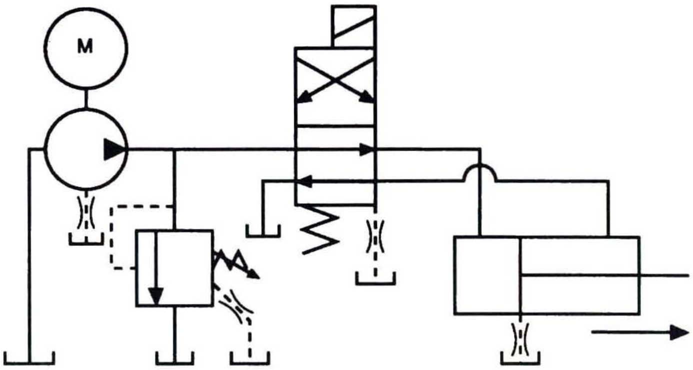
To achieve the best seal possible, clearances between moving parts are kept to a minimum. However, clearance size is not so small that a fluid cannot pass through and lubricate. Size of a clearance is frequently a compromise between sealing and lubrication.

Clearances between internal moving parts of a hydraulic component are in effect orifices; they continually meter lubricative-leakage flow. Just as any orifice, flow through a component clearance is affected by fluid viscosity.



With a viscous fluid, leakage and therefore lubricative flow through a clearance will be reduced. On the other hand, a fluid which is not viscous enough, or too thin, means that excessive fluid passes through component metal-to-metal clearances. This results in less flow passing into the system and an unnecessary buildup of heat.

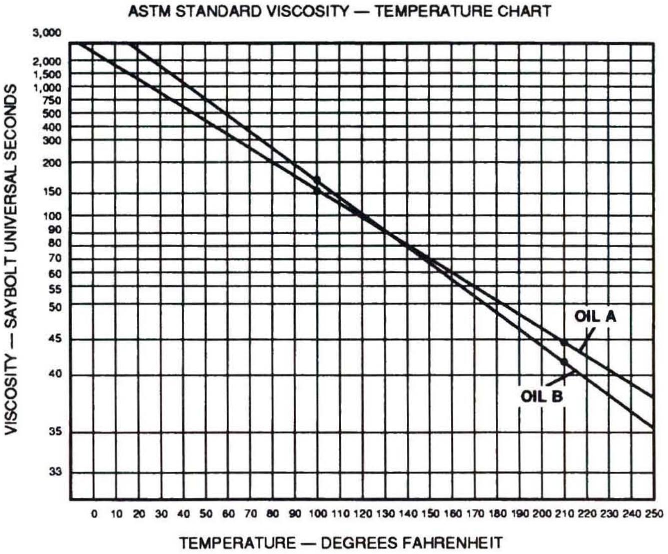
Metal-to-metal clearances between component moving parts can be considered built-in fixed restrictions which are continually bleeding off flow. Too much leakage, then, can be harmful to the system. However, if too little flow passes through the clearance, the component may not be sufficiently lubricated. The system may become erratic and undependable as a result. A happy medium can be found with a fluid of the appropriate viscosity.



viscosity index

Since the viscosity of hydraulic oil does change with temperature and since viscosity is an important factor in a hydraulic system, systems which are not, or cannot be, maintained at a constant temperature need an oil whose viscosity remains relatively stable over a given temperature range.

An oil's viscosity index illustrates how viscosity is affected with changes in temperature. This relationship can be depicted by a straight line using ASTM (American Society for Testing Materials) standard viscosity-temperature charts for liquid petroleum products. When the viscosity of an oil at two temperatures is plotted on the paper, viscosity of the oil at any temperature can be determined by drawing a straight line connecting and running through the two points. (This can be done with any liquid petroleum product which does not have chemicals added that affect its natural viscosity-temperature relationship.)



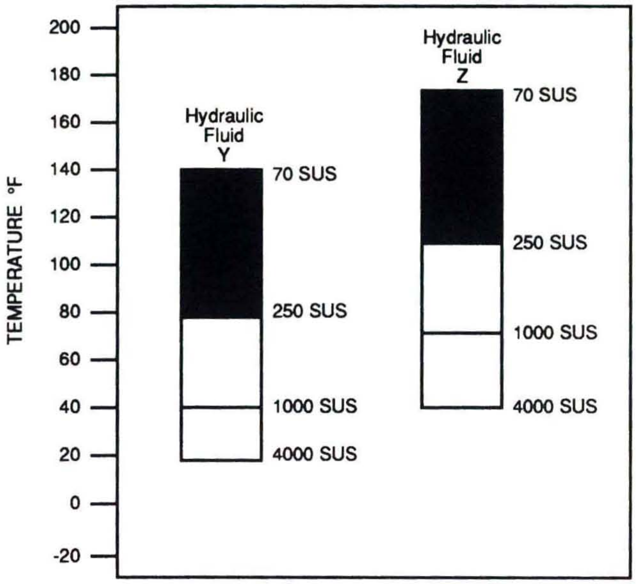
If the viscosities of two oils were plotted on the graph paper, the oil with the more horizontal line would have the higher viscosity index. For example, oil A has a viscosity of 153 SUS (33 CST) @ 100°F (37.7°C) and 44 SUS ((9.5 CST) @ 210°F (98.9°C); while oil B has a viscosity of 165 SUS (35.6 CST) @ 100°F (37.7°C) and 42 SUS (9.1 CST) @ 210°F (98.9°C). Oil A has a more horizontal line and therefore has a higher viscosity index.

When the term viscosity index was first adapted, a certain oil showing a very rapid change in viscosity with respect to temperature was assigned a viscosity index of 0, while the best oil type showing a small change with temperature was arbitrarily given a viscosity index of 100. Therefore, oils at that time all had VIs between 0 and 100. With up-to-date refining practices, oils can now have VIs above 100.

In a modern industrial hydraulic system, an oil's viscosity index is generally required to be 90 or above. However, viscosity index means little for systems with a relatively constant temperature.

oil operating range

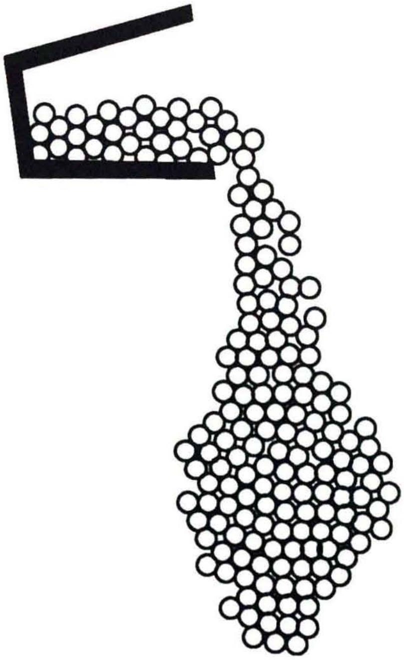
Petroleum oil is an excellent lubricant for a hydraulic system, but not at all viscosities. If viscosity of an oil were too low, its fluid film would be like water and consequently too thin. If an oil's viscosity were too high, insufficient amounts of fluid would flow into bearings and component clearances. For this reason, manufacturers of rotating equipment (pumps, motors) which are especially dependent on proper bearing lubrication, specify the viscosity range at which their components are to be operated. When these components are sufficiently lubricated, it usually means the rest of the system is lubricated as well.



If components have a required viscosity range, then this information, along with the temperature range of the system, indicates the use of a specific oil. For example, a particular system at its operating temperature requires a minimum/ maximum viscosity of 70-250 SUS (15-54 CST). If the operating temperature range were 80-140°F (26.7-60°C), hydraulic fluid Y would be used. If the temperature range were 110-170°F (43.3-76.7°C), hydraulic fluid Z would be used.

Since temperatures can become quite low even in industrial environments, an oil can become extremely viscous. To ensure that their pumping mechanisms will fill, pump manufacturers also specify the maximum viscosity allowable at start-up. In general, these viscosities are 1000 SUS (216 CST), and 7500 SUS (1618 CST) for piston, vane and gear equipment, respectively.

pour point



ASTM graph paper does not point it out, but at extremely low temperatures petroleum oil does not flow. At low temperatures, wax structures begin to form in hydraulic fluids containing any paraffinic base crude. These wax formations hinder and may even stop flow.

Pour point of a hydraulic fluid is the lowest temperature at which it will pour under an ASTM laboratory test. In an actual system, if the maximum viscosity start-up specification is adhered to, the pour point of a fluid is generally not considered. But, when a system has the possibility of operating under extremely low temperature conditions, pour point of an oil should be at least 20°F below the lowest expected temperature.

Pour points for various oils are indicated in the manufacturer's data sheet of the specific oil.

oil problems and additives

In the day-to-day operation of a system as petroleum base hydraulic fluid performs its function, certain problems can arise which may affect both fluid and system. Some of these problems are high pressure lubrication, oil oxidation, and oil contamination with water, air bubbles, and dirt. To correct some of these problems, hydraulic fluids are equipped with chemical additives.

The problems encountered with hydraulic fluids and the usual additives found to correct the problems, are dealt with below. It should be realized, however, that chemical additives cannot solve every fluid problem and that an oil cannot contain every available additive making it a super oil. Many fluid additives are not compatible with each other and therefore would give an unfavorable reaction if mixed.

high pressure lubrication

A good quality petroleum base hydraulic fluid is not a good enough lubricant for some systems. As pressures climb, the hydrodynamic fluid wedge between moving parts has more of a tendency to break down. This means lubrication is more dependent on a fluid's inherent lubricity. To aid in lubricity or boundary lubrication at high pressures, hydraulic fluids are equipped with chemical additives.

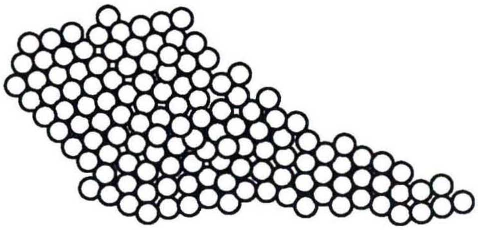
antiwear additives

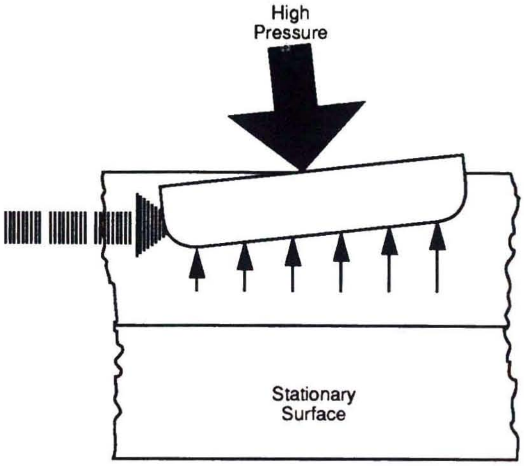
Antiwear (AW) or wear resistant (WR) additives can be divided into three types. One type, sometimes called an oiliness or lubricity agent, is a chemical made up of molecules that attach themselves vertically like blades of grass to metal surfaces. This creates a chemical film which acts as a solid when an attempt is made at penetration.

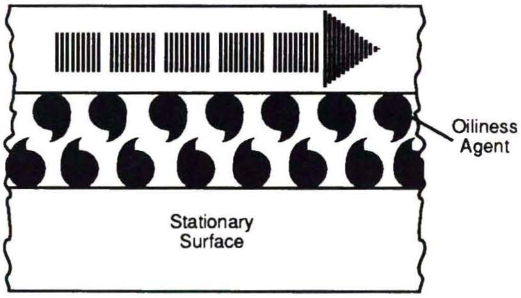
The additive molecules support the load, allowing a moving part to slip by. But this film is not very durable, tending to break down at high temperatures.

Another type of antiwear additive chemically combines with a metal surface to form a protective film. This film forms as low frictional heat is generated between contacting points of moving surfaces. They serve to smooth out or polish surfaces so that friction is reduced.

Another antiwear agent, known as an extreme pressure (EP) additive, forms a film on a metal







**WR
(WEAR RESISTANT)**

**AW
(ANTI-WEAR ADDITIVE)**

**EP
(EXTREME PRESSURE ADDITIVE)**

surface as high frictional heat is generated. In a high pressure system, as mechanical interaction between surfaces becomes excessive, heat becomes excessive and the surfaces attempt to weld together. The extreme pressure additive comes out of solution at this point, keeping the surfaces apart.

All three types of antiwear additives are not found in the same fluid and are not used in the same applications. When oiliness agents are used, they are generally found in relatively low pressure systems (below 1000 psi/68.97 bar). When extreme pressure additives are found in a hydraulic system, the system will probably be operating above 3000 psi (207 bar), or the same fluid that is used to lubricate gears and machine ways is also used in the hydraulic system. A very common antiwear additive is the one which operates in the medium pressure range (1000-3000 psi/68.97-207 bar).

check for high pressure lubrication

The check for a fluid's ability to give high pressure lubrication is the title of the oil or a manufacturer's catalog sheet. For example, with a Gulf Oil Co. fluid titled "Harmony 48AW", the AW stands for antiwear. Or, with a Sun Oil Co. fluid titled "Sunvis 816 WR", the WR indicates wear resistant.

Many refiners do not indicate the antiwear additive in an oil title. Consequently, the refiner's catalog or data sheet for a particular fluid must be referred to.

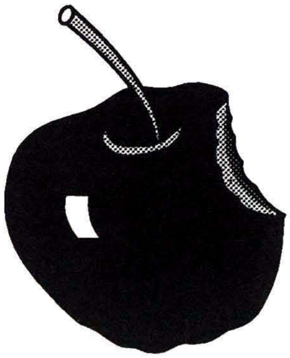
If excessive component wear has been a problem and the system's hydraulic fluid does not contain antiwear additives, switching to an oil with an antiwear additive will probably reduce the problem. This assumes, however, that the component wear was not the result of fluid contamination.

oil oxidation

Oxidation is a process by which material chemically combines with oxygen; this is a common occurrence.

If you have ever taken a bite out of an apple, you know that the pulp quickly turns brown as it is exposed to air. The same process happens when a car's fender is scraped down to bare metal; the exposed metal reacts with oxygen in the air and rusts. Many things on earth, including oil, oxidize in this manner.

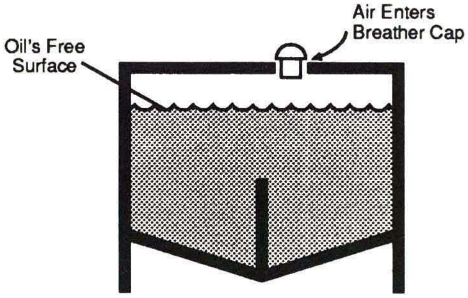
Oxidation of hydraulic fluid can be pinned down to basically two system locations - reservoir and pump outlet. In both cases, oil reacts with oxygen but in different ways and the oxidation products are not the same.



In a reservoir, the free surface of the oil reacts with oxygen in the air. The product of this reaction includes weak acids and soaps. Acids weaken and pit component surfaces; soaps coat surfaces and can plug pressure-sensing orifices and lubrication paths.

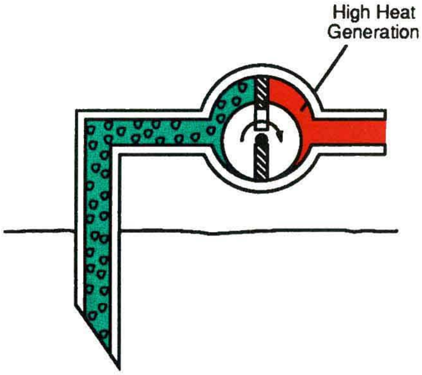
Heat is a major contributor to oil oxidation in a reservoir. As a rule, oil oxidizes twice as fast as normal for every 18-20°F (10-11°C) rise in temperature above an average reservoir temperature of 130°F (54.4°C). Reservoir oil also oxidizes more readily in the presence of iron and copper particles and water droplets.

Besides the reservoir, another location where oil oxidation occurs is at pump outlet. If air bubbles are present in a pump suction line as a result of an air leak in the suction line or returning fluid velocity churning up the reservoir, they suddenly collapse upon being exposed to high pressure at pump outlet. This action generates a high temperature which according to some calculations can rise to 2100°F (1149°C) when the bubble is compressed from 0-3000 psi (207 bar). The high temperature fries the oil, forming resinous products, and causes the oil to acquire a characteristic burnt odor.



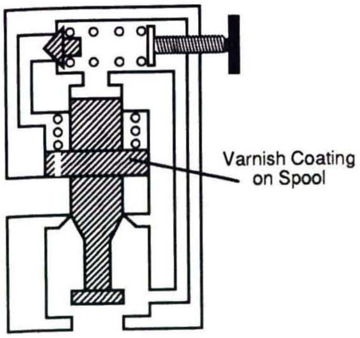
As high-temperature oxidation at pump outlet occurs, resinous materials are formed, but dissolve in the oil. When a hot surface (pump rotor, relief valve spool) is encountered, resins come out of solution forming a varnish or lacquer coating on the hot surface; this causes moving parts to stick.

Resinous material can also form sludge which combines with dirt and floats around the system plugging small openings in valves and filters, and interferes with heat transfer to reservoir walls. Strong evidence exists that collapsing air bubbles at pump outlet is a major influence in rapid oil degradation.



check for oxidized oil

A check for oxidized oil is performed by comparing a sample of the questionable fluid with a sample of new fluid out of a drum. With both fluids at the same temperature, fresh, new fluid will have a definite "body" and will tend to stick to your fingers as it is poured over your hands. And, if thumb and forefinger are rubbed together, the fluid will feel slippery.

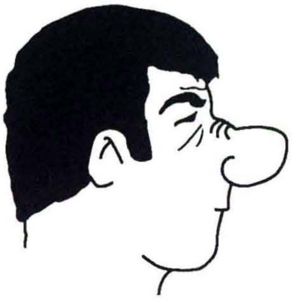


Oxidized fluid feels very much like water. As it is poured over your hand and fingers, oxidized oil runs off just as water. It exhibits little "body" and small tendency to adhere.

Oil which has been oxidized by the high temperature collapse of air bubbles will also have a characteristic pungent odor.

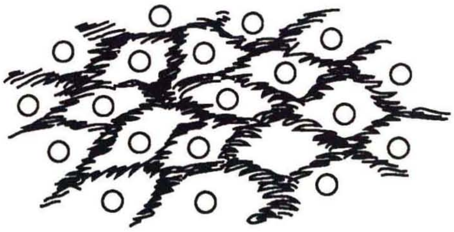
If any fluid sample exhibits the characteristics of oxidized oil, its condition is questionable. In this case, the fluid should be sent to a lab for further analysis. If this is impractical, the system should be drained and refilled with fresh fluid.

water in hydraulic oil



All hydraulic oil contains water in varying amounts, attempts to mix large amounts of water and oil will result in water settling out at the bottom of a tank. In small quantities, however, water is broken into small droplets which are carried around by an oil.

We know from experience that water and oil do not mix (except for water soluble oils). Attempts to mix large amounts of water and oil will result in water settling out at the bottom of a tank. In small quantities, however, water is broken into small droplets which are carried around by an oil.



If an oil contains acidic and resinous products of oxidation, it has an increased tendency to take on water.

check for water in hydraulic oil

A check for water in hydraulic oil is performed by comparing a sample of the questionable fluid with a sample of new fluid.

Holding a beaker or glass of fresh oil up to a light, you will notice that it looks crystal; it sparkles a little. If a fluid sample contains .5% water, it will appear dull or smoky. If the sample contains 1% water, it will look milky.

40 micrometres

An additional means of checking for water in oil is heating a fluid sample which appears milky or smoky. If the sample clears after a time, the oil probably contained water.

If an oil contains a small percentage of water (less than .5%), it is usually not discarded unless the system is critical. While in the fluid, water will hasten the oxidation process and reduce lubricity. After time, water will evaporate, but its products of oxidation will stay behind to cause further harm.

If an oil contains water in large quantities, much of it will eventually settle out. Centrifuging can be used to separate water and oil if time is important.

rusting and corrosion

In the context of a hydraulic system, corrosion refers to a deterioration of a component surface due to a chemical attack by acidic products of oil oxidation. Rusting refers to the process of a ferrous surface oxidizing due to the presence of water in oil.

The process of corrosion dissolves metal and washes it away, reducing the metal part size and weight. On the other hand, rusting adds materials to a ferrous surface, increasing its size and weight. Since the efficiency of precision components is affected when their parts are either too large or too small, rusting and corrosion cannot be tolerated in a hydraulic system.

rust and oxidation inhibitors

Rusting of ferrous component surfaces can be expected in a hydraulic system even if water is present in minute quantities; oil in its natural state does not provide adequate rust protection. Since it is impossible in actual practice to keep water out of a hydraulic system, hydraulic fluids are generally equipped with a rust inhibitor which coats metal surfaces with a chemical film.

Oxidation due to the interaction of air and fluid in a system's reservoir generates a chain of products which eventually attack metal surfaces and cause further fluid oxidation to occur. An oxidation inhibitor is a chemical which interferes with the oxidation chain.

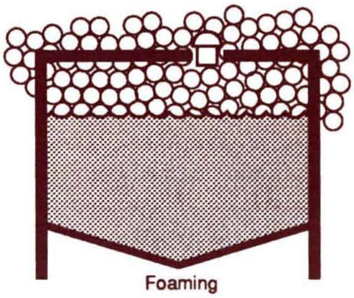
The high-temperature oxidation which occurs as air bubbles collapse at pump outlet, cannot be reduced by a chemical. This form of fluid oxidation can be eliminated by removing air bubbles from the fluid stream to pump inlet.

Rust and oxidation inhibitors are the basic additives for most industrial systems. Hydraulic fluids equipped with these additives are sometimes referred to as R & O oils; the high grade is R & O turbine quality. Lower quality turbine oil is still suitable for many hydraulic applications and is designated R & O less-than-turbine quality."

R & O
(RUST AND OXIDATION INHIBITORS)

foaming

As oil returns to a reservoir, it should release any entrained air bubbles which have been acquired in the system. In some systems where leaks are prevalent and/or returning oil is churned up as it enters a reservoir, foaming of the oil occurs. As a result, entrained air is pumped into the system, causing spongy, erratic operation, rapid oil oxidation and noise. In more severe cases, oil foam could bubble out of a reservoir creating a housekeeping problem.

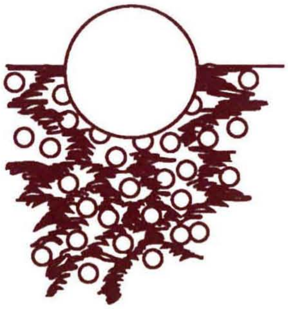


Foaming

Probably the best solution for alleviating foaming oil is to fix any system leaks and redesign the return part of the system with baffles or larger return lines which reduce fluid velocity. Sometimes, because of economics, convenience, or a lack of training, chemicals are used to solve the problem.

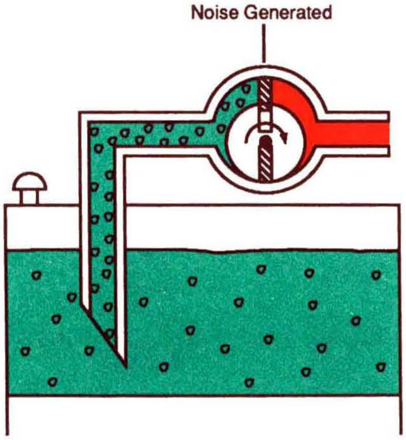
anti-foam additives

In an attempt to discourage oil foaming hydraulic fluids can be equipped with anti-foam additives. In some cases, these additives work by combining small air bubbles into large bubbles which rise to a fluid surface and burst. In other cases, these additives function by interfering with air release which action reduces foaming, but increases the amount of air bubbles in the system. If an anti-foam chemical is desired in an oil, care should be taken that the agent selected does allow air to escape.



check for foaming

A check for foaming oil is performed by taking a fluid sample. By draining or drawing off fluid from a system's reservoir, you can tell by sight whether air bubbles are present in the fluid. The sample should be taken as close as possible to pump inlet line so that a representative sample of what is getting into the system can be taken.



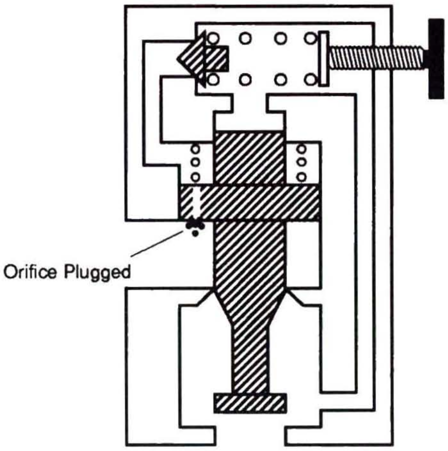
Another indication that air bubbles are present in a system is noise. As air bubbles are swallowed by a pump, a high-pitched, erratic noise is emitted. In some cases, a pump will periodically emit a loud bang as if someone were exploding firecrackers inside the pump housing.

An additional indication of air bubbles is spongy system operation. This is evidenced by erratic actuator movements and erratic gage readings as a system is operating.

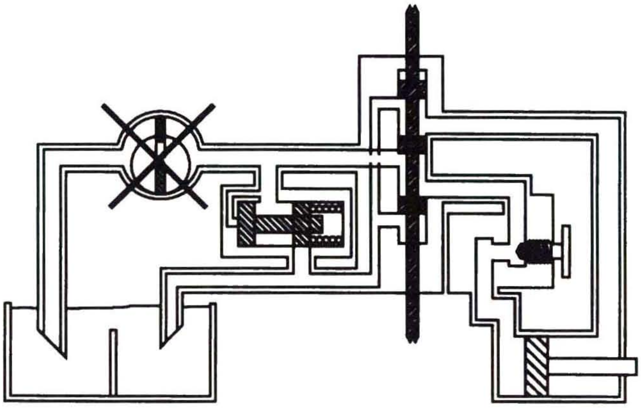
dirt in oil

The biggest problem with hydraulic oil in service is that it can easily become contaminated. The source of contamination can be water or air, but more frequently it is dirt.

Dirt in a hydraulic fluid can plug sensing orifices, cause moving parts to stick and wear excessively, and act as a catalyst to oxidize oil.



Dirt is an insoluble material in an oil which has several sources for contaminating oil. Dirt can be built into a system due to manufacturing, storing, and handling practices of system components and their assembly into a hydraulic system. Dirt can be generated within a system as a result of internal moving parts, flexing of component housings, and rust formation on reservoir walls. Dirt can also be added to a system as a result of servicing failed system components, not servicing reservoir breathers, and cylinder rods pulling in dirt as they retract. There is a continuous influx of dirt into hydraulic fluid.

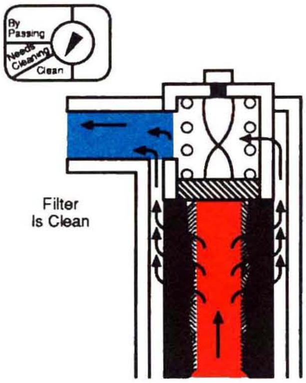


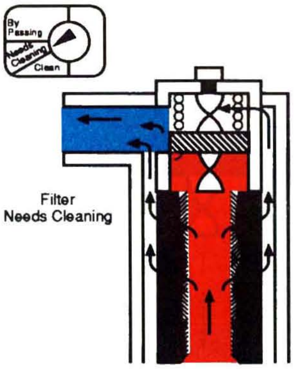
At present, there is not a chemical additive which either keeps dirt out of, or removes dirt from, hydraulic fluid. Keeping dirt out of a system is the function of good system design and maintenance practices. Removing dirt from a fluid is the responsibility of filters and maintenance men.

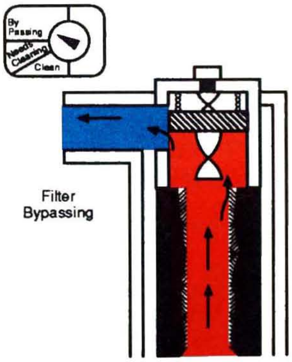
check for dirt in oil

Trying to determine the dirt level of a fluid with the unaided eye is many times impossible. Holding a glass or beaker of hydraulic oil up to a light and inspecting for dirt is an inaccurate means of determining dirt contamination. Many harmful dirt particles for a hydraulic system are not normally visible. Determination of dirt contamination is best performed in a lab.

A check for dirt contamination in a hydraulic fluid is performed by checking indicators of a system's filters. Assuming that the filter element is appropriate for the system and that the indicator is functioning properly, the filter indicator will give an idea if the fluid is clean enough for the system. With an indication of "needs cleaning", the filter element should be serviced. If the indicator shows a bypassing condition, fluid is probably not clean enough and the filter should be serviced at once.





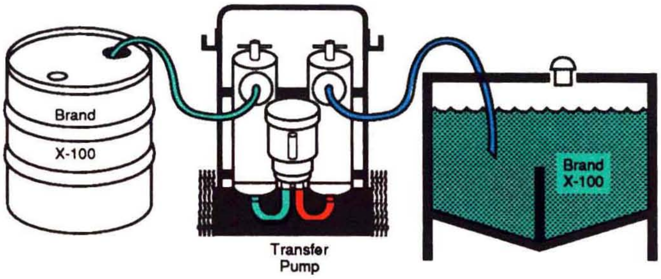


hydraulic oil maintenance considerations

As has been pointed out, hydraulic oil has several functions in a system and it contains additives which aid it in performing its function. Hydraulic oil is something special and it should be given special handling during storage, transfer to machine reservoir, and while operating in a system.

Keeping a fluid in top condition as it is stored, is a major consideration. Oil which becomes contaminated as it sits in a drum, is not only wasteful, but results in a false sense of security as oil supplies become depleted.

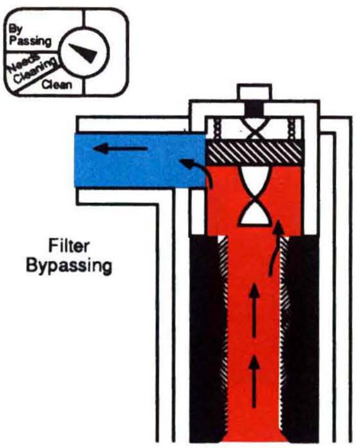
As a general rule, oil drums should be stored in a clean, dry place. If drums are stored outside, they should be stacked on their sides so that rain water does not collect on drum covers and leak past the seals into the oil.



Transferring oil from barrel to reservoir is another important consideration. Before the drum plugs are removed, the drum cover should be wiped clean. This procedure should also be followed for any apparatus or tools which will be used in the process such as hoses, pumps, funnels, reservoir filler hole, and the operator's hands.

Before the oil is actually dumped into the reservoir, check to see that the barrel contains the correct fluid by brand name and viscosity. All hydraulic fluids do not contain the same additives. Mixing additives is not recommended unless authorized by the oil manufacturer.

Once an oil is in a system, it should be monitored and maintained at regular intervals. Maintenance of the oil includes filling a reservoir when its minimum oil level has been reached (with fluid the same as or compatible with the fluid in the reservoir), fixing leaks, and servicing filters.



Servicing filter elements is very helpful in keeping a fluid in top condition. Dirt can be very harmful to a fluid because it acts as a catalyst for oil decomposition. This is especially true if the dirt particles are ferrous, lead, or copper. Filters usually remove a great percentage of dirt from a fluid stream. They do not remove dirt from the system, however; this is a maintenance function. Consequently, if filters are not maintained and cleaned when indicated, uncaught dirt not only passes to downstream components affecting their operation, but stored dirt on the filter element remains in the system contributing to oil decomposition.

cleaning wire mesh filter elements

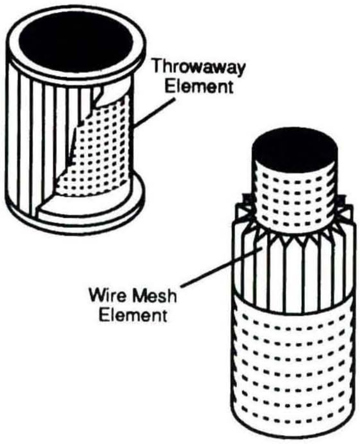
When servicing a filter with a wire mesh element, the element may be cleaned.

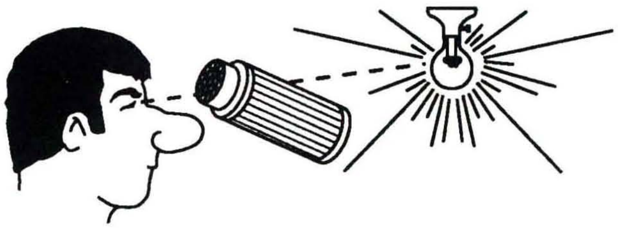
Wire mesh filter elements can be cleaned in several ways. With relatively coarse elements, no one way is by itself better than another. The degree to which an element becomes clean depends on the care and effort used in the cleaning process, not to the specific cleaning method.

A common way of cleaning elements is washing in a clean solvent or a hot soap-water-ammonia solution and blowing off the element with clean air. A soft bristle brush (new paint brush) is helpful in scrubbing the element. At no time should a wire brush or any abrasive material be used.

To check the cleanliness of the element after cleaning, hold it up to a light. Any gray or dark areas indicate that the element must be recleaned.

Ultrasonic cleaning is a more expensive, but a more convenient way to clean elements. Dirty filter elements can be placed inside the ultrasonic device for a time and be removed clean and ready for re-use. Wire cloth elements with ratings of 40 micrometers or less need ultrasonic cleaning to effectively restore element life.



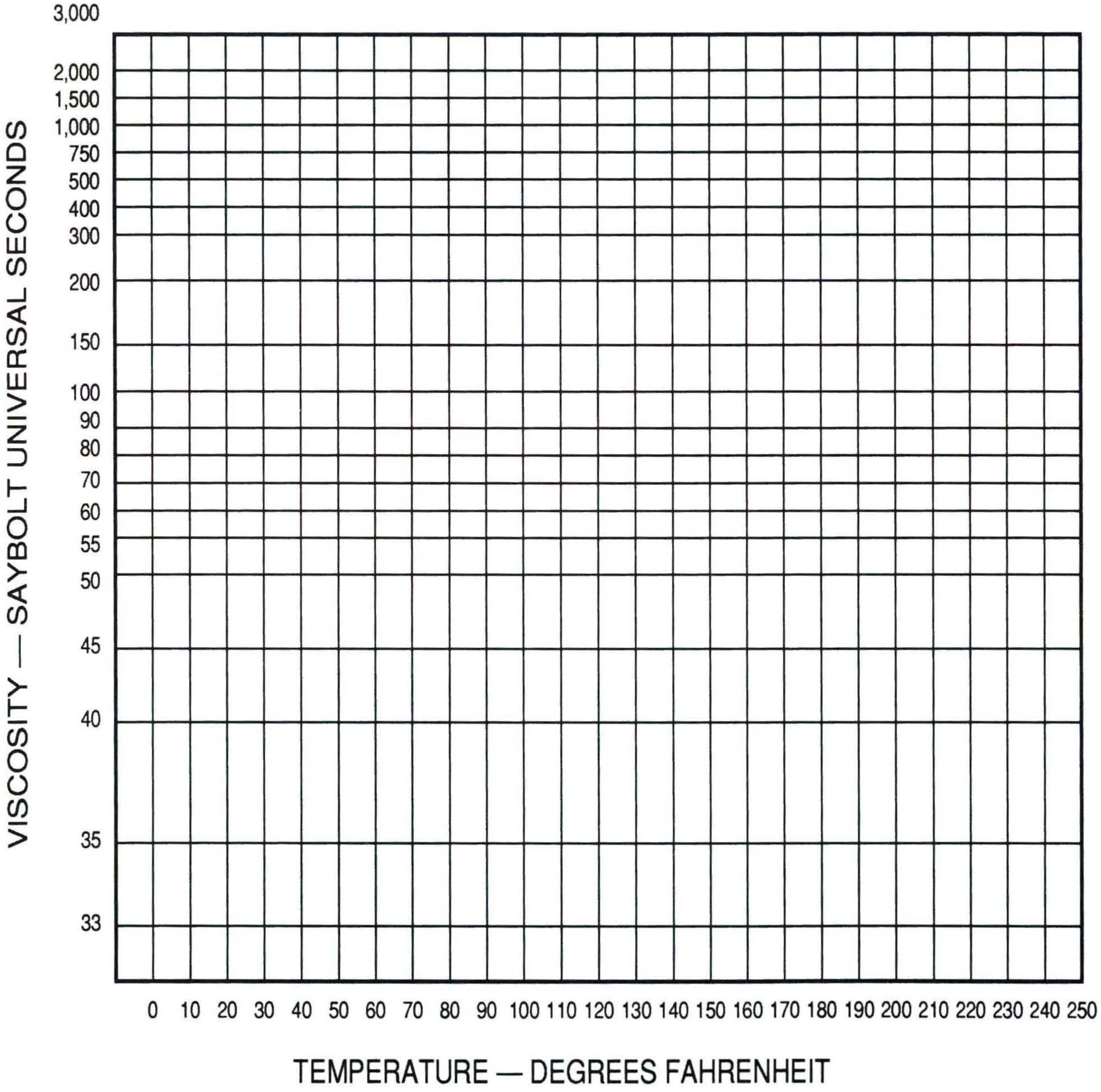


problem 1

A system's hydraulic reservoir is filled with Mobil DTE 25 fluid. There is some concern by the maintenance supervisor that the fluid will be too viscous in the winter for his vane pumps. He expects the temperature to drop to 35°F (1.7°C) in the machine area during some winter months. Determine how viscous the fluid will become.

Brand Name	Fluid Type	Specific Gravity	Viscosity (SUS)	
Mobil DTE 25	PB	876	225 @ 100°F	49 @ 210°F

ASTM STANDARD VISCOSITY — TEMPERATURE CHART



problem 2

Observing that a system's fluid had a tendency toward foaming, it was decided to switch to an oil with an anti-foam additive. With the addition of the oil to the system's reservoir, foaming ceased but the oil appeared to oxidize quickly. Offer an explanation for the rapid oxidation of the oil.

problem 3

Coolant is falling onto a machine's hydraulic reservoir and into the fluid. When a maintenance man informs the machine operator of the condition, the operator points out that since water and oil don't mix, the water will settle to reservoir bottom and not harm a thing. Comment with respect to what harm the coolant could do in the oil.

problem 4

Because of excessive leakage in a plant, a maintenance supervisor decides to switch to a straight mineral oil (an oil without additives) which is relatively inexpensive. The fluid will operate at 2200 psi (151.7 bar).

Describe what probable results can be expected from this action.

problem 5

The spool of a directional valve of a particular system would periodically stick. Taking apart the valve, a maintenance man finds that the spool is covered with a brown coating which he can't wipe off with a rag.

Explain what the coating is and where it came from.