AVIT
AARUPADAI VEEDU INSTITUTE OF TECHNOLOGY

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

Accredited by NAAC

Approved by AICTE

DEPARTMENT OF MECHANICAL ENGINEERING

ENGINEERING THERMODYNAMICS

REGULATIONS-2021

LAB MANUAL

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LAB MANUAL

Prepared by

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DEPARTMENT OF MECHANICAL ENGINEERING

ENGINEERING THERMODYNAMICS

GENERAL INSTRUCTIONS

- All the students are instructed to wear protective uniform, shoes & identity card before entering into the laboratory.
- Before starting the exercise, students should have a clear idea aboutthe principal of that exercise.
- All the students are advised to come with completed record andcorrected observation book of previous experiment.
- Don't operate any instrument without getting concerned staff member's prior permission.
- All the machineries/equipment's/instruments are highly valuable.Hence handle them carefully, to avoid fine for any breakage.
- One student form each batch should put his/her signature during receiving the instrument in instrument issue register.

DEPARTMENT OF MECHANICAL ENGINEERING

ENGINEERING THERMODYNAMICS

LIST OF EXPERIMENTS

1. IC Engine Valve Timing diagrams.
2. IC Engine Port Timing diagrams.
3. Determination of Flash Point and Fire Point of Various fuels / Lubricant
4. Determination of Viscosity of Various fuels / Lubricant
5. Actual P-V diagrams of IC engines.
6. Determination of Calorific value of liquid fuel.

DEPARTMENT OF MECHANICAL ENGINEERING

ENGINEERING THERMODYNAMICS

Exp.No	Date	Title of the Experiment	Page.No	Marks Obtained (10)	Signature

STUDY OF FLASH POINT AND FIRE POINT TESTING METHODS

Introduction

A good lubricating oil reduces the loss of energy in the form of heat and it increases the efficiency of a machine. It should also not volatilize under the working temperatures. Even if the volatilisation takes place to some extent, the vapours formed should not form inflammable mixtures with air under the conditions of lubrication. Therefore, the flash and fire point of a lubricating oil have a great importance. The flash point is defined as the minimum temperature at which the oil gives off sufficient vapour that ignite for a moment, when a flame is brought near it. While the fire point is the lowest temperature at which the vapours of the oil burn continuously for at least five seconds, when a flame is brought near it. Since a good lubricating oil should not volatilise under working conditions, so it should have flash point above the operating temperature in most cases. Similarly, in most cases, the fire points are 5 to 40o F higher than the flash points. But these fire and flash points do not have any bearing with the lubricating property of the oil.

Important of Flammability Testing

Process industries routinely use flammable materials. This exposes them to frequent risk of fire and explosion.To minimise this risk, it is important to test the materials used in processes for their flammability.

These materials will have certain key characteristics:

- Lower flammability limit – the lowest concentration at which a material consisting of vapour or gas and air is flammable
- Upper flammability limit – the highest concentration this material is flammable
- Limiting oxygen characterisation – the minimum concentration of oxygen that will produce a flammable result when mixed with the material
- Deflagration index – the volume-normalised maximum rate of rising pressure for a flammable material.

Flammability testing should account for the different variables which can affect the flammability of a material.

These variables include:

- Environment
- Temperature
- Pressure
- Ignition energy
- Gas composition.

The size and shape of the testing container can also influence flammability in tests.

The data from flammability testing can then help in implementing safety procedures and minimise the threat of fire or explosion.

Uses of Flash Point Testing

The major uses of flash point testing are:

- Assessing safety hazards of liquids and semi-solids, including their flammability
- Classifying these materials according to these results.

In assessing the risk of flammability, flash point analysis is an effective and efficient method.Essentially, the lower a substance's flash point temperature, the higher its risk of flammability.By classifying materials according to this risk, this enables their correct and safe use and storage.Specifications of different materials will include their flash points to control this flammability risk, and for quality control purposes.Correct classification of materials, including chemicals containing petroleum, is essential for maintaining up to date safety instructions about packaging, handling and use.Flash point testing can determine whether a liquid is classifiable as flammable, ignitable or combustible. For example, a liquid with a flash point below ambient temperature will be more hazardous.If there is a change in flash point in a material, this can indicate that it contains contaminants which could be volatile. Sometimes one material is adulterated by another, and flash point testing will expose this too.

Contaminants can have a significant effect on flash points, especially in those situations where the contaminant is more volatile than the material itself.Another important use of flash point testing for contamination is in oil analysis.If diesel or petrol fuel contaminates engine oil, it can act as a thinner, causing the oil's viscosity to drop dramatically. This viscosity is a key property of engine oil, as it helps protect engine parts against abnormal wear and failure.A flash point test will indicate the presence of diesel or petrol fuel in engine oil. Used with a viscosity test, it can pinpoint whether oil thinning is due to degradation or contamination.

Determines Flash Point

The flash point of a volatile material is the lowest temperature at which its vapours will ignite.Liquids will have a specific vapour pressure. Vapour pressure is the measure of the pressure that a gas exerts above a liquid in a sealed container.For example, if you heat a bottle of water, its vapour, and the amount of pressure, will increase.Liquids with a substantial vapour pressure at room temperature are classed as volatile.Vapour pressure is subject to Boyle's Law. This determines the relationship between the compression and expansion of a gas at a constant temperature.When you apply an ignition source to the vapour of a material, the lowest temperature at which the material combusts, and keeps burning once you remove the ignition source, is its flash point.Determining a material's flash point requires the heating of a sample in a container and then introducing a small flame (the ignition source) above the liquid surface.

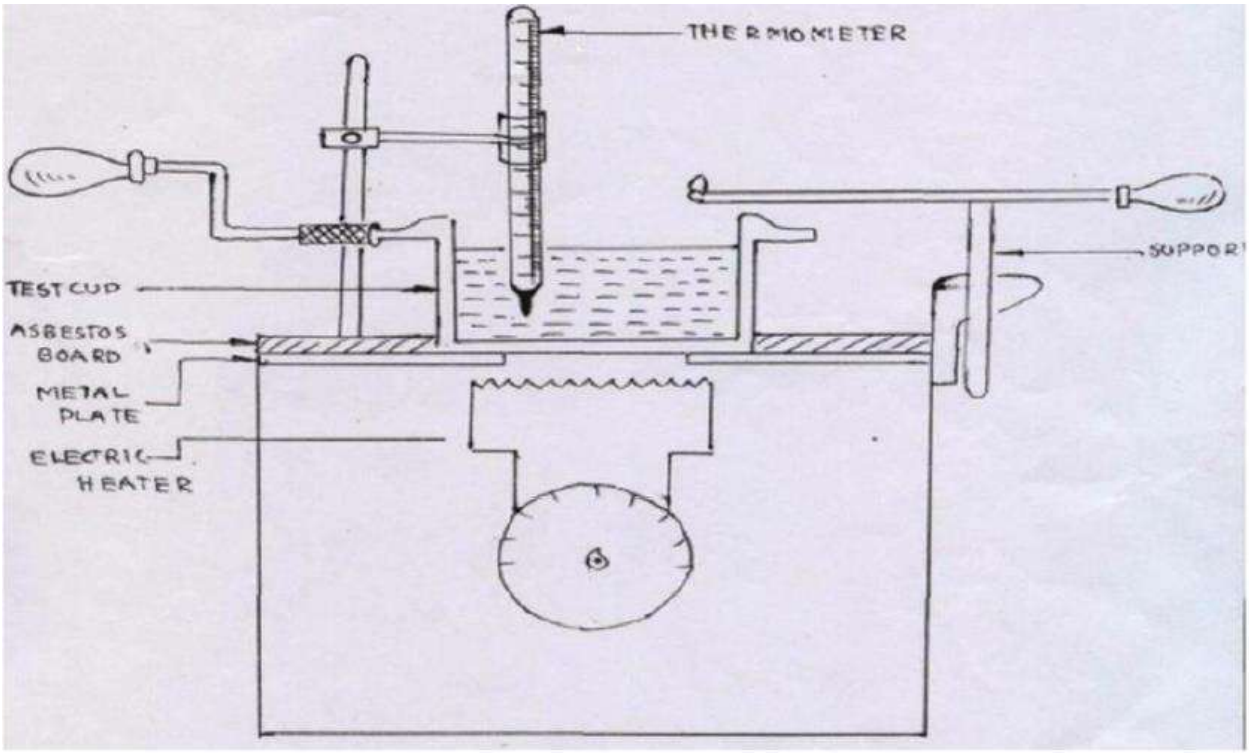
Flash Point Testing Methods

There are two main methods for carrying out the flash point test: open cup and closed cup.

Each of these methods may be more appropriate for different applications. Certain products or regulations may specify one method or the other. The type of product you are testing should be within the scope of the testing method you choose. Within the two broad open cup and closed cup classes of flash point testing, there are several different techniques.

Open Cup Flash Point Measurement

The open cup method for flash point testing uses a vessel, or container, that is exposed to the outside air.Once the sample material is placed in the vessel, you then gradually raise its temperature, and pass an ignition source over it, until it flashes and ignites at a certain point.This is the sample's flash point.The most common open cup method is the Cleveland open cup (COC). Other methods include Tag and Setaflash. Initially, the open cup method for flash testing was developed to assess potential hazards when there were spillages of liquids.As a method, the open cup test is less precise than closed cup, because vapours are free to escape into the atmosphere, and may be affected by local conditions.Flash point results from this method may also read higher at temperatures above ambient because of the reduced concentration of vapours compared to closed cup methods.



Closed Cup Flash Point Measurement

In the closed cup method, you conduct the test using a vessel, which is sealed off from the outside atmosphere.You then heat both the vessel and sample, which replicates the effect of accidently introducing an ignition source into a sealed container, such as a gas tank or other storage vessel.This close approximation of real-life conditions, and the precise nature of the testing, makes the closed cup method ideal for product specifications and regulations.Closed cup testing will generally produce lower flash points because the contained heat is more likely to make the sample material flammable at an earlier stage.This delivery of lower results tends to make closed cup methods preferred for industry standards.It is the common method for testing the fire and flash points of all petroleum products that have a flash point above 79°C.There are four main closed cup flash point testing methods: Pensky Martens, Abel, Tag and Setaflash.

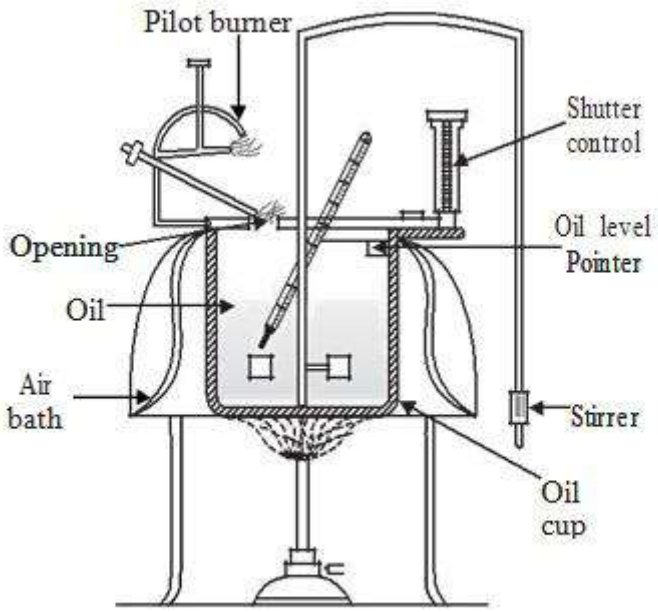


Fig. Pensky Marten's flash point apparatus

STUDY OF MEASUREMENT OF VISCOSITY

Introduction

It is a measure of the resistance offered by one layer of fluid to the other layer of the same fluid during motion. It is expressed in Pa.s unit. The viscosity of the fuel or petroleum products is experimentally measured by a device called a viscometer.

A Redwood viscometer is used to determine the viscosity of petroleum products. The ‘Redwood Viscometer‘determines the viscosity in terms of seconds (which are terms as Redwood seconds), it’s the time taken by oil to pass through a standard orifice, and the collection of the same oil in a 50 cc flask. Originally Redwood Viscometer was developed for the measurement of viscosity of petroleum products.

Measurement of Viscosity

The device used for measurement of viscosity is known as viscometer and it uses the basic laws of laminar flow.

The principles of measurement of some commonly used viscometers are discussed here:

1. Rotating Cylinder Viscometer
2. Falling Sphere Viscometer
3. Capillary Tube Viscometer
4. Saybolt and Redwood Viscometer

Rotating Cylinder Viscometer

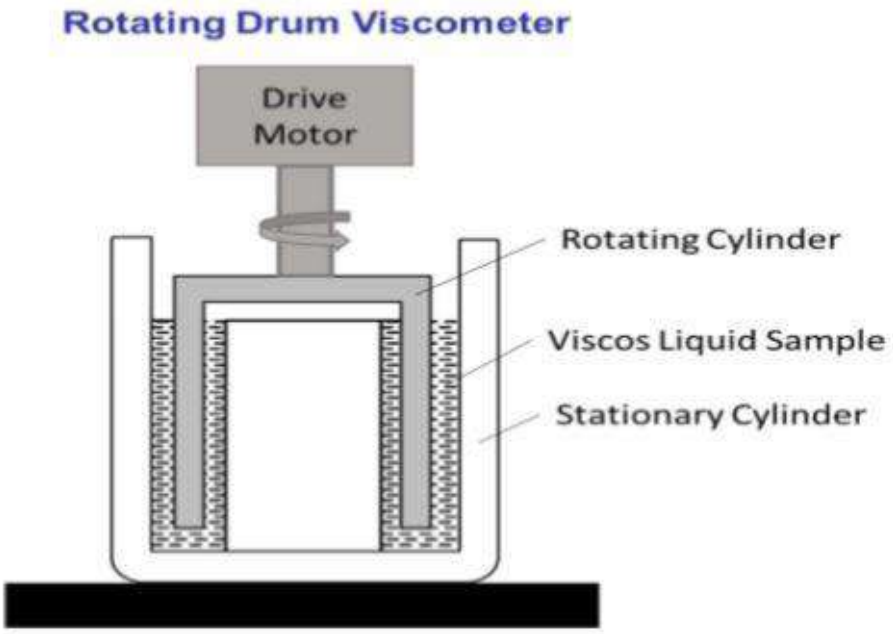
It consists of two co-axial cylinders suspended co-axially as shown in the Figure. The narrow annular space between the cylinders is filled with a liquid for which the viscosity needs to be measured. The outer cylinder has the provision to rotate while the inner cylinder is a fixed one and has the provision to measure the torque(T) and angular rotation. When the outer cylinder rotates, the torque is transmitted to the inner stationary member through the thin liquid film formed between the cylinders.

Let r1 and r2 be the radii of inner and outer cylinders, h be the depth of immersion in the inner cylinder in the liquid and t = r2 - r2 is the annular gap between the cylinders.

Considering N as the speed of rotation of the cylinder in rpm, one can obtain viscosity as:

$$\mu = T/CN$$

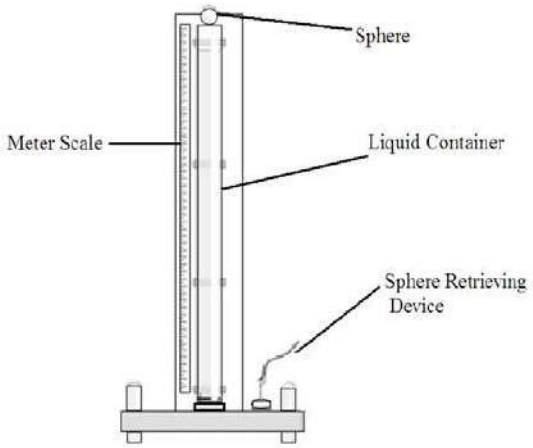
Here, C is a constant quantity for a given viscometer



Falling Sphere Viscometer

It consists of a long container of constant area filled with a liquid whose viscosity has to be measured. Since the viscosity depends strongly with the temperature, so this container is kept in a constant temperature bath as shown in figure. A perfectly smooth spherical ball is allowed to fall vertically through the liquid by virtue of its own weight (W) . The ball will accelerate inside the liquid, until the net downward force is zero i.e. the submerged weight of the ball (FB) is equal to the resisting force (FR) given by Stokes' law. After this point, the ball will move at steady velocity which is known as terminal velocity. If W_l and W_s are the specific weights of the liquid and the ball, respectively and the spherical ball has the diameter D that moves at constant fall velocity V in a fluid having viscosity μ then

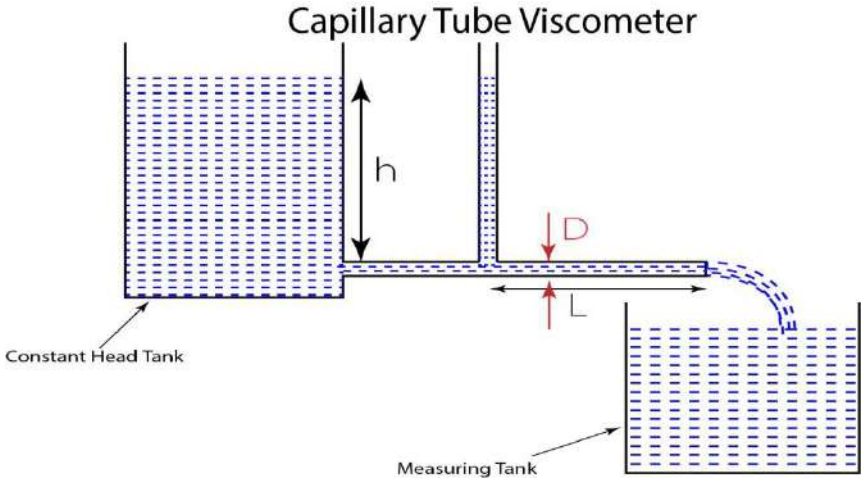
$$\mu = \frac{D^2}{18V}\left(w_s - w_l\right) \text{ where } V = \frac{L}{t}$$



Capillary Tube Viscometer

In capillary tube method, the viscosity of a liquid is calculated by measuring the pressure difference for a given length of the capillary tube. This type of viscometer is based on laminar flow through a circular pipe. It has a circular tube attached horizontally to a vessel filled with a liquid whose viscosity has to be measured. Suitable head (hf) is provided to the liquid so that it can flow freely through the capillary tube of certain length (L) into a collection tank as shown in figure. The flow rate (Q) of the liquid having specific weight wl can be measured through the volume flow rate in the tank. The Hagen-Poiseuille equation for laminar flow can be applied to calculate the viscosity (μ) of the liquid.

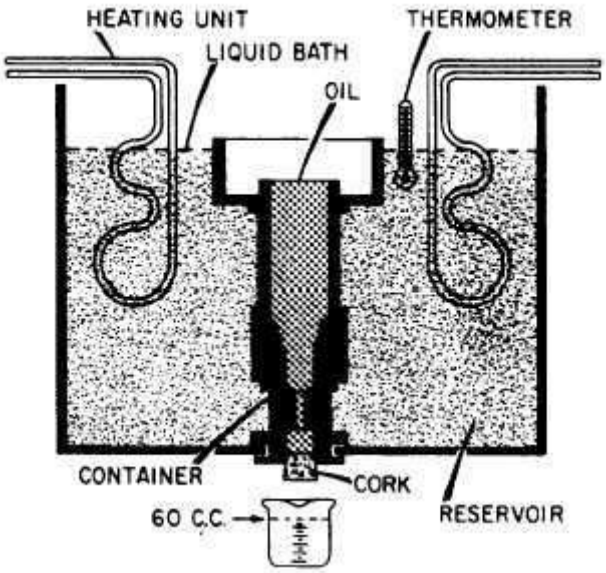
$$\mu = \left(\frac{\pi}{128}\right)\frac{w_l h_f d^4}{QL}$$



Saybolt Viscometer

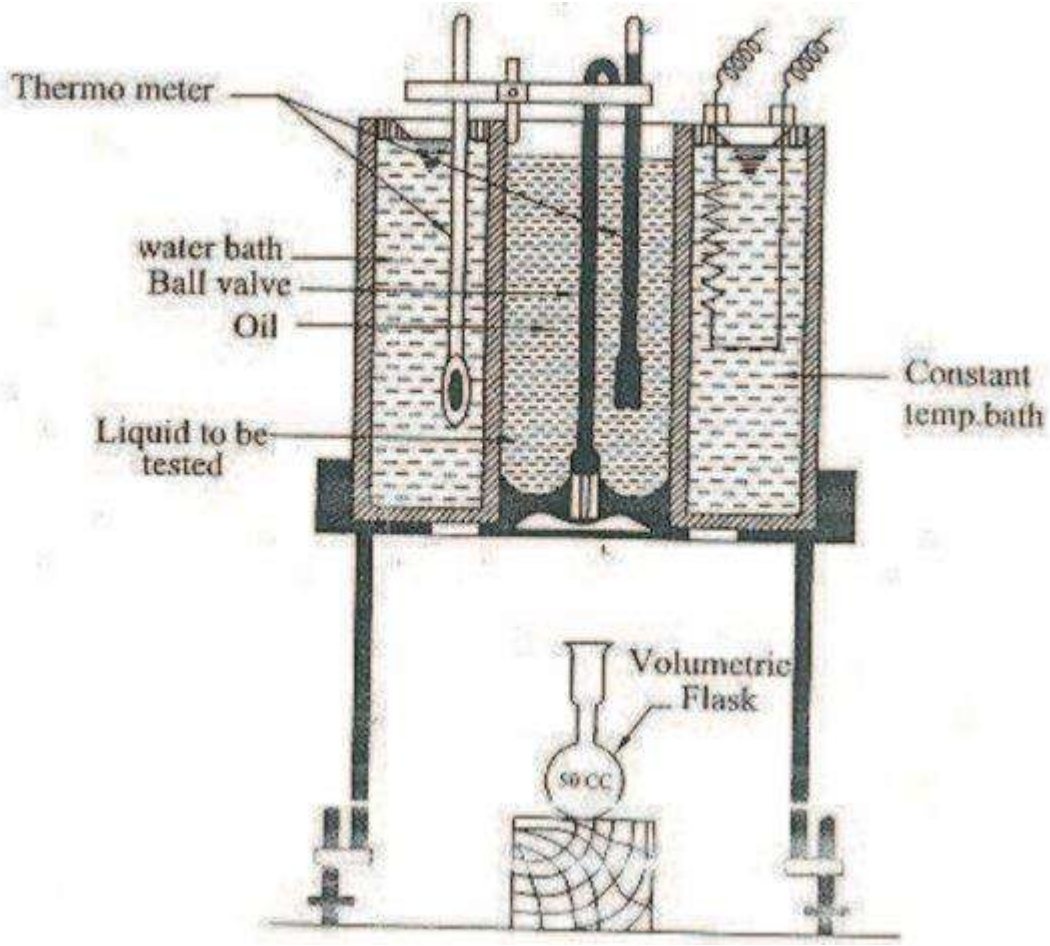
The Saybolt viscometer has a vertical cylindrical chamber filled with liquid whose viscosity is to be measured (Figure). It is surrounded by a constant temperature bath and a capillary tube (length 12mm and diameter 1.75mm) is attached vertically at the bottom of the chamber. For measurement of viscosity, the stopper at the bottom of the tube is removed and time for 60ml of liquid to flow is noted which is named as Saybolt seconds. For calculation purpose of kinematic viscosity (ν), the simplified expression is obtained as below.

$$\nu = \frac{\mu}{\rho} = 0.002t - \frac{1.8}{t};\ \text{where, } \nu \text{ in Stokes and } t \text{ in seconds}$$



Redwood Viscometer

A Redwood viscometer works on the same principle of Saybolt viscometer. Here, the stopper is replaced with an orifice and Redwood seconds is defined for collection of 50ml of liquid to flow out of orifice. Similar expressions can be written for Redwood viscometer. In general, both the viscometers are used to compare the viscosities of different liquid. So, the value of viscosity of the liquid may be obtained by comparison with value of time for the liquid of known viscosity.


Thermo meter
water bath
Ball valve
Oil
Liquid to be tested
Constant temp.bath
Volumetric Flask
50 CC

STUDY OF CONSTRUCTION OF BOMB CALORIMETER

Introduction

The calorimeter used to determine the energy change during a reaction accurately is known as a bomb calorimeter. The modern Bomb calorimeter is a development of the original calorimeter of Berthelot. The modern bomb calorimeter is made of corrosion resisting steel in which the combination Bomb Calorimeter.

The bomb calorimeter is an instrument used to measure the heat of reaction at a fixed volume and the measured heat which is called the change of internal energy (ΔE). In chemistry, the changes of heat of a reaction can be measured at fixed pressure or volume.

Working of Bomb Calorimeter

The bomb calorimeter is a type of constant-volume calorimeter used to measure the combustion heat of oxygen-burnable samples. Four critical parts are needed in every bomb calorimeter.

The bomb calorimeter is a laboratory instrument used to measure the amount of a sample's combustion heat or heat power when excess oxygen combustion occurs. The purpose of this research is to determine the effect of using the bomb calorimeter on the ability of physics students to process science. Influences involve the efficacy of using the devices and learning how to develop the abilities of the scientific method of students before and after using materials.

If the heat capacity of the calorimeter is known, then one can determine the heat change during a chemical reaction by noting the change in the temperature in the process.

The heat
$Q = C_v(T_f - T_i)$
where, q is the amount of heat according to the change in temperature measured in joules
C_v is the heat capacity of the calorimeter
T_f is the final temperature
T_i is the initial temperature

Construction of Bomb Calorimeter

The bomb calorimeter is used to determine the calorific values of solid and liquid fuels. It consists of a strong steel shell known as a bomb.

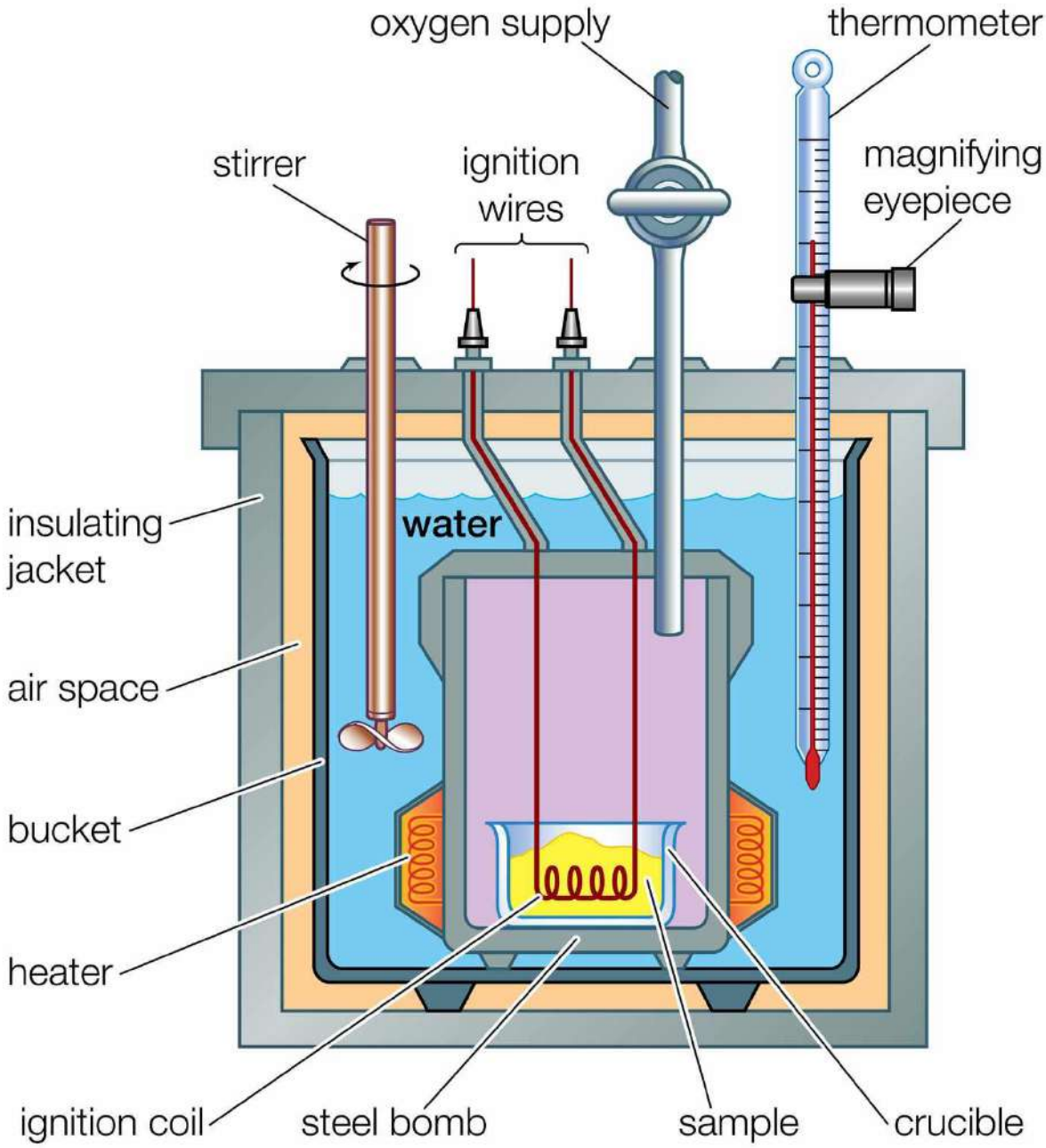
It consists of a base which supports the platinum crucible and is screwed to the body of the bomb. The top of the bomb carries an oxygen supply connection and a valve to release the product. One gram of powdered sample coal is taken for the test and the calorimeter is filled with 2000cm3 of water. The sample is placed in the platinum crucible. The iron fuse wire which surrounds the sample of coal, is connected to the lower end of the two electrodes. The electrodes extend through the base of the bomb and connect the fuse wire to an electric circuit. The coal can be ignited by closing the electric circuit.

The bomb is placed inside a copper vessel which contains water. There is a stirring device for agitating the water within the calorimeter. The calorimeter containing the bomb is placed in

another container which acts as a heat insulator. The temperature of water in the calorimeter is measured by a thermometer.

The oxygen cylinder is coupled to the bomb and oxygen is admitted to the bomb through the value until the pressure gauge in the cylinder indicates a pressure of 25 atmospheres. The fuel is ignited by passing a current through the fuse wire. The temperature of both starts increasing and the readings on the thermometer are taken at one minute intervals for 10 minutes, after the maximum intervals for 10 minutes, after the maximum temperature is reached. Thereafter the temperature starts falling slowly. When the temperature fall shows a steady rate the readings are taken at regular intervals for an additional five minutes.

Heat given by the combustion of coal + Heat given by the combustion of fuse wire = Heat taken by the water and calorimeter.



Uses of Bomb Calorimeter

A bomb calorimeter is an instrument used to determine the heat emitted from a given quantity of biomass sample combustion and to calculate the HHV of that biomass fuel. Approximately one gramme of sample fuel is ground and diluted after each test to fit into a capsule for bomb combustion. The emitted heat increases the temperature of the water covering the bomb by combusting the fuel. The total heat of the fuel is determined by increasing the temperature and the real mass of the fuel.

In different industries and academic environments, calorimeters are helpful, and an industrial pilot plant may use a DSC to assess a shift in the formula of a substance and how it impacts the formula itself. To calculate the amount of heat (calories) in food, oxygen bomb calorimeters are useful in food testing laboratories.

Date: **EXPERIMENT NO: 1**

VALVE TIMING DIAGRAM FOR FOUR STROKE DIESEL ENGINE

Aim :

To draw the valve timing diagram for the given four stroke diesel engine.

Apparatus Required :

1. Four Stroke Cycle Diesel Engine
2. Measuring Tape
3. Chalk
4. Piece of paper

Description :

The diagram which shows the position of crank of four stroke cycle engine at the beginning and at the end of suction, compression, expansion and exhaust of the engine is called valve timing diagram.

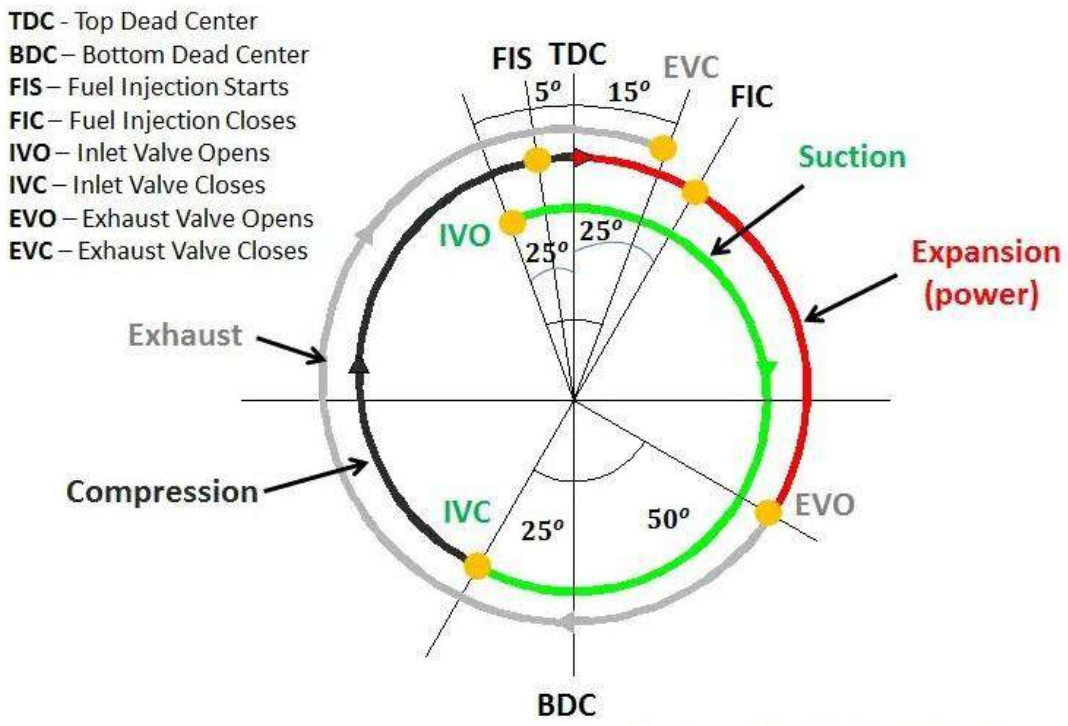
The extreme position of the piston at the bottom of the cylinder is called "Bottom Dead Centre" and the extreme position at the top of the cylinder is called "Top Dead Centre". In an ideal engine, the inlet valve opens at TDC and closes at BDC. The exhaust valve opens at BDC and closes at TDC. The fuel is injected into the cylinder when the piston is at TDC and at the end of the compression stroke. But in actual practices it will differ.

Inlet Valve Opening and Closing :

In an actual engine, the inlet valve begins to open 5^o to 20^o before the piston reaches the TDC during the end of the exhaust stroke. This is necessary to ensure that vakce will be fully open when the valce reaches TDC. And the inlet valve is closed 25^o to 40^o after BDC, as the cylinder would receive less amount of air than its capacity if the valve is closed at BDC. And also the pressure at the end of the suction will be below the atmospheric pressure.

Exhaust Valve Opening and Closing :

Complete clearing of the burnt gases from the cylinder is necessary to take in more air into the cylinder. To achieve this the exhaust valve opens at 35 – 45^o before the BDC and closes at 10 -20^o after the TDC. And for a certain period towards the end of a cycle, both the inlet and exhaust valves are kept open. The crank angles for which both valves are open are called Valve Overlap Period.



Actual Valve Timing Diagram of 4 Stroke Diesel Engine

TABULATION

CIRCUMFERENCE OF THE FLYWHEEL = ...cm

Sl.No	Events	Position with reference to Dead Centres	Distance from their respective Dead Centre in 'cm'	Angle (degrees)
1	Inlet Valve Open (IVO)	Before TDC		
2	Inlet Valve Close (IVC)	After BDC		
3	Exhaust Valve Open (EVO)	Before BDC		
4	Exhaust Valve Close (EVC)	After TDC		

Formula Used :

Angle of Valve opening : $\frac{360 \times \text{Distance from Dead Centre in degrees}}{\text{Circumference of the flywheel}}$

- DISTANCE = Distance of the valve opening or closing position marked on flywheelwith respect to their dead centre.

Procedure :

1. Identify the engine components and ports from the cut –section of the engine.
2. Mark the TDC and BDC position on the flywheel.
3. Insert the paper in the tappet clearance of both inlet and exhaust valves.
4. Slowly rotate the crank until the paper in the tappet clearance of inlet valve is gripped. Make the mark on flywheel against fixed reference. This position represents the inlet valve open(IVO). Measure the distance from TDC and tabulate the distance.
5. Rotate the crank further, till the paper is just free to move. Make the marking on the flywheel against the fixed reference. This position represent the inlet valve close (IVC). Measure the distance from BDC and tabulate the distance.
6. Rotate the crank further, till the paper in the tappet clearance of exhaust valve is gripped. Make the markingon the flywheel against the fixed reference. This position represents the exhaust valve open(EVO). Measure the distance from BDC and tabulate it.
7. Rotate the crank further, till the paper in the tappet clearance of exhaust valve is just free to move. Make the marking on the flywheel against the fixed reference. This position represent the exhaust valve close (EVC). Measure the distance from TDC and tabulate it.
8. Then convert the measured distances into angle in degrees.

Model Calculation:

Result :

Thus the valve timing diagram for the given four stroke diesel engine found out and it is drawn

Inlet Valve Open at.....degree

Inlet Valve close at.....degree

Exhaust Valve Open at.....degree

Exhaust Valve Close at.....degree

Date: **EXPERIMENT NO: 2**

PORT TIMING DIAGRAM FOR TWO STROKE PETROL ENGINE

Aim :

To draw the port timing diagram for the given two stroke diesel engine

Apparatus Required :

1. Four Stroke Cycle Diesel Engine
2. Measuring Tape
3. Chalk

Description :

The diagram which shows the position of crank at which the ports of a two stroke engine opens and close during a cycle is called a port timing diagram.The extreme position of the piston at the bottom of the cylinder is called “Bottom Dead Centre” (BDC).The extreme position of the piston at the top of the cylinder is called “Top Dead Centre” (TDC).

In two stroke petrol engines the inlet port open when the piston moves from the BDC to TDC and closes when the piston moves from the TDC to BDC.

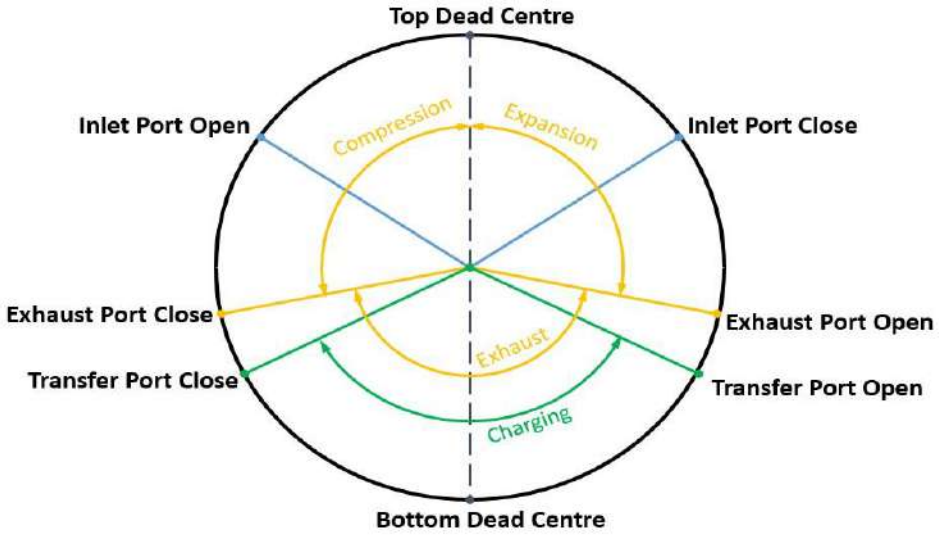
The transfer port is opened when the piston moves from TDC to BDC and the fuel enters into the cylinder through the transfer port from the crank case of the engine. The transfer port is closed when piston moves from BDC to TDC . The transfer port opening and closing are measured with respect to the BDC.

The exhaust port is opened , when the piston moves from TDC to BDC and is closed when piston moves from BDC to TDC. The exhaust port opening and closing are measured with respect to BDC.

Formula Used :

Angle of Valve opening: $\frac{360 \times \text{Distance from Dead Centre}}{\text{Circumference of the flywheel}}$ in degrees

- DISTANCE = Distance of the port opening or closing position marked on flywheelwith respect to their dead centre.



Actual Port Timing Diagram of 2 stroke Petrol Engine

TABULATION

CIRCUMFERENCE OF THE FLYWHEEL =.....cm

Sl.No	Events	Position with reference to Dead Centres	Distance from their respective Dead Centre in 'cm'	Angle (degrees)
1	Inlet Port Open (IPO)	Before TDC		
2	Inlet Port Close(IPC)	After TDC		
3	Transfer Port Open (TPO)	Before BDC		
4	Exhaust Port Open (EPO)	Before BDC		
5	Transfer Port Close (TPC)	After BDC		
6	Exhaust Port Close (EPC)	After BDC		

Procedure :

1. Identify the engine components and ports from the cut –section of the engine.
2. Mark the TDC and BDC position on the flywheel.
3. Rotate the flywheel in clockwise direction and observe the movement of piston and opening of ports asthe cylinder moves up and down.
4. When the piston moves from BDC to TDC mark on the flywheel the inlet port openings as the piston's skirt uncovers bottom end of the inlet port. Similarly mark the inlet port closing as the piston's skirt covers the port as it moves from TDC to BDC.
5. In the same stroke observing the opening of transfer port and exhaust port mark the positions on the flywheel. Thus the following positions, Transfer Port Open, Exhaust Port open, Transfer Port Close and Exhaust Port Close are marked in sequence.
6. Measure the distance of Inlet Port Open and Inlet Port Close from TDC .
7. Measure the distance of Transfer Port Open, Exhaust Port Open , Transfer Port Close and Exhaust PortClose from BDC.

Model Calculation:

Result :

Thus the port timing diagram for the given two stroke petrol engine found out and it is drawn

Transfer Port Open at.....degree

Transfer Port Close at..... degree

Exhaust Port Open at.....degree

Exhaust Port Close at.....degree

Date: **EXPERIMENT NO: 3**

DETERMINATION OF FLASH AND FIRE POINTS FOR GIVEN OIL USING OPEN CUP APPARATUS

Aim :

. To determine the flash and fire point of the given oil using open cup apparatus

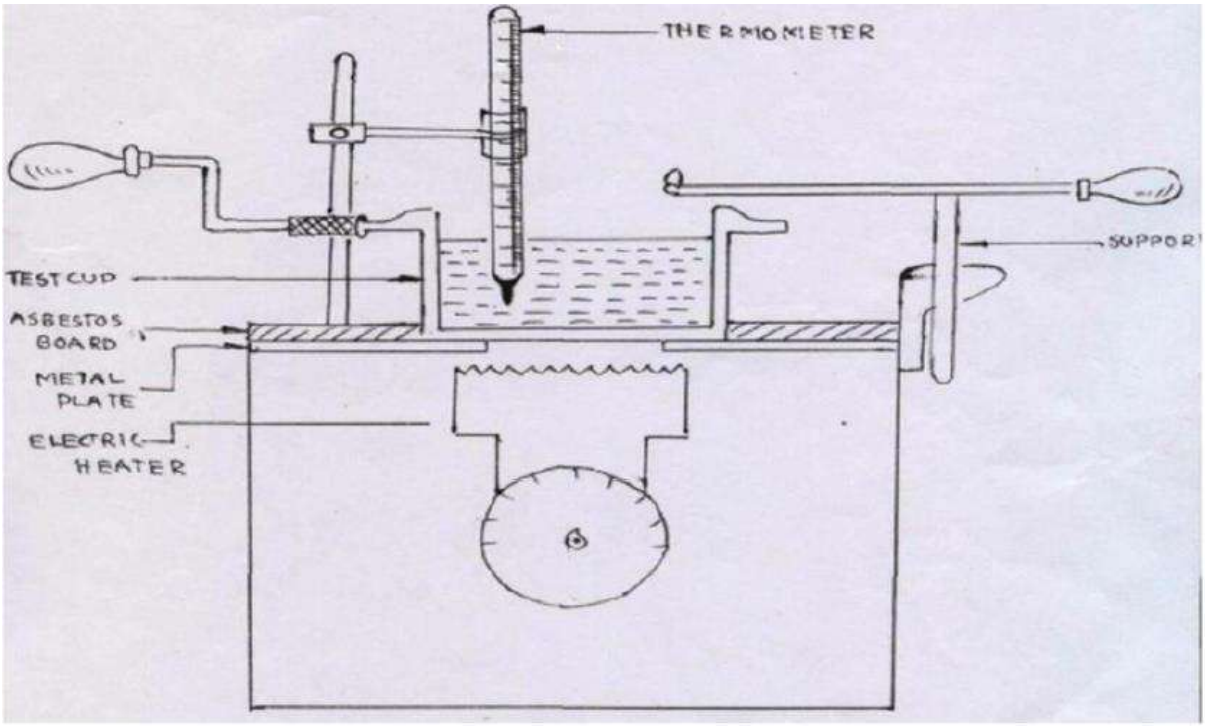
Apparatus Required :

1. Open Cup Flash Point Apparatus
2. Thermometer
3. Splinter Sticks
4. Fuel Sample

Description :

The flash point of a fuel is defined as the lowest temperature at which it forms vapours and produces combustible mixture with air. The higher flash point temperature is always desirable for any lubricating oil. If theoil has the lower value of flash point temperature, it will burn easily and forms the carbon deposits on the moving parts. The minimum flash temperature of the oil used in IC Engines vary from 200^0C to 250^0C. When a oil is tested in open cup apparatus, the temperature is slightly more than the above temperatures. The flash point and fire point temperatures differs by 20^0C to 60^0C when it is tested by open cup apparatus. The flash point and fire point of a fueldepends on the viscosity of the oil.

The Cleaveland open cup apparatus consists of a cylindrical cup of standard size. It is held in position in a metallic holder which is placed on a wire gauge. Is is heated by means of an electric heater housed inside a metallic holder. A provision is made on the top of the cup to hold the thermometer. A standard filling mark is done on the inner side of the cup and the sample of oil is filled up to the mark. This apparatus will give more accurate results than the Pensky Marten Closed cup apparatus.



.Open Cup Apparatus

TABULATION

Observe the reaction of the oil vapours when introducing the test flame and tabulate them

GIVEN FUEL = SAE 20-40W

SI.NO	**Temperature(**°C**)**	**Observed Flash Point (Yes/No)**	**Observed FirePoint (Yes/No)**

Procedure :

1. The fuel under examination is filled up to the mark in the oil cup and then heated by heating the water bath by burner.
2. Stirrer is worked between tests at a rate of about 1 to 2 revolution per seconds.
3. Heat is applied so as the raise the oil temperature by about 5°C per minutes.
4. At every 10°C raise of temperature flame is introduced for a moment by working the shuffle.
5. The temperature at which a testing flash a combination of a weak sound and light appears is noted and is the flash points.
6. The heating is continued thereafter and the test flame is applied as before.
7. When the oil ignites and continued to burn for a at least 5 seconds the temperature reading is noted and is five points.

Model Calculation:

Result :

Thus the flash and fire point of the given oil is found out experimentally

Flash point =……

Fire point =……

.

Date: **EXPERIMENT NO: 4**

DETERMINATION OF VISCOSITY OF OIL USING REDWOOD VISCOMETER

Aim :

To determine the kinematic viscosity and absolute viscosity of lubricating oil at different temperatures using Redwood Viscometer.

Apparatus Required :

1. Redwood Viscometer
2. Thermometer
3. Stop Watch
4. 50 ml standard narrow necked flask.
5. Oil sample.

Description :

Viscosity :

Viscosity is the property of fluid. It is defined as the "internal resistance offered by the fluid to the movement of on layer of fluid over an adjacent layer. It is due to the cohesion between the molecules of the fluid. The fluids which obey the Newton law of Viscosity are called as Newtonian fluid. The dynamic viscosity of the fluid is defined as the shear required producing unit rate of angular deformation.

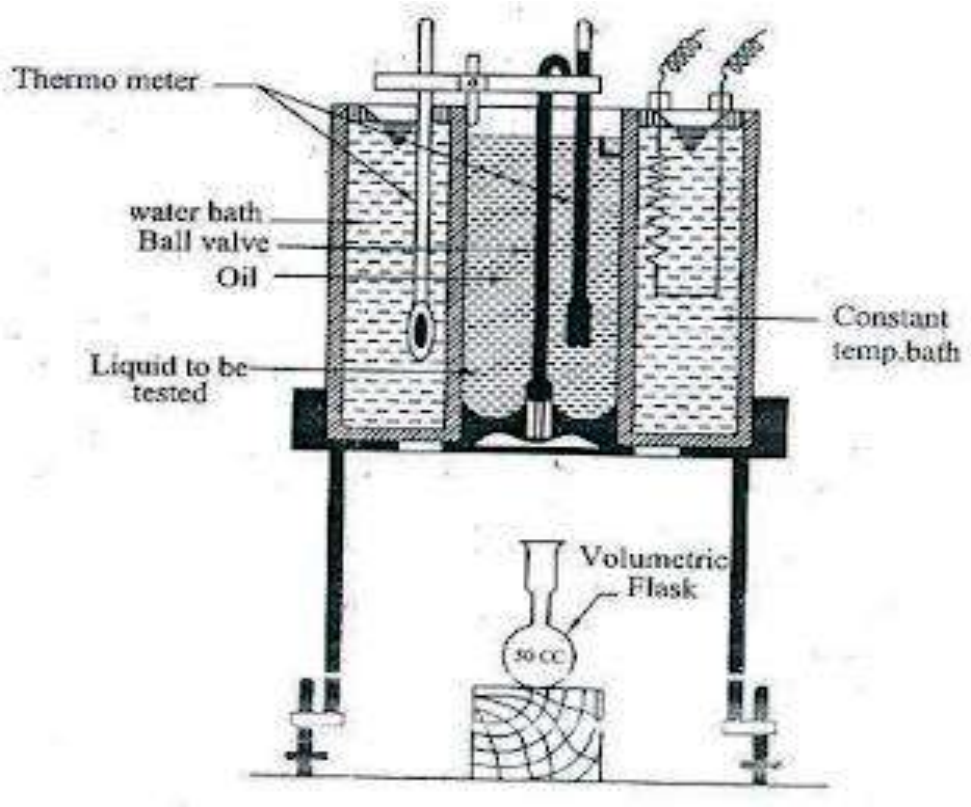
Redwood Viscometer :

The Redwood viscometer consists of a vertical cylindrical cup with an orifice in the centre of its base. The orifice can be closed by a ball. A hook pointing upward serves as a guide mark for filling the oil. The cylindrical cup is surrounded by a water bath. The water bath maintains the temperature of the oil to be tested at constant temperature. The oil is heated by heating the water bath by means of an immersed electric heater in the water bath. A provision for stirring the water bath is also provided, to maintain uniform temperature in the water bath. A thermometer is used to record the temperature of the oil bath and the water bath.

Specification :

Cylinder diameter	:	47.625 mm
Cylinder depth	:	88.90 mm
Orifice diameter	:	1.70 mm

Length : 12 mm



Redwood Viscometer Experimental Setup

TABULATION

Room Temperature =

Density of oil at room temperature =

S.No	Temperature of Oil	Time taken to fill 50ml flask (secs)	Kinematic Viscosity Centi-stokes	Density gm / cc	Dynamic / Absolute Viscosity Centi-poise

Formulae used :

1.Kinematic Visososity :

$$\gamma = At - \frac{B}{t} \quad \text{in Centi-stokes}$$

A - 0.0026

B - 1.72

t - Time taken for collecting 50 ml of oil - Redwood seconds

2.Density of Oil at particular temperature:

$$\mathbf{P = \rho R - 0.00065 (T - TR)} \quad \text{in gm/cc}$$

T - Temperature at which the density is required in ^{o}C.

T_R - Room Temperature

ρR - Density of oil at room temperature in gm / cm^2

3.Dynamic Viscosity :

$$\mu = \gamma \times \rho \quad \text{in Centi-Poise}$$

Procedure:

1. Clean the cylindrical oil cup and ensure the orifice tube is free from dirt.
2. Close the orifice with ball valve.
3. Place the 50 ml flask below the opening of the orifice.
4. Fill the oil in the cylindrical cup up to the mark in the cup.
5. Fill the water in the water bath.
6. Insert the thermometers in the respective places to measure the oil and water bath temperatures.
7. Heat the oil by heating the water bath. Stir the water bath and maintain uniform temperature.
8. At a particular temperature lift the ball valve and collect the oil in the 50 ml flask and note the timetaken for collecting 50 ml of the oil. This time is called Redwood seconds.
9. Increase the temperature and repeat the procedure and note down the Redwood seconds.

Model Calculation:

Graphs :

The following graph has to be drawn.

1. Temperature vs Redwood seconds
2. Temperature vs Kinematic Viscosity
3. Temperature vs Dynamic Viscosity.

Result :

The kinematic and dynamic viscosity of oil at different temperatures is determined.

Date: **EXPERIMENT NO: 5**

ACTUAL P-V DIAGRAM OF FOUR STROKE DIESEL ENGINE

Aim: To diagram the Actual P-v diagram for the given four stroke Diesel engine.

Apparatus Required:

1. Measuring tape
2. Chalk piece

Formula Used :

Angle of Valve opening : $\frac{360 \times \text{Distance from Dead Centre in degrees}}{\text{Circumference of the flywheel}}$

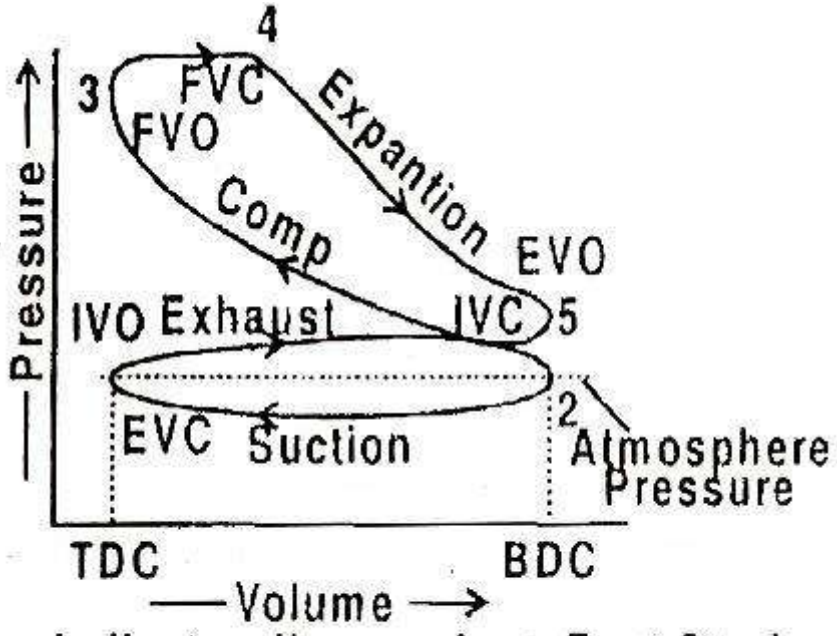
Procedure:

1. Valves are opened and closed by cam mechanism.
2. Valves will balances on its seat are closed abrupt.
3. Opening or closed of valves spread over a certain crank angle
4. Inlet valve open before Top Dead Center (approx).
5. Inlet valve close before Bottom Dead Center (approx) to take advantage of rapidly moving gases.
6. Ignition occurs before Top Dead Center (approx).This to allow the time delay between the spark and commencement of combustion.
7. Exhaust valve open at Bottom Dead Center (approx), else pressure will rise enormously and the work required expecting the gas will increase.
8. Exhaust valve close at Top Dead Center (approx) this is to increases the volumetric efficiency.

TABULATION

Events	Distance from their respective Dead Centre In 'cm'	Valve Opening Period in 'Degrees'
Inlet Valve Open **[IVO]**		
Inlet Valve Close **[IVC]**		
Exhaust Valve Open **[EVO]**		
Exhaust Valve Close **[EVC]**		

Model P-V diagram:



Indicator diagram for a Four Stroke Cycle Diesel Engines.

Model Calculation:

Result:

Thus the actual P-v diagram for given four stroke diesel engine is drawn.

Date: **EXPERIMENT NO: 6**

DETERMINATION OF CALORIFIC VALUE OF GIVEN BY BOMB CALORIMETER

Aim: To Determination of Calorific Value of GivenBy Bomb Calorimeter.

Apparatus Required:

3. Bomb calorimeter.
4. Oxygen cylinder.
5. Pressure pipe for flowing oxygen from cylinder to bomb.
6. Temperature measuring device (Thermometer)
7. Digital weight meter.
8. Fuse wire.
9. Crucible.
10. Cotton.

Description :

The bomb calorimeter is normally used to determine the higher calorific value of solid as well as liquids fuels. The combustion of fuels takes place at constant volume totally enclosed by vessel.

Thus the higher calorific value at constant volume of the supplied fuel is determined. The combustion leads to reduction in volume of product of combustion when reduced to initial temperature. The values obtained are the different from actual heat liberated.

Formula Used :

Heat liberated by fuel and wire = Heat absorbed in the calorimeter Or,

$CX+C1Xw= (W + w) (\theta1-\theta2) Cp$

Where

C= calorific value of burnt fuels.

C1= calorific value of wire burnt.

X = mass of fuel burnt.

X w = mass of wire.

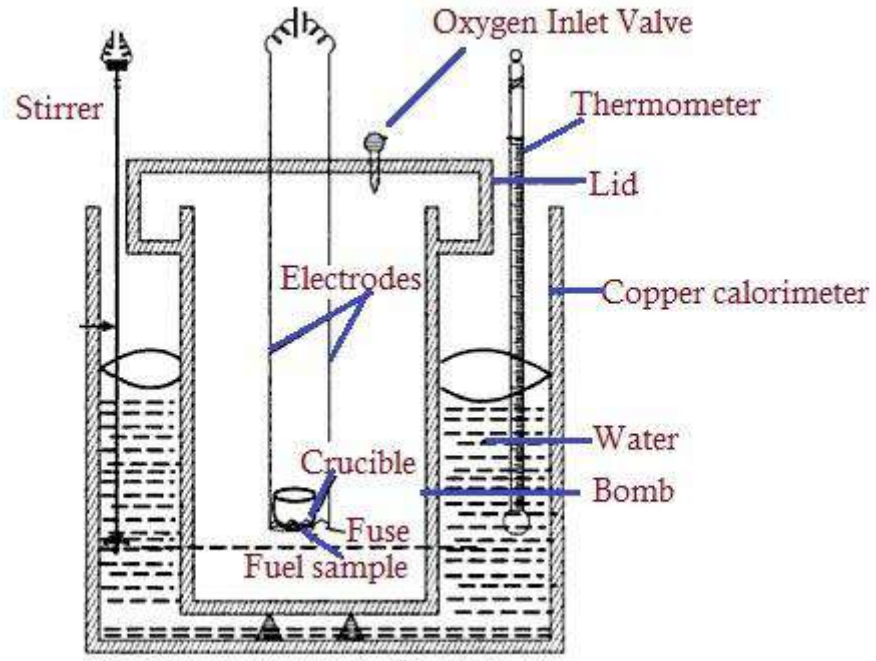
$\theta1$ = temperature after combustion.

$\Theta2$ = temperature before combustion.

W = water equivalent of water.

w = weights of water in calorimeter.

Cp = specific heat of water.



Bomb Calorimeter Apparatus

TABULATION

To find out the water equivalent of calorimeter bomb using benzoic acid.

Calorific value of benzoic acid = 26 KJ/gm

SL. No	Empty crucible Weight	Crucible +B.A Weight	Weight of B.A
Unit	In gm	In gm	In gm

SL. No	Initial Temperature(θ1 °C)	Time interval	Temperature	Final Temperature(θ2 °C)	Temperature Rise(θ1-θ2) °C	Water equivalent

Procedure:

1. At first measure the water equivalent of calorimeter using benzoic acid whose calorific value is known.
2. First measure empty crucible in gm.
3. Take the measurement of crucible filled with benzoic acid.
4. Set fuse wire & cotton in proper position of electrode.
5. Fill bomb with oxygen from oxygen cylinder at 25 atm.
6. Get the proper electrical connection to activate firing unit, stirrer system & temperature indicator.
7. Measure and note down the temperature raising of water every 60 Sec after firing till the temperature becomes steady.
8. Measure the calorific value of fuel by known water equivalent of calorimeter using the equation (1).
9. The next procedure is same as above only the difference is that instead of Benzoic acid take the supplied fuel.

Model Calculation:

Result:

The Calorific value of liquid fuel is determined.