MECHANICAL ENGINEERING LAB

LIST OF EXPERIMENTS

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Viscosity Test by Redwood Viscometer I

Introduction: This apparatus is used to determine the viscosity of oil in arbitrary units but not the absolute viscosity. It is primarily intended for the determination of the relative viscosity of any petroleum product which is a true viscous liquid at the temperature of test.

There are two forms of the viscometer-Redwood-I and Redwood-II apparatus, which have the same principle of operation. The No.I instrument shall be used for oils whose viscosity is less than 2000 Secs. and No.II instrument for oils whose viscosity is greater than 1000 secs. only. It will be normally found that the Redwood-II instrument after applying the correction factor and multiplying by 10 will give a figure close to the Redwood I secs. In general test runs shall be made at the following temperatures: Room temperature or 21°C, 38°C, 50°C, 60°C, 94°C & 121°C.

Aim: To study the variation of the viscosity of the given sample of oil with temperature.

Apparatus: Viscometer, sample oil, measuring flask, stopwatch, thermometers, etc.

Description of Redwood No.1 Viscometer:

Oil cup: The oil cup is an open top cylindrical brass vessel of 2-3 mm wall thickness, provided with a flange in the base. The flange is provided with a threaded portion 55 mm + 0.2 overall diameter, by means of which the oil cup is provided with a tapering central hole into which the jet is fitted and cemented concentric with respect to the cup. The level to which the oil is to be filled in the cup is indicated by a tapered and upward turned right angled stout wire. The oil cup is heavily silver plated internally to reduce corrosion.

Jet: The jet is constructed of agate and the central hole is drilled and polished to precision. The upper end of the jet is provided with a concave depression into which a ball valve may be fit for starting or stopping the flow of oil. The lower end is made convex to prevent the out flowing oil from creeping along the base of the oil cup.

Heating bath and stirrer: The cylindrical bath of sheet copper surrounds the oil cup and is provided with a tap for emptying water. An Electrical immersion heater within the bath remote from the oil cup is provided. The stirrer is a cylinder provided with four vanes, the upper and lower portions of which are turned in opposite directions. A curved shield is fixed to the upper edge of the cylinder to within approximately 1.2 cm. of the walls of the bath. This provides both a means of attachment for two insulated handles for rotating the stirrer and support for the bath thermometer.

Valve: The valve for starting and stopping the flow of the liquid from the oil-cup consists of a metal ball carried on a stiff wire, both wire and ball being heavily silver plated. The upper end of the wire is bent to provide a hook by means of which the valve may be hung on the thermometer support so that there is no interference with the flow of the oil through the jet.

Thermometer support: A spring clip is provided to support the oil cup thermometer. This clip is carried on a vertical rod fixed to the upper edge of the oil cup.

Oil-cup cover: The oil cup is furnished with a brass cover fitted with an insulated handle, suitable slots being provided for the oil cup thermometer and valve.

Procedure: The apparatus along with a clean oil cup shall be set up and leveled. The temperature of the bath is adjusted until the temperature of the oil in the cup is maintained at the desired value, the stirrer in the bath being gently rotated continuously, when the temperature of the oil has become quite steady at the desired value, the adjustments of oil level if any, are to be made and the oil cup cover shall be put in position, and the test commenced.

The clean and dry standard 50 ml. Flask shall be placed centrally below the jet. The valve shall then be lifted and the time recording device simultaneously started. The time recording device shall be stopped at the instant the oil reaches the graduation made on the flask and a final reading of the oil cup thermometer is noted. The test shall be considered invalid if the temperature of the oil varies during the test by more than $\pm 0.1^{\circ}C$.

This procedure is repeated to note the afflux time at various temperatures.

Precautions:

1. The Redwood viscometer shall not be used when the time of afflux is less than 30 Secs.
2. For temperatures up to and including 94°C water may be used in the heating both but for higher temperatures it is necessary to use oil.
3. The oil shall be stirred continuously during the preliminary period of heating but the oil shall not be stirred during the actual test.
4. When the ball valve is lifted it shall be suspended from the clip supporting the oil thermometer by means of the hook in the wire stem.
5. It should be ensured before the start of the test, that the ball valve seats properly in its socket and there.
6. A suitable screen could be placed to prevent undue cooling of the under side of the instrument when it is used for tests above 38°C.
7. The bath must be filled with heating liquid to a level not less than 10mm. below the rim of the cup.

Calculation of Viscosities: The relation between viscosity and efflux time is given by

$$\nu = \mu / \rho = A\,T_2 - B / T_2$$

Where ν = kinematic viscosity in stokes (cm^2 / sec)

μ = Absolute viscosity in poises (dyne – sec / cm^2)

ρ = Density of the oil, (gm / cm^3)

T_2 = Redwood seconds,

A and B are constants of the instrument as given below.

In case of lubricating oils, the variation of viscosity with temperature indicates whether a particular oil suitable for a given application, according to the specifications provided by the manufacturer. Viscosity affects load carrying capacity of the oil, i.e., a high viscosity oil will give a good oil film to carry the load but will increase the frictional drive requirement. Factors influenced by viscosity may be summarized as: frictional drag effects, pipe flow losses, flow through small orifices (atomization), load carrying capacity between surfaces, fouling factor, spread factor etc.

INSTRUMENT CONSTANTS :

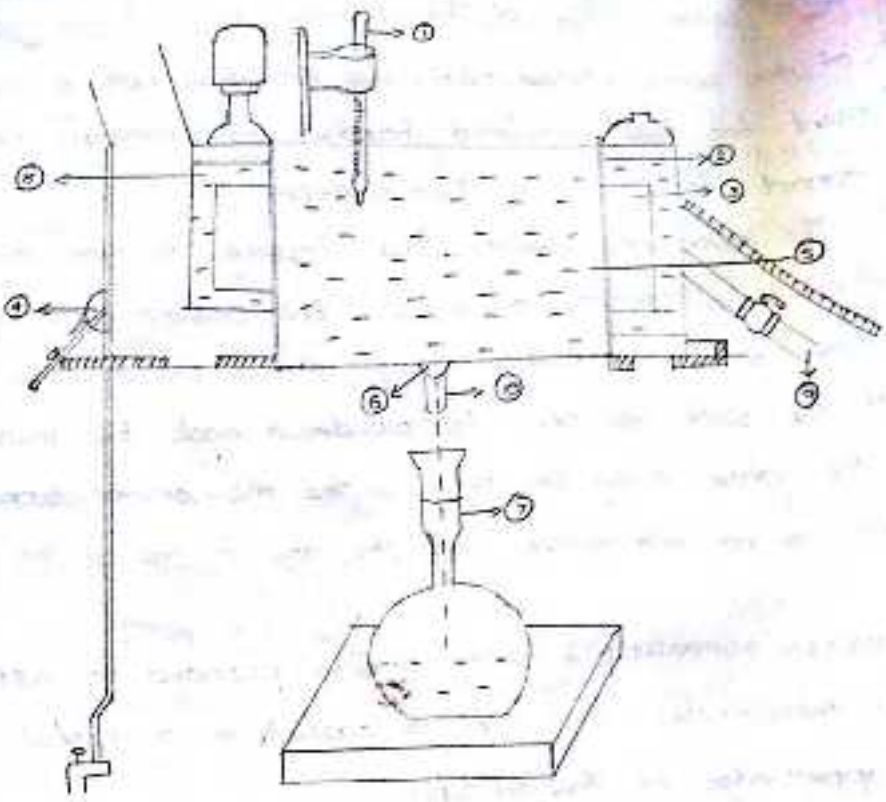
For Redwood No.1 viscometer SAE 30 oil Density 0.884.

A = 0.00264 B = 1.79 for Tr $\leq$ 100 Sec.

A = 0.00246 B = 0.5 for Tr > 100 Sec.

For Redwood No.2 viscometer SAE 30 oil Density 0.884.

A = 0.02458 and B = 0.4 Tr < 2000 Sec.



REDWOOD VISCOMETER - I

1. THERMOMETER
2. OIL CUP
3. STIRRER
4. CABLE
5. OIL
6. BALL VAVE
7. COLLECTING FLASK
8. WATER BATH
9. TAP
10. ORIFICE

Viscosity Test by Redwood Viscometer II

Introduction: This apparatus is used to determine the viscosity of oil in arbitrary units but not the absolute viscosity. It is primarily intended for the determination of the relative viscosity of any petroleum product which is a true viscous liquid at the temperature of test.

There are two forms of the viscometer-Redwood-I and Redwood-II apparatus, which have the same principle of operation. The No.I instrument shall be used for oils whose viscosity is less than 2000 Secs. and No.II instrument for oils whose viscosity is greater than 1000 secs. only. It will be normally found that the Redwood-II instrument after applying the correction factor and multiplying by 10 will give a figure close to the Redwood I secs. In general test runs shall be made at the following temperatures: Room temperature or 21°C, 38°C, 50°C, 60°C, 94°C & 121°C.

Aim: To study the variation of the viscosity of the given sample of oil with temperature.

Apparatus: Viscometer, sample oil, measuring flask, stopwatch, thermometers, etc.

Description of Redwood No.2 Viscometer:

Oil cup: The oil cup is an open top cylindrical brass vessel of 2-3 mm wall thickness, provided with a flange in the base. The flange is provided with a threaded portion 55 mm + 0.2 overall diameter, by means of which the oil cup is provided with a tapering central hole into which the jet is fitted and cemented concentric with respect to the cup. The level to which the oil is to be filled in the cup is indicated by a tapered and upward turned right angled stout wire. The oil cup is heavily silver plated internally to reduce corrosion.

Jet: The jet is constructed of agate and the central hole is drilled and polished to precision. The upper end of the jet is provided with a concave depression into which a ball valve may be fit for starting or stopping the flow of oil. The lower end is made convex to prevent the out flowing oil from creeping along the base of the oil cup.

Heating bath and stirrer: The cylindrical bath of sheet copper surrounds the oil cup and is provided with a tap for emptying water. An Electrical immersion heater within the bath remote from the oil cup is provided. The stirrer is a cylinder provided with four vanes, the upper and lower portions of which are turned in opposite directions. A curved shield is fixed to the upper edge of the cylinder to within approximately 1.2 cm. of the walls of the bath. This provides both a means of attachment for two insulated handles for rotating the stirrer and support for the bath thermometer.

Valve: The valve for starting and stopping the flow of the liquid from the oil-cup consists of a metal ball carried on a stiff wire, both wire and ball being heavily silver plated. The upper end of the wire is bent to provide a hook by means of which the valve may be hung on the thermometer support so that there is no interference with the flow of the oil through the jet.

Thermometer support: A spring clip is provided to support the oil cup thermometer. This clip is carried on a vertical rod fixed to the upper edge of the oil cup.

Oil-cup cover: The oil cup is furnished with a brass cover fitted with an insulated handle, suitable slots being provided for the oil cup thermometer and valve.

Procedure: The apparatus along with a clean oil cup shall be set up and leveled. The temperature of the bath is adjusted until the temperature of the oil in the cup is maintained at the desired value, the stirrer in the bath being gently rotated continuously, when the temperature of the oil has become quite steady at the desired value, the adjustments of oil level if any, are to be made and the oil cup cover shall be put in position, and the test commenced.

The clean and dry standard 50 ml. Flask shall be placed centrally below the jet. The valve shall then be lifted and the time recording device simultaneously started. The time recording device shall be stopped at the instant the oil reaches the graduation made on the flask and a final reading of the oil cup thermometer is noted. The test shall be considered invalid if the temperature of the oil varies during the test by more than $\pm 0.1^{0}C$.

This procedure is repeated to note the afflux time at various temperatures.

Precautions:

1. The Redwood viscometer shall not be used when the time of afflux is less than 30 Secs.
2. For temperatures up to and including $94^{0}C$ water may be used in the heating both but for higher temperatures it is necessary to use oil.
3. The oil shall be stirred continuously during the preliminary period of heating but the oil shall not be stirred during the actual test.
4. When the ball valve is lifted it shall be suspended from the clip supporting the oil thermometer by means of the hook in the wire stem.
5. It should be ensured before the start of the test, that the ball valve seats properly in its socket and there.
6. A suitable screen could be placed to prevent undue cooling of the under side of the instrument when it is used for tests above $38^{0}C$.
7. The bath must be filled with heating liquid to a level not less than 10mm. below the rim of the cup.

Calculation of Viscosities: The relation between viscosity and efflux time is given by

$$\nu = \mu / \rho = A\,T_1 - B / T_1$$

Where ν = kinematic viscosity in stokes (cm^2 / sec)

μ = Absolute viscosity in poises (dyne – sec / cm^2)

ρ = Density of the oil, (gm / cm^3)

T_1 = Redwood seconds.

A and B are constants of the instrument as given below.

For Redwood No.2 viscometer SAE 40 with an oil density 0.87 kg/m^3.

A = 0.02458 and B = 0.4 for Time (redwood seconds) < 2000 Sec.

Observations and Calculations:

Type of the Viscometer: RW 2
Name of oil sample: SAE 40
Density of the oil: 0.87 kg/m^3

S.No.	Temp. ^{0}C	Time Secs	AT_1	B/T_1	ν stokes	Log ν	μ poise

Model Calculation: Sample calculation for one set of readings should be included.

Graphs: The following graphs should be drawn.

1. Temperature V_t efflux time
2. Temperature V_t kinematic viscosity
3. Temperature V_t log kinematic viscosity

Report: The time in seconds as determined shall be reported to the nearest 0.5 sec. specifying the type of instrument and temperature as indicated below.

Ex: Redwood viscosity No. ---2----------, at ----------, ----------sec
(temperature ^{0}C) (time)

Significance of the Test: Apart from affecting the power required to pump the fuel through pipe lines of the fuel system, viscosity has very marked influence upon the formation of the fuel spray in the combustion chamber of the engine and thus upon the rate of vaporization as well as combustion.

In case of lubricating oils, the variation of viscosity with temperature indicates whether a particular oil suitable for a given application, according to the specifications provided by the manufacturer, Viscosity affects load carrying capacity of the oil, i.e., a high viscosity oil will give a good oil film to carry the load but will increase the frictional drive requirement. Factors influenced by viscosity may be summarized as: frictional drag effects, pipe flow losses, flow through small orifices (atomization), load carrying capacity between surfaces, fouling factor, spread factor etc.

6. A suitable screen could be placed to prevent undue cooling of the under side of the instrument when it is used for tests above 38°C.

7. The bath must be filled with heating liquid to a level not less than 10mm. Below the rim of the cup.

CALCULATION OF VISCOSITIES : The relation between viscosity and efflux time is given by

$$\nu = \mu / \rho = A\,T_f - B / T_f$$

Where ν = kinematic viscosity in stokes (cm^2 / sec)
μ = Absolute viscosity in poises (dyne – sec / cm^2)
ρ = Density of the oil, (gm / cm^3)
T_f = Redwood sec.
A and B are constants of the instrument as given below.

A = 0.00264	B = 1.79	for $T_f \leq$ 100 sec.
A = 0.00246	B = 0.5	for $T_f >$ 100 sec.

OBSERVATIONS AND CALCULATIONS :

Type of the Viscometer Name of sample Density of the oil :

S.No.	Temp. °C	Time Secs	AT_f	B/T_f	ν stokes	Log ν	μ poise

MODEL CALCULATIONS : Sample calculation one set of readings should be included.

GRAPHS : The following graphs should be drawn.

1. Temperature V_s eillux time
2. Temperature V_s kinematic viscosity
3. Temperature V_s log kinematic viscosity

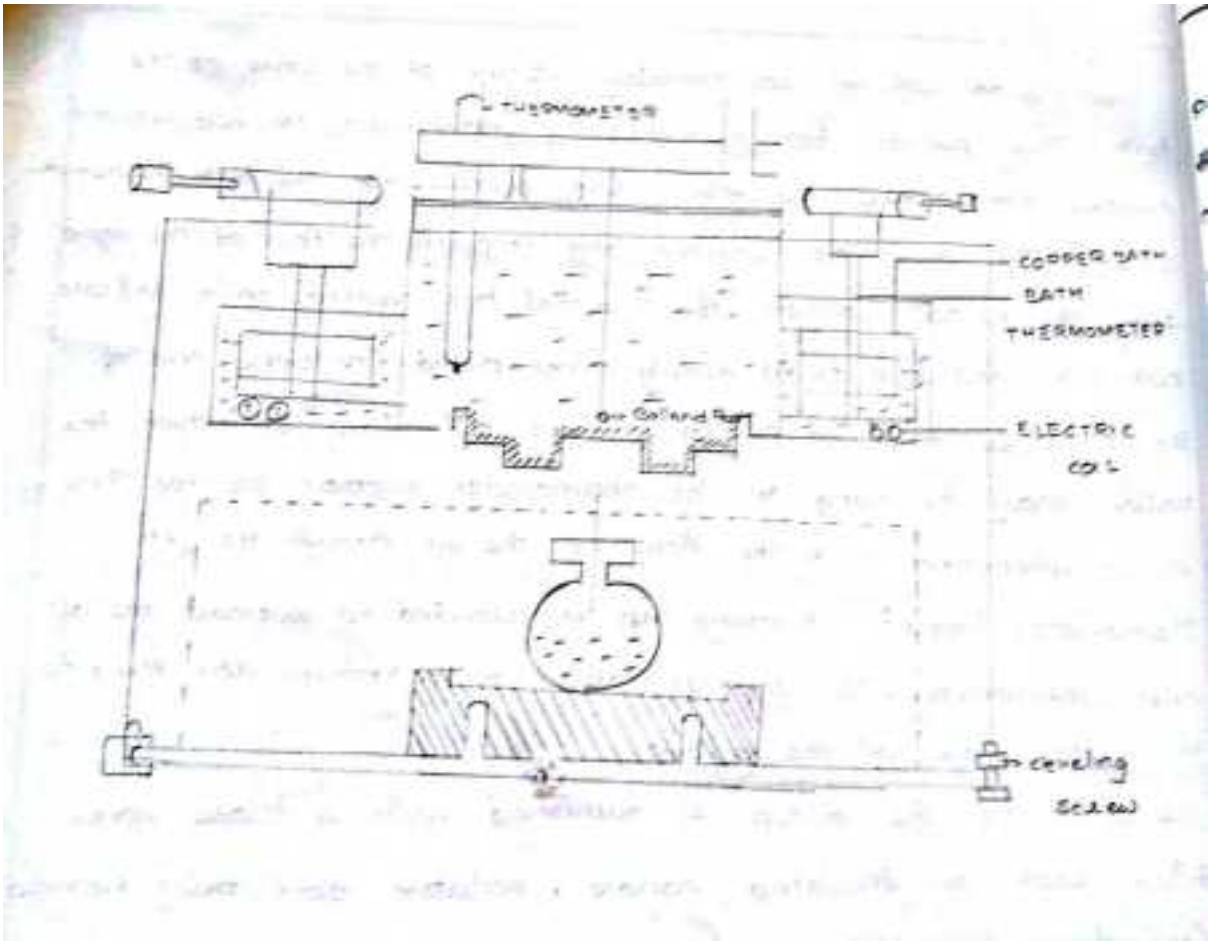
REPORT :

The time in secs. as determined shall be reported to the nearest 0.5 secs. specifying the type of instrument and temperature as indicated below.

Ex: Redwood viscosity No.———— at ———— ————secs.
(temperature °C) (time)

SIGNIFICANCE OF THE TEST :

Apart from affecting the power required to pump the fuel through pipe lines of the fuel system, viscosity has very marked influence upon the formation of the fuel spray in the combustion chamber of the engine and thus upon the rate of vaporization as well as combustion.


THERMOMETER
COPPER BATH
BATH
THERMOMETER
ELECTRIC
COIL
leveling
screw

Calibration of Pressure Gauge

Aim: To calibrate the given pressure gauge and draw the calibration curves.

Apparatus: Pressure gauge with fittings, Pressure gauge testing equipment and Vernier calipers.

Description: The apparatus used for finding out the accuracy of the pressure gauge consists of an oil barrel with a screwed piston, inside it. The barrel has on one side a vertical cylinder with a plunger and on the other side another cylinder connected to the pressure gauge to be calibrated. The oil sent into the barrel can be compressed by a screwed piston. When the oil enters the barrel through the oil cup, the screw will be closed by tightening. As such, the oil is filled in to the barrel fully up to the plunger at one side and up to the pressure gauge on the other side. When the piston is screwed in, the plunger is lifted to some extent due to the pressure of the oil in the barrel. The same pressure is maintained, all the way throughout the oil, according to Pascal's law, and it is denoted by the pressure gauge reading. By keeping different weights on the plunger head, the corresponding pressure is shown on the pressure gauge.

Sketch: A representative figure of the apparatus with details should be included.

Procedure: The oil is poured in the oil cup. The cock of the oil cup is opened so that oil enters into the barrel. Then the screw is opened fully and tightened four or five times in order to release to air from the oil barrel and to fill it completely with oil. As soon as it is observed that no air bubbles are coming out, the screw is kept in full open position and the cock in the oil cup is closed. By slight tightening of the screw, the plunger is lifted under oil pressure and the whole system is in equilibrium. The weight of the plunger alone acts on the oil and the corresponding pressure shown by the pressure gauge is noted. By putting various weights on the plunger head, the correspooding gauge pressures are noted.

The actual pressure developed due to the weights placed on the plunger head is found out by

$$p = F/A = (W + w) * 4 / \pi D^2$$

Where W = Weight placed on the plunger head
w = Weight of the plunger = 1 Lb. = 335.6 gm
D = Diameter of the plunger = 0.37 inches

Or

The weights are directly calibrated as pressure (kg/cm^2) values based upon standard plunger diameter.

The error in the gauge is given by the difference of gauge pressure and the calculated pressure. Correction is negative of the error. Then, the percentage error and the percentage correction are calculated on the basis of pressure gauge reading. The graphs are drawn for the correction and percentage correction against gauge pressure.

Observations:

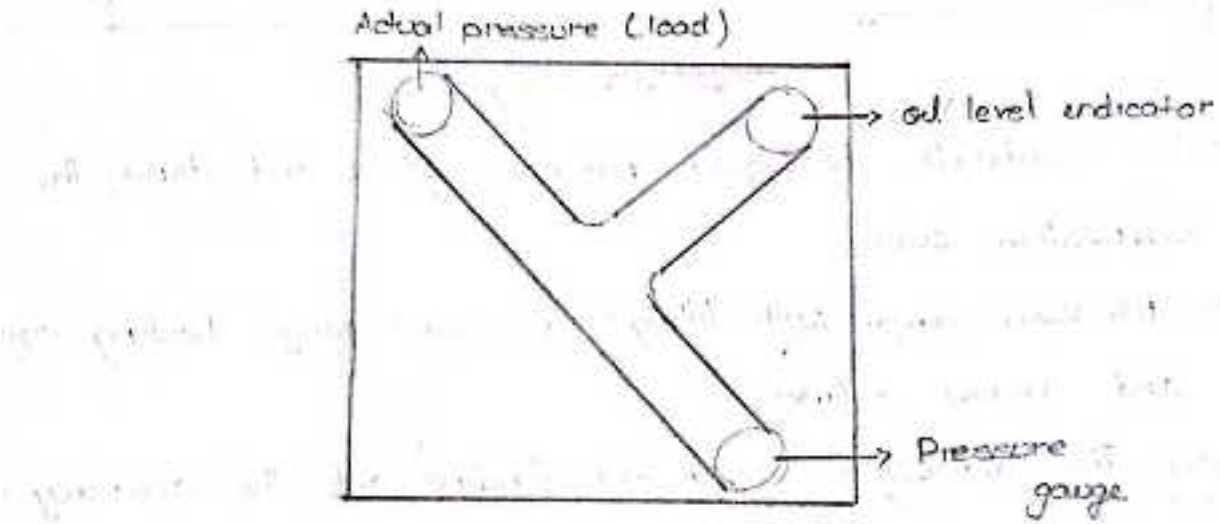
S. No.	Load Pressure in kg/cm^2	Gauge pr. (1) in kg/cm^2	Cal. Pr. (2) in kg/cm^2	Error (3) = (1)-(2) in kg/cm^2	Correction (4) = (2)-(1) in kg/cm^2	%error = $\frac{(3)}{(2)} * 100$	%correction = $\frac{(4)}{(2)} * 100$
1							
2							

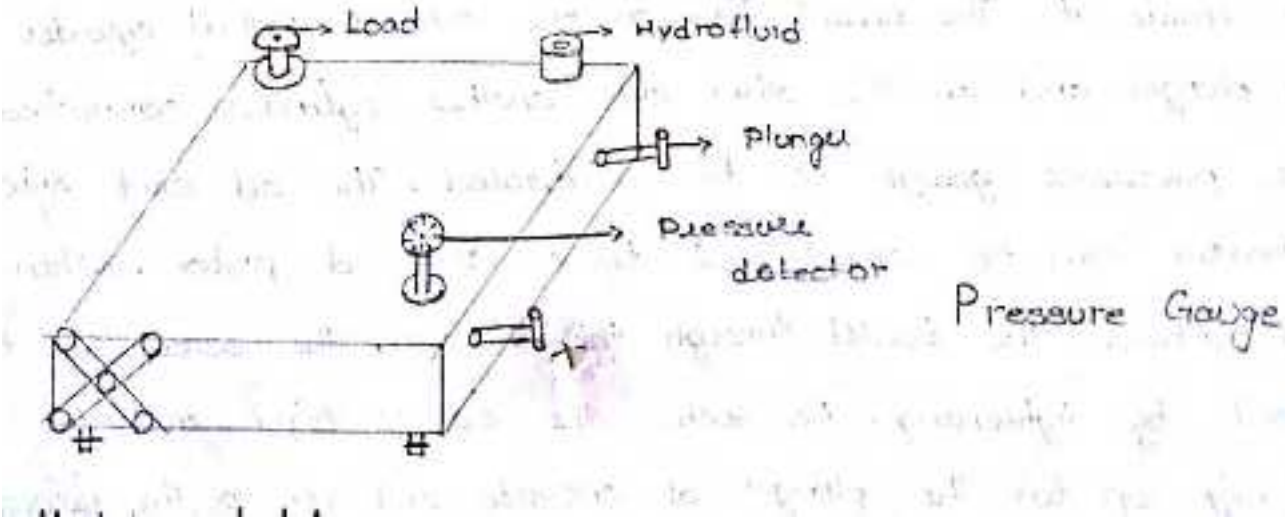
Model Calculation:

Precautions:

Conclusion:

Significance of the Test: All mechanical devices are to be checked frequently as they may loose their accuracy due to wear and tear as well as repeated use. Further, material deterioration, mechanical deformity, loss of elastic properties, friction etc., may cause improper measurements. For example, with a pressure gauge, leakage of oil, deformation of Bourdon tube, change in cross section of tube may be some the causes to indicate inaccurate readings. Hence, frequent and periodic calibration of pressure gauges is an essential step in preventive maintenance schedule of any plant. Moreover, any manufacturing defects of equipment can be identified by means of initial calibration of measuring instruments.





Pressure Gauge

Flash and Fire Point Test – Cleveland's Open Tester

Aim: To determine the Flash and Fire points of given by using Cleveland open tester.
Apparatus: Cleveland open tester, thermometer, splinters and a spirit lamp.

Theory: Flash Point:

The flash point of oil is the lowest temperature of the oil that allows inflammable vapor to be formed.

Fire Point:

The temperature at which the oil gives of sufficient vapors which on application of a test flame ignites and continuously to burn for a period of at least 5 seconds.

Preparation of Apparatus

1. Support the tester on a level steady table in a draft-free room as component. During the test 30°F (17°C) rise in the temperature prior to the flash point, care must be taken to avoid disturbing the vapors in the test cup by careless movement or breathing near the cup.

2. Clean the cup with an appropriate solvent and remove all gums, carbon deposits and oxide coating from the inside of the cup with fine steel wool until a bright metallic surface is prepared.

3. Support the thermometer in vertical position with the bottom of the bulb ¼ in (0.635 cm) from the bottom of the cup and above a point half way between the centre and back of the cup.

Procedure:

Fill the cup at any convenient temperature so that the top of the meniscus is exactly at the filling line. Destroy any air bubbles on the surface of the sample. Light the test flame and adjust it to a diameter of 5/32 in. ± 1/32 in. (0.4 ± 0.08 cm), the size of the comparison bead, if one is mounted on the apparatus. Apply heat initially so that the rate of temperature rise of the sample is 23 to 30°F per minute. When the sample temperature is approximately 100°F (56°C) below the anticipated flash point, decrease the heat so that the rate of temperature rise for this last 50°F before the flash point is 10°F/min.

Starting at least 50°F below the flash point, apply the test flame when the temperature read on the thermometer reaches each successive 5°F mark. Pass the test flame across the centre of the cup, at right angles to the diameter which passes through the thermometers. With a smooth, continuous motion apply the flame in a straight line or along the circumference of a cycle. The centre of the test flame moves in a plane not

more than 5/64 in. (0.2 cm.) above the plane of the upper edge of the cup. The time consumed in passing the test flame across the up shall be about 1 second.

Record the flash point as the temperature read on the thermometer when a flash appears at any point on the surface of the oil, but do not confuse the true flash with the blush halo that some times surrounds the test flame.

To determine the fire point, continue heating so that the sample temperature increases at a rate of $10^{0} \pm 1^{0}$F per minute. Continue the application of the test flame at 5^{0}F intervals until the oil ignites and continuous to burn for at least 5 seconds. Record the temperature at this point on the fire point of the oil.

Correction for Barometric Pressure:

If the barometric pressure at the time of the tests is less than 715 mm, of mercury, record it and add the appropriate correction from table 1 to the flash and fire points as determined.

Table 1 Corrections for Barometric Pressure

Barometric Pressure in mm of mercury	Corrections ^{0}F	^{0}C
715 to 635	5	2.8
634 to 550	10	5.5

Observations: Name of the oil sample:

S. No	Trial	Flash point in ^{0}C	Fire point in ^{0}C
1	1		
2	2		

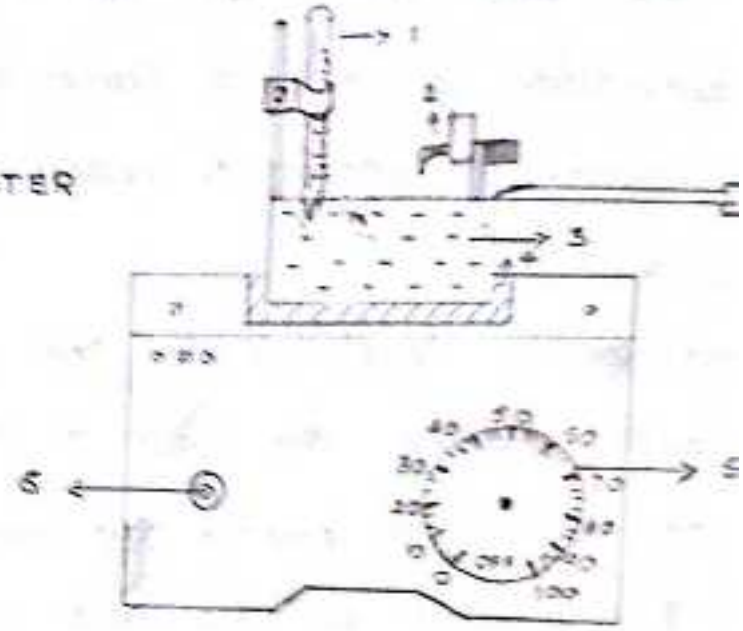
Result: The Flash point and Fire points of given ---------- oil are, respectively,

----------^{0}C, ----------^{0}C

Note: The sketch of the apparatus (Cleveland's open tester) is provided by the student.

CLEVELAND'S

OPEN TESTER



1 - THERMOMETER

2 - TEST FLAME

3 - OIL SAMPLE

4 - ASBESTOS PLANE

5 - REGULATOR

6 - INDICATOR

7 - HOLDER

Flash Point by Pensky Martins Apparatus

Aim: To determine the flash point of the given oil sample using Pensky –Martin's apparatus.

Apparatus: Pensky Martin's apparatus, heating element, auto transformer rheostat, standard thermometer, oil sample (kerosene).

Theory: The flash point is the lowest temperature at which it gives sufficient vapour so that when mixed with air forms an ignitable mixture and gives momentary flash and application of a small plot flame.

Flammable liquids are volatile and speed of evaporation increases appreciably when the liquid is heated .The vapors being heavier than air go on accumulating at the lowest level such that pits under the tank when their concentration reaches within the explosive range and explode and burn in the presence of an ignition source .This can be prevented by mechanical ventilation of any pit at the bottom of oil tanks. This increases the rate of diffusion of vapors and the explosive range is not approached.

Apparatus Description: It consists of an oil cup which is above 5 cm in diameter and 5.5 cm deep. The level of the oil is to be filled to I marked inside the cup .The cup lid is provided with an opening of standard thermometer which is inserted in one passage second passage is for introducing the flame, third opening possesses stirrers carrying four blades and fourth is meant for admissions of air shutter opens the lid and flame is dipped into the opening thereby bringing the flame over the oil surface, flame exposure device is a small flame and this is connected to the shutter by a lever mechanism .Oil cup is supported by its flange over a water bath which is heated by an electric heater .It is an indirect heating system. Thus water in the bath is heated first and later, the heat is transferred to the oil cup.

Procedure:

1. Clean the oil cup thoroughly and fill it with the oil sample upto the mark given.
2. Insert the thermometer into the oil cup through the clamp which indicates the oil temperature.
3. Connect the heater through the mains through an auto transformer or rheostat and rate of heating is adjusted.
4. The oil sample is tested for a flash point with a test flame for every 2°C rise in temperature.
5. When the oil given momentary flash on the application of test flame the corresponding temperature is recorded as the flash point of the oil.
6. Repeat the experiment with fresh oil sample three times to increase the accuracy.

Precautions

1. As moisture affects the flash point, all parts of the cup at its accessories should be dried before placing oil in the cup.
2. Always a fresh portion of oil sample should be used .A second determination on the same portion of oil shows higher flash point.
3. Thermometer bulb should not touch the bottom of the oil cup.
4. Thermometer should be inserted carefully through the sample.
5. Stirring should be discontinued during the application of the test flame.
6. For applying test flame, the slide should be opened and closed quickly.

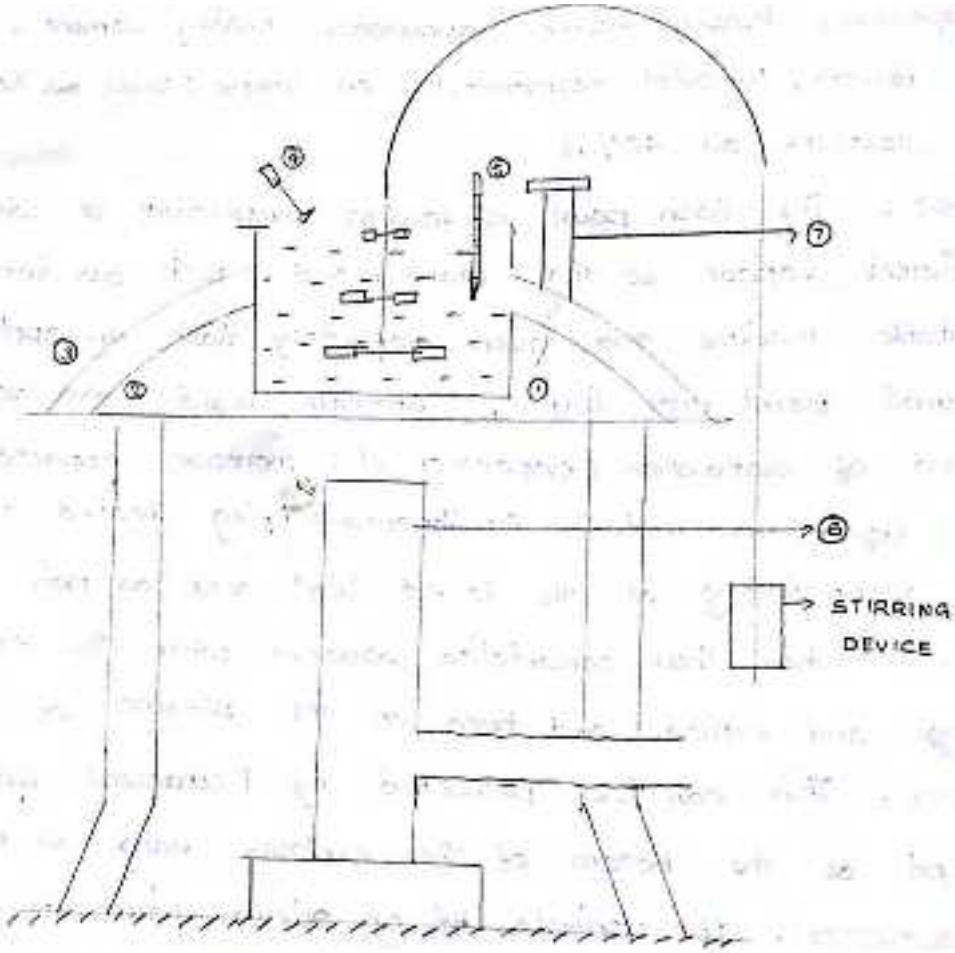
Observations

Name of the oil used:

S.No	Trail Number	Flash Point ^{0}C

Result

The flash point of the given---------- oil is found to be ___ ^{0}C.



PENSKY MARTINS CLOSED FLASH TESTER

1. Hoged oilcup
2. annular iron casting
3. Brass Jacket
4. Test Flame
5. Thermometer
6. Burner
7. slide arrangement

JUNKER'S GAS CALORIMETER

Aim: Experimental Determination of the Calorific value of gaseous fuel by Junker's Gas Calorimeter.

Apparatus: Junker's Gas Calorimeter, stop watch, thermometers (three numbers), circulating water collecting tank.

Description: The gas calorimeter is of non-recording flow type and is used for the determination of calorific value of combustible gases. It consists of a gas meter, a gas pressure regulator with manometer attached to it, a suitable burner to maintain complete combustion of the gas and a set of accurate thermometers. The gas first passes through the gas meter and via the regulator is led to burner. The calorimeter is so designed that the gases from the burner flame pass upwards through the combustion chamber and at the top are deflected downwards and pass through the flues and finally escape into the air through the outlet. The combustion chamber is enclosed by a water jacket. The calorimeter is enclosed in an outer cover to minimize radiation losses. There is an outlet for condensed projects of combustion.

Definition: The calorific value of a gaseous fuel is defined as the amount of heat liberated in K.cal. by complete combustion of 1 cubic metric of gas at S.T.P.

Procedure: The regulator is so adjusted that a very uniform flow of gas is maintained. Pressure of the gas is measured by the manometer. The rate of gas flow is obtained by timing the rotating hand of the gas meter with in stop watch. The gas temperature is measured at the inlet to the gas meter by a thermometer. The temperature of the products of combustion is measured by another thermometer placed at the outlet for the products of combustion. The water inlet temperature is measured by a thermometer at J water outlet temperature is measured by another thermometer. Water flowing continuously absorbs heat produced by burning gas and is finally discharged in measuring collecting tank to know the rate of flow of the water.

Readings: The calorific value of an gaseous fuel is usually expressed in heat units per cubic metre of gas at S.T.P.

Let 't' be the duration of the test

Gas used V_{gas} = ... m^3
Gas temperature at inlet T_{gas} = ... ^0C
Barometric reading h_b = ... cm. of mercury
Manometer reading h_w = ... cm. of water

Gas pressure $P_g = \left(\frac{h_w}{13.6} + h_b\right)$ cm. of mercury abs.

= ..... cm. of mercury abs.

Cooling water temperature at inlet t_{1w} = ... ^{0}C

Cooling water temperature at outlet t_{2w} = ... ^{0}C

Total amount of cooling water W = ... Kg.

Specific heat of water

C = Unity

Pressure at STP, P_o = 76 cm. of mercury

Temperature at STP T_o = 288 K

Volume of gas reduced to STP conditions

$$V_o = \frac{V_{gas} \; P_{gas}}{T_{gas}} \cdot \frac{T_o}{P_o} = \ldots\ldots\ldots m^3$$

∴ Higher calorific value of the gas is given by,

$$H.C.V. = \frac{C_w \; W \; (t_{2w} - t_{1w})}{V_o}$$

H.C.V. = ... $Kcal/m^3$

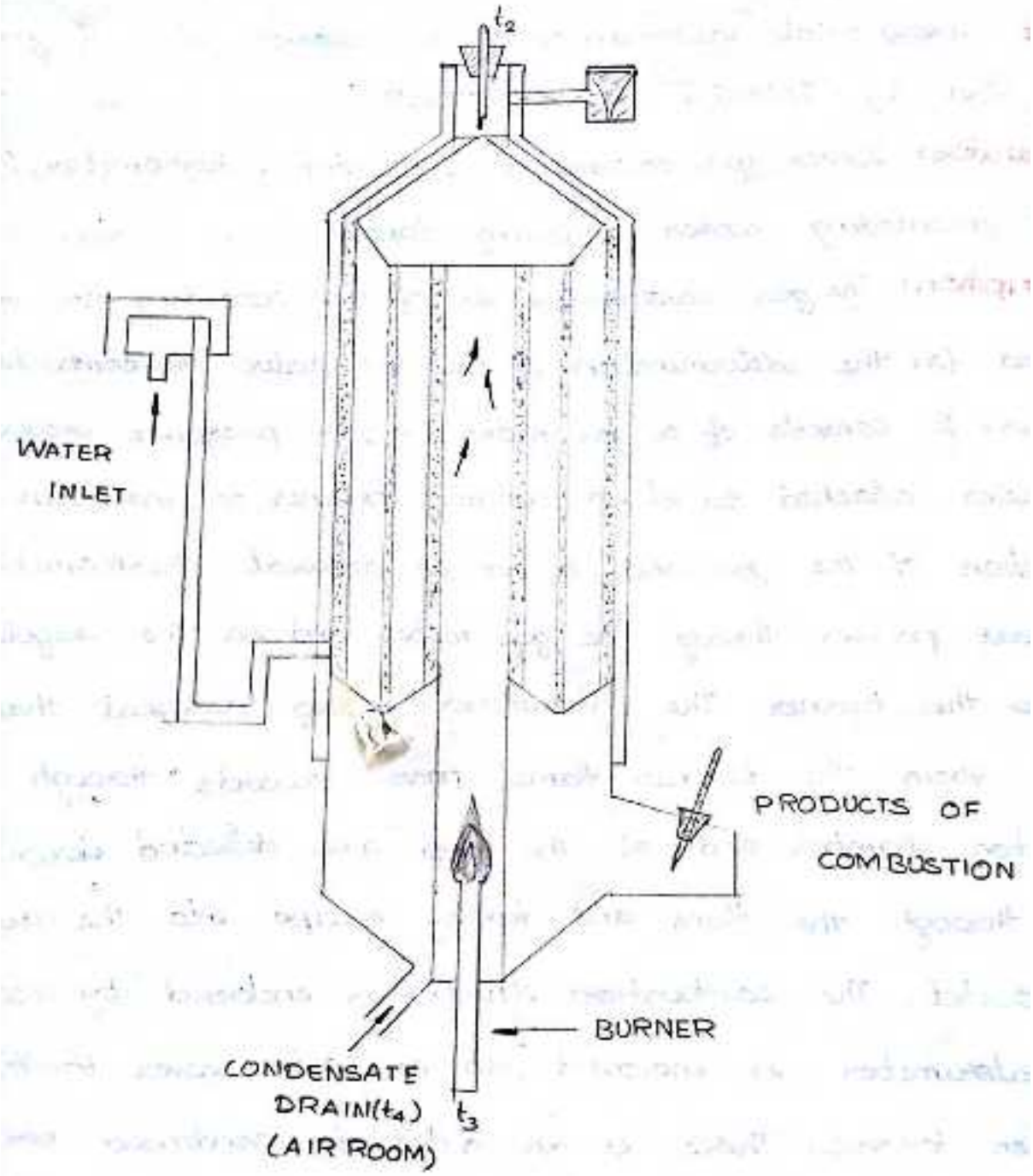
The experiment is repeated for two more trials and the average reading of H.C.V. is to be taken.

Precautions:

1) The gas flow meter should be kept perfectly horizontal.
2) Test readings are to be taken only after the steady conditions are reached.
3) There should not be much variation in velocity of flowing water from tap.
4) The temperature of circulating water should not be less than 5°C below the room temperature

---------- x ----------

Note: Sketch of the Junker's gas calorimeter is to be provided by the student.



JUNKERS GAS CALORIMETER