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Temperature dependent Dynamic (Absolute) scosity of Oil

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***Abstract:** The viscosity of a fluid is an important property in the analysis of liquid behavior and fluid motion near solid boundaries. The knowledge of viscosity is needed for proper design of required temperature for storage, pumping or injection of fluids. There are two related measures of fluid viscosity known as dynamic (or absolute) and kinematic viscosity. In this paper an attempt has been made to find temperature dependent dynamic (or absolute) viscosity of some common domestic usable Oil namely Soya bean Oil, Coconut oil, Kerosene oil and 2T Oil. Oil is a complex substance with each hydrocarbon molecules consisting of many atoms of carbon, hydrogen and oxygen and others and lubrication of Oil is critical which only depend on viscosity. All oil shows decrease in viscosity with increase in temperature The dynamic viscosity calculated in terms of Kinematic Viscosity .The temperature dependent kinematic Viscosity has been determine in terms of Redwood Seconds using Redwood Viscometer No.2.*

Keywords: Dynamic (or absolute) Viscosity, Oil, kinematic viscosity, Redwood Viscometer No.2 Viscosity,

I. INTRODUCTION

The viscosity of a fluid is an important property in the analysis of liquid behavior and fluid motion near solid boundaries. The viscosity is the fluid resistance to shear or flow and is a measure of the adhesive/cohesive or frictional fluid property. The resistance is caused by intermolecular friction exerted when layers of fluids attempt to slide by one another. Viscosity is a measure of a fluid's resistance to flow. The knowledge of viscosity is needed for proper design of required temperature for storage, pumping or in byjection of fluids. There are two related measures of fluid viscosity known as dynamic (or absolute) and kinematic viscosity. The dynamic or absolute viscosity (μ) and kinematic viscosity (v) can be related by

$$v = \mu/\rho$$

where v = kinematic viscosity(stoke (St) or centistoke (cSt)

μ= absolute or dynamic viscosity (Ns/m^2 or Pa.S or Kg/m.s)

ρ = density (kg/m^3)

The viscosity of a fluid is highly temperature dependent and for either dynamic or kinetic viscosity to be meaningful, the reference temperature must be quoted. The reference temperature for a residual fluid is 100°C. For a distillate fluid the reference temperature is 40°C.

1) For a liquid- the kinematic viscosity will decrease with higher temperature.

2) For a gas- the kinematic viscosity will increase with higher temperature

Viscosity is a property of a liquid related to its state transition temperatures. The state a substance takes depends upon temperature and pressure to which it is being subject. We all know that the temperature can determine whether a substance is solid or liquid, but why does the viscosity of liquid like oil changes with temperature. This is due to the nature of liquids; they are substance where the molecules are loosely associated with one another. Oil is a complex substance with each hydrocarbon molecules consisting of many atoms of carbon, hydrogen and oxygen and others. The atoms in each hydrocarbon molecules are strongly chemically bonded together. The basic property which gives the characteristics we perceive as viscosity is cohesion. Cohesion is an expression of how strongly molecules of a substance are attracted to other molecules of that same substance. This in turn is partly dependent on the size (or weight) of each molecule. It is easy to imagine that a liquid made up of long, stringy molecules would be more viscous than one composed of shorter molecules. It is for this reason increasing viscosity oil is usually denser as well. Lubrication of Oil is critical which only depend on viscosity. All oil shows decrease in viscosity with increase in temperature. The amount of viscosity loss proportional to temperature increase is called Viscosity Index (VI). It is advantageous to have oil which loses viscosity as little as possible as the temperature increases. In this paper an attempt has been made to find out quality of Oil with reference to change in temperature by showing variation in Viscosity with temperature of some domestic usable oil namely Soya bean Oil, Coconut Oil, Kerosene and 2T Oil. The viscosity is finding in terms of Redwood Seconds using Redwood Viscometer No.2

II. MATERIALS & METHODS

The material required to conduct the experiment are

i) Redwood Viscometer No. 2 , ii) Soya bean Oil, iii) Coconut Oil , iv) Kerosene Oil

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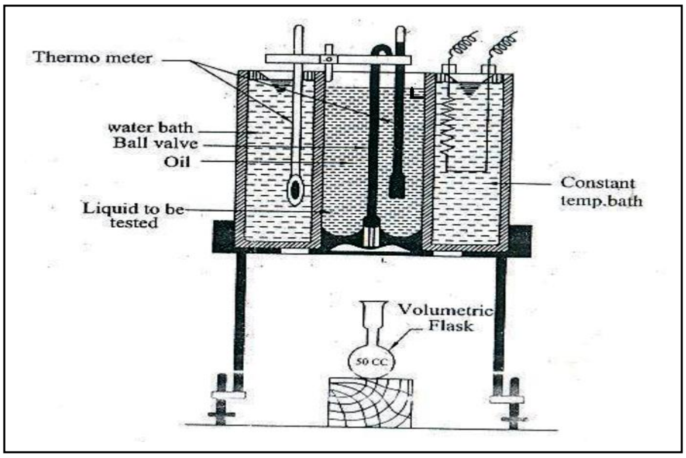
v) 2T Oil , vi) 0° C to 100° C thermometer



Redwood Viscometer No. 2

III. PROCEDURE

- Clean the viscometer cup properly with the help of suitable solvent e.g. CCl4, ether, petroleum spirit or
- Benzene and dry it to remove any traces of solvent.
- Level the viscometer with the help of leveling screws.
- Fill the outer bath with water for determining the viscosity at 100 °C and below.
- Place the ball valve on the jet to close it and pour the test oil into the cup up to the tip of indicator.
- Place a clean dry Kohlrausch flask immediately below and directly in line with discharging jet.
- Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
- Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired
- Temperature, stop the heating.
- Lift the ball valve and start the stop watch. Oil from the jet flows into the flask.
- Stop the Stop Watch when lower meniscus of the oil reaches the25 ml mark on the neck of receiving flask.
- Record the time taken for 25 ml of the oil to collect in the flask.
- Repeat the experiment to get more readings.

IV. RESULTS

Table 3.1: For Soya bean Oil

Sr. No.	Temperature (°C)	Kinematic Viscosity (Redwood Seconds) (v)	Density (ρ) (Kg/m^3)	Dynamic (or absolute) Viscosity (Redwood Seconds) (μ = v x ρ)
1	35	15.77	926	14603.02
2	40	15.17	926	14047.42
3	45	11.67	926	10806.42
4	50	11.25	926	10417.5
5	55	10.93	926	10121.18
6	60	10.13	926	9380.38
7	65	7.73	926	7157.98
8	70	7.23	926	6694.98
9	75	6.87	926	6361.62
10	80	6.35	926	5880.1
11	85	5.92	926	5481.92
12	90	5.64	926	5222.64
13	95	5.43	926	5028.18
14	100	5.23	926	4842.98

Table 3.2: For Coconut Oil

Sr. No.	Temperature (°C)	Kinematic Viscosity (Redwood Seconds) (v)	Density (ρ) (Kg/m^3)	Dynamic (or absolute) Viscosity (Redwood Seconds) (μ = v x ρ)
1	35	16.36	924	15116.64
2	40	15.64	924	14451.36
3	45	12.65	924	11688.6
4	50	11.87	924	10967.88
5	55	11.16	924	10311.84
6	60	10.69	924	9877.56
7	65	10.12	924	9350.88
8	70	9.78	924	9036.72
9	75	8.45	924	7807.8
10	80	7.72	924	7133.28
11	85	7.03	924	6495.72
12	90	5.98	924	5525.52
13	95	5.34	924	4934.16
14	100	5.08	924	4693.92

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Table 3.3: For Kerosene Oil

Sr. No.	Temperature (°C)	Kinematic Viscosity (Redwood Seconds) (v)	Density (ρ) (Kg/m^3)	Dynamic (or absolute) Viscosity (Redwood Seconds) (μ = v x ρ)
1	35	5.82	820.1	4772.982
2	40	5.21	820.1	4272.721
3	45	4.97	820.1	4075.897
4	50	4.74	820.1	3887.274
5	55	4.51	820.1	3698.651
6	60	4.42	820.1	3624.842
7	65	4.29	820.1	3518.229
8	70	4.13	820.1	3387.013
9	75	3.93	820.1	3222.993
10	80	3.79	820.1	3108.179
11	85	3.61	820.1	2960.561
12	90	3.49	820.1	2862.149
13	95	3.28	820.1	2689.928
14	100	3.11	820.1	2550.511

Table3.4: For 2T Oil

Sr. No.	Temperature (°C)	Kinematic Viscosity (Redwood Seconds) (v)	Density (ρ) (Kg/m^3)	Dynamic (or absolute) Viscosity (Redwood Seconds) (μ = v x ρ)
1	35	15.34	900	13806
2	40	14.56	900	13104
3	45	13.43	900	12087
4	50	10.67	900	9603
5	55	10.17	900	9153
6	60	8.58	900	7722
7	65	7.53	900	6777
8	70	7.39	900	6651
9	75	7.04	900	6336
10	80	6.77	900	6093
11	85	6.34	900	5706
12	90	6.06	900	5454
13	95	5.68	900	5112
14	100	5.34	900	4806

V. DISCUSSION

The viscosity of a fluid is an important property in the analysis of liquid behavior and fluid motion near solid boundaries. The viscosity is the fluid resistance to shear or flow and is a measure of the adhesive /cohesive or friction fluid property. The resistance is caused by intermolecular friction exerted when layers of fluids attempt to slide by one another. Viscosity is s measure of a fluid resistance to flow. The knowledge of viscosity is needed for proper design of required temperature for storage, pumping or in by ejection of fluids. There are two related measure of fluid viscosity known as dynamic (or absolute) and kinematic viscosity. The kinematic viscosity can be determined using stoke method (application of gravity) but the dynamic (or absolute) cannot be determine by any such method. The absolute viscosity can be determined if we know the density as well as the kinematic viscosity of a given fluid. In the above study the kinematic viscosity are determined using Redwood Viscometer No.2 and by knowing the value of density of given oil absolute viscosity have calculated. The experimental value of kinematic viscosity in terms of Redwood Seconds and density of corresponding oil is given in column 3 and column 4 of each table and the calculated value of absolute viscosity is shown in the 5 column of each table. Again it will be significance if we see the variation of all these value with temperature. All Oil show deceases in viscosity with increase in temperature (Fig.3.1, 3.2, 3.3 and 3.4). It is an inherent characteristic of liquid in general. Both kinematic and dynamic viscosity decrease with increasing temperature.

As with any sort of viscosity, it is really a measure of how momentum is diffused through a fluid. If you are familiar with the heat equation, you should notice some analogs between it and the Navier-Stokes equations. The heat equation:

$$\frac{\partial \phi}{\partial t} = c^2 \nabla^2 \phi$$

The incompressible Navier-Stokes equation:

$$\frac{\partial v}{\partial t} + v.\nabla v = -\frac{1}{\rho}\nabla p + v\nabla^2 v + f$$

The heat equation is a simplified version of the diffusion equation that describes the diffusion of basically any quantity through a material. In heat transfer, $c^2 = \alpha = \frac{k}{\rho c_p}$ is the thermal diffusivity?

In the Navier-Stokes equations, notice that the $v\nabla^2 v$ term takes the same form, only the N-S equations are a momentum balance, so the kinematic viscosity, ν , is essentially a diffusivity constant that describes how momentum diffuses through the medium. In other words, it describes one particle's ability to affect the momentum of the adjacent particles. As we from fig 3.1 to 3.4 that both the kinematic and dynamic viscosity decrease with temperature so, it may conclude that ability to affect momentum of adjacent particle by previous one decreases with temperature.

VI. CONCLUSION

The above study is used to find the kinematic viscosity of any oil by determining the dynamic viscosity interns of Redwood seconds and same value is used to describe one particle's ability to affect the momentum of the adjacent particles and both the kinematic and dynamic viscosity decrease with temperature so, it may conclude that ability to affect momentum of adjacent particle by previous one decreases with temperature.

VII. FUTURE SCOPE OF STUDIES

The method used above may use for determine the diffusion coefficient of any type of medium though the present study is used only for oil.

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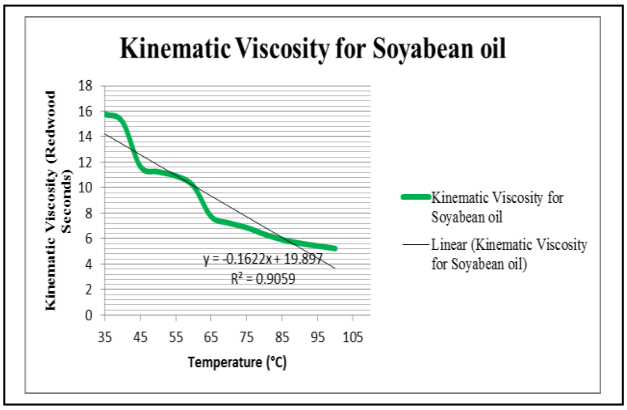
APPENDIX



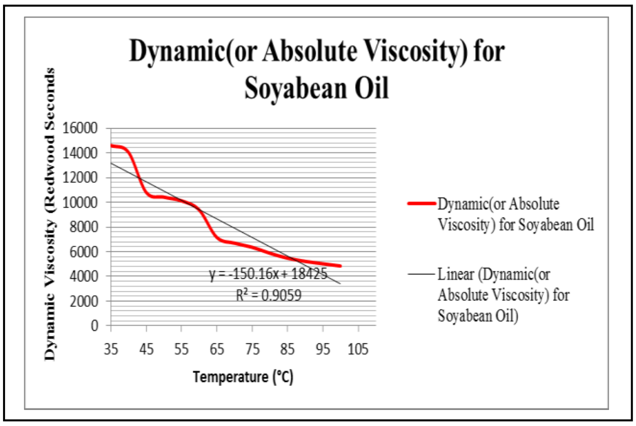
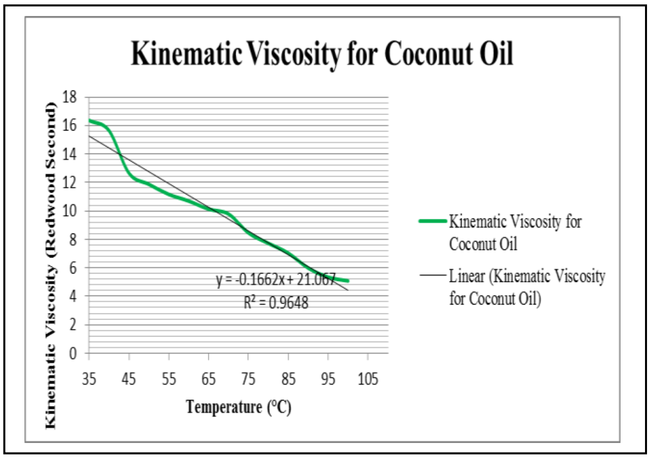


Fig: 3.1 Variation of Kinematic and dynamic Viscosity of Soyabean Oil with temperature. The viscosity is measured in terms of Redwood seconds using Redwood Viscometer



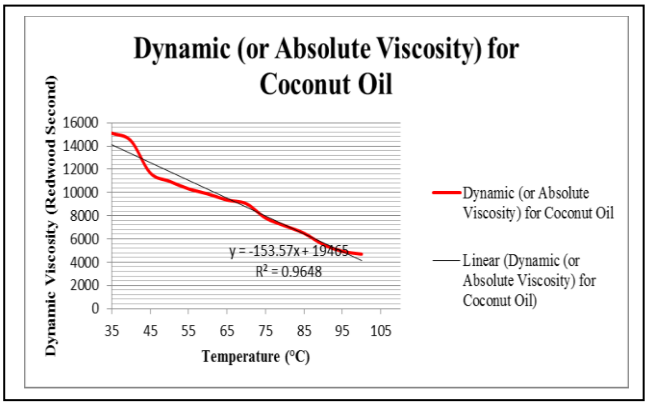
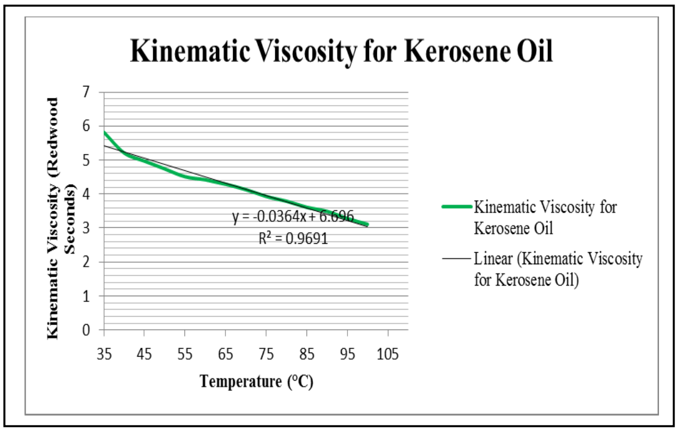


Fig: 3.2 Variation of Kinematic and dynamic Viscosity of Soyabean Oil with temperature. The viscosity is measured in terms of Redwood seconds using Redwood Viscometer



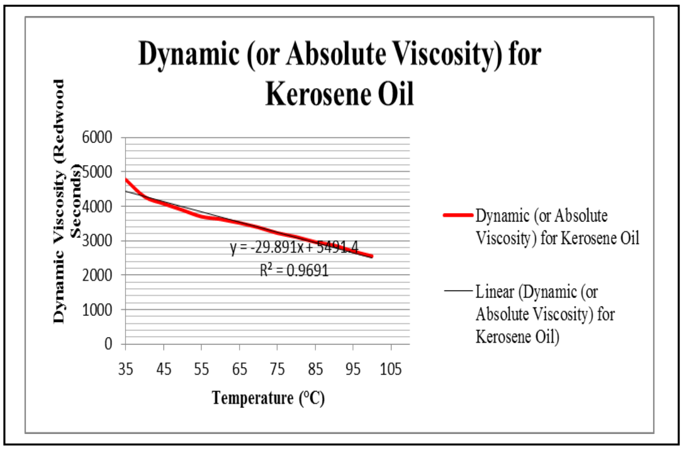


Fig: 3.3 Variation of Kinematic and Dynamic Viscosity of Kerosene Oil with temperature. The viscosity is measured in terms of Redwood seconds using Redwood Viscometer No.2

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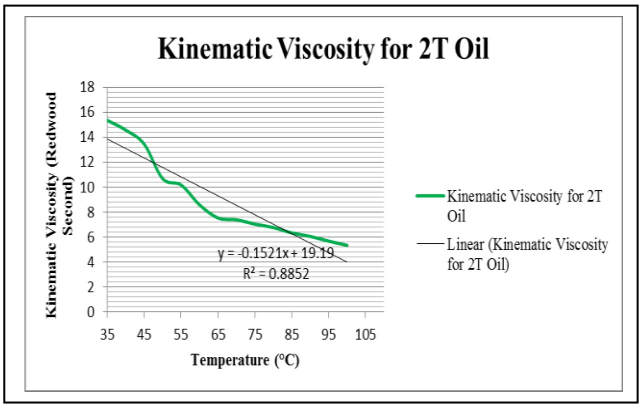

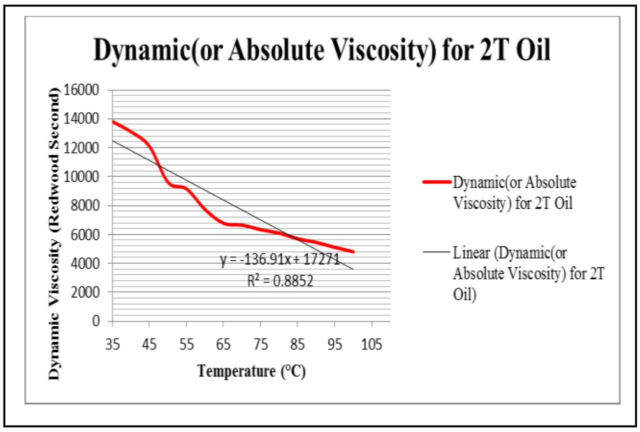

Fig: 3.4 Variation of Kinematic and Dynamic Viscosity of 2T Oil with temperature. The viscosity is measured in terms of Redwood seconds using Redwood Viscometer No.2