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# A REVIEW ON THE IMPORTANCE OF VISCOSITY IN ENGINE OILS

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***ABSTRACT***

***Oil viscosity is regarded as the key parameter for any lubrication system. One should always be certain that oil viscosity in use meets original equipment manufacturer recommendations. Engine oil is of different substances that are used for lubrication of machinery. Its main function is to reduce wear and tear on moved parts, sludge free, inhibits corrosion etc. Engine oils are blended by different hydro carbons and organic compounds. Engine oils are used in internal combustion engine, generators and other machinery. This increases fuel power output, decreases fuel consumption and engine failure.***

***The viscosity will determine how efficiently oil is pumped to the working components, how easily it passes through filter and how quickly it drains back to engine. The lower the viscosity the easier this happens. So, a compromise is chosen to decrease power loss, but maximize load support. For domestic use, in motor sports etc., engine life is important.***

***The Parameters like Protection, fuel economy, horse power, cleanliness, fight for oil consumption, advanced design, leakage prevention decreases in an order from fully synthetic, semi synthetic to conventional respectively. In this paper, we compare viscosity with various parameters which involves in engine oils.***

***KEYWORDS: Viscosity, Engine Oil & Lubrication***

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## INTRODUCTION

Traditionally engine oil is a mixture of base oil and additives used for lubrication of engine parts, to limit friction, clean, cool and protect the engine. Modern synthetic motor oils are intricate mixtures, designed to perform various tasks. It depends on the key factor viscosity.

Viscosity is a measurable quantity that defines a liquids thickness. It is the measurement of fluid internal resistance to flow at a particular temperature. It is mostly categorized into “dynamic viscosity” which is a fluid’s resistance to flow or deform when subjected to a force and “kinematic viscosity“ which is traditionally measured by considering time taken for fluid sample to flow through an orifice in a capillary under gravity.

On September 6, 1866 Continuous Oil Refining Company founded by “American John Ellis”. He made his breakthrough when he developed oil that worked efficiently at high temperatures. In 1873 Ellis officially renamed the company Valvoline after steam engine valves the product lubricated. Viscosity measurement was discovered by French physicist “Jean Leonard Marie Poiseuille”.

## TYPES OF ENGINE OILS AND GRADES

**Engine Oils are Majorly Categorized as Follows**

- Mineral oil
- Semi synthetic oil
- Fully synthetic oil

**Mineral Oils**

Mineral oil is one of the n numbered by product made from petroleum. It is extracted from crude oil and further refined and made to use it for versatile functions and is the one that comes as default recommended one for 90 percent of bikes. These mineral oils composed of various hydrocarbons and organic compounds. These are made from a heavier, thicker petroleum hydrocarbon base stock derived from crude oil, with additives for improvement of properties. Another manipulated property is TOTAL BASE NUMBER to measure reserve alkalinity of oil. Analogously, TOTAL ACID NUMBER is measure of lubricants acidity.

***Semi Synthetic Oils***

sThese oils compose of 68 to 80 percentage mineral oil and rest synthetic. Its life is same as mineral oil and should be changed after 2000 kilometers and cost is bit higher.

**Fully Synthetic Oils**

It is a lubricant composed of artificially synthesized chemical compounds other crude petroleum. Its actual cost is triple that of mineral oil and leads at least 6000 plus kilometers. The use of these lubricants broadened through 1950s and 1960s owing to a property at another apex of temperature spectrum. Esters and poly alpha olefins extend their major contribution for fully synthetic oils. The “Society of Automotive Engineers, SAE” system applies to these oils.

Also there is another category called Bio based oils. These oils existed prior to the evolution of petroleum based oils in 19$^{th}$ century. They became the subject of interest with the advent of bio fuels and push for green technologies. Test results indicate the satisfactory performance for these oils.

**Grades**

The SAE has established a numerical code system for motor oil grading according to their characteristics of their viscosity. SAE viscosity grading includes the following, from low to high viscous range: 0, 5, 10, 20, 25, 30, 40, 50 or 60. The numbers are suffixed with the letter “W”, designating they are “winter”.

The SAE has a separate viscosity rating system for gear, axle, and manual transmission oils, SAE J306, which should not be puzzled with engine oil viscosity.

Regarding the change, Michael Covitch of Lubrizol, chair of SAE international “Engine Oil Viscosity Classification, EOVC” committee was stated “If we continued to count down from SAE 20 to 15 to 10, etc we would be facing continuous customer confusion troubles with popular low temperature viscosity grades” he declared this.

**Single Grade**

Single grade engine oil, as defined by SAE J300, cannot use a polymeric viscosity index improver additive. SAE J300 has launched "11" viscosity grades, of which "6" are advised as winter grades. These oils are often referred to as "straight weight oils".

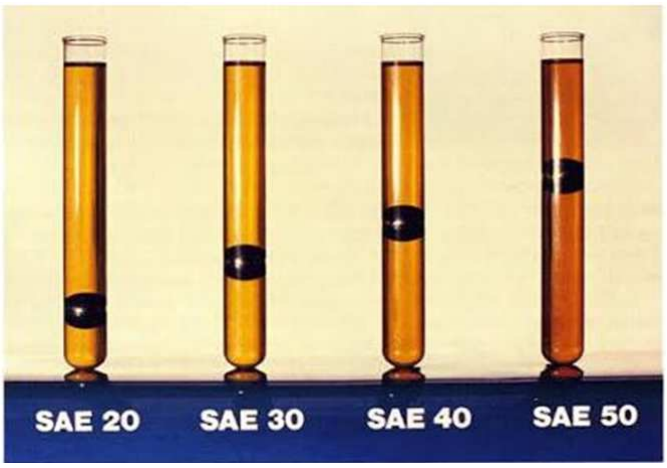


**Figure 1**

Above figure shows steel balls of equal weight dropped into test tubes filled with motor oils at different rates. Their rate of decrement depends on the viscosity of the oil. The ball travelling through the light SAE 20 oil has travelled farthest, while the ball in the SAE 50 has travelled least.

**Multi Grade**

The temperature range the oil is exposed to in most automobiles can be wide, ranging from cold temperature in winter before the vehicle is started up, to hot operating temperatures when the vehicle is fully warmed up in hot summer weather. When cold oil will have high viscosity and vice versa at operating temperatures of engine. This enables one type of oil to be used all year. The SAE designation for multi grade oils incorporates two viscosity grades, for example, 10W-30 designates common multi grade oil. This oil can be tagged. If any VIIs are used however, then that oil can't be labeled as single grade.

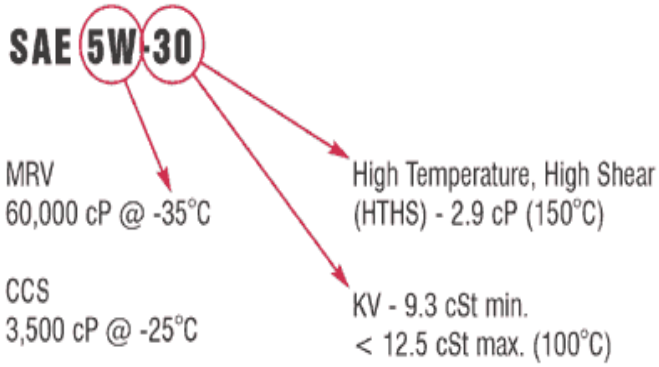


**Figure 2**

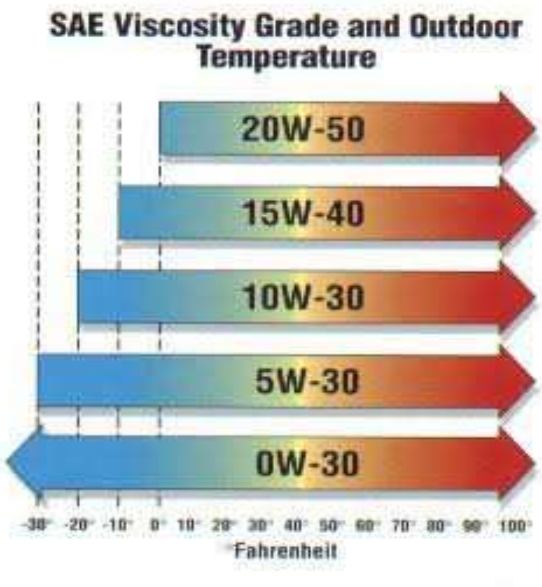


**Figure 3**

**Table 1: Viscosity and Density Over Temperature**

| | SAE 30 | | |
|---|---|---|---|
| **Temperature ($^0$C)** | ***Dynamic Viscosity (mPa.s)*** | ***Kinematic Viscosity ($mm^2/s$)*** | ***Density ($g/cm^3$)*** |
| 0 | 1124.10 | 1257.25 | 0.8941 |
| 10 | 491.10 | 553.20 | 0.8878 |
| 20 | 239.39 | 271.56 | 0.8815 |
| 30 | 128.42 | 146.70 | 0.8754 |
| 40 | 74.55 | 85.76 | 0.8693 |
| 50 | 46.43 | 53.80 | 0.8630 |
| 60 | 30.58 | 35.69 | 0.8569 |
| 70 | 21.17 | 24.89 | 0.8506 |

## PROPERTIES OF ENGINE OILS

Most of the engine oils are made from a hefty, thicker petroleum hydrocarbon base stock plagiarized from crude oil, with additives to improvise specific properties. The bulk of traditional motor oil consists of hydrocarbons with an average of 18 to 34 carbon atoms pee molecule. The viscosity index is a measure of how much oils viscosity changes as temperature changes. A higher viscosity index indicates the viscosity changes less with temperature than lower viscosity index.

Motor oil must be capable to flow adequately at the lowest temperature it is expected to experience in order to minimize metal to metal contact between moving parts up on starting of engine. The pour point defined first this property of motor oil as explained by ASTM D97.

Oil is largely composed of hydrocarbons which can burn if ignited. Another important property of motor oil is its flash point, the lowest temperature at which the oil gives off vapors which can ignite. It is hazardous for the oil in an engine to conflagrate and burn, so, a high flash point is desirable. At a petroleum refinery, fractional distillation separates a motor oil fraction from other crude oils, removing the more volatile components and therefore, improving the oils flash point.

TOTAL BASE NUMBER which is a measurement of the reserve alkalinity of oil, meaning its ability to neutralize acids. Analogously, TOTAL ACID NUMBER is the measure of lubricants acidity. The NOACK volatility test determines the physical evaporation loss of lubricants in high temperature test.

## IMPORTANCE OF VISCOSITY IN ENGINE OILS

Viscosity occupies a key role in determining the efficiency of engine oil. It affects heat generation in bearings, cylinders and gear sets related to an oils internal friction. It governs sealing effect of engine oils and rate of oil consumption as well as determines the ease with which machines can be started or operated under diversified temperature conditions, especially in cold climates. An oil's viscosity is measured most commonly by kinematic viscosity and reported in a unit called "Centistoke, cSt". It is measured in the time it takes for a particular volume of oil to flow through a special device called capillary tube.

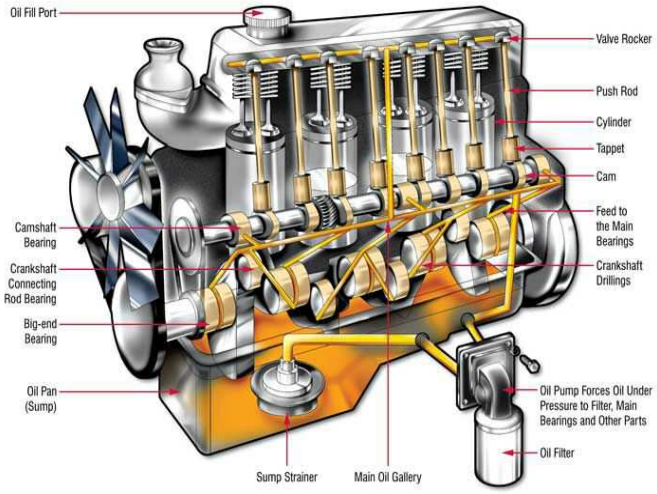


**Figure 4**

Above figure indicates the flow of engine oil in an internal combustion engine.

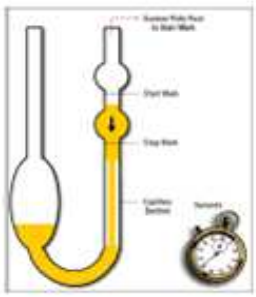

**Figure 5**

Above figure 5 shows the measurement of kinematic viscosity of a prescribed liquid.

Under dynamic conditions, dynamic viscosity is considered, measured in units called "poiseulle, P".

Dynamic Viscosity (cP) = Kinematic Viscosity (cSt) x Fluid Density (kg/m3)

## FACTORS AFFECTING VISCOSITY IN ENGINE OILS

**Engine Oil's Flow Behavior Depends on Three Factors**

- The oil's inner molecular structure.
- The external forces acting upon the oil that deform it and make it flow.
- The ambient conditions let temperature and pressure when stressed by external forces.

Depending on these factors oils flows and develops different types of flows. Only one type of flow is suitable for testing its viscosity.

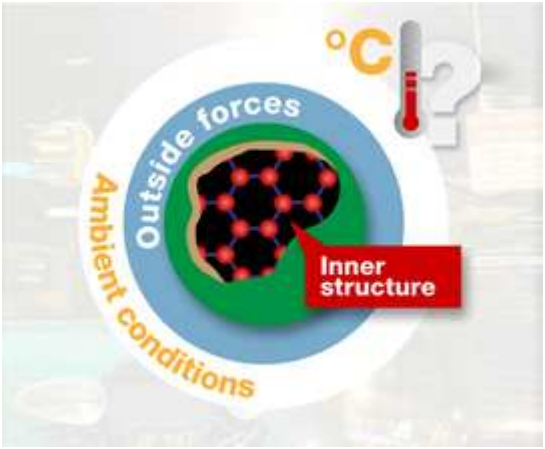


**Figure 6**

**Flow Conditions**

**Laminar and Turbulent**

For testing a fluids viscosity defined flow conditions are important. The fluid has to develop laminar flow. With this, the oil travels in imaginary thin layers in which molecules do not change from one layer to another. This flow is an orderly structure.

In turbulent flow no recognizable structure or layers can be observed. Molecules move freely. The fluid forms vortices.

For example, shear rate is too high for tested substance that can lead to turbulent flow.

Laminar and turbulent flows of a fluid can be demonstrated in the following figure 7.

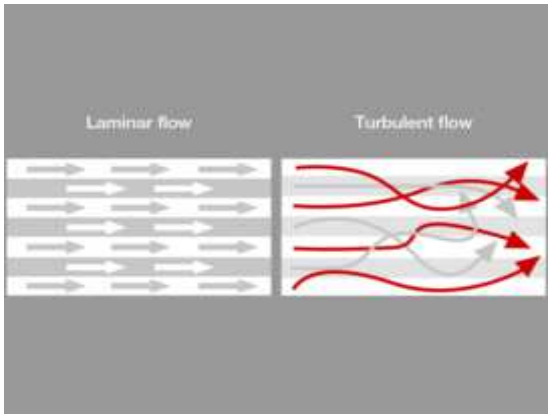


**Figure 7**

**Temperature**

A fluids viscosity strongly depends on its temperature. Along with the shear rate temperature is the dominating influence. The higher the temperature the lower a substance viscosity is. Eventually, decreasing temperature causes an increase in viscosity.

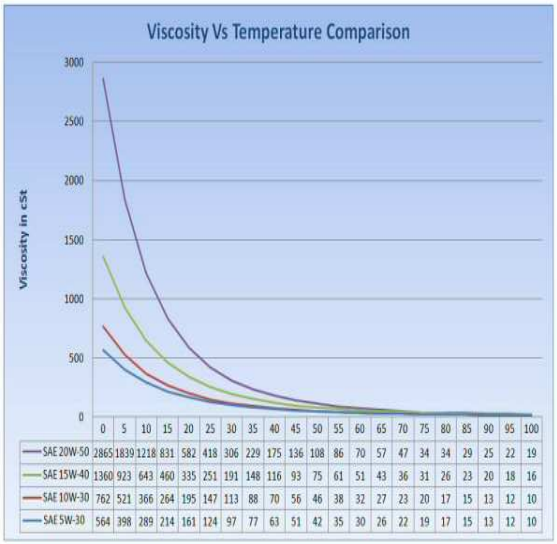


**Figure 8**

Above figure 8 shows the graph that was plotted with the relation between viscosity and temperature on ordinate and abscissa respectively.

**Pressure**

In many cases, a fluids viscosity increases with increasing pressure. Compared to the temperature influence, liquids are influenced very little by the applied pressure.

The reason is that liquids are almost incompressible at low or medium pressures. Even for enormous pressure difference of 0.1 to 200 “MPa” the viscosity increase for most low molecular liquids amounts to a factor 3 to 7 only. For most liquids viscosity increases with increase in pressure because the amount of free volume in the internal structure decreases due to compression and molecules move less freely and internal friction forces increase. This results in an increased flow resistance.

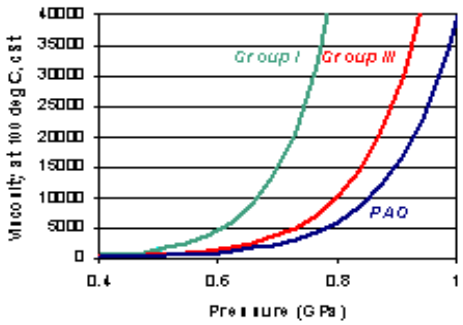


**Figure 9**

The above figure 9 shows the relationship between viscosity and pressure by plotting a graph, viscosity in ordinate and pressure in abscissa.

## APPLICATIONS AND DISADVANTAGES

Engine oil is a lubricant used in I C engines, which power the automobiles, lawnmowers, generators and other machinery. In engines parts which move, the friction knockoffs otherwise otherwise useful power by transforming kinetic energy into heat. This decreases efficiency and leads to degradation of engine and increases fuel consumption, decreases power output and lead to engine failure.

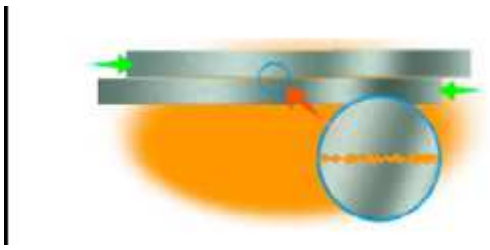

**Figure 10**

Lubricating oil produces a separate film between surfaces of adjacent moving parts to decrease direct contact between them, minimizing heat induced due to friction and reducing wear and protecting engine. Engine oil transports heat by convection and through buildup of oil gases nullified by Positive Crankcase Ventilation system.

Engine oil may also as a cooling agent. In some complications oil is sprayed through a nozzle inside a crank case on to piston to provide cooling for the specific parts which has been under gone high temperature strain. On other hand, the thermal capacity of oil sump has to be filled that is the oil has to be reaching its determined temperature range before it can protect the engine under high load. This typically takes longer than heating the main cooling agent up to its operating temperature.

## SUMMARY

Most of us do not have a vivid understanding regarding the role of viscosity in engine oils, its significance and maintenance. The viscosity of a fluid and reactions to various variables will determine how better a fluid can perform the basic functions of a lubricant. There no compromise for the proper viscosity. All machinery that included in oil analysis program should be evaluated for the perfect sampling hardware. Over greasing can result in higher operating temperatures,

premature failure of bearing and increase in risk of contaminant entry. Through documentation of every task performed in this lubrication program offers best way force acting procedures must be developed by ultimate practices in mind and may not represent what currently is being done in your plant. For a moment if new oil is arriving and being put into use without any testing order contamination, this far from best practice. Instead new oil should be sampled upon delivery for conformation. The same holds true for inspections in lubrication program. We need to design procedures in a manner that enables to reach a world class level. A new process to break down complex organic compounds like polyethylene found in many consumer containers, is used to make a paraffin like wax with correct molecular properties for conversion into a lubricant bypassing the costly Fischer Tropsch process. Another class of base oils suited for motor oils are poly malkylene glycols. They provide zero ash, bio no tox properties and lean burn characteristics. Thus we have compared the various properties of engine oil with respect to viscosity.

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