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Department of Mechanical Engineering

COURSE NAME	**: ENERGY LAB MANUAL**
COURE CODE	**: 17MEL58**
SEMESTR	**: V**

REDWOOD VISCOMETER

AIM

To determine the viscosity in Redwood seconds of the given sample of oil and to plot the variation of Redwood seconds, kinematic and dynamic viscosity with temperature.

APPARATUS

- Redwood viscometer-I,
- Stopwatch,
- Thermometer (0-110^{0}C)
- Measuring flask. (50 c.c.)

THEORY

The viscosity of given oil is determined as the time of flow in Redwood seconds. The viscosity of a fluid indicates the resistance offered to shear under laminar condition. Dynamic viscosity of a fluid is the tangential force on unit area of either of two parallel planes at unit distance apart when the space between the plates is filled with the fluid and one of the plate's moves relative to the other with unit velocity in its own plane. The unit of dynamic viscosity is dyne-sec/cm^2. Kinematic viscosity of a fluid is equal to the ratio of the dynamic viscosity and density of the fluid. The unit of kinematic viscosity is $cm^2/\sec$.

DESCRIPTION

Redwood viscometer-I consists of a water bath and oil bath, both provided with two thermometers inside them. There is a ball valve, which is located at center of oil bath to flow of oil through the orifice. A heater with regulator is fixed for heating purpose.

PROCEDURE

1. Clean the oil cup with a suitable solvent thoroughly and dry it using soft tissue paper.
2. Keep the ball valve in its position so as to keep the orifice closed.

3. The water is taken into the water bath and the oil whose viscosity is to be determined is taken into the oil cup up to the mark.
4. Note down the time taken in Redwood seconds for a collection of 50 cc. of oil with a stopwatch at the room temperature without supply of electric supply.
5. Heat the bath and continuously stir it taking care to see that heating of the bath is done in a careful and controlled manner.
6. When the desired temperature is reached, place the cleaned 50 c.c. Flask below the orifice in position.
7. Remove the ball valve and simultaneously start a stopwatch. Note the time of collection of oil up to the 50 c.c. Mark.
8. During the collection of oil don't stir the bath. Repeat the process at various temperatures.

OBSERVATIONS

S. No.	Oil Temperature ^{0}C	Time for collecting 50 c.c. of oil sec	Kinematic viscosity $\nu = (A \times t) - \left(\frac{B}{t}\right)$ cm^2/sec	Density (ρ) gm/sec	Absolute Viscosity $\mu = \nu \times \rho$ $dyne-sec/cm^2$

Where

$A = 0.0026 \ \frac{cm^2}{\sec^2}$

$B = 1.72 \ cm^2$

GRAPHS TO BE DRAWN

1. Redwood seconds *Vs*. temperature
2. Kinematic Viscosity *Vs*. temperature
3. Absolute Viscosity *Vs*. temperature

PRECAUTIONS

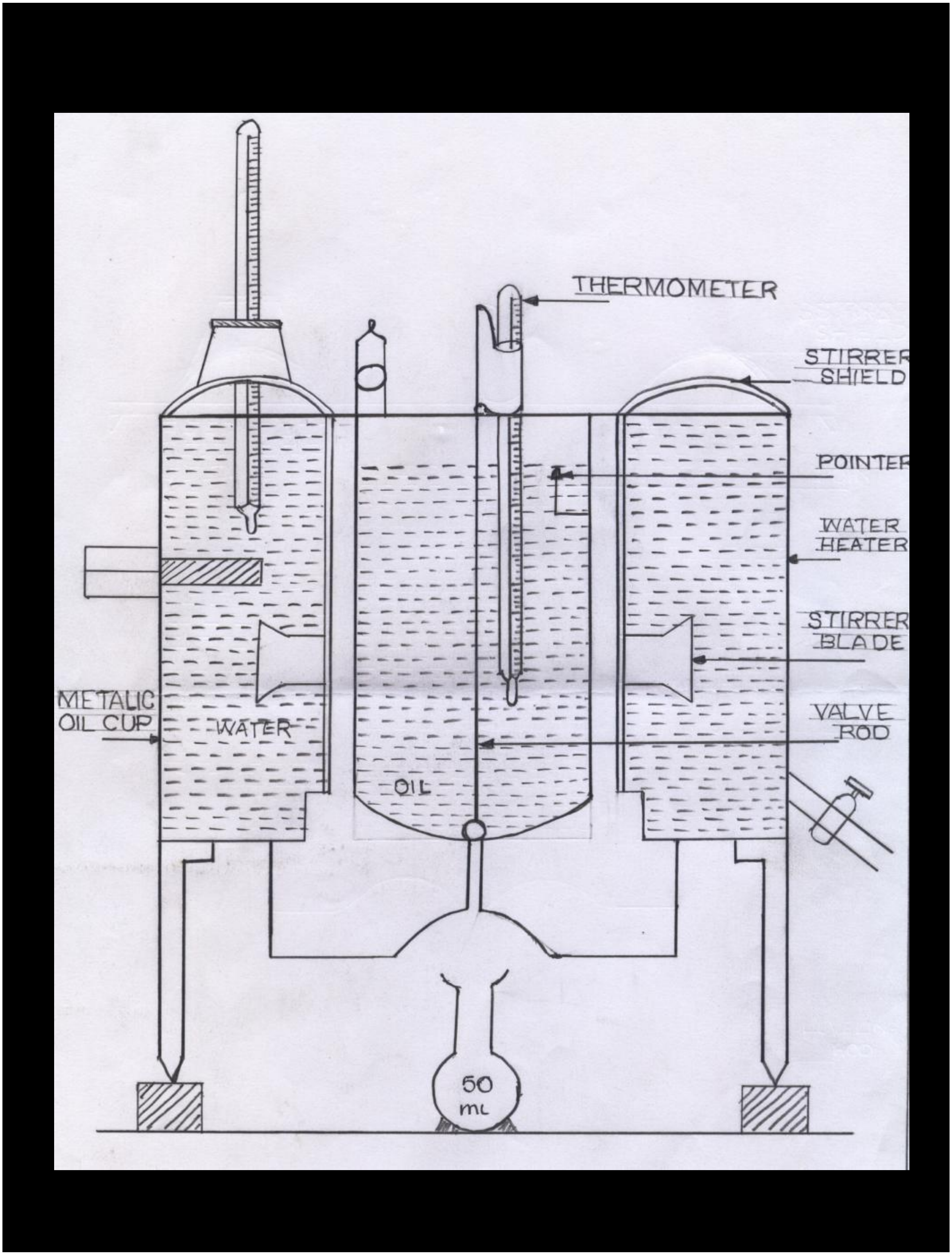
1. Stir the water continuously so that the temperature of the oil and water are equal.

Temp

2. Before collecting the oil at a temperature, check whether the oil is up to the Indicator in the oil cup.
3. Always take the readings at a stable temperature
4. Ensure proper setting of the ball valve to avoid leakage

RESULT

Variation of Redwood seconds, absolute viscosity and Kinematic viscosity with temperature, were observed and found to be decreasing with temperature.


THERMOMETER
STIRRER SHIELD
POINTER
WATER HEATER
STIRRER BLADE
VALVE ROD
METALIC OIL CUP
WATER
OIL
50 ml


YBOLT VISCOME

SAYBOLT VISCOMETER

AIM

To determine the viscosity in Saybolt seconds of the given sample of oil and to plot the variation of Saybolt seconds, kinematic and dynamic viscosity with temperature.

INSTRUMENTS

- Saybolt viscometer,
- Stop watch,
- Thermometer (0-110^{0}C),
- Measuring flask (60 c.c)

THEORY

The viscosity of given oil is determined as the time of flow in Saybolt seconds. The viscosity of a fluid indicates the resistance offered to shear under laminar condition. Dynamic viscosity of a fluid is the tangential force on unit area of either of two parallel planes at unit distance apart when the space between the plates is filled with the fluid and one of the plate's moves relative to the other with unit velocity in its own plane. The unit of dynamic viscosity is dyne-sec/cm^2. Kinematic viscosity of a fluid is equal to the ratio of the dynamic viscosity and density of the fluid. The unit of kinematic viscosity is cm^2 / sec.

DESCRIPTION

Saybolt viscometer consists of a water bath and oil bath, both provided with two thermometers inside them. There is a ball valve, which is located at center of oil bath to flow of oil through the orifice. A heater with regulator is fixed for heating purpose.

PROCEDURE

1. Clean the oil cup with a suitable solvent thoroughly and dry it using soft tissue paper.
2. Keep the cork in its position so as to keep the orifice closed.
3. The water is taken into the water bath and the oil whose viscosity is to be determined is taken into the oil cup up to the mark.

4. Before switch on the electric supply, at room temperature note down the time taken in Saybolt seconds for a collection of 60 c.c. of oil with a stop watch.
5. Heat the bath and continuously stir it taking care to see that heating of the bath is done in a careful and controlled manner.
6. When the desired temperatureis reached, place the cleaned 60 c.c. flask below the orifice in position.
7. Remove the cork valve and simultaneously start a stopwatch. Note the time of collection of oil up to the 60 c.c. Mark.
8. During the collection of oil don't stir the bath.
9. Repeat the process at various temperatures.

OBSERVATIONS

S. No.	Oil Temperature ^{0}C	Time for collecting 50 c.c. of oil sec	Kinematic viscosity $\nu = (A \times t) - \left(\frac{B}{t}\right)$ $\frac{cm^2}{sec}$	Density (ρ) $\frac{gm}{sec}$	Absolute Viscosity $\mu = \nu \times \rho$ $\frac{dyne-sec}{cm^2}$

Where

$A=0.00226\ \frac{cm^2}{sec^2}$

$B=1.8\ cm^2$

GRAPHS TO BE DRAWN

1. Saybolt seconds vs. temperature
2. Kinematic Viscosity vs. temperature
3. Dynamic Viscosity vs. temperature

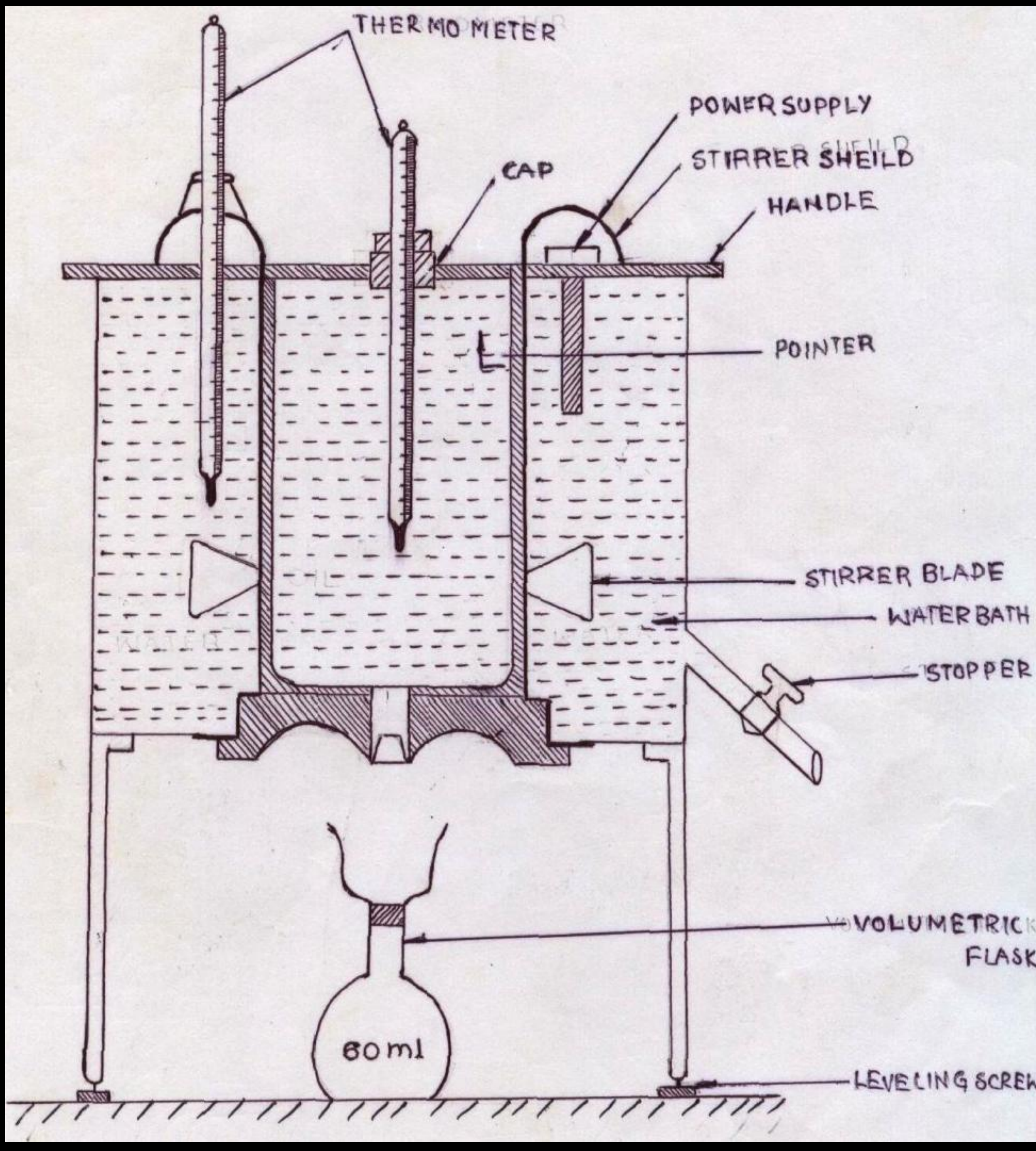
PRECAUTIONS

1. Stir the water continuously so that the temperature of the oil and water are equal.
2. Before collecting the oil at a temperature, check whether the oil is up to the level.
3. Always take the readings at a stable temperature.
4. Ensure proper setting of the cork to avoid leakage.

Temp

RESULT

Variation of Saybolt Seconds, Absolute viscosity and Kinematic viscosity with temperature, were observed and found to be decreasing with temperature.



SAYBOLT VISCOMETER

CLEVELAND'S FLASH AND FIRE POINT TEST

CLEVELAND'S FLASH AND FIRE POINT TEST

AIM

To determine the flash and fire points for the given oil using Cleveland's open cup apparatus.

APPARATUS

Cleveland's open cup apparatus,

Thermometer (0-100^{0}C).

THEORY

This method determines the open cup flash and fire points of petroleum products and mixtures to ascertain whether they give off inflammable vapours below a certain temperature.

FLASH POINT

It is the lowest temperatures of the oil at which application of test flame causes the vapours above the sample to ignite with a distinct flash inside the cup.

FIRE POINT

It is the lowest temperature of the oil, at which, application of test flame causes burning for a period of about five seconds.

DESCRIPTION

The apparatus consists of a brass cup, test flame arrangement, thermometer socket, and energy regulator.

PROCEDURE

1. Clean the oil cup and take the sample up to the level of groove marked in it.
2. Place the cup in the groove provided on the asbestos sheet
3. Fix the thermometer in the fixture, so that the bulb should not touch the bottom of the cup.
4. Switch on, the power supply and adjust the regulator so that slow and steady heating may be obtained.
5. When the temperature of oil is about 5 to 10^{0}C below the expected flash temperature start introduction of a test flame.
6. Apply the test flame at every 0.5^{0}C to 1^{0}C rise in temperature.
7. Record the minimum temperature at which a distinct flash in obtained on the given sample of oil.

8. Continue heating and apply test flame on the surface of the oil and record the minimum temperature at which the oil burns with continuous flame on the surface for a minimum of 5 seconds and record it as fire point temperature.
9. Repeat the experiment 2 or 3 times with fresh sample of the same oil
10. Take the average value of flash and fire points.

OBSERVATIONS

Sample oil	Flash point ^0C	Fire point ^0C

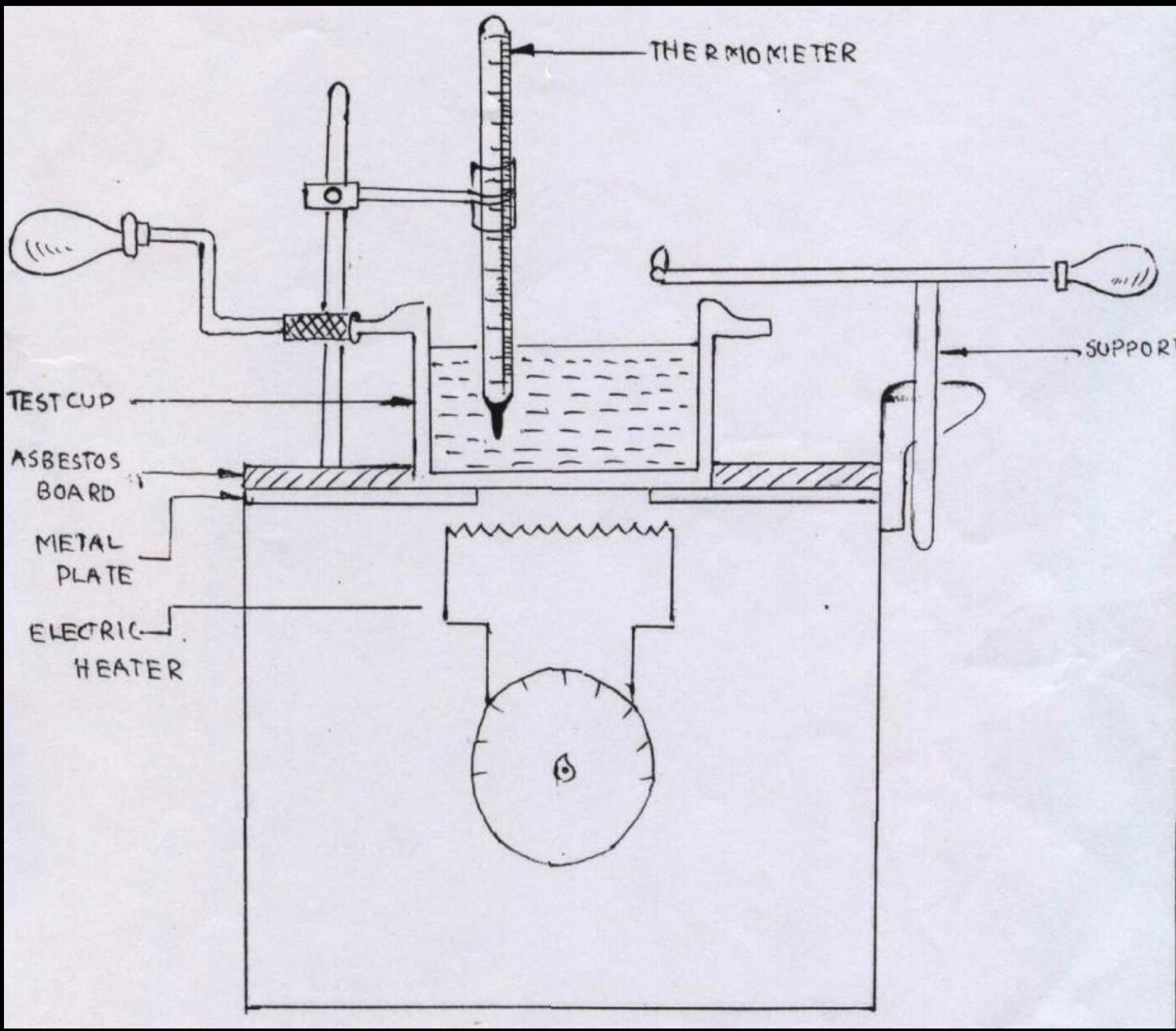
PRECAUTIONS:

1. The thermometer bulb should be at the center of the oil cup and below the oil surface. It should not touch the bottom surface of the oil cup.
2. The heating should be slow and steady.
3. After every trial the cup should be cooled to room temperature.

RESULT:

The flash point of given oil is= ……………….. ^0C

The flash point of given oil is=………………… ^0C



CLEVELAND’S FLASH AND FIRE POINT TEST


29 9 2007

PENSKY MARTEN'S FLASH AND FIRE POINT TEST

AIM

To determine the flash and fire point of the given sample of oil using Pensky Marten's apparatus by both open and closed cup methods.

APPARATUS

- Pensky Marten's apparatus,
- Thermometer (0-110ºC).

THEORY

This method determines the closed cup and open cup flash and fire points of petroleum products and mixtures to ascertain whether they give off inflammable vapours below a certain temperature.

Flash Point: It is the lowest temperatures of the oil at which application of test flame causes the vapour above the sample to ignite with a distinct flash inside the cup.

Fire point It is the lowest temperature of the oil, at which, application of test flame causes burning for a period of about five seconds.

DESCRIPTION

The apparatus consists of a brass cup and cover fitted with shutter mechanism without shutter mechanism (open cup), test flame arrangement, hand stirrer (closed cup), thermometer socket, etc., heated with energy regulator, a thermometer socket made of copper.

PROCEDURE

1. Clean the oil cup thoroughly and fill the oil cup with the sample oil to be tested up to the mark.
2. Insert the thermometer into the oil cup through a provision, which measures the rise of oil temperature.
3. Using the Energy regulator, control the power supply given to the heater and rate of heating
4. The oil is heated slowly when temperature of oil rises, it is checked for the flash point for every one degree rise in temperature.

5. After determining the flash point, the heating shall be further continued. The temperature at which time of flame application which causes burning for a period at least 5 seconds shall be recorded as the fire point.
6. Repeat the experiment 2 or 3 times with fresh sample of the same oil
7. Take the average value of flash and fire points.

PRECAUTIONS

1. Stir the oil bath continuously to maintain the uniform temperature of sample oil.
2. The bluish halo that some time surrounds the test flame should not be confused with true flash.

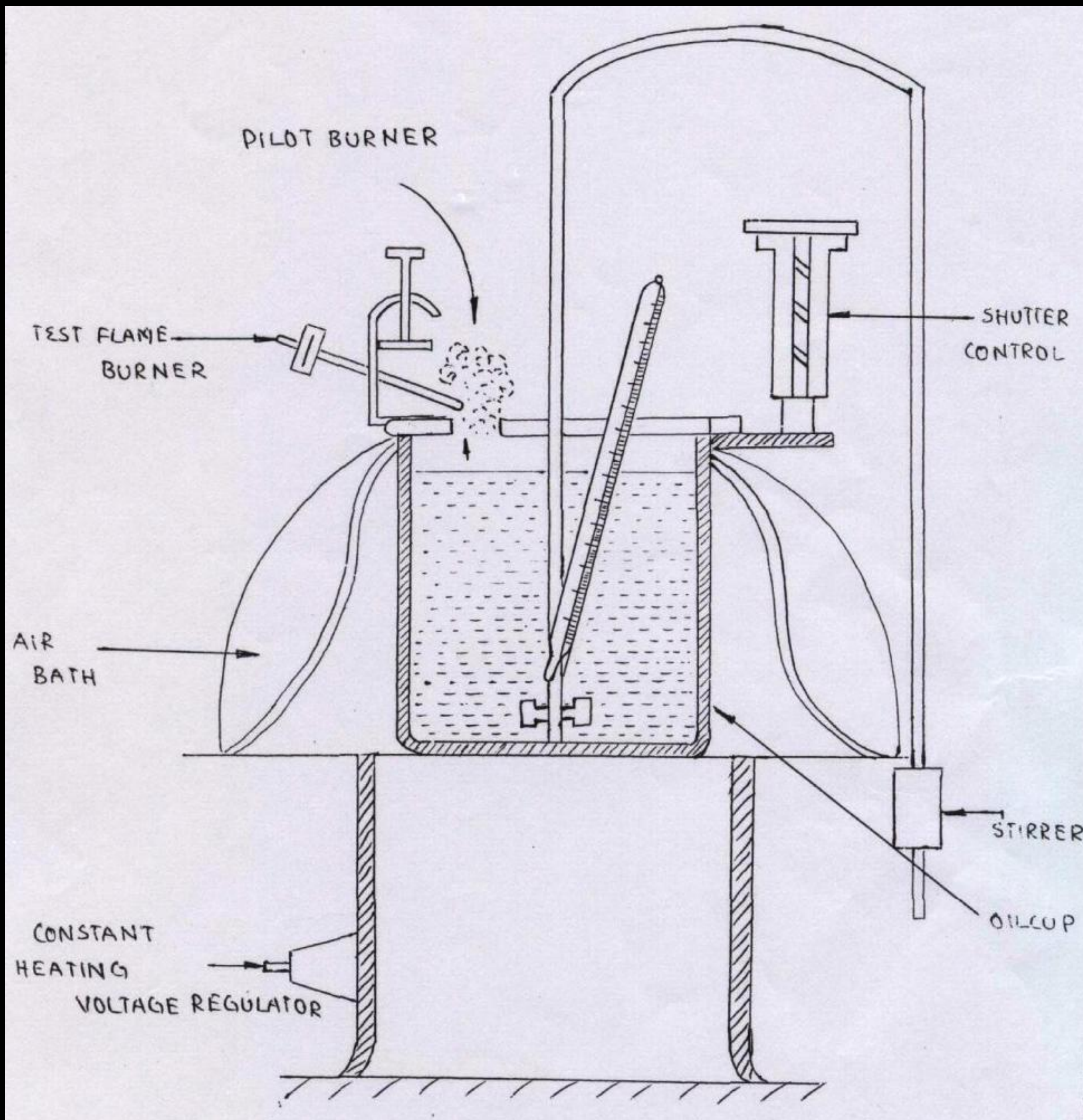
OBSERVATIONS

Sample oil	Flash Point, ^{0}C	Fire Point, ^{0}C

RESULT

The flash point is observed at ^{0}C

The fire point is observed at ^{0}C


PILOT BURNER
TEST FLAME BURNER
SHUTTER CONTROL
AIR BATH
STIRRER
OILCUP
CONSTANT HEATING VOLTAGE REGULATOR


29 9 2007

ABEL'S FLASH AND FIRE POINT TEST

AIM

To determine the flash and fire point of the given sample of oil using Abel's apparatus closed cup methods.

APPARATUS

Abel's apparatus, Thermo meter (0-110^{o}C).

THEORY

This method determines the closed cup flash and fire points of petroleum products and mixtures to ascertain whether they give off inflammable vapours below a certain temperature.

FLASH POINT:

It is the lowest temperatures of the oil, at which, application of test flame causes the vapour above the sample to ignite with a distinct flash inside the cup.

FIRE POINT:

It is the lowest temperature of the oil, at which, application of test flame causes burning for a period of about five seconds.

DESCRIPTION

The apparatus consists of a brass cup and cover fitted with shutter mechanism, test flame arrangement, hand stirrer, thermometer socket. The brass cup is heated by water bath (with energy regulator), fitted with a funnel and overflow pipe.

PROCEDURE

1. Clean the oil cup and fill the up to the mark with the sample oil.
2. Insert the thermometer into the oil cup through the provision to note down the oil temperature.
3. Using the Energy regulator, control the power supply given to the heater and rate of heating
4. The oil is heated slowly when temperature of oil rises; it is checked for the flash point for every one-degree rise in temperature.

5. After determining the flash point, the heating shall be further continued. The temperature at which time of flame application that causes burning for a period at least 5 seconds shall be recorded as the fire point.
6. Repeat the experiment 2 or 3 times with fresh sample of the same oil
7. Take the average value of flash and fire points.

PRECAUTIONS:

1. Stir the oil bath continuously to maintain the uniform temperature of sample oil.
2. The bluish halo that some time surrounds the test flame should not be confused with true flash.

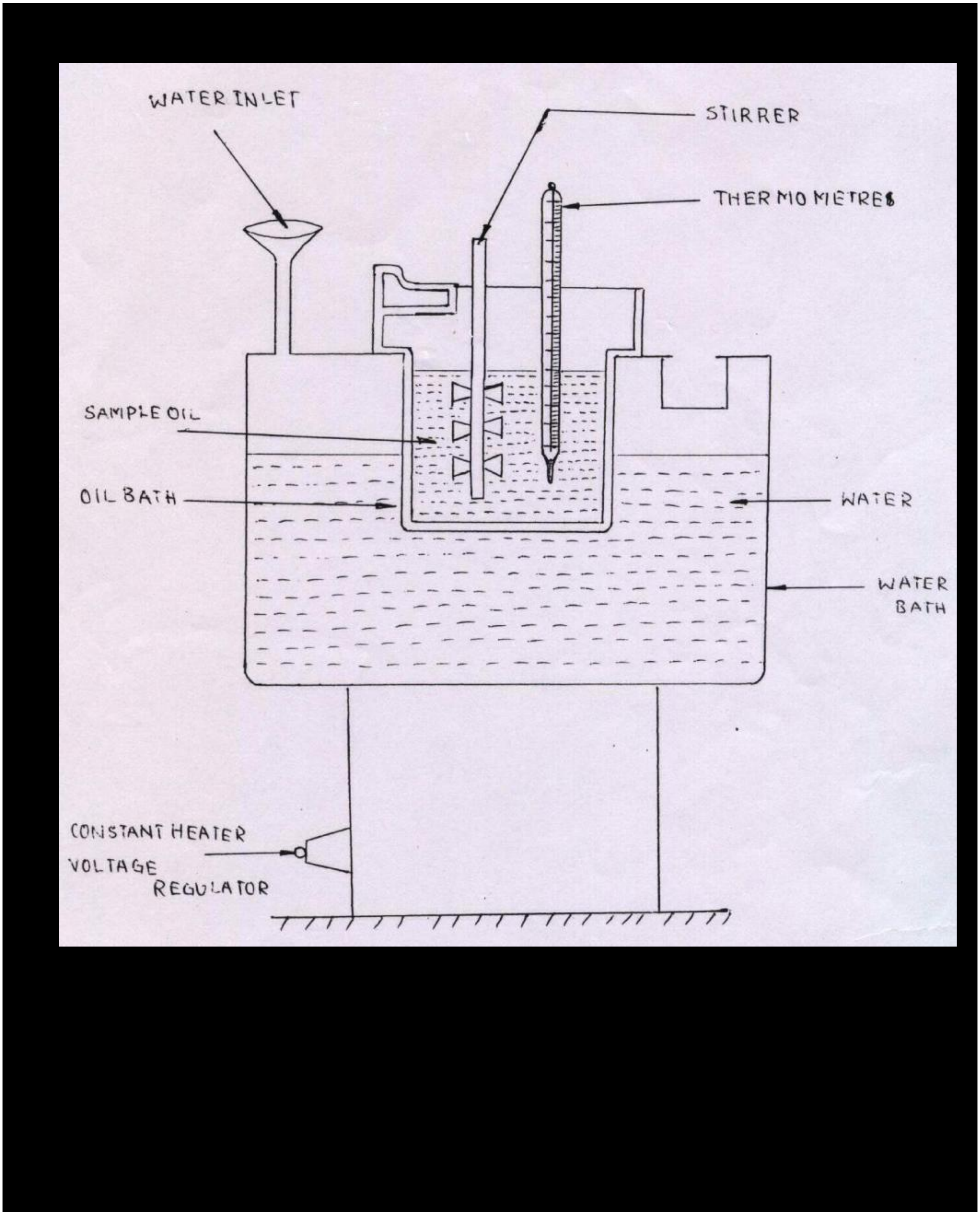
OBSERVATIONS:

Sample oil	Flash Point, ^0C	Fire Point, ^0C

RESULT

The flash point is observed at ^0C

The fire point is observed at ^0C


WATER INLET
STIRRER
THERMO METRES
SAMPLE OIL
OIL BATH
WATER
WATER BATH
CONSTANT HEATER
VOLTAGE
REGULATOR

BOMB CALORIMETER

AIM

To determine the water equivalent of the calorimeter using the given sample of solid or liquid fuel of known calorific value (or) To determine the calorific value of the given solid or liquid fuel if the water equivalent of the calorimeter known.

APPARATUS

Bomb, water jacket, stirrer, calorimeter vessel, combined lid, sensitive thermometer, analytical balance with weight box, oxygen cylinder with pressure gauge, fuse wire, cotton thread, firing unit, regulating valve and crucible hand pellet press

PRINCIPLE OF OPERATION

A Bomb Calorimeter will measure the amount of heat generated when matter is burnt in a sealed chamber (Bomb) in an atmosphere of pure oxygen gas. A known amount of the sample of fuel is burnt in the sealed bomb, the air in the bomb being replaced by pure oxygen under pressure. The sample is ignited electrically. As the sample burns heat is produced and rises in the temperature. Since the amount of heat produced by burning the sample must be equal to the amount of heat absorbed by the calorimeter assembly, and rise in temperature enables the determination of heat of the combustion of the sample. If

W = Water equivalent of the calorimeter assembly in calories per degree centigrade.

T = Rise in temperature (registered by a sensitive thermometer) in degrees centigrade.

H = Heat of combustion of material in calories per gram.

M = Mass of sample burnt in grams.

Then $W \times T = H \times M$

If the water equivalent of the calorimeter is to be determined, a substance like Benzoic acid has a stable calorific value can be burnt in the bomb. Assuming the calorific value of Benzoic acid and water equivalent can be determined.

CALORIFIC VALUE

Gross or higher calorific value: The total amount of heat produced when one unit mass of fuel has been burnt completely and the products of combustion have been cooled to room temperature.

Net or Lower Calorific Value: The net heat produced when unit mass of fuel is burnt completely and the products are permitted to escape.

LCV = HCV – Latent heat of water vapour formed

DESCRIPTION

i. BOMB

The bomb consists of three parts i.e. bomb body, lid and the cap. Bomb Body and the lid are made of corrosion resistant stainless steel containing Chromium, Nickel and Molybdenum. The bomb body is cylindrical vessel having a capacity of 300 ml . The walls are strong enough to withstand the normal operating pressure (30atm) to extreme high pressures (300 atm.). During burning at high pressure the nitrogen and sulphur contents are oxidized to nitric acid and sulphuric acid respectively. The corrosion resistant nature of the bomb material protects it from corrosive vapors. The bomb has lid, which is provided with two terminals. The metallic rods pass through the terminals one of which are provided with a ring for placing the crucible with a small hook and the other with a groove. Each rod is also provided with a ring to press the fuse wire attached to it. The upper side of the lid also provided with a small hook rod lifting and with a Schrader valve for filling oxygen in the bomb

ii. WATER JACKET

The water jacket is made of copper and is highly chromium plated on the inside and outside to minimize radiative losses. The jacket is filled with water.

iii. STIRRER UNIT

A stirrer is provided which is driven directly by an electric motor. The stirrer is immersed in the water. The water is continuously stirred during the experiment for uniform heat distribution.

iv. **COMBINED LID**

This is made of Borolite sheet and is provided with a hole for to keep the stirrer unit in fixed position and hole to insert the temperature sensor. It has also another hole to take out the connecting wires from the terminals on the bomb lid to firing unit.

v. **HAND PELLET PRESS**

It is used for pressing the powder into a pellet.

vi. **CRUCIBLE**

It is made of stainless steel. The fuel to be burnt is weighed in this crucible.

vii. **IGNITION WIRE**

It is recommended that platinum wire used but an alternative nichrome wire is also being offered.

viii. **FIRING UNIT**

It consists of the firing key, provision to give power to the stirrer motor, a switch for operating the stirrer motor, two indicating lamps. When the circuit is completed the indicating lamp glows. After the firing key is closed on, the fuse wire burns, the indicating lamp stops glowing indicating the burning of the fuse wire.

PROCEDURE

- About 0.5 to 1 *grm* of finely ground benzoic acid (Preferably compressed into a pellet) is accurately weighed and taken into crucible.
- Place the bomb lid on the stand provided and stretch pieces of fuse wire across the electrodes (metal rods) provided in the lid tie about 5 *cm* of sewing cotton round the wire.
- Place the crucible in position and arrange the loose end of the cotton thread to contact the Benzoic acid pellet in the crucible.
- About 10 *ml* of distilled water are introduced into the bomb to absorb vapors of sulphuric acid and nitric acids formed during the combustion and lid of the bomb is screwed
- Charge the bomb slowly with oxygen from the oxygen cylinder to a pressure of 25 atm. close the value and detach the bomb from the oxygen supply.

- Fill the calorimeter vessel with sufficient water to submerge the cap of the bomb to a depth of at least 2mm leaving the terminals projecting lower the bomb carefully in the calorimeter vessel and after ascertaining that it is gas tight, connect the terminals to the ignition circuit.
- Adjust the stirrer and place the temperature sensor and cover in position. Start the stirring mechanism, which must be kept in continuous operation during the experiment after stirring for 5 minutes note the temperature reading of the calorimeter. Close the circuit momentarily to fire the charge and continue the observations of the temperature at an interval of one minute till the rate of change of temperature becomes constant.
- Afterwards stop the stirrer and remove the power supply to the firing unit. Remove the bomb from the calorimeter and relax the pressure by opening the value. Verify that the combustion is complete and washout the contents of the bomb clean and dry.
- Calculate the calorific value of the fuel or water equivalent of the calorimeter.

OBSERVATIONS:

Weight of the empty crucible (W_1)	=	gm
Weight of the empty crucible + Benzoic acid pellet (W_2)	=	gm
Weight of the benzoic acid pellet $(W_2 - W_1)$	=	gm
Weight of water taken in the calorimeter (W_3)	=	gm
Temperature of the water just before firing (t_1)	=	^0C
Temperature of the water after firing (t_3)	=	^0C

CALCULATIONS

Heat produced by burning of benzoic acid + Heat produced by burning of fuse wire and cotton wire etc = Heat absorbed by calorimeter.

$$(W_2 - W_1) \times C_v = (W_3 - W_e)(t_2 - t_1)$$

PRECAUTIONS

Sample should not exceed 1 gms.

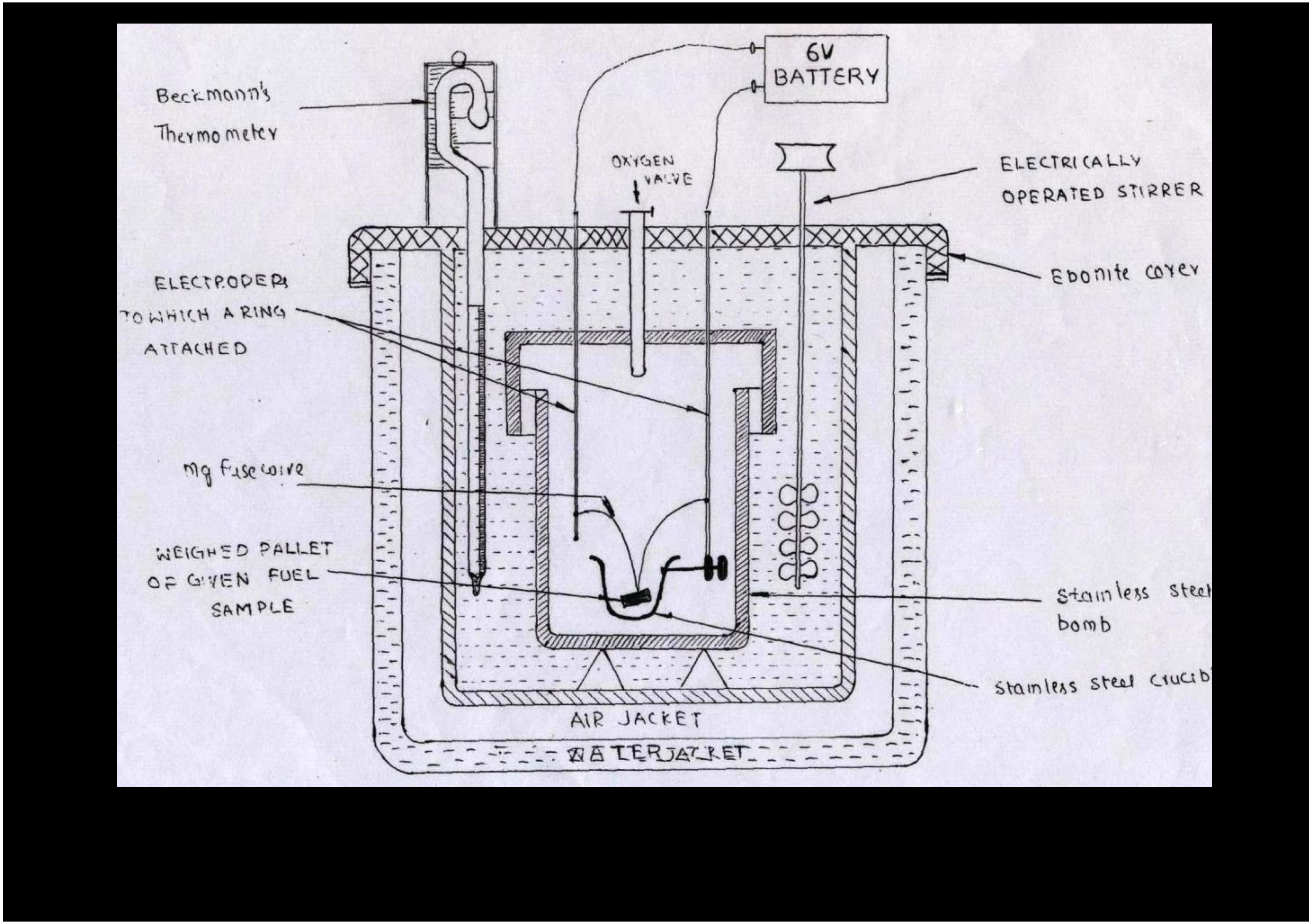
Don't charge with more oxygen than is necessary.

Don't fire the bomb if gas bubbles are leaking from the bomb when it is submerged in water.

RESULT

Water equivalent of calorimeter (W_e) = gm

Calorific value of sample (C_v) = cal/gm


6V
BATTERY
Beckmann's
Thermometer
OXYGEN
VALVE
ELECTRICALLY
OPERATED STIRRER
Ebonite cover
ELECTRODES
TO WHICH A RING
ATTACHED
Mg fuse wire
WEIGHED PALLET
OF GIVEN FUEL
SAMPLE
Stainless steel
bomb
Stainless steel crucib
AIR JACKET
WATER JACKET

CLOUD & POUR POINT TEST

AIM: To determine the cloud & pour point of a given fuel / lubricant / oil, using cloud &pour point apparatus.

APPARATUS:

Cloud & pour point apparatus,

Digital stem thermometer

THEORY:

CLOUD POINT: The temperature, expressed to the nearest degree centigrade, at which a cloud or haze appear when the oil is cooled under prescribed conditions.

POUR POINT: The lowest temperature, expressed as a multiple of 3^0 c, at which the oil is observed to flow when cooled & examined under prescribed conditions.

PROCEDURE:

CLOUD POINT:

1. Bring the sample to a temperature of at least 15 ^0C above the approximate cloud point and pour it into the jar to a height of 51 to 57 mm.
2. Close the jar with the cork so that the thermometer bulb rests on the centre of the bottom of the jar.
3. Fit the gasket on to the jar 25 mm from the bottom and insert the jar into gasket.
4. Support the jacket and jar in a vertical position in the bath so that not more than 25 mm projects from the cooling medium.
5. At each thermometer reading of one degree centigrade, remove the jar from the jacket quickly but without disturbing the oil, inspect the material for cloud, and replace the jar, this complete operation shall not take more than 3 sec.
6. If the sample does not show a cloud when it has been cooled 10 ^0C. Place the jar and jacket in another bath maintained at a temperature of -15 ^0C to -18 ^0C.

7. If the sample does not show a cloud when it has been cooled to -7 ^0C. Place the jar and jacket in another bath maintained at a temperature of -32 ^0C to -35 ^0C.
8. When an inspection of the sample first reveals a distinct cloudiness or haze at the bottom of the jar, record the reading of the thermometer as the cloud point after correcting the thermometer errors if necessary.

POUR POINT:

1. The sample has cooled enough to allow the formation of the crystals.
2. Maintain the bath temperature at -1 ^0C to 2 ^0C
3. Support the jacket and jar in a vertical position in the bath so that not more than 25 mm projects from the cooling medium.
4. Beginning at a temperature 12 ^0C above the expected pour point, at each thermometer reading which is a multiple of 3 ^0C, remove the jar from the jacket carefully, and tilt it just enough to see whether the oil will move and the replace it, this complete operation shall not take more than 3 $\sec$.
5. As soon as the sample ceases to flow when the jar is tilted, hold the jar in horizontal position for exactly 5 $\sec$.
6. If the sample shows any movement replace the jar in the jacket and cool down the sample for another 3 ^0C. If the oil shows no movement during the 5 $\sec$, record the reading of the thermometer.
7. Add 3 ^0C to the temperature recorded above and corrected for thermometer errors if necessary, and note down the result as the pour point.

OBSERVATIONS:

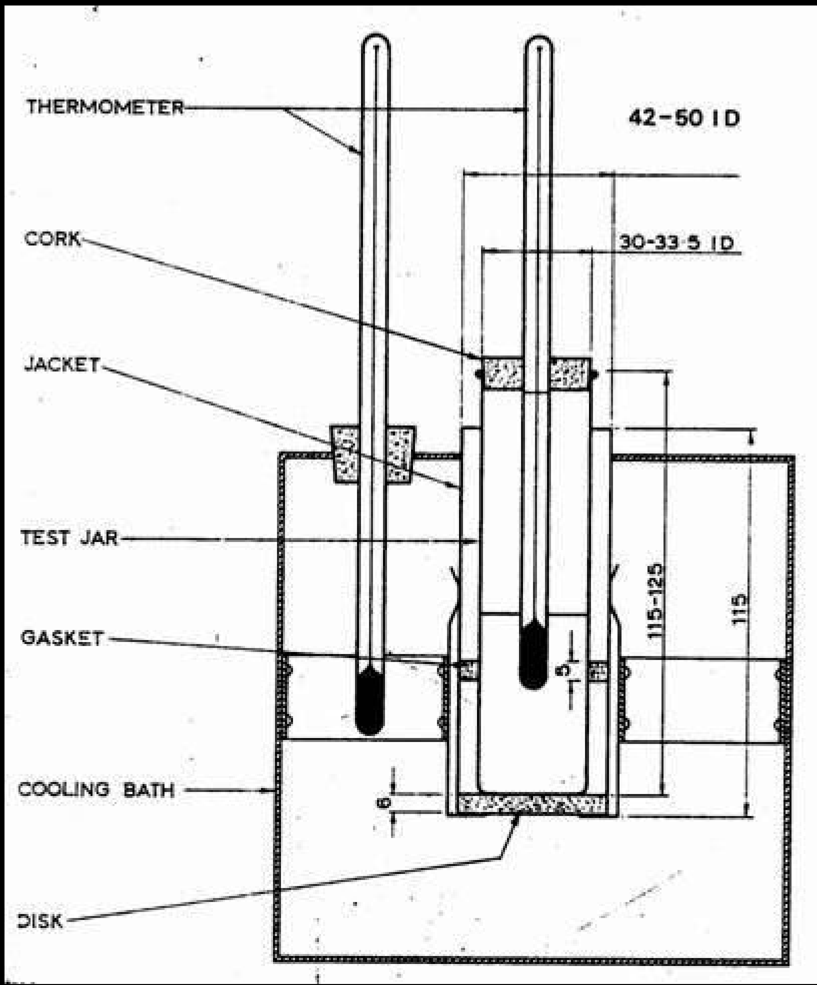
OIL	CLOUD POINT (^0C)	POUR POINT (^0C)

PRECAUTIONS:

1. The disc, the gasket, and jacket shall be kept clean and dry.
2. Don't disturb the mass of sample nor don't permit the thermometer to shift in the sample. Any disturbance of the spongy network of crystals will lead to false results.

RESULT:

For a given sample of oil the Cloud & Pour point s are and respectively.


THERMOMETER
42–50 I D
CORK
30-33·5 I D
JACKET
TEST JAR
115-125
115
GASKET
5
COOLING BATH
6
DISK

MULTI CYLINDER PETROL ENGINE TEST RIG

INTRODUCTION:

The prime mover using petroleum products as the source of energy are being increasingly important in the modern world. It is needless to say that the countless number of examples of these prime movers are being used right from household captive power hauling of aircrafts. The prime mover using petroleum fall into two categories viz., reciprocating and rotary (turbines) engines.

The reciprocating engines are commonly used ones, further divided into diesel, petrol, paraffin, kerosene gas driven ones. While the rest are discussed elsewhere in standard text books. The petrol engine which is of our present concern falls into the category of compression ignition prime mover which products maximum power for minimum ranges as compared to any other reciprocating prime movers.

The understanding of speed Vs Load, petrol consumption Vs Load per unit time (Specific fuel consumption = SFC) and efficiency is important from application point of view to get the maximum benefit at minimum cost. The following paragraphs deal with the engine ad the test.

OBJECT:

To conduct Morse test and performance test on 4– stroke petrol engine(Four cylinders) and to draw the following graphs:

1. B.P Vs S .F.C.
2. Mechanical Efficiency Vs B.P
3. B.P Vs indicated thermal efficiency
4. B.P Vs Brake thermal efficiency
5. Air fuel ratio Vs B.P
6. Air fuel ratio Vs S.F.C

DESCRIPTION:

The test rig consists of 4 – stroke of 4 cylinder petrol engine (water cooled) tobe tested for performance is coupled to hydraulic dynamometer with swinging field facility and with load cell by universal coupling. The arrangement is made for the following measurements of the set up. The complete frame and instrumentation are mounted on anti vibration mounts and separate control panel.

1. The rate of fuel consumption is measured by volumetric burette reading againstthe known time.
2. Torque indicator is mounted on a control panel.
3. air flow is measured by manometer connected to air box
4. separate cooling waterline is provided to the engine with Rota meter

5 the different hydraulic loading is achieved by operating the needle valve (2 nos)On the hydraulic dynamometer.

6. The torque on the engine is measured by load cell with torque arm of theDynamometer
7. The engine speed (RPM) is measured by electronic digital counter.
8. Temperature at different points is measured by electronic digital temperatureIndicator with k - type thermocouple.

SPECIFICATION:

- **ENGINE : 4 CYLINDER, 4 – STROKE PETROL ENGINE (WATER COOLED) SPARK IGNITION.**
- **MAKE : MARUTHI**
- **CYLINDER CAPACIY : 1000 CC**
- **BORE AND STROKE : 72mm , 61 mm**
- **COMPRESSION RATIO 9.4 : 1**
- **RATED POWER OUT PUT: 49 HP 6500 RPM.**
- **ENGINE : SAE 20 W /40 (3.5 LTRS CAPACITY**
- **STARTING : AUTO START**
- **LOADING : BY HYDRAULIC DYNAMOMETER**

5. Apply load to the engine by operating needle valves in the hydraulicDynamometer.
6. Adjust the throttle (speed regulator) to any desired speed.
7. Cut – off the spark ignition from the first cylinder by operating theCorresponding switch lever.
8. Now the speed of the engine decreases attain the normal speed byAdjusting the load without adjusting the throttle valve.
9. Now note down all the readings speed, load, temperature, petrolFlow rate And Air flow.
10. Repeat the procedure (6) to (11) for different loads by cuing – offThe other cylinders, one a time.
11. Tabulate the readings as shown in the enclosed sheet.
12. After the experiment is over, keep the petrol control -Valve at closed position, and release the load

NOTE:-

TEMPERATURE POINTS:-

T_1	=	Air inlet
T_2	=	Engine cooling water inlet
T_3	=	Engine cooling water out let
T_4	=	Exhaust gas

1. Total brake power (BP), (when all cylinders are firing)

$$BP = \frac{2 \pi N \ T \times 9.81}{60000} \text{ KW}$$

Where N = RPM of engine

T = Torque in Kg – m = 0.250 X F

F = Load in kgs.

2. Total fuel consumption (TFC).

m_f = The mass of fuel consumed per minute

$$m_f = \frac{\text{Fuel consumed in cc} \times \text{Density of petrol} \times 60}{1000 \times \text{time taken in seconds}} \text{ Kg min}$$

Where, Density of petrol = 0.8 grams cc

T = Time taken in seconds for consumption of 10 cc of petrol

Therefore, fuel consumption per hour TFC = m_f X 60 Kg / Hr

3. specific fuel consumption (SFC)

Where m_a = Mass of air = V_a X ρ_a Kg / min

$$SFC = \frac{TFC}{BP} \text{ Kg / Kwhr}$$

4. Brake thermal efficiency

$$\eta_{B\ ther} = \frac{BP}{100HI} X$$

Where V_a= Actual volume of air intake in m^3 / min

5. Air fuel ratio

$$AF = \frac{m_a}{m_f}$$

d = Dia of orifice = 20mm

g = 9.81 m /sec^2

h_a = Height of air column in mtrs of water

$$\frac{h_{water} \times \rho_{water}}{\rho_{air}}$$

ρ_{water} = 1000 Kg / m^3 $\rho_{air} = \frac{P_a}{R\,T_a}$

P_a = Atmosphere pressure in N m^2 = $\frac{X}{76}$ 101325 N m^2

x = in cms Mercury

R = 287 Nm / kg k

Therefore,

$$\rho_{air} = \frac{(72/76) \times 101325}{287 \times 304} = 1.10\ Kg/m^2$$

$$h_a = \frac{h_w \times 1000}{1.10} = 909\ h_w$$

$$h_a = 909\ h_w$$

where h_w = Manometer reading in mtr

5. Indicated Thermal Efficiency

$$\eta_{I\ ther} = \frac{IP}{HI} \times 100$$

IP FROM MORSE TEST

Where, HI = Heat input

$$HI = \frac{TFC}{60 \times 60} \times CV \quad KW$$

Where , TFC in Kg /Hr

CV = calorific value of light petrol = 40000 KJ /Kg

5. Mechanical efficiency

$$\eta_{mech} = \frac{BP}{HP} \times 100$$

MORSE TEST

Morse test is used to find a close estimate of indicated power (IP) of a multicylinder engine. In this test, the engine is coupled to a suitable hydraulic dynamometer and the brake is determined by running the engine at the required speed. Now the fuel of the first cylinder can be cut off.

As a result of cutting out the first cylinder, the engine speed will drop load on the engine is now removed o that the original speed is attained. The brake powerunder this load is determined and recorded (BP).The first cylinder operation is restricted normal and the second cylinder is cut off. The engine speed will again vary. By adjusting the load on the engine speed brought to original speed and the new BP is recorded (BP_2).Same procedure is continued till the last cylinder is cut off.

1. Total brake power (BP), when all cylinders are firing.

$$BP = \frac{2\pi N T \times 9.81}{60000} KW$$

$$BP_4 = \frac{2 \pi N T_3 \times 9.81}{60000} \text{ KW}$$

3.Indicated power (IP_1), when first cylinder is not firing.

$IP_1 = (BP) – (BP_1)$ KW

4.Similarly , when second ,third ,fourth cylinders are not firing$IP_2 = (BP) – (BP_2)$ KW

$IP_3 = (BP) – (BP_3)$ KW

$IP_4 = (BP) – (BP_4)$ KW

5. Total indicated power (IP) = $IP_1 + IP_2 + IP_3 + IP_4$

<u>OBSERVATIONS AND TABULATIONS</u>

Sl. no	cylinder condition	Engine speed n(rpm)	torque T(kg-m)	Brake power kw	indicated power(kw)
1	All cylinders are firing			(BP)=	(IP)
2	First cylinder is cut -off			(BP)=	$(IP)_1$
3	Second cylinder is cut-off			(BP)=	(IP)2
4	Third cylinder is cut offFourth			(BP)=	(IP)3
5	cylinder is cut off			(BP)=	(IP)4

PETROL ENGINE TEST RIG

INTRODUCTION:

The prime movers using petroleum products as the source of energy are being increasingly important in the modern world. It is needless to say that the countless number of examples of these prime movers is being used right from household captive power to hauling of aircrafts. The prime movers using petroleum products fall into two categories, VIZ., Reciprocating & (Turbine) engine.

The reciprocating engines are commonly used ones, further divided into diesel, petrol, paraffin, and kerosene, gas driven ones. While the rest are discussed elsewhere in standard test books, the petrol engine which is o our present concern fall into the category of spark ignition prime mover which products maximum power for minimum weight as compared any other reciprocating prime movers.

The understanding of speed Vs load, petrol consumption Vs load per unit time (specific fuel consumption = SFC) and efficiency is important from application point of view to get the maximum cost. Thefollowing paragraphs deal with the engine and the test.

OBJECT:

To conduct performance test on 4 – stroke air cooled petrolengine and to draw the following graphs:

1. B.P V/S S.F.C
2. MECHANICAL EFFICIENCY V/S B.P
3. B.P V/S INDICATED THERMAL EFFICIENCY
4. AIR FUEL RATIO V/S B.P
5. AIR FUEL RATIO V/S S.F.C

Specification:

- Type : 4 – stroke petrol engine (air Cooled) spark ignition.
- Make : Crompton greaves MK - 25
- Rated power : 3HP, at 3000 RPM.
- Bore and stroke : 70 mm , 66.7mm
- Compression ratio : 4.56 Standard
- Starting : auto start. (by D.C. Motor)
- Loading : By electrical D C machine
- Dia of orifice : 15 mm.

DESCRIPTION:

The test rig consists of Four – stroke petrol engine (air cooled)to be tested for performance is coupled to electrical dynamometer (D Cmachine).

The out put of the generator is connected to load (resistive air heaterswith a exhaust fan, fixed beneath the control panel).

1. The rate of fuel consumption is measured by using volumetricburette.
2. Air flow is measured by manometer, connected to air box.
3. The different electrical loading is achieved by operating electrical loading switches in steps (each is 0.5kw) on thecontrol panel.
4. The voltage and current of the generator is measure by digitalvoltmeter and ammeter.
5. The engine speed (RPM) is measured by electronic digitalindicator.
6. Temperature at air inlet and engine exhaust gas is measured byelectronic digital temperature indicator with thermocouple.

The whole instrumentation is mounted on a self – contained unitReady for operation.

OPERATION:

1. Check the petrol in tank.

2. Keep the ignition is in on position

3. Switch on the console and observe all the meters are energized.

4. Allow petrol, start the engine by operating the change over switch to motor position and press the green push button switch and slowly increase the speed of the motor and observesound of the engine and conclude engine is started once engine is started bring back the change over switch to generator position then it be comes a generator

5. Set the speed of the engine to less than 3000 rpm by operating The by operating governor lever

6. Allow some time so that the speed stabilizes

7. Apply the electrical loading by operating the electrical loading switches in steps.

8. Now take down temperature, petrol flow rate And Air consumption, speed, voltage, ammeter readings

9. Repeat the procedure (4) to (9) for different loads

10. Tabulate the readings as shown in the enclosed sheet.

11. After the experiment is over, keep the petrol control Valve at closed position, to avoid rich of the Engine for subsequent operation.

FORMULA FOR CALCULATION

1. BRAKE POWER (BP)

$$BP = \frac{V \times I}{1000} \times \frac{1}{0.70}$$

Where v = Generator voltage in voltsI =

Generator current in amps

0.70 = 70% efficiency of the generator.

2. TOTAL FUEL EFFICIENCY (TFC).

m_f = the mass of fuel consumed per minute

$$m_f = \frac{\text{Pipette reading} \times \rho P \times 60}{T \times 1000} \text{ kg /min.}$$

Where ρP = Density of petrol = 0.8

T = Time Taken in seconds for consumption of petrol.

Therefore ,total fuel consumption per hour, TFC = mf X 60 kg /hr

3. SPECIFIC FUEL CONSUMPTION (SFC).

$$SFC = \frac{TFC}{BP} \text{ kg /Kw hr.}$$

4. Air consumption in Kg / Min.

$$m_a = 0.6 \times A_O \times V_a \times 1.29 \times 60$$

Where A_O = Area of orifice in m^2

$$= \frac{\pi\, d2}{\quad} \text{ where d = Dia of Orifice = 15 mm4}$$

$$= (\pi / 4)(15 / 1000)^2 = 1.7671 \times 10^{-4}\, m^2$$

$$\text{Velocity of air} = Va = \quad 2g\,(hm_{/1000}) \times \frac{\delta_w}{\delta_a}\text{ ----- } 1$$

Where δ_w = density of water = 1000 Kg / m^3

δ_a = density of air = 1.29Kg / m^3

V_a = h_m (123.24) m /sec h_m is in mtr water column (from manometer)

5. Air to fuel ratio

$$A / F = \frac{m_a}{m_f}$$

6 .Heat input, KW

$$HI = \frac{TFC \times C_V}{60 \times 60} KW$$

Where TFC is in Kg / Hr.

C_V = 40,000 KJ /Kg (Calorific value of petrol)

7. Brake thermal efficiency

$$\eta_{B\ ther} = \frac{BP}{HI} \times 100$$

TABLE OF READING

SL NO		ENGINE SPEED IN RPM	ELECTRICAL LOAD CONNECTED IN WATTS	AIR CONSUMPTION IN METERS OF WATER READ ON MANOMETER	FUEL CONSUMPTION		TEMPERATURE		GENERATOR VOLTAGE 'V'	GENERATOR CURRENT IN AMPS
					VOLUME IN CC 10 ML	TIME IN SECONDS	T_1 AIR INLET 0^{C}	T_2 EXHAUST 0^{C}		

<u>TABLE OF CALCULATIONS</u>

SL NO		Engine speed in RPM ‘ N’	Fuel consumed ‘W_a’ In Kg/Hr	Air consumed ‘W_F’ In Kg/Hr	Air to fuel Ratio ‘Wa /W_F’	Engine output ‘BHP’ In KW	Specific consumption ‘SFC’ IN Kg/BHP .Hr	Heat input HI IN KW	Brake % η Thermal efficiency

4 –STROKE PETROL ENGINE TEST RIG

INTRODUCTION:

The prime movers using petroleum products as the source of energy are being increasingly important in the modern world. It is needless to say that the countless number of examples of these prime movers is being used right from household captive power to hauling of aircrafts. The prime movers using petroleum products fall into two categories, VIZ., Reciprocating & (Turbine) engine.

The reciprocating engines are commonly used ones, further divided into diesel, petrol, paraffin, and kerosene, gas driven ones. While the rest are discussed elsewhere in standard text books, the petrol engine which is o our present concernfall into the category of spark ignition prime mover which products maximum power for minimum weight as compared any other reciprocating prime movers.

The understanding of speed Vs load, petrol consumption Vs load perunit time (specific fuel consumption = SFC) and efficiency is important fromapplication point of view to get the maximum cost. The following paragraphs deal with the engine and the test.

OBJECT:

To conduct performance test on 4 – stroke air cooled petrol engine and to draw the following graphs:

1. B.P V/S S.F.C
2. MECHANICAL EFFICIENCY V/S B.P
3. B.P V/S INDICATED THERMAL EFFICIENCY
4. AIR FUEL RATIO V/S B.P
5. AIR FUEL RATIO V/S S.F.C
6. V.C.RATIO

DESCRIPTION:

The test rig consists of Four – stroke petrol engine (air cooled) to be tested for performance is coupled to electrical dynamometer (A.C machine).

The output of the generator is connected to load (resistive air heaters with a exhaust fan, fixed beneath the control panel).

There is a provision for varying the compression ratio o the engine (varies from 8 to 2.11). by operating the hand wheel provided on the top of the engine head with scale

1. The rate of fuel consumption is measured by using volumetric burette.
2. Air flow is measured by manometer, connected to air box.
3. The different electrical loading is achieved by operating electrical loading switches in steps (each is 0.5kw) on the control panel.
4. The voltage and current of the generator is measure by digital voltmeter and ammeter.

5. The engine speed (RPM) is measured by electronic digital indicator.
6. Temperature at air inlet and engine exhaust gas is measured by electronic digital temperature indicator with thermocouple.

The whole instrumentation is mounted on a self – contained unit Ready for operation.

Specification:

- Type : 4 – stroke petrol engine (air Cooled) spark ignition.
- Make : Crompton greaves MK - 25
- Rated power : 3HP, at 3000 RPM.
- Bore and stroke : 70 mm , 66.7mm
- Compression ratio : 4.56 Standard

  (Varies from 8 to 2.11)
- Starting : manual rope start start.
- Loading : By electrical alternator
- Dia of orifice : 15 mm.

PROCEDURE

1. Check the petrol in tank.

2. Keep the ignition is in on position

3. Switch on the console and observe all the meters are energized.

6. Allow petrol, start the engine by using rope (Manually)

7. Set the speed of the engine to less than 3000 rpm by operating The engine speed control or initially put some load (say - 1.0kw).so that the generator voltage should not exceed 300 volts

8. Allow some time so that the speed stabilizes9 . Apply the electrical loading by operating The electrical loading switches in steps.

10. Now take down temperature, petrol flow rate And Air consumption, speed, voltage, ammeter readings

11. Repeat the procedure (4) to (9) for different loads and differentC.R

12. Tabulate the readings as shown in the enclosed sheet.

13. After the experiment is over, keep the petrol control Valve at closed position, to avoid rich of the Engine for subsequent operation.

$$1.\ \text{BRAKE POWER (BP)} = \frac{V \times I}{1000} \times \frac{1}{0.70}$$

Where v = Generator voltage in voltsI =

Generator current in amps

0.70 = 70% efficiency of the generator.

2. TOTAL FUEL EFFICIENCY (TFC).

m_f = the mass of fuel consumed per minute

$$m_f = \frac{\text{Pipette reading} \times \rho P \times 60}{T \times 1000} \text{ kg /min.}$$

Where ρP = Density of petrol = 0.8

T = Time Taken in seconds for consumption of petrol.

Therefore ,total fuel consumption per hour, TFC = mf X 60 kg /hr

3. SPECIFIC FUEL CONSUMPTION (SFC).

$$SFC = \frac{TFC}{BP} \text{ kg /Kw hr.}$$

4. Air consumption in Kg / Min.

$$m_a = 0.6 \times A_O \times V_a \times 1.29 \times 60$$

Where A_O = Area of orifice in m^2

$f_w = (\pi / 4)(15 / 1000)^2 = 1.7671 \times 10^{-4}\ m^2$

Velocity of air = Va = 2g (hm /1000) X ------------------------------ 1

f_a

Where f_w = density of water = 1000 Kg / m^3 f_a

= density of air = 1.29Kg / m^3

V_a = h_m (123.24) m /sec h_m is in mtr water column (from manometer)

5. Air to fuel ratio

$$A / F = \frac{m_a}{m_f}$$

6 .Heat input, KW

$$HI = \frac{TFC \times C_V}{60 \times 60} KW$$

Where TFC is in Kg / Hr.

C_V = 40,000 KJ /Kg (Calorific value of petrol)

8. Brake thermal efficiency

$$\eta_{B\ ther} = \frac{BP}{HI} \times 100$$

TABLE OF READING

SL.NO	Vol . flow rate Of water In LPM , V_W	Mass of gas consumed In grams	Temperature Of water T_1 ^{0}CINLET	Temperature Of water T_2 ^{0}C OUT LET	Inlet pressure Of gas "P_g" Kgf /cm^2	REMARKS