To study the influences of climate on the properties of lubricants

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ABSTRACT

Lubrication is the process or technique employed to reduce friction between, and wear of one or both, surfaces in proximity and moving relative to each other, by interposing a substance called a lubricant in between them.

The lubricant can be a solid, solid/liquid dispersion, a liquid such as oil or water, liquid-liquid dispersion or a gas. A lubricant property is greatly influence by climatic conditions. A lubricant behaves differently at high temperatures and low temperatures. A lubricants can be characterise by its viscosity, it flow resistance or by the thickness of its oil film. Viscosity of lubricants changes with climatic condition.

Finally, conclusions are listed for controlling the lubricants properties with the help of certain additives which suits to the climatic condition and proper working of equipments or engines.

INTRODUCTION

The science of friction, lubrication and wear is called tribology. Operation and maintenance of equipments, machines tool, vehicles are greatly depends on the types of lubricants used. Lubricants properties greatly influenced by climatic conditions. As all lubricating fluids have practical's limits on the acceptable operating temperature and pressure range both high and low levels. The machine loses stability and experiences conditional failures whenever the system's lubricating fluids temperature violates these limits. Proper knowledge of properties of lubricants and uses of certain additives to the lubricants provide temperature stability to the lubricants. Thus optimize the performance and prolonged equipments service life.

OBJECTIVE OF RESEARCH

The objective of this research is to study the influences of climate on the properties of lubricants.

THEORY

Lubrication is the process of introducing lubricants between contact surfaces to reduce the frictional force. The main property of the lubricant is that it should produce very lower shear strength and form a layer between the sliding surfaces.

2.1 BASIC TYPES OF LUBRICANT

Lubricants are usually divided into four basic classes.

(a) Oils: A general term used to cover all liquid lubricants, whether they are mineral oils, natural oils, synthetics, emulsions, or even process fluids.
(b) Greases: Technically these are oils, which contain a thickening agent to make them semisolid.
It is convenient, however, to include the anti seize pastes and the semi fluid greases under the same heading.
(c) Dry lubricants: These include any lubricants, which are used in solid form, and may be bulky solids, paint like coatings, or loose powders.
(d) Gases: The gas usually used in gas bearings is air, but any gas can be used which will not attack the bearings, or itself decompose.

The advantages and disadvantages of oils stem from their ability to flow easily. Thus, on the credit side, it is very easy to pour them from a container, to feed them into a bearing by dripping, splashing or pumping, and to drain them out of a machine when no longer fir for use. Other advantages are the cooling of a bearing by carrying away heat, and cleaning it by removing debris.

The behaviour of greases is very similar to that of oils, but the former are used where the advantages of easy flow are outweighed by the disadvantages. Thus grease do not easily leak out of a machine, or container, do not migrate away, and will form an effective seal against contaminants.

The advantages and disadvantages of solid lubricants are rather like the extremes for greases, where the lubricant will not flow at all.

Similarly, the advantages and disadvantages of gas lubricants are like the extremes of oils, where the flow properties are almost too good.

(a) (b)

Figure 1- (a) Greases lubricant (b) Oils lubricant (c) Dry lubricant (d) Gas lubricant

2.2 MODE OF LUBRICATION

As the load increases on the contacting surfaces three distinct situations can be observed with respect to the mode of lubrication, which are called regimes of lubrication.

(a) **Fluid film lubrication**: - It is the lubrication regime in which, through viscous forces, the load is fully supported by the lubricant within the space or gap between the parts in motion relative to one another object and solid–solid contact is avoided.

Hydrostatic lubrication is when an external pressure is applied to the lubricant in the bearing, to maintain the fluid lubricant film where it would otherwise be squeezed out.

Hydrodynamic lubrication is where the motion of the contacting surfaces, and the exact design of the bearing is used to pump lubricant around the bearing to maintain the lubricating film. This design of bearing may wear when started, stopped or reversed, as the lubricant film breaks down.

(b)**Boundary lubrication**: - Thin mono-layer of fluid film is formed between the frequent asperity contact that leads to high values of coefficient of friction and wear compared to hydrodynamic lubrication.

(c)Mixed film lubrication: - It is the combination of full film lubrication and boundary lubrication.

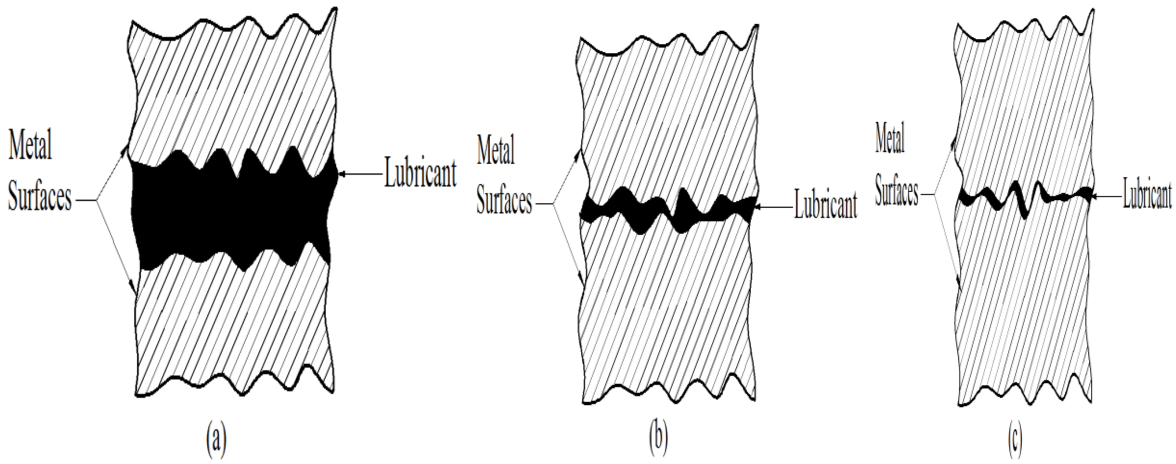


Figure 2- Mode of lubrication (a) Fluid film lubrication (b) Boundary lubrication (c) Mixed film lubrication

DESCRIPTION AND DISCUSSION OF RESEARCH

A lubricant can be characterised by its viscosity, flow resistance or by the thickness of its oil film. In lubricants oil weight refers to its measure viscosity at a given temperature. Unit of measure is centistokes (cSt) . With increase measure of viscosity centistokes (cSt), higher value of oil weight occurs. Absolute viscosity provides a measure of a fluid's internal resistance to flow. For liquids, viscosity corresponds to the informal notion of "thickness". For example, honey has a higher viscosity than water.

Many different substances can be used to lubricate machine parts, tools and equipments but oils and greases are most common. Lubrication plays a key role in the life expectancy of an engine. Without oil, an engine would succumb to overheating and seizing very quickly. Lubricants help mitigate this problem, and if properly monitored and maintained, can extend the life of your motor. Lubricants containing oil have additives that enhances, add or suppress properties within the base oil. The amount of additives depends on the types of oil and application for which it will be used. A typical additive package found in engine oil would include a detergent and a dispersant. These two additives work together to help rid the engine system of deposits caused by the burning of fuel and contributed to by blow of gases. Dispersants and detergents are small particles that have a polar head and an oleophilic tail. The polar heads are attracted to contaminants within the oil and surround them, forming a structure called a micelle. Soot is a good example of a deposit that is controlled by detergents and dispersants. Soot particles are enveloped by dispersant particles, forming a micelle, and are kept from attaching to metal surfaces. They are moved in this state through the oil system until they are removed by the filter. This also prevents a process known as congealing. During congealing, soot particles begin to stack upon each other or congeal into a larger particle. Smaller soot particles that could pass through components without interrupting the fluid film can congeal to make larger particles, which may disrupt the film and damage surfaces. Most vehicle engines use some form of multi grade oil. This type of oil has an additive called a viscosity index (VI) improver. A common example would be 10W30 or 5W40. These VI improvers are long chain organic molecules that change shape as the temperature of their environment changes. When in cold environments (engine start up), these molecules are tightly bound. As the oil heats up, they begin to stretch out. This allows an oil to flow more readily at colder temperatures but still maintain an acceptable viscosity and, more importantly, a lubricating layer in the operating temperature range.

The main requirements for lubricants oil are defined temperature viscosity properties, protection against wear and corrosion, keeping the engine clean, holding particles like soot or abrasives in suspension, yield strength under compression and many more. To ensure that our equipments or engines performs optimally, lubricants oil should retain a certain level of viscosity in all weather conditions: It should remain fluid at low temperatures (to make cold starts easier) and viscous at high temperatures (in order to provide protection and sealing).

The SAE (Society of Automotive Engineers) has developed a means of classifying lubricants in order to specify their viscosity levels when hot and when cold. The viscosity designation is made up of two numbers separated by the letter “W” (for “winter” for the cold grade).The numbers that come before the W refer to the product’s cold grade, i.e., its viscosity at low temperatures. The lower the viscosity when cold, the more fluid the oil is at low temperatures and the more easily it can be pumped. Greater levels of fluidity at low temperatures make cold starts easier. The numbers to the right of the letter “W” are its hot grade. The higher the grade, the more viscous the oil will be at high temperatures.

Followings are name of some lubricant engine oils which is available in different SAE grades to suit the climate:-

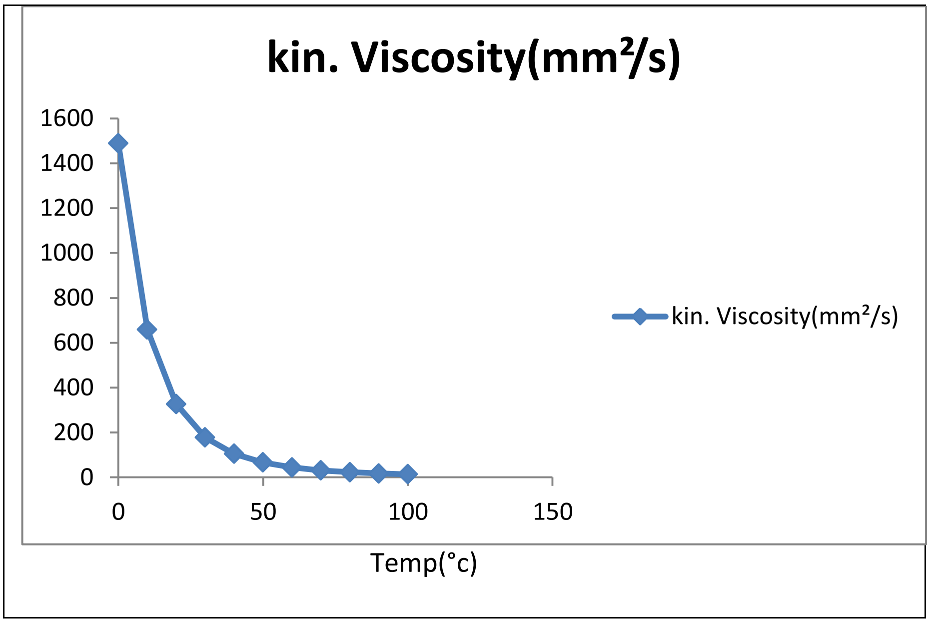
- SAE 15W-40
- SAE 10W-40
- SAE 10W-60
- SAE 5W-40
- SAE 0W-30
- SAE 30

Figure-3 shows the certain SAE grade lubricating oil which is generally used.

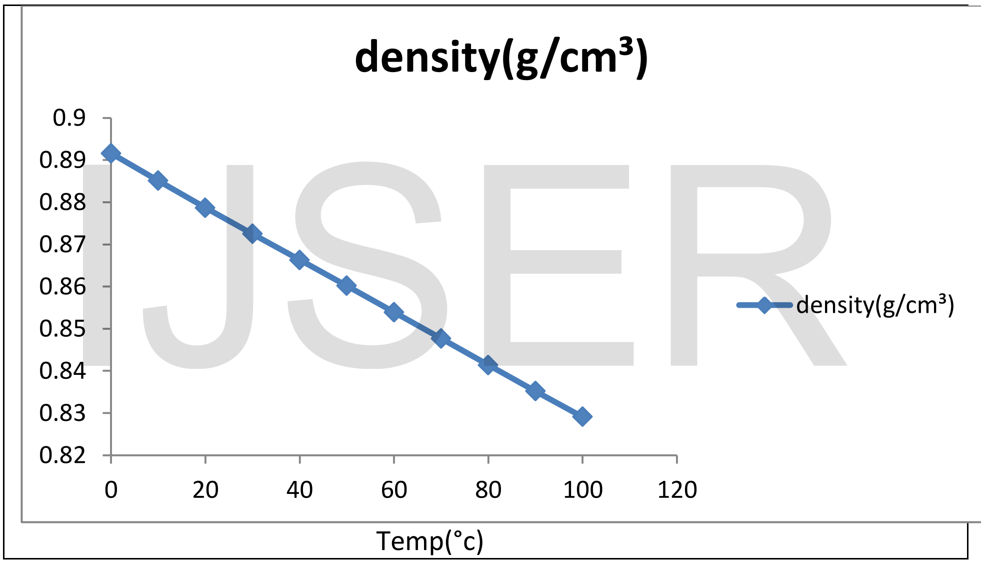
Measurement data for above lubricant engine oils which are shown below is obtained from engine oil - viscosity table and viscosity chart and graph is drawn for the respective oil.

SAE 15W-40

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	1328.0	1489.4	0.8916
2	10	582.95	658.60	0.8851
3	20	287.23	326.87	0.8787
4	30	155.31	178.01	0.8725
5	40	91.057	105.10	0.8663
6	50	57.172	66.46	0.8602
7	60	38.071	44.58	0.8539
8	70	26.576	31.35	0.8477
9	80	19.358	23.00	0.8414
10	90	14.588	17.46	0.8352
11	100	11.316	13.64	0.8291



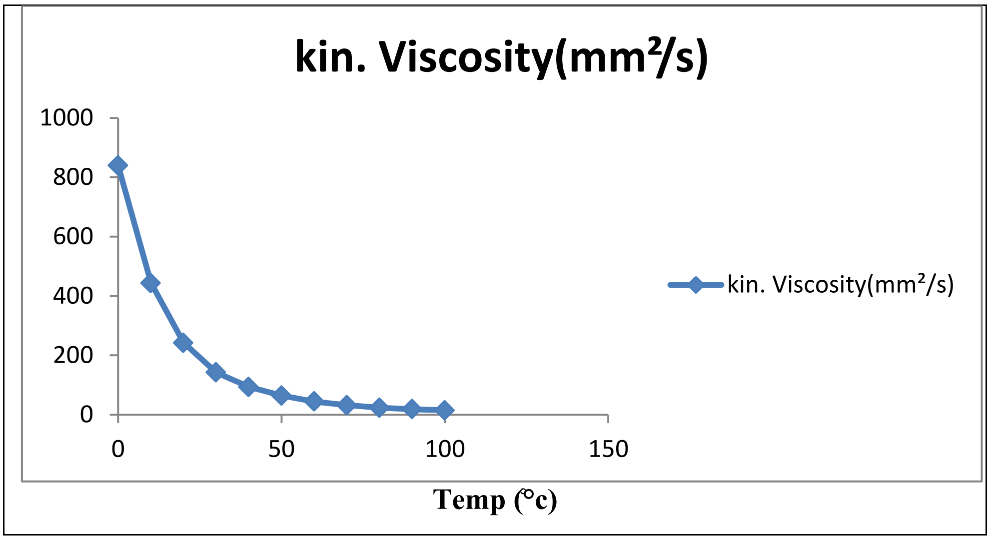
Graph -1 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE 15W-40



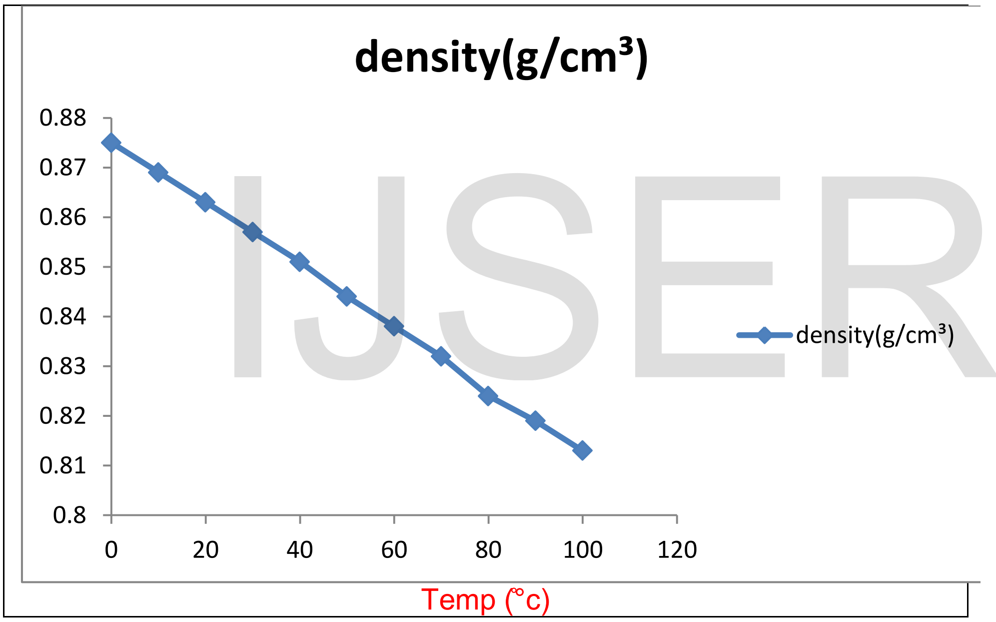
Graph-2 between density (g/cm³) vs. Temp (°c) for SAE 15W-40

SAE 10W-40

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	735.42	839.76	0.875
2	10	385.53	443.53	0.869
3	20	208.89	242.07	0.863
4	30	121.63	141.98	0.857
5	40	79.33	93.274	0.851
6	50	53.90	63.85	0.844
7	60	37.14	44.33	0.838
8	70	26.50	31.87	0.832
9	80	19.69	23.26	0.824
10	90	15.09	18.42	0.819
11	100	11.87	14.61	0.813



Graph -3 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE 10W-40

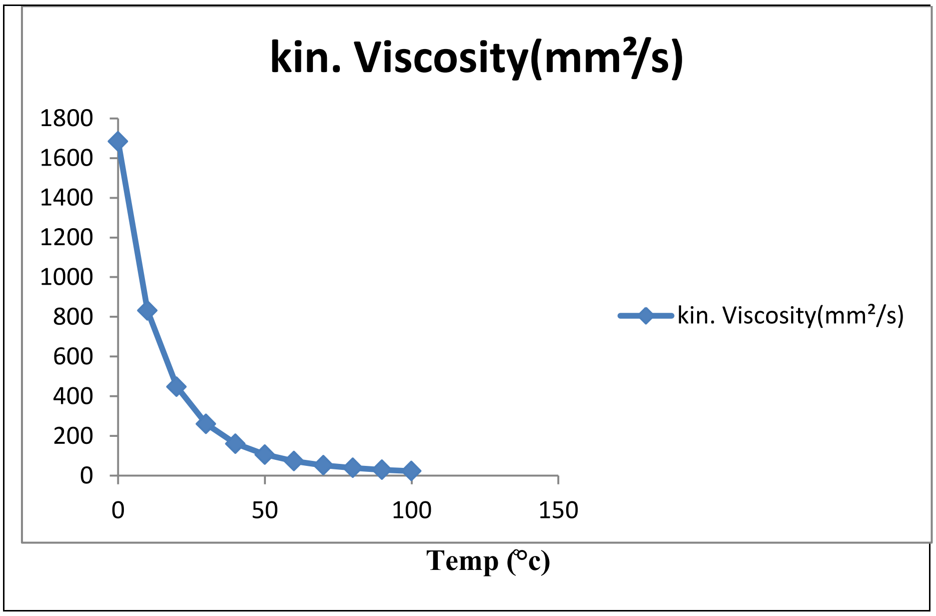


Graph-4 between density (g/cm³) vs. Temp (°c) for SAE 10W-40

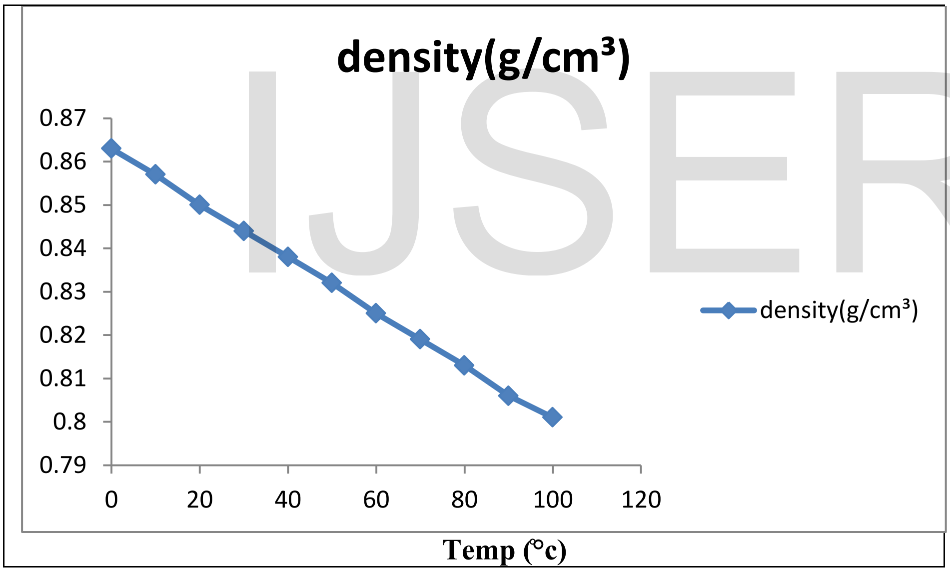
<u>SAE 10W-60</u>

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	1453.8	1684.4	0.863
2	10	712.34	831.44	0.857
3	20	381.08	448.10	0.850
4	30	220.06	260.69	0.844
5	40	135.52	161.73	0.838
6	50	88.55	106.47	0.832
7	60	60.60	73.41	0.825
8	70	43.23	52.77	0.819

9	80	31.95	39.29	0.813
10	90	24.31	30.13	0.806
11	100	18.99	23.72	0.801



Graph -5 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE 10W-60

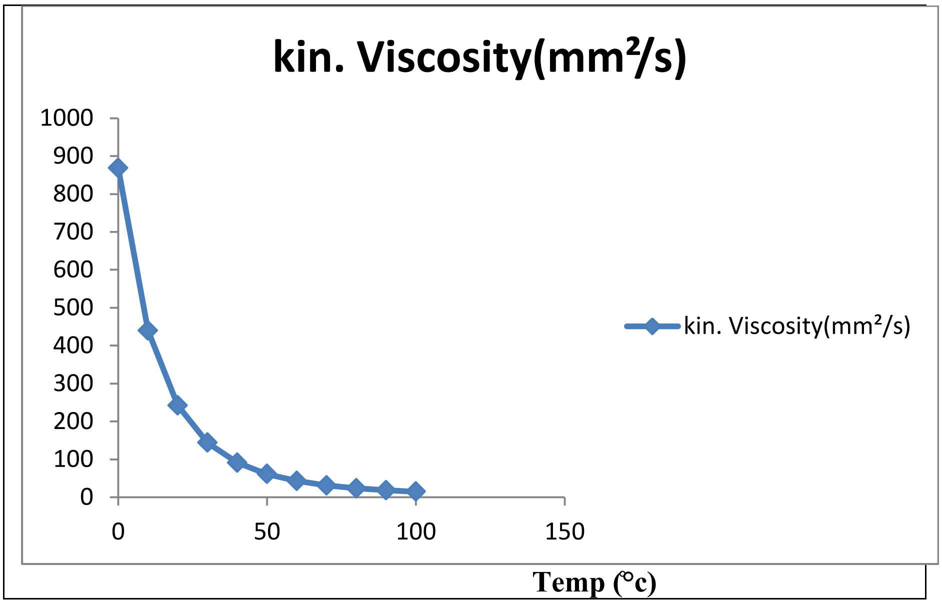


Graph-6 between density (g/cm³) vs. Temp (°c) for SAE 10W-60

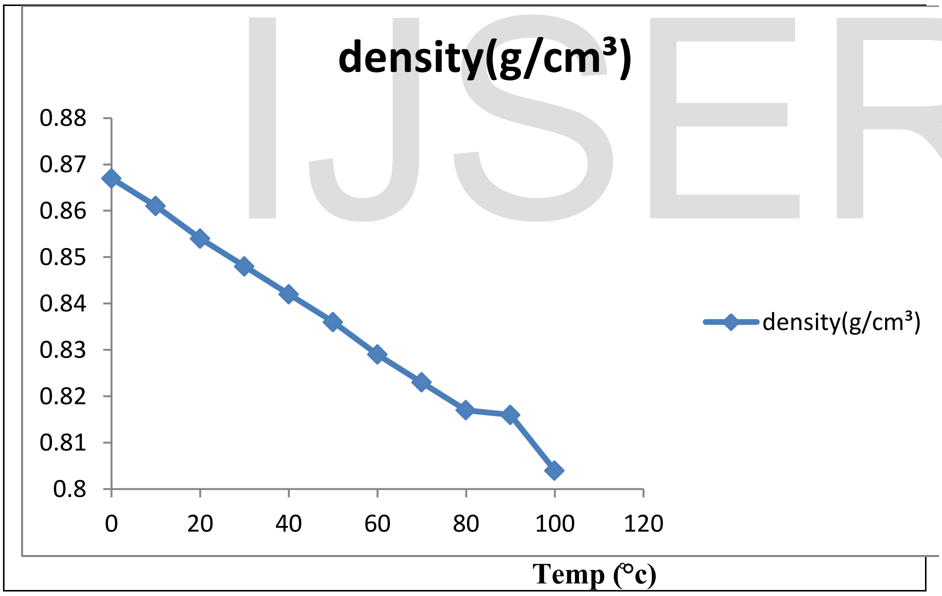
SAE 5W-40

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	753.52	868.78	0.867
2	10	378.65	439.85	0.861
3	20	206.89	242.10	0.854
4	30	121.90	143.70	0.848
5	40	76.55	90.90	0.842
6	50	50.86	60.85	0.836
7	60	35.41	42.68	0.829

8	70	25.63	31.13	0.823
9	80	19.18	23.48	0.817
10	90	14.74	18.19	0.816
11	100	11.62	14.44	0.804



Graph -7 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE 5W-40

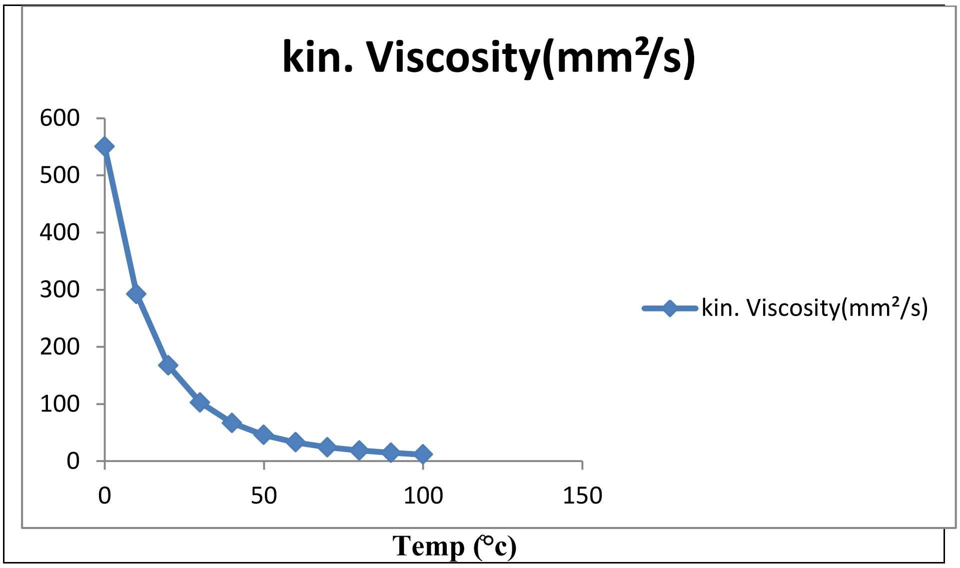


Graph-8 between density (g/cm³) vs. Temp (°c) for SAE 5W-40

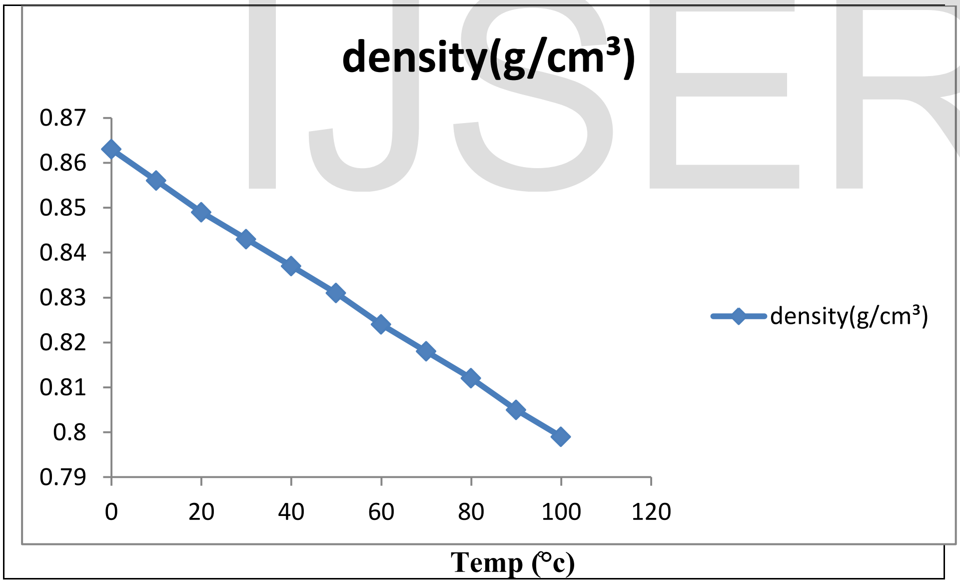
SAE 0W-30

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	474.65	550.23	0.863
2	10	249.94	291.93	0.856
3	20	142.17	167.29	0.849
4	30	86.60	102.66	0.843
5	40	55.93	66.80	0.837
6	50	38.01	45.75	0.831

7	60	27.01	32.75	0.824
8	70	19.84	24.26	0.818
9	80	15.06	18.56	0.812
10	90	11.73	14.57	0.805
11	100	9.35	11.70	0.799



Graph -9 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE 0W-30

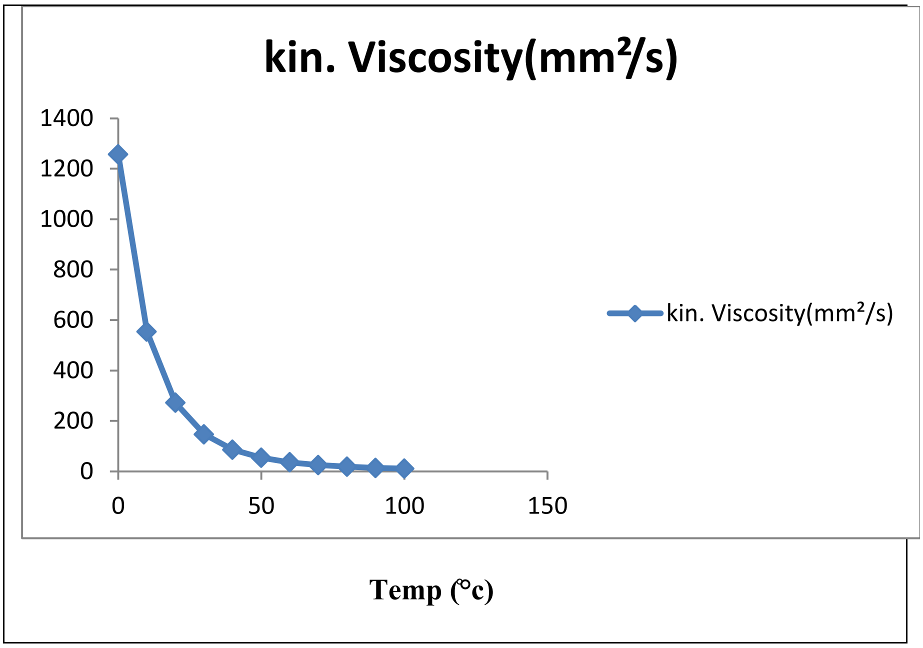


Graph-10 between density (g/cm³) vs. Temp (°c) for SAE 0W-30

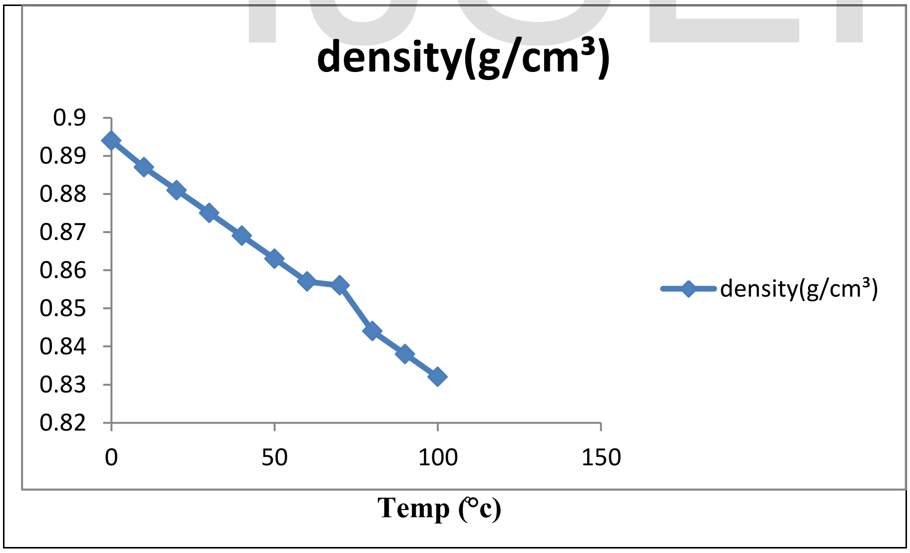
SAE-30

Sl.No	Temp (°c)	Dyn. viscosity (mPa.s)	kin. Viscosity(mm²/s)	density(g/cm³)
1	0	1124.10	1257.25	0.894
2	10	491.10	553.20	0.887
3	20	239.39	271.56	0.881
4	30	128.42	146.70	0.875
5	40	74.55	85.76	0.869

6	50	46.43	53.80	0.863
7	60	30.58	35.69	0.857
8	70	21.17	24.89	0.856
9	80	15.28	18.10	0.844
10	90	11.42	13.62	0.838
11	100	8.80	10.58	0.832



Graph -11 between kin. Viscosity (mm²/s) vs. Temp (°c) for SAE-30



Graph-12 between density (g/cm³) vs. Temp (°c) for SAE-30

CONCLUSION

Detailed description shows how influences of climate on the properties of lubricants have been presented in this paper. From observation it is found that all lubricant viscosity is inversely proportional to the temperature i.e. with increase in temperature, viscosity of lubricant oil decreases and with decrease in temperature, viscosity of lubricant oil increase. Effect of climatic pressure on lubricant oils viscosity is directly proportional i.e. with increase in pressure oil viscosity increases due to compressibility effect.

In order to control the properties of lubricants as per the climatic condition certain additives are added to the lubricants. Additives which are mostly used are

- Detergent and a dispersant which help rid the engine system of deposits caused by the burning of fuel and contributed to by blow off gases.
- Viscosity index (VI):- VI improvers are long chain organic molecules that change shape as the temperature of their environment changes. When in cold environments (engine start up), these molecules are tightly bound. As the oil heats up, they begin to stretch out. This allows an oil to flow more readily at colder temperatures but still maintain an acceptable viscosity and, more importantly, a lubricating layer in the operating temperature range.
- Antiwear (AW):- AW additives form a sacrificial layer that protects the surfaces beneath them from degradation under boundary conditions. Zinc dialkyl dithio phosphate (ZDDP) is a common form of this additive
- Glycol (antifreeze):-contamination does the opposite, increasing viscosity so the oil doesn't flow as well into places that require thinner oil.

The lubricants properties must be maintained to ensure proper operating conditions and to achieve the maximum life of the engine's components. Changing oil regularly and sustaining appropriate fluid levels are the keys to optimize engine performance and prolong engine service life.

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