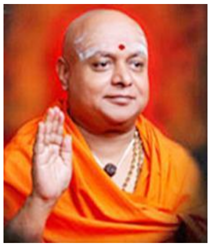

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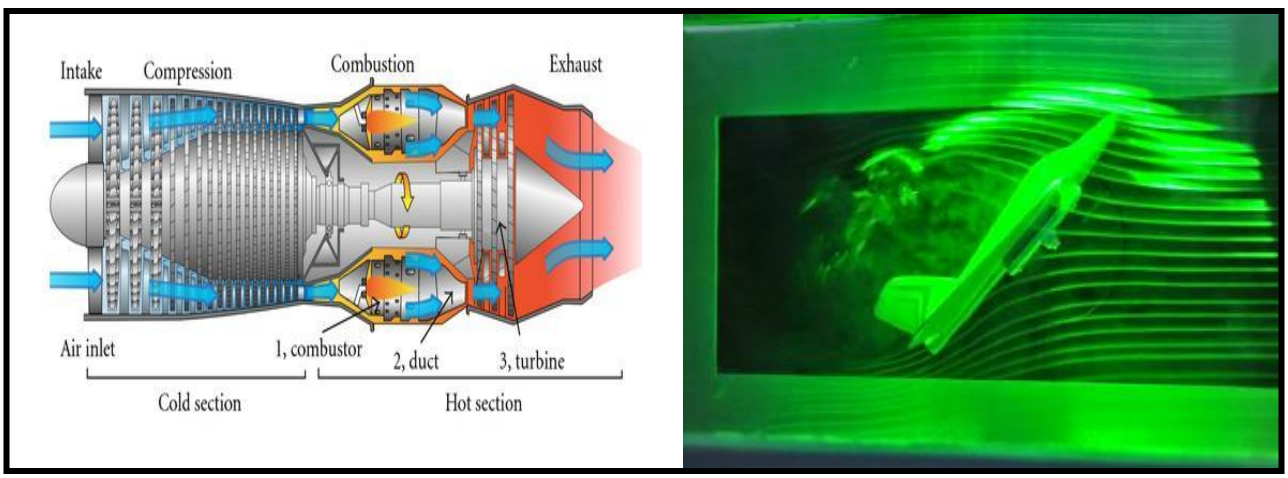
ENERGY CONVERSION AND FLUID MECHANICS LAB – 18AEL58

V SEMESTER

LABORATORY MANUAL



Prepared by

Dr.NAGESH.D
Assistant professor

Prof. SUNKAPPA
Assistant professor

DEPARTMENT OF AERONAUTICAL ENGINEERING

//JAI SRI GURUDEV//

S.J.C. INSTITUTE OF TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING

VISION:

PREPARING COMPETENT AERONAUTICAL ENGINEERS TO SERVE THE SOCIETY

MISSION:

M1: Strengthening the Fundamental concepts in Aeronautical Engineering

M2: Building Analytical ability among students with innovative problem-solving techniques.

M3: Training students in multidisciplinary research areas in collaboration with Industries embedding the culture of continuous learning.

M4: Imparting skillset in line with emerging industrial needs with leadership qualities.

M5: Making students responsible citizens to serve society with ethics and values.

PROGRAM EDUCATIONAL OBJECTIVE(PEOs)

PEO1: Engage in designing, manufacturing, testing, operating and maintaining of systems in Aeronautical and Allied Industries.

PEO2: Identify, plan and lead the projects in challenging industrial projects in challenging industrial environment independently and become successful professionals in their career.

PEO3: Pursue higher studies enhancing their Academic & research capabilities as to adopt to the changing Technologies.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Aeronautical Engineering Graduates will be able to

PSO1: Apply knowledge of fundamental concepts of Aeronautical Engineering in solving contemporary alternative fuels, UAV and Composites problems.

PSO2: Demonstrates, solve multidisciplinary problems with knowledge of Aeronautics.

PSO3: Building risk taking abilities & decision making capabilities in Aeronautical field.

OBJECTIVE:

The objective of this lab is to teach students, the importance of Energy conversion and fluid mechanics through involvement in experiments. This lab helps to have knowledge of the world due to constant interplay between observations and hypothesis, experiment and theory in this subject. Students will gain knowledge in various areas of Energy conversion and fluid mechanics so as to have real time applications in Aeronautical engineering stream.

OUTCOMES:

On successful completion of this course, students will be able to

CO1 – **Conduct** tests and determine the properties of fuels and oils.
CO2 - **Demonstrate** and Conduct performance tests on IC engines and draw characteristics plots.
CO3 – **Perform** experiments to determine the coefficient of discharge of flow measuring devices.
CO4 – **Verify** the Bernoulli's equation and evaluate the viscosity of fluid.

CO-PO Mapping															
Course Outcomes(CO)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	-	-	-	2	-	-	2	3	2	-
CO2	3	2	3	2	-	-	-	-	2	-	-	2	3	2	-
CO3	3	2	3	3	-	-	-	-	2	-	-	2	3	2	-
CO4	3	2	2	-	-	-	-	-	2	-	-	2	3	2	-
Average attainment	3	2	2.5	2.5	-	-	-	-	2	-	-	2	3	2	-

CONTENTS

ENERGY CONVERSION AND FLUID MECHANICS LAB [18AEL58]

Maximum Marks for Internal Assessment = 40

WEEKLY: 3 hrs per batch

TEST: 16 MARKS

RECORD: 24 MARKS

TEST PROCEDURE:

NO. OF TEST TO BE CONDUCTED: 1

MAXIMUM MARKS: 24

DURATION: 3 hrs

1) No of experiment to be conducted: 2

   One group experiment: 08 marks

   One individual experiment: 08 marks

- Procedure for both the experiments
- Tabular column
- Necessary formula & ideal graph if any
- Conduction
- Calculation & results
- Graph & conclusion

2) VIVA: 08 MARKS

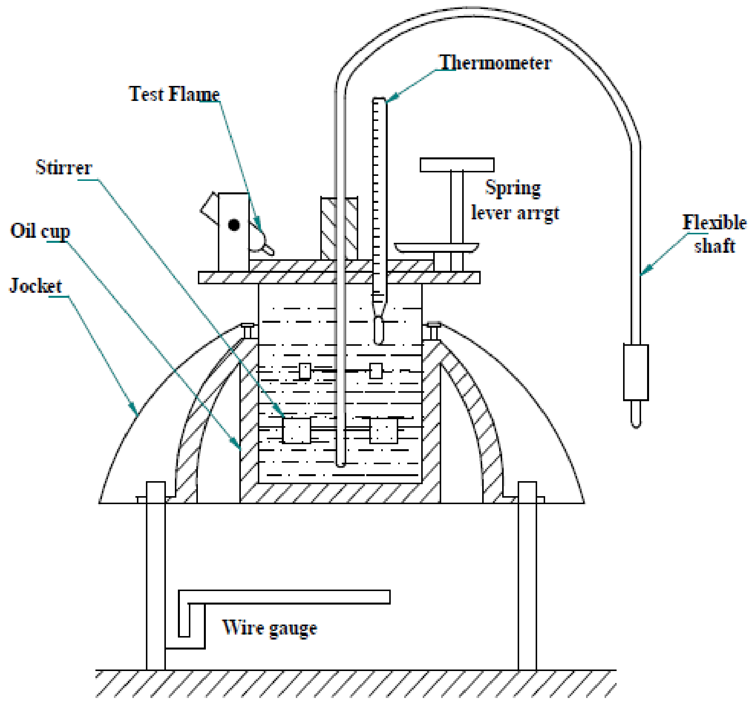
Scheme of Semester End Examination

ONE Question from Part-A:	**40 Marks**
ONE Question from Part-B:	**40 Marks**
Viva-Voce:	**20 Marks**
Total	**100 Marks**

EXPERIMENT NO.1
MARTIN-PENSKY APPARATUS

AIM: To determine the flash and fire point of the lubricating oil using Pensky-Martin apparatus.

APPARATUS: Pensky-Martin apparatus, Thermometer, Broom sticks.



DESCRIPTION OF THE EQUIPMENT:

This is widely used for determination of closed cup Flash Point of Fuel Oil, cut back asphalts, other viscous material and suspension of solids having a flash point about 490C(1200F).The apparatus serve the purpose according to IP 34, ASTM-D-93-58T, IS-1448(P:I) 1960(P:21) and IS 1209/1958 method B. The apparatus consists of Brass Test cup with handle removable cup cover with spring operated rotating shutter having pilot jet, stirrer with flexible shaft. The assembly rests in Air Bath which is covered with Dome shape metal top. The cup is fitted with insulated handle and locking arrangement near cup flange. The assembly rests on a round shaped heater with different temperature regulation system suitable for operation on 220 Volts AC main

PROCEDURE:

1. Clean the oil cup and dry it.
2. Pour a fresh sample of oil into the cup of the apparatus up to the level indicated by the filling mark.
3. Insert a thermometer into the cup.
4. Place the lid in proper position.
5. Heat the oil and stir it continuously.
6. Apply the test flame at temperature intervals of 1degreeC. Do not stir the oil during the application of test flame.
7. Note down the temperature at which a distinct flash is visible.
8. Continue the heating and applying of test flame.
9. Record the temperature when the oil ignites and continue to burn at least 5 seconds.

TABULAR COLUMN

Type of oil:

Temperature ^{o}C	Remarks	Flash point ^{o}C	Fire point ^{o}C

RESULT

The Flash point of a given sample of oil = ------- ^{0}C

The Fire Point of given oil = --------- ^{0}C

EXPERIMENT NO. 2

ABEL-PENSKY APPARATUS

AIM: To determine the flash and fire point of the lubricating oil using Abel's Pensky apparatus

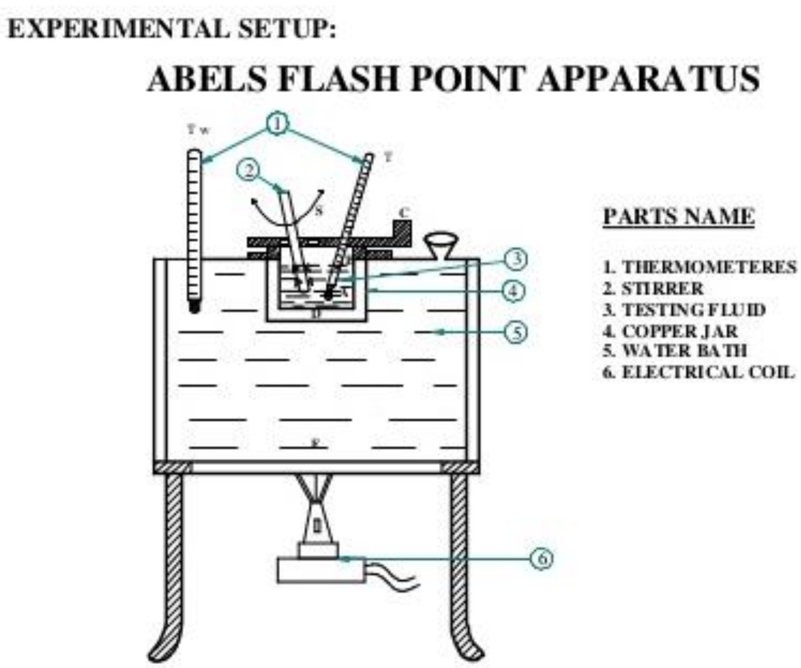
APPARATUS: Abel-Pensky apparatus, thermometer, Broom sticks.

THEORY: Write the theory on following topics

a. Properties of oils with definition.

DESCRIPTION OF THE EQUIPMENT:

Used for determining of the closed cup Flash point of Petroleum Products, their mixtures, others liquids & Paints having Flash Point below 700C. The apparatus consists of one brass cup and cover fitted with shutter mechanism test flame arrangement (Oil test jet or Gas test jet) and stirrer, placed on a water bath made of copper sheet double walled. The outer jacket of the water bath is fitted with a stand. For electrically heated apparatus, heater is fitted to the stand the heat of which may be controlled different temperature regulation system of operated on 220 Volts AC mains. For Gas heated model the drum is heated by a burner. (Without burner).



PROCEDURE:

1. The apparatus is setup as shown in the fig. A thermometer is inserted in the oil cup.

2. Before starting the room temperature is noted. The oil is heated for every 2^0 rise in temperature is observed for the momentary flash.

3. The temperature at which flash appears is the flash point and is noted.

4. The oil is further heated till the oil catches the fire and burns continuously at least for 5sec and it is the fire point and is noted.

5. The flame is then put off

PRECAUTIONS:

1. Clean the water tank regularly after use

2. Do not run the equipment if the voltage is below 180V

3. Check all the electrical connections before running

4. Before starting and after finishing the experiment the mains should be put off.

5. Do not attempt to alter the as this may cause damage to the whole system.

SPECIFICATIONS:

1. Outer Chamber : Made of Copper
2. Inner Chamber : Made of Copper
3. Voltage : 230 Volt A.C. supply
4. Wattage : 750 Watts
5. Heater: Electrically heated with energy regulator
6. Cup made: Brass
7. Test usage: For testing oil temperature of flash range of ambient to 700oC

TABULAR COLUMN

Type of oil:

Temperature ºC	Remarks	Flash point ºC	Fire point ºC

RESULT

The flash point of a given sample of oil = ------- ^{0}C

The Fire Point of given oil = --------- ^{0}C

EXPERIMENT. NO. 3

RED WOOD VISCOMETER

AIM: To determine the kinematic and absolute viscosities of the given oil using red wood viscometer.

APPARATUS: Red wood viscometer, stop watch, 50cc standard flask, thermometer

THEORY: Write the theory on following topics

a. Red Wood Viscometer description.

b. Definition of absolute viscosity, kinematic viscosity, viscosity index

c. Grading of lubricants, Single grade, Multi grade oils

d. Derivation of viscosity formula

DESCRIPTION OF THE EQUIPMENT:

Redwood viscometer Consists of a cylindrical oil cup furnished with a gauge point, a gate/ metallic Orifice jet at the bottom having a concave depression from inside to facilitate a ball with stiff wire to act as a valve to start or stop oil flow. The outer side of the orifice jet is convex, so that the oil under test does not creep over the lower face of the oil cup. The oil cup is surrounded by a water bath with a circular electrical immersion heater and a stirring device. Two thermometers are provided to measure water bath temp. & oil temperature under test. A round flat-bottomed flask of 50cc marking, to measure 50 ml of oil flow against time. The water bath with oil cup is supported on a tripod stand with leveling screws.

PROCEDURE:

1. The instrument is cleaned and leveled. The oil is poured into the cylinder up to the mark provided the thermometer is placed inside.

2. At the room temperature, time for flow of 50cc into the standard flask is noted.

3. The oil is again poured into the cylinder up to the mark and the heater is switched ON

4. The temperature of oil is adjusted as required. The oil and water are continuously stirred during the experiment.

5. When the temperature is steady at the desired value the contact from the orifice is removed to allow the oil to flow into 50cc standard flask.

6. The time taken for 50cc oil flow is recorded.

PRECAUTIONS:

1. Clean the water tank regularly after use
2. Do not run the equipment if the voltage is below 180V
3. Check all the electrical connections before running
4. Before starting and after finishing the experiment the mains should be put off.
5. Do not attempt to alter the as this may cause damage to the whole system
6. For testing the fluids below 90^{o}C use the water bath and above 100^{o}C use oil bath.
7. Do not stir the sample while testing.

SPECIFICATIONS:

1. Flask=50ml
2. Heater=750W
3. Specific gravity of linseed oil=0.915
4. Nozzle diameter=1.82mm, length-10mm

TABULAR COLUMN:

Type of oil:

Sl. No.	T ^{0}C	m1 kg	m2 kg	m kg	t S	ρ kg/m^3	S	RWN	ν m ^{2}/ S	μ N-S/m^2

Where
T= Temperature of oil, ^{0}C
m1 = Mass of empty flask, kg
m2 = Mass of flask with oil, kg
m = Mass of oil collected, kg = m2-m1
t = Time taken for collecting 50cc of oil in seconds
ρ = Density of oil, kg / m^3

$$\rho = \frac{m}{50 \times 10^{-6}}$$

S=Specific gravity of the oil

$$S = \frac{\rho}{1000}$$

RWN= Red Wood Number

$$RWN = \frac{100 \times S \times t}{535 \times 0.915}$$

ν = Kinematic viscosity, m^2/S

$$\nu = \left[0.26t - \frac{188}{t}\right] \times 10^{-6}$$

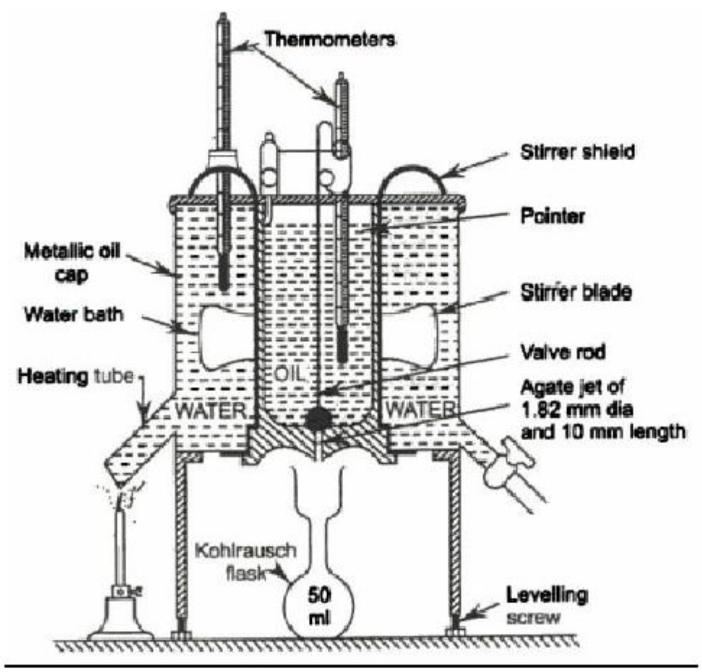
μ = Absolute viscosity, $N\text{-}S/m^2$

$$\mu = \nu \times \rho$$

GRAPH: 1. T v/s μ

2. T v/s ν

RESULTS: viscosity of given oil **…………………………**



Redwood Viscometer

EXPERIMENT NO: 4

BOMB CALORIMETER

AIM: To Determine the Calorific Value of solid or liquid Fuel by Bomb Calorimeter

APPARATUS: Bomb Calorimeter, dies, thermometer, fuse wire, Rheostat, stirrer, benzoic acid, firing unit, pressure gauge.

THEORY: Write the theory on following topics

a. Definition of calorific value

b. Types of calorific values and their definitions

c. Types of calorimeters and their applications

DESCRIPTION OF THE EQUIPMENT:

Bomb Calorimeter is normal used for determining the higher calorific value of solid fuels and also used for liquid fuels. The combustion takes place at constant volume in a totally enclosed vessel.

The bomb calorimeter consists of a strong stainless shell which is known as bomb. The inner surface of the bomb is coated with special enamel to prevent the corrosion on account of acids formed as result of combustion of fuels containing sulphur or nitrogen .The capacity of bomb is 65^0cc and it can withstand up to 200atm.Though the thread are gas tight, water is filled in the bomb to a specified level to act as well seal. On the top cover is placed with oxygen connection and the product release value bottom cover of the bomb supports on rights, one of them carrying a ring to support crucible made of silica and quartz. The upright are provided through the bottom with two insulated firing plugs through which the leads from the main supply are taken through rheostat. During a test, the bomb is placed in a copper vessel known as calorimeter which contains 250^0cc of water that is agitated by a stirrer run by a motor. Thermometer is used to measure the rise in temperature .therefore 3^0c to 4^0 $_C$ rise in temperature is anticipated with the specified quantity of water in the calorimeter.

A known quantity of solid fuel in the powdered form is taken and a briquette prepared from it with the help of briquette mold apparatus as shown. The mass sample of fuel taken for test is 1gm.

PROCEDURE:

1. The briquette is placed in the crucible and fine fuse wire is coiled round it. The crucible is then placed in the bomb. The bomb is then connected to the oxygen cylinder through oxygen valve and the bore tube.
2. Oxygen is admitted to the bomb and the pressure is adjusted to about 25 to 30 atm. pr. The water in the calorimeter is stirred and temperature noted. When the temperature has become steady the electric circuit is closed by means of switch. The temperature starts rising continuously due to mechanical energy input by the stirrer. It is only to be noted that the rise is already. The fuse wire ignites the fuel in the presence of abundant availability of oxygen.
3. The temperature of water starts rising and with the help of precision thermometer reading up to $1/100^0$ C of the temperature is taken.
4. Initially the temp. are taken forever 15 seconds after firing till maximum temperature is reached after wards the temperature reading are taken for every half minute for about 10 minutes or till the drop in temperature for about 5 successive reading is uniform. Actually if the calorimeter is perfectly insulated no drop in temperature will be recorded. After reaching the temperature. Due to heat liberated by fuel the temperature may continue to rise steadily due to mechanical energy input by the water.
5. After the experiment the bomb is taken out of the calorimeter. The product of combustion is released with the help of release valve. It is dried and opened.
6. The in brunt fused wire if any is collected and weighed.

PRECAUTIONS:

1. Do not put bomb parts on the bench top.
2. Carefully release the pressure by loosening the needle valve on top of the bomb
3. Check the pressurized bomb for leaks
4. Do not exceed air pressure 25 atm.
5. The bomb must not be fired if gas bubbles are leaking from it when submerged in water
6. The operator should stand back for at least 15 sec after igniting the sample and should keep clear of the top of the calorimeter. An explosion would be most likely to drive the top upward.

7. Much less than 1 g of sample should be used for testing materials of unknown combustion characteristics.

8. The use of high-voltage ignition systems is to be avoided. Arcing between electrodes may cause the electrode seals to fail and permit the escape of hot gases with explosive force.

SPECIFICATIONS:

1. Mass of nichrome wire=

2. Calorific value of wire=9.66kJ/kg

3. Mass of water in the calorimeter=2lit

4. Water equivalent of calorimeter=

5. Volume of bomb=650cc

6. Max. speed of the stirrer=

7. Max. pressure of oxygen in the bomb=15bar

TABULAR COLUMN:

Trials	mf kg	T1 ^oC	T2 ^oC	HCV kJ/kg

Where,
mf= Mass of fuel burned, kg

T1= Initial temperature of water, ^oC

T2= Final temperature of water, ^oC

CV= Calorific value of the fuel, kJ/kg

$$CV = \frac{(m_w + m_{wc})C_{pw}(T_2 - T_1) - (CV)_{wire} m_{wire}}{m_f}$$

mw= Mass of water taken in calorimeter, kg

mwc= Water equivalent of calorimeter=0.441kg or

$$= \frac{(m_2 - m_1)(CV)_{ba} - E_1}{dT}$$

m1= Mass of crucible +nichrome wire, kg

m2=Mass of crucible +mass of nichrome wire+ mass of benzoic acid, kg

(CV)ba=Calorific value of benzoic acid=26539kJ/kg

dT= Temperature rise, ^{o}C

E1= Heat energy of nichrome wire=1400kJ/kg

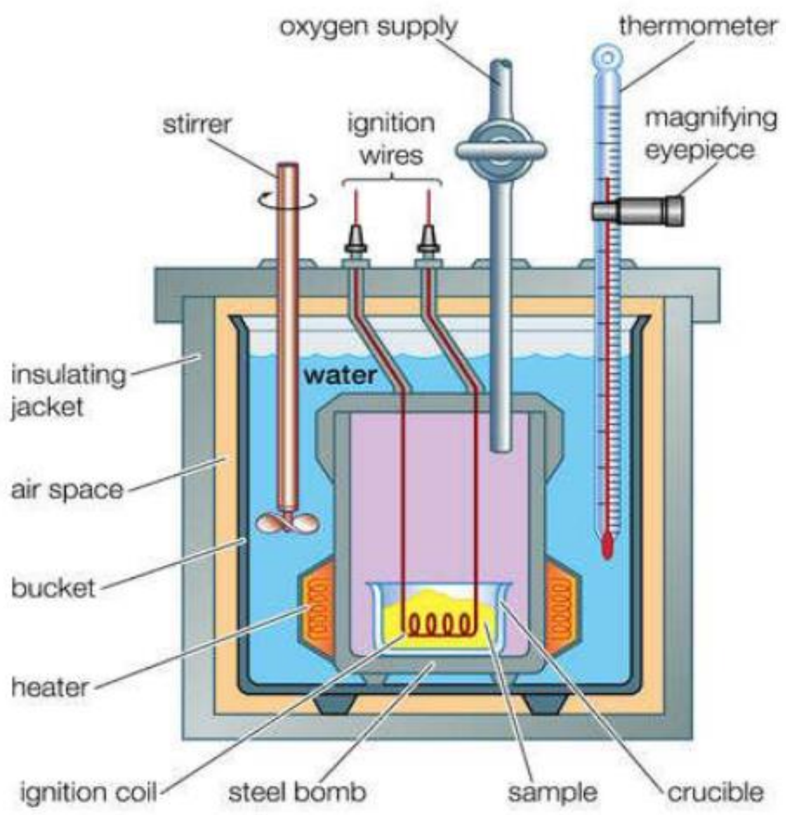
Cpw= Specific heat of water, 4.2 kJ/kg

T1 and T2 = Initial and final temperature of water, oC

CVwire= Calorific value of wire, kJ/kg

M wire= Mass of wire burnt, kg

RESULTS: Calorific value of given fuel ____________kJ/kg



Bomb calorimeter

EXPERIMENT NO: 5
TORSION VISCOMETER

AIM: To determine the viscosity of given oil using torsion viscometer

APPARATUS: Torsion Viscometer, sample oil & thermometer

DESCRIPTION OF THE APPARATUS:

The torsion viscometer consists of a flywheel with a pointer suspended in horizontal position by means of a torsion wire. The wire is fixed to the torsion head at the top. Adopters are used to adjust the length of the wire. Surrounding the flywheel, there is a circular scale graduated in degrees. A Cylinder is attached to the flywheel. The instrument is supported on a tripod with leveling screws. The apparatus consists of a device to hold a solid cylinder and a flywheel by means of a Torsion wire with end connectors. A release pin is provided to hold the flywheel in horizontal position. The flywheel is, surrounded by a graduated scale in degrees (0 to 360).A pointer is attached to the flywheel to indicate the angular movement of the flywheel. Oil cup to hold the oil under test;

PROCEDURE:

1. Install the apparatus on a plain flat table and level it with leveling screws
2. Insert the torsion wire with end connectors into the tube vertically downwards with the top end connector of the wire fixed to a stationary head
3. Insert the bottom end connector of the wire into the top portion of the flywheel and secure it.
4. Fix the solid cylinder to the bottom portion of the flywheel.
5. Pour clean filtered oil to be tested into the oil cup up to about 5mm to 10mm below the top of the oil cup and place it on the platform provided and properly position it.
6. Slightly lift the top stationery head so that the flywheel along with torsion wire is free to rotate horizontally and position the pointer of the flywheel exactly in front of the release pin.
7. Adjust the pointer of the flywheel to zero degree by turning the stationary head either way with absolutely no torsion in the wire and tighten the stationary head.

8. Lift the oil cup along with the platform in such a way that, the solid cylinder under the flywheel completely immersed in the oil under test.

9. Manually give one full rotation to the flywheel (0 to 0^0) and secure it in the release pin.

10. Now the apparatus is ready for the test
11. Slowly pull the release pin back without disturbing the set up.

12. The flywheel starts rotating and completes one full rotation (0 to 0^0) and moves beyond zero purely by virtue of its momentum. This angular movement beyond zero (over swing) is recorded and the viscosity of the oil under test in Redwood seconds is obtained from the graph provided.

    To conduct the experiment above ambient, the oil is heated in a separate container to above5^0 C to 7^0C beyond the desired oil temperature and follow steps 5 to l2.

PRECAUTIONS:

1. Clean the oil tank regularly after use

2. Do not run the equipment if the voltage is below 180V

3. Check all the electrical connections before running

4. Before starting and after finishing the experiment the mains should be put off.

5. Do not attempt to alter the as this may cause damage to the whole system.

SPECIFICATIONS:

1. Capacity of oil tank=

2. Diameter and length of the wire=

3. Dimensions of the bob=

TABULAR COLUMN:

Type of Oil:

Sl. No.	**T** **°C**	**ω** **Degree**	**R**	**Y** **m^2/s**

Where,

T= Temperature to which oil is heated, °C

ω= Circular scale reading, degrees

R= Redwood seconds taken from graph provided

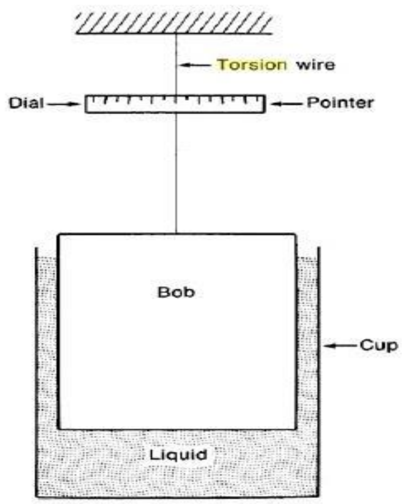
ν= Kinematic viscosity, m^2/s

$$\nu = \left(0.260R - \frac{170}{R}\right) \times 10^{-6} \text{ for } 34<R<100$$

$$\nu = \left(0.247R - \frac{50}{R}\right) \times 10^{-6} \text{ for } 100<R<2000$$

GRAPH: T v/s **ν**

RESULTS: Kinematic viscosity of oil is



Schematic diagram of torsion viscometer

Torsion viscometer

EXPERIMENT NO. 6

VALVE TIMING DIAGRAM

AIM:- **To draw the value timing diagram of the given engine**

APPARATUS:- Given engine, measuring tape, scale.

THEORY: Write the theory on following topics

a. Difference between 2-stroke and 4-stroke engine.

b. Define the valve over lapping.

c. Difference between SI and CI Engines.

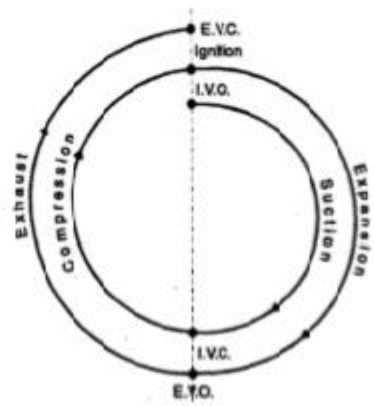
d. Significance of valve timing diagram

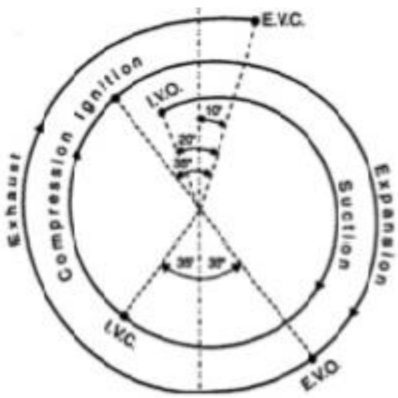
e. Draw the theoretical valve time diagram for 4- stroke SI engine.

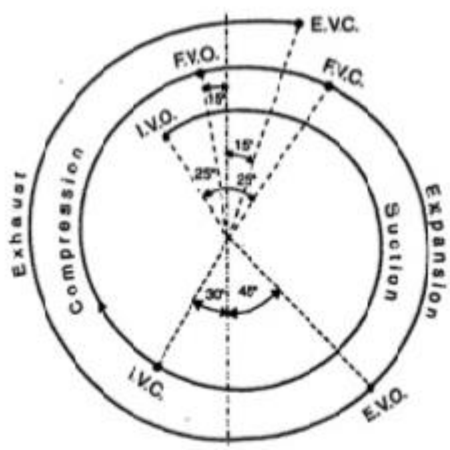
f. Draw the theoretical valve time diagram for 2- stroke CI engine.

PROCEDURE:

1. Note the location of the inlet and exhaust valves of the given engine.
2. The flywheel is turned in clockwise direction and the positions of TDC and BDC are identified with respect to the crank position
3. The circumferential length of flywheel is measured with help of thread and ruler
4. The flywheel is turned in clock wise direction and the position and inlet valve begins to open is marker.
5. This point is measured from the initial reference mark (TDC) and this length is noted.
6. The flywheel turned in the same direction and the position of inlet valve closing and exhaust valve opening and exhaust valve closing are noted and corresponding length with respective to the reference marks.
7. The reading is recorded in the tabular column and corresponding angles turned (in degrees) are determined.







TABULAR COLUMN:-

Sl.No.	Valve positions	S m	θ Degree	Remarks
1	IVO			
2	IVC			
3	EVO			
4	EVC			

OBSERVATION AND CALCULATION:-

Where,
S = Arc length, cm

$$\theta = \frac{S \times 360}{\pi \times D}$$

θ *in degrees*

D=Flywheel diameter, m

Swept volume Vs = ($\prod$ D^2 L)/4 m^3

Where D= Bore diameter of the cylinder, L= stroke length.

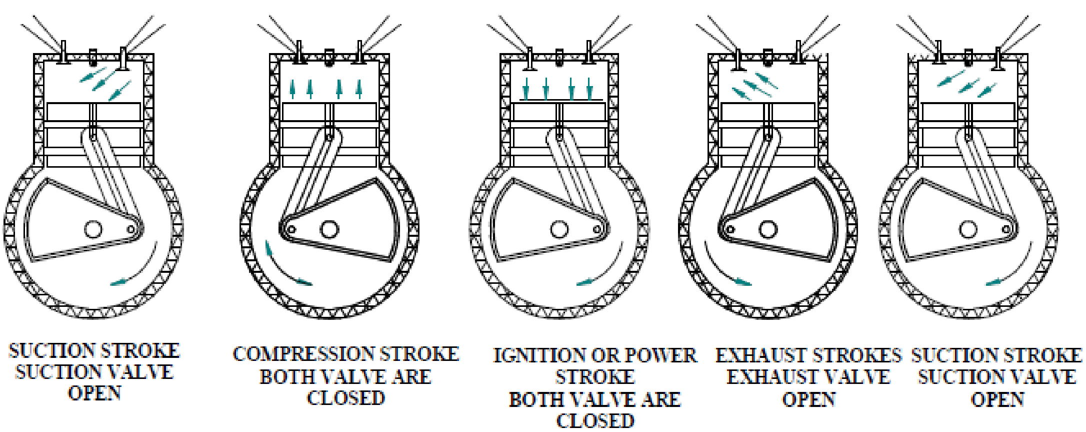
Compression ratio, Rc =(Vs+Vc)/Vc

Where, Vc = Clearance Volume m^3

Name of the stroke	Crank angle degree
Suction	
Compression	
Expansion	
Exhaust	

CONCLUSION:-

Valve timing diagram is drawn as shown in the graph.



EXPERIMENT NO.7

PLANIMETER

AIM:-To calibrate the given planimeter.

APPARATUS:- Planimeter, drawing board and sheet, drawing instruments.

THEORY:-

Write the theory on following topics

a. Different methods used for measuring irregular area

b. Principle of planimeter

c. Construction features of planimeter

DESCRIPTION OF THE EQUIPMENT:

Amsler's Polar and Linear Planimeter

In 1854. Jakob Amslcr invented the polar planimeter a brilliant and simple device for measuring the area of a region. Schematic drawings of polar and linear planimeter are shown in Figures. The main part of each is a movable rod, called the tracer arm. With a tracer point at one end (labeled T). A wheel is attached to the rod with its axis parallel to the rod. The wheel is equipped with a scale typically calibrated in square inches or square centimeters. It is similar to a map reader wheel in that it can roll both forwards and backwards, and we will call it the measuring wheel. In a linear planimeter, the end of the tracer arm opposite the tracer point is restricted to follow a linear track, along which it can slide freely. In contrast, in a polar planimeter, the tracer rod is hinged to a second rod, the pole arm, forming an elbow. The end of the pole arm opposite the hinge, called the pole, is fixed so that the pole arm can pivot around it consequently the elbow follows the arc of a circle as it moves. To operate a planimeter, the user selects a starting point on the boundary of the region to be measured, places the tracer point there, and sets the counter on the wheel to zero. The user then moves the tracer point once around the boundary of the region, as shown in Figure. The tracer point is typically a stylus or a point marked on a magnifying glass to facilitate the tracing. In a polar planimeter, as the tracer point moves, the elbow at die hinge will flex and the angle between the pole arm and the tracer arm will change. In a linear planimeter, the end of the tracer arm in the track will slide along the track. In both planimeter the wheel rests gently on the paper, partially rolling and partially sliding, depending on how the tracer point is moved. If the pointer is moved parallel to the tracer arm, the wheel slides and does not roll at all. If the pointer is moved perpendicular to the tracer arm, the wheel rolls, and does not slide at all. Motion of the pointer in any other direction causes the wheel to both roll and slide. When the tracer point returns to the starting point, the user can read the area from the scale on the wheel

PROCEDURE:

1. Fix the figure whose area is to be determined on a smooth surface, preferably on a horizontal drawing board.

2. Set the index to read 100Sq cm on the tracing arm if the area is required in square cm.

3. Fix the anchor point inside or outside the figure such that the tracer is able to trace the whole boundary of the area.

4. Mark a starting point on the boundary of the figure & place the tracer on the starting point. Note the initial reading.

5. Move the tracer slowly along the boundary of the area in clock wise direction, until it comes back to the starting point

6. The No. of times the zero of the dial passes the fixed index mark neither in a clockwise or anticlockwise direction during the above process should be carefully noted. Record the final reading F & compute the area by using the above equation.

PRECAUTIONS:

1. Do not dismantle and alter the equipment as this may cause damage to the whole system.

2. Percentage of error is calculated only for regular areas.

SPECIFICATIONS:

1. Length of tracing arm=

2. Length of anchoring arm=

3. Multiplier=

4. Planimeter constant=

TABULAR COLUMN:-

Sl. NO.	Shape of the plane	A_{th} cm^2	PLANIMETER READING			Am cm^2	% Error
			I	F	M		
1	Square						
2	Circle						
3	Triangle						
4	Rectangle						
5	Ellipse						

Where

Ath= The theoretical area of the given shape, cm2

I = Initial reading

F = Final reading

M = Multiplier of planimeter, 100 cm2

Am = Measured area of the given shape cm2.

$$A_m = M(F - I \pm 10 \times N \ + C)$$

N= No. of rotations of the disc (+ ve for clockwise direction, -ve foe anticlockwise direction)
C= constant of planimeter, considered only when the anchor point is kept inside the plane

$$\% \text{ Error}=\frac{A_{th} - Am}{A_{th}} \times 100$$

<u>RESULTS:</u> The percentage error of area measured is tabulated as shown.

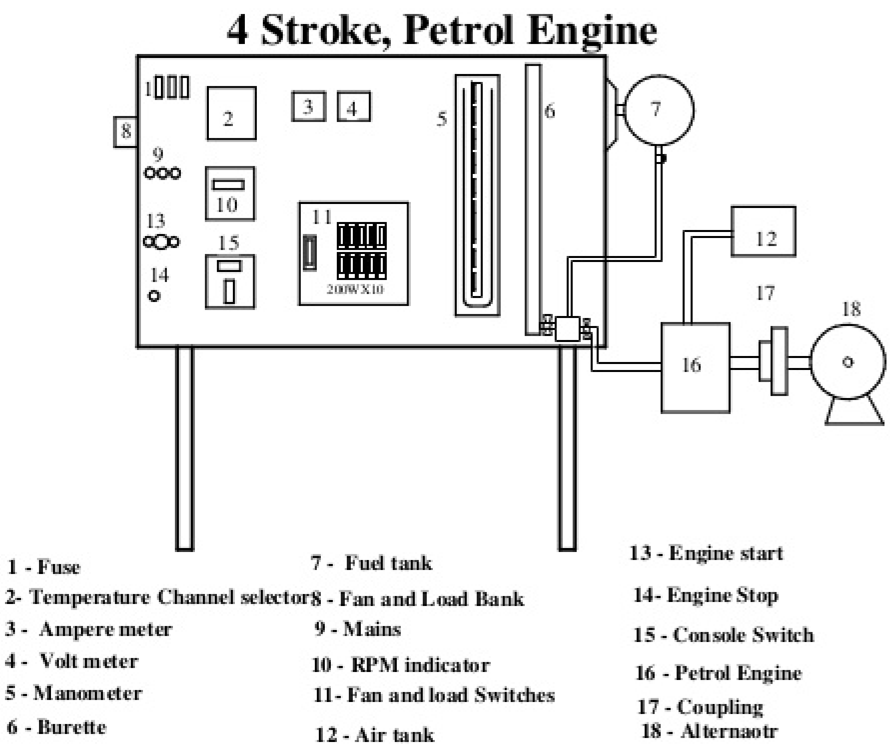
EXPERIMENT NO: 8

FOUR STROKE PETROL ENGINE

AIM:-To study the performance of four stroke petrol engine and to calculate Brake Power, Brake Thermal Efficiency and BSFC.

APPARATUS: Four stroke petrol engine experimental setup, Stop watch, tachometer, etc..

EXPERIMENTAL SETUP:



THEORY:

Refer the working principle of 4-stroke petrol Engine in Valve timing diagram experiment.

PROCEDURE:-

1. Start the engine and run it at constant speed.(say 2000rpm)
2. Apply the electric load on the engine, Now the speed of the engine will reduce.
3. Obtain the original speed of the engine by supplying more petrol through throttle valve.
4. Note down the readings of voltage, current, manometer and temperature reading.
5. Note down the time taken for 5cc consumption of petrol.
6. Repeat the steps 2,3,4,5 for different loads.

SPECIFICATIONS:-

- Cylinder bore diameter, D=0.07 m
- Stroke length ,L = 0.0667m
- Rated brake power, BP = 2.208 KW
- Cubic capacity = 256cc
- Rated speed , N = 3000rpm
- Compression ratio = 4.07:1
- Diameter of the orifice =d_2= 0.0335m

TABULAR COLUMN:

Sl. No.	**Electrical loading KW**	**Generator reading**		**t Sec**	**V_f cc**	**m_f Kg/Sec**	**BP KW**	**BSFC Kg/KWh**	**η_{bt} %**	**η_v %**
		Voltmeter **V**	Ammeter A							

FORMULAE:

x= Pressure Head difference in mercury manometer in cm of Hg

h= Pressure head difference in m of water. =0.126x

t= Time taken to consume 5cc of petrol in Sec

V_f= Volume of petrol consumed =5cc

m_f= mass of petrol consumed in Kg/sec

$$= \frac{V_f * sp.gr * 1000}{10^6 * t}$$

Sp. gr. of petrol =0.72

BP= Brake power in KW

$$= \frac{V*I}{1000*\eta_{gen}}$$

η_{gen}= Efficiency of generator= 0.8

BSFC= Brake Specific Fuel Consumption in Kg/KWh

= mf * 3600/BP

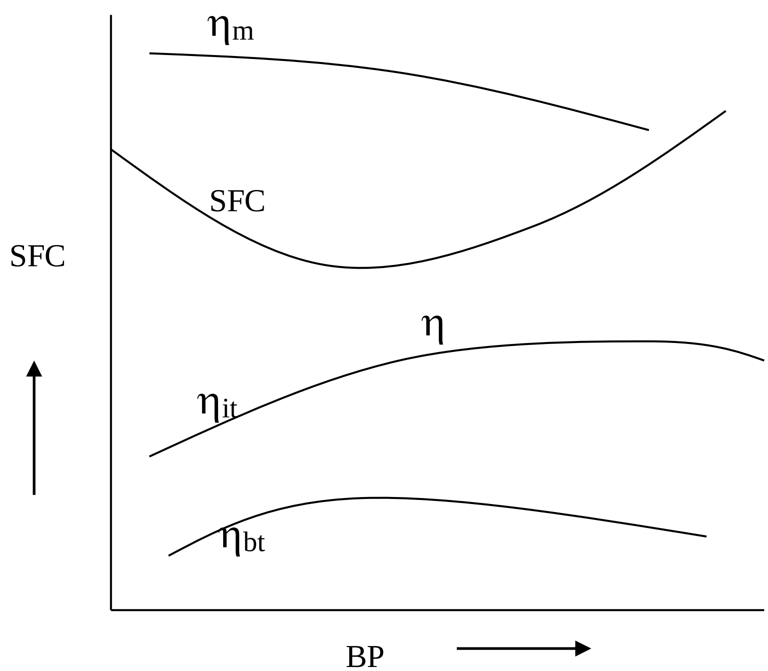
η_{bt}= Brake Thermal Efficiency

= BP/(m_f*CV)

CV= Calorific Value of petrol=43100 KJ/Kg

GRAPHS:-

1. BSFC V/S Brake Thermal Efficiency



CONCLUSION;

The experiment was conducted successfully on the 4-stroke petrol engine, and its performance on brake power, BSFC, η_{bt} is tabulated in the tabular column.

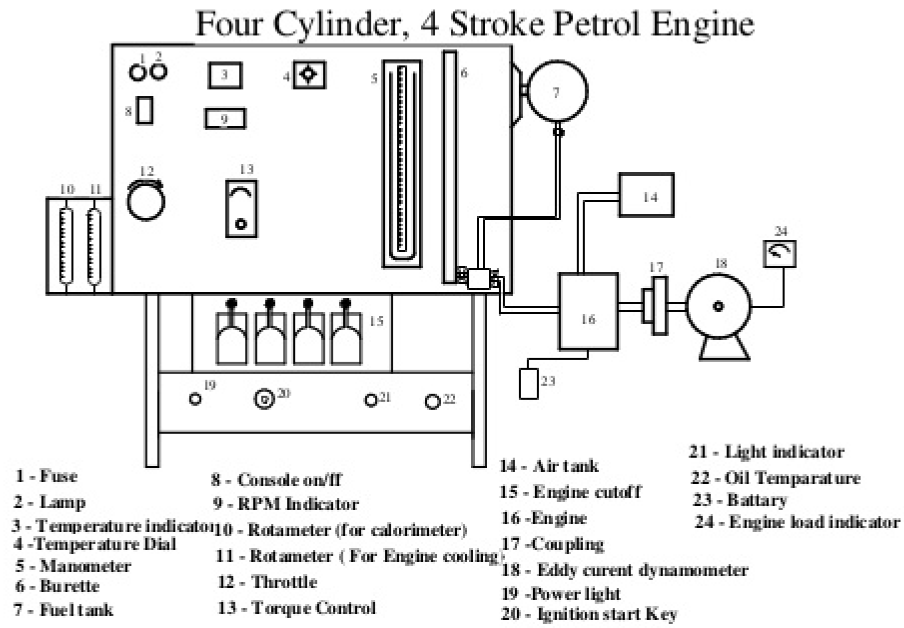
EXPERIMENT NO. 9

Morse test

AIM: To conduct the Morse test on a Multi cylinder petrol engine and determine the IP and BP

APPARATUS: 4-cylinder, 4-stroke petrol engine experimental setup, tachometer, etc.,

EXPERIMENTAL SETUP:



THEORY: In single cylinder engines the FP is found by the following methods.

1. From the total fuel consumption curve (Willan's line)
2. From the difference between IP and BP
3. Motoring test.

For the multi cylinder engines, in addition to the above, the Morse test can also be conducted to find the FP.

In short, the test consists off cutting of each cylinder one by one and finding out the net BP every time, without varying any other parameters (speed, throttle position). The difference between the total BP (with all cylinders working) and BP with any one cylinder put off gives the indicated power developed in that cylinder. Knowing the power developed in each cylinder individually, the total IP can be obtained as the sum of all of them. The difference between total IP and Total BP gives the FP

PRECAUTIONS:

1. Check fuel level
2. Check lubricating oil level.
3. Check cooling water system.
4. Keep the engine free from load before starting.
5. See the battery terminals are connected properly.

PROCEDURE:

1. Start the engine and allow it to run at constant speed.
2. Load the engine for full load.
3. When the engine is loaded for a specified load, adjust the throttle to maintain the speed of the engine to its rated rpm.
4. Allow the engine to run for stability.
5. Cut off the cylinder no.1 by lifting the lever 1. Now the speed of the engine decreases
6. Reduce the load on the engine to bring back the original speed note down the load.
7. Restore the spark supply to cylinder no.1.
8. Cut off the cylinder no.2 and bring the engine to the original speed by adjusting the load in the dynamometer and note down that load.
9. Repeat the procedure for third and fourth cylinder.

TABULAR COLUMN:

Sl. No.	Condition	Load on the dynamometer Kg	Power output (BP) KW
1	All cylinders working	W	
2	1st cylinder cut off	W_1	
3	2nd cylinder cut off	W_2	
4	3rd cylinder cut off	W_3	
5	4th cylinder cut off	W_4	

CALCULATIONS:

When all cylinders working, Brake power $BP = WN/C * 0.736$

Where W= load in the dynamometer in Kg

N= speed of the engine in rpm

C = Dynamometer constant =2000

When 1st cylinder is cut off $BP_1 = W_1N/C * 0.736$

2nd cylinder is cut off $BP_2 = W_2N/C * 0.736$

3rd cylinder is cut off $BP_3 = W_3N/C * 0.736$

4th cylinder is cut off $BP_4 = W_4N/C * 0.736$

IP of 1st cylinder = $IP_1 = BP - BP_1$

IP of 2nd cylinder = $IP_2 = BP - BP_2$

IP of 3rd cylinder = $IP_3 = BP - BP_3$

IP of 4th cylinder = $IP_4 = BP - BP_4$

Total IP= $IP_1+IP_2+IP_3+IP_4$

Frictional power FP=IP-BP

Mechanical efficiency η_m =BP/IP

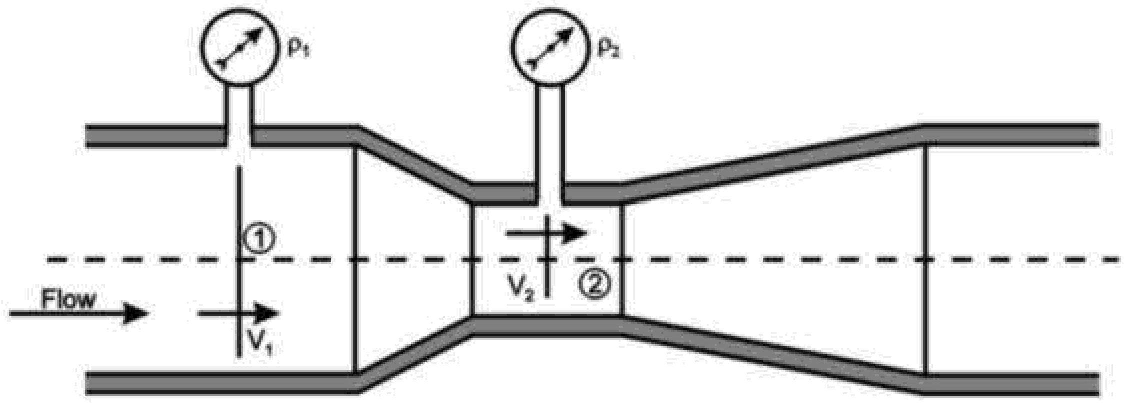
RESULTS:

EXPERIMENT NO. 10

CALRIBRATION OF VENTURIMETER

AIM: To calribrate the venturimeter

APPARATUS: Venturimeter experimental set up, stop watch.



THEORY: Venturimeter is a simple and reliable device used for measuring the rate of flow of a fluid flowing particularly in large sized pipe and is efficient in measuring large flow rates. It is based on the principle of Bernoulli's equation. It was invented by Clemens Hershel in 1887 and has been named in the honor of an Italian engineer Venturi. A Venturimeter consists of three parts. 1) A short converging cone 2) Throat and 3) Diverging cone.

The convergent cone is a short pipe, which tapers from the original size of the pipe to smaller section of the venturimeter known as the throat.

The convergent cone has a sharp angle of about 20^0, while the divergent cone has a relatively flat angle of about 5^0 to 7^0.This results in the convergent cone of the venturimeter being smaller than its diverging cone. The throat is a short parallel-sided pipe, which is the smallest section of the venturimeter. In order to avoid the phenomenon of cavitations to occur, the diameter of the throat section can be reduced only unto a certain limited value. In general the diameter of the throat section may vary from 1/3 to ¾ of the pipe diameter and more commonly it is kept equal to 1/2 of the pipe diameter. The diverging cone of the venturimeter is a gradually diverging pipe with cross-sectional area increasing from that of the throat section back to the original size of the pipe.

Coefficient of discharge is defined as the ratio of actual discharge to the theoretical discharge.

PROCEDURE:

1. Note down the diameter of the pipe, d_1 (i.e., the diameter of the venturimeter at the throat) to which the given venturimeter is connected, and also note down the diameter of the throat, d_2.
2. Connect the pressure tapings to the U- tube manometer (if not connected) and expel any air entrapped in the system.
3. Open the control valve to get some discharge, note down the deflection in mercury level (x) in the U-tube manometer and also note down the time taken (T) for 'R' m rise of water level in the measuring tank.
4. Increase the discharge in steps by adjusting the flow control valve and note down the readings x & T.
5. Repeat the above procedure for pipes of different diameters (if you wish!).

FORMULAE:

Theoretical discharge through a venturimeter is given by,

$$Q_t = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1^2 - a_2^2)}} ==K\sqrt{h},$$

$$\text{Where K} = \frac{a_1 a_2 \sqrt{2g}}{\sqrt{(a_1^2 - a_2^2)}}$$

Where a_1= cross-sectional area of the pipe = Π $d_1^2/4$ in m^2

a_2 = cross-sectional area of throat = Π $d_2^2/4$ in m2

d_1 = diameter of the pipe (diameter of the venturimeter at the mouth) in m

d_2 = diameter of the throat in m

h = difference of pressure head (equivalent head of water in U- tube manometer)

= 12.6x in m

x = deflection in mercury level in manometer in m

Actual discharge Q_a = AR/T m3/s

A = cross-sectional area of the measuring tank in m^2

R = rise of water level in m

T = time taken for R m rise in water level in s

CALCULATIONS:

OBSERVATIONS:

- Cross-sectional area of the measuring tank = 0.64 m^2
- Diameter of the pipe (diameter of the venturimeter at the mouth), d_1 = --m
- Diameter of the throat, d_2 = …………….m
- cross-sectional area of the pipe, $a_1 = \Pi (d_1)^2/ 4$ = ………… m^2
- cross-sectional area of the throat, $a_2 = \Pi (d_2)^2/ 4$ = ………… m^2
- [Rise of water level in the measuring tank =…0.1m]

TABULAR COLUMN:

Sl. No.	**x** m of H_g			**h** m of H_2O	**T** in S	**Q_a** m^3/s	**Q_t** m^3/s	C_d= **Q_a/Q_t**	ln (h)	ln (**Q_a**)
	LHS	**RHS**								
1										
2										
3										
4										
5										
6										

GRAPHS: Draw the following graphs;

$\sqrt{h}$ v/s Q_a and log Qa v/s log h

ANALYSIS: By plotting the graph from experimental results Qa as base and $\sqrt{h}$ as ordinate, a straight line is obtained from which the slope can be found.

$$C_d = \left[\frac{1}{a_2 M \sqrt{2g}}\right] \times \frac{Q_a}{\sqrt{h}} = \quad C_d = \left[\frac{1}{a_2 M \sqrt{2g}}\right] \times \frac{1}{\text{slope of the line}}$$

Where M = velocity of approach factor or coefficient of venturimeter $= \dfrac{1}{\sqrt{\left(1-\left[a_2/\ a_1\right]^2\right)}}$

$\therefore$ From the graph C_d = ……..

CALIBRATION:

Actual discharge $Qa = C_d\, a_2\, M\, \sqrt{2gh}$

$= K^l h^n$, where the constant $K^l = C_d\, a_2\, M\, \sqrt{2g}$ and n = ½.

Taking logarithms on both sides of the equation log Qa = log k^1 + nlogh, which is an equation of a straight line. By plotting the graph from experimental results, logh as base and log Qa as ordinate, a straight line is obtained from which k^1 and n can be determined. The value of log k^1 is the intercept on the ordinate and n is the gradient of the straight line. From the graph;

Log k^1	K^l	Gradient, n = $\Delta y/\Delta x$	$Qa = K^l h^n$

$\therefore$ Coefficient of discharge, $C_d = \dfrac{k^1}{a_2 M \sqrt{2g}}$

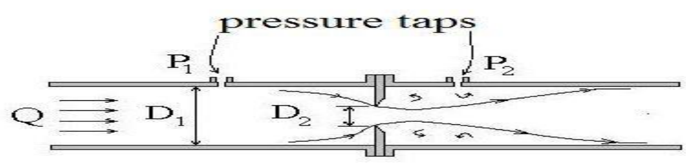
RESULT:

EXPERIMENT NO. 11

DETERMINATION OF COEFFICIENT OF DISCHARGE OF ORIFICE METER

AIM: To determine the coefficient of discharge of a given Orifice meter

APPARATUS: Orifice meter, experimental set up, stop watch.



Orifice Meter Parameters

THEORY: An Orifice meter or orifice plate is a simple and reliable device used for measuring the rate of flow of a fluid flowing particularly in large sized pipe and is efficient in measuring large flow rates. It is based on the principle of Bernoulli's equation. It works on the same principle as Venturimeter it consists of a flat circular plate which has a circular shape edged hole called orifice, It is an opening in the side or bottom of a vessel or a tank through which liquid will flow under the condition that the liquid surface is always above the top edge of the opening, The orifice diameter is 0.5 times the diameter of pipe a differtial monometer is connected at inlet pipe which is at a distance of about 1.5 to 2times the pipe diameter upstream from the orifice plate and at outlet which is at a distance of about Half the diameter of the orifice on the downstream side from orifice plate,

Coefficient of discharge is defined as the ratio of actual discharge to the theoretical discharge.

PROCEDURE:

1. Note down the diameter of the pipe, d_1 (i.e., the diameter of the pipe) to which the given Orifice meter is connected, and also note down the diameter of the orifice plate , d_2.
2. Connect the pressure tapings to the U- tube manometer (if not connected) and expel any air entrapped in the system.

3. Open the control valve to get some discharge, note down the deflection in mercury level (x) in the U-tube manometer and also note down the time taken (T) for 'R' m rise of water level in the measuring tank.
4. Increase the discharge in steps by adjusting the flow control valve and note down the readings x & T.
5. Repeat the above procedure for pipes of different diameters (if you wish!).

FORMULAE:

1, Theoretical discharge through a Orifice meter is given by,

$$Q_t = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1^2 - a_2^2)}} = = K\sqrt{h},$$

$$\text{Where } K = \frac{a_1 a_2 \sqrt{2g}}{\sqrt{(a_1^2 - a_2^2)}}$$

Where a_1= cross-sectional area of the pipe = Π $d_1^2/4$ in m^2

a_2 = cross-sectional area of orifice = Π $d_2^2/4$ in m2

d_1 = diameter of the pipe (diameter of the Orifice meter at the mouth) in m

d_2 = diameter of the orifice in m

h = difference of pressure head (equivalent head of water in U- tube manometer)

= 12.6x in m

x = deflection in mercury level in manometer in m

2, Actual discharge Q_a = AR/T m3/s

A = cross-sectional area of the measuring tank in m^2

R = rise of water level in m

T = time taken for R m rise in water level in s

CALCULATIONS:

OBSERVATIONS:

- Cross-sectional area of the measuring tank = 0.64 m^2
- Diameter of the pipe (diameter of the Orifice meter at the mouth), d_1 = --m
- Diameter of the orificet, d_2 = …………….m
- cross-sectional area of the pipe, $a_1 = \Pi (d_1)^2/ 4$ = ………… m^2
- cross-sectional area of the orifice, $a_2 = \Pi (d_2)^2/ 4$ = ……….. m^2
- [Rise of water level in the measuring tank =…0.1m]

TABULAR COLUMN:

Sl. No.	**x** m of H_g			**h** m of H_20	**T** in S	**Q_a** m^3/s	**Q_t** m^3/s	C_d= **Q_a/Q_t**	ln (h)	ln (**Q_a**)
	LHS	**RHS**								
1										
2										
3										
4										
5										
6										

GRAPHS: Draw the following graphs;

√h v/s Q_a and log Qa v/s log h

ANALYSIS: By plotting the graph from experimental results Qa as base and √h as ordinate, a straight line is obtained from which the slope can be found.

$$C_d = \left[\frac{1}{a_2 M\sqrt{2g}}\right]\times\frac{Q_a}{\sqrt{h}} = \quad C_d = \left[\frac{1}{a_2 M\sqrt{2g}}\right]\times\frac{1}{\text{slope of the line}}$$

Where M = velocity of approach factor or coefficient of Orifice meter = $\dfrac{1}{\sqrt{\left(1-[a_2/\ a_1]^2\right)}}$

∴ From the graph C_d = ……..

CALIBRATION:

Actual discharge $Qa = C_d \, a_2 \, M \sqrt{2gh}$

$= K^l h^n$, where the constant $K^l = C_d \, a_2 \, M \sqrt{2g}$ and $n = ½$.

Taking logarithms on both sides of the equation $\log Qa = \log k^1 + n\log h$, which is an equation of a straight line. By plotting the graph from experimental results, logh as base and log Qa as ordinate, a straight line is obtained from which k^1 and n can be determined. The value of $\log k^1$ is the intercept on the ordinate and n is the gradient of the straight line. From the graph;

$\log k^1$	K^l	Gradient, $n = \Delta y/\Delta x$	$Qa = K^l h^n$

$$\therefore \text{ Coefficient of discharge, } C_d = \frac{k^1}{a_2 M \sqrt{2g}}$$

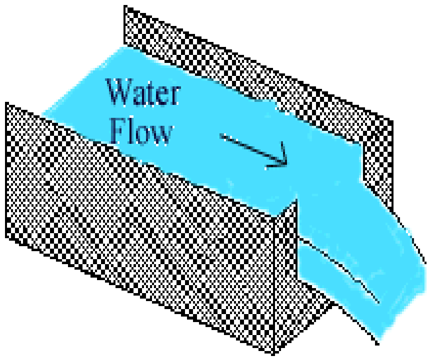
RESULT:

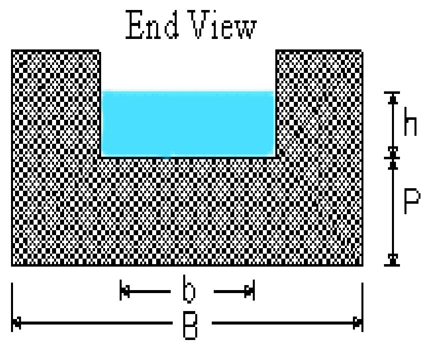
EXPERIMENT NO:12

CALIBRATION OF RECTANGULAR NOTCH

AIM: To Calibrate the rectangular notche.

APPARATUS: Rectangular and triangular notches' experimental set up, stop watch.





THEORY:

A notch is a device used for measuring the rate of flow of a liquid through a small channel or a tank. It may be defined as a small structural opening (generally metallic) with sharp edge. The intention of providing a sharp edge is to minimize the friction. A notch is provided in the side of a tank or a small channel in such a way that the liquid surface in the tank or channel is below the top edge of the opening.

The notches are classified as;

1. According to the shape
   a) Rectangular notch b) Triangular notch c) Trapezoidal notch d) stepped notch etc.,
2. According to the effect of the sides on the nappe
   a) Notch with end contraction b) Notch without end contraction or suppressed notch

Note: Nappe- The sheet of water flowing through a notch is called Nappe or Vein.

Crest- the bottom edge of a notch, over which water flows, is known as Crest or Sill.

PROCEDURE:

1. Note down the initial reading on the hook gage which is the level of water in the channel at the sill.

2.Allow some water to flow through the channel and wait till flow becomes steady and take final reading on the hook gage. Initial reading minus final reading of the hook gage gives head over the sill

–3. Note down time taken for ‘R’

4. Repeat steps 2&3 for different discharge of water.

FORMULAE:

Actual discharge $Q_a = AR/T\ m^3/s$

Theoretical discharge $\mathbf{Q_t = 2/3 \times L \times (\sqrt{2g}) \times H^{3/4}}$ m^3/s (for rectangular notch)

Where L = length of the rectangular notch in m

H = head of water over the crest in m Q_t

g = acceleration due to gravity = $9.81 m/s^2$

C_d =Actual discharge/ Theoretical discharge = $Q_{a/}\ Q_t$

CALCULATIONS:

OBSERVATIONS:

- ❖ Area of the measuring tank = 0.64 m^2
- ❖ Length of the rectangular notch = 0.20 m
- ❖ [Rise of water level in the measuring tank = …….m]

TABULAR COLUMN:

Sl.No	H in m (I.R-F.R)	T in seconds	Actual discharge Q_a m^3/s	Theoretical discharge $Q_t m^3/s$	$C_d = Q_a / Q_t$	ln (H)	ln(Q_a)
1							
2							
3							
4							
5							
6							

RESULT:

EXPERIMENT NO:13

VERIFICATION OF BERNOULLI'S EQUATION

AIM:-To verify the Bernoulli's theorem.

APPARATUS USED:-A supply tank of water, a tapered inclined pipe fitted with no. of piezometer tubes point, measuring tank, scale, stop watch.

THEORY:-Bernoulli's theorem states that when there is a continues connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point.

FORMULA USED:-

$$\mathrm{H}_1 = Z_1 + P_1/w + V_1^2/2g$$

$$\mathrm{H}_2 = Z_2 + P_2/w + V_2^2/2g$$

PROCEDURE:-

1. Open the inlet valve slowly and allow the water to flow from the supply tank.
2. Now adjust the flow to get a constant head in the supply tank to make flow in and out flow equal.
3. Under this condition the pressure head will become constant in the piezometer tubes.
4. Note down the quantity of water collected in the measuring tank for a given interval of time.
5. Compute the area of cross-section under the piezometer tube.
6. Compute the area of cross-section under the tube.
7. Change the inlet and outlet supply and note the reading.
8. Take at least three readings as described in the above steps.

TABULAR COLUMN:

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Reading of piezometric tubes										
Area of cross section under the foot of each point										
Velocity of water under foot of each point										
$V^2/2g$										
p/ρ										
$V^2/2g + p/\rho$										

RESULT:

EXPERIMENT NO: 14

DETERMINATION OF COEFFICIENT OF LOSS OF HEAD IN SUDDEN CONTRACTION AND FRICTION FACTOR

AIM: To determine the coefficient of loss of head in sudden contraction and friction factor in a given pipe.

APPARATUS: Major and minor losses experimental setup, stop watch etc.

THEORY: The loss of head or energy due to friction in a pipe is known as major loss, while the loss of head or energy due to change of velocity of flowing fluid in magnitude or direction is called minor loss. The minor loss of energy or head includes the following cases.

1. Loss of head due to sudden enlargement.
2. Loss of head due to sudden contraction.
3. Loss of head at the entrance to a pipe.
4. Loss of head at the exit of a pipe.
5. Loss of head due to bend in the pipe.
6. Loss of head due to an obstruction in a pipe.
7. Losses of head in various pipe fittings.

In case of long pipe the above losses are small as compared with the loss of head due to friction and hence they are called minor losses and even may be neglected without serious error. But in case of short pipe, these losses are comparable with the loss of head due to friction.

PROCEDURE:

1. Note down the diameter of the test pipe.

2. Check whether the levels of mercury in both left-hand limb and right-hand limb of the U-tube manometer are same. If not make them at same level.
3. Connect the manometer limbs to pressure tapings at the bend, for the long pipe section, at sudden expansion and at sudden contraction.
4. Open the cocks of the tapings for the required portion and all other connections of the manometer stand must be closed.
5. Open the corresponding control valve of the test pipe and allow some water to flow through it.
6. Note down the deflection of mercury in the manometer and also note down time taken for ‘R’ meter rise of water level in the measuring tank.
7. Repeat steps 5 & 6 for different discharge of water.
8. Repeat steps 4, 5&6 for different portions of the pipe.

FORMULAE:

Actual discharge Q_a = AR/T m^3/s

Where A= area of the measuring tank in m^2

R= rise of water level in the measuring tank

T= time taken for ‘R’ in seconds.

Actual velocity $V_a = Q_a/a$ in m/s

Where a = cross-sectional area of the pipe at the entry.

a) Loss of energy due to sudden contraction

$$h_L = 0.375\frac{V^2}{2g}$$

b) Loss of energy due to friction

a) Darcy-Weisbach Formula $h_f = \dfrac{4fLV^2}{2gd}$

Where, h_f = loss of head due to friction

f = co-efficient of friction which is a function of Reynolds number.

$= \dfrac{16}{R_e}$ for $R_e \langle 2000$

$= \dfrac{0.079}{R_e^{1/4}}$ for R_e varying from 4000 to 10^6

L = length of pipe

V = mean velocity of flow

d = diameter of pipe.

b) Chezy's formula $V = C\sqrt{mi}$

Where, C = Chezy's Constant

m for pipe is always equal to $\dfrac{d}{4}$

i = loss of head due to friction/unit length of pipe.

<u>OBSERVATIONS:</u>

- Diameter of the test pipe =----------m;
- Area of the measuring tank = ---------m^2;
- Rise of water level in the measuring tank =------.m
- Time taken for 'R'=-----------sec

TABULAR COLUMN:

Type	**Difference in Mercury level**	**Discharge Q (m^3/s)**	**Velocity V (m/s)**	**Loss of head in m**
Sudden contraction.				
Friction (flow in long pipes)				

RESULT:

ENERGY CONVERSION LAB - VIVA QUESTION

1. What do you understand by two stroke engine?
2. How does a two stroke engine differ from four stroke engine?
3. Are two stroke engines more efficient than four stroke engines?
4. On what air cycle petrol engine works?. Name the different processes.
5. Is the above cycle is accordance with II law of thermodynamics?
6. Draw T-S and P-V diagrams for the same. Explain the significance of such diagrams.
7. What do you understand by IP?. What are the different ways of finding IP?
8. What are the ports?. How are they different from valves?.
9. What is the dynamometer?. What is its use?
10. What type of dynamometer you have used in energy lab?
11. What is a carburettor?
12. What do you mean by scavenging?
13. What are different methods of scavenging?
14. What do you understand A:F and compression ratio?
15. What are the different types of spark plugs used in petrol engines?
16. Classify the following engines into two stroke and four stroke engines.
    a) TVS-50 engine
    b) Luna engine
    c) Fiat engine
    d) Ambassador engine

e) TATA bus engine
f) Enfield 350
g) Yezdi 250
h) Yamha 350

17. What do you understand by
    a). 1210 SE TATA vehicle
    b). Fiat 1100
    c). D-250 classic
    d) TVS-50
18. Why clearance has to be provided in engine?
19. What is the effect of clearance volume on volumetric efficiency and power output?
20. What is knocking?
21. Why fins are provided on petrol aie cooled engines?
22. What is the function of piston rings? What are their types?
23. What are the materials that have been used in the manufacture of piston, cylinders, crankshafts?
24. What are the different types of ignition systems used in petrol engines?
25. What is accelerator/
26. Why a venturi has been provided in the carburettor assembly?
27. What is the approximate gap that has to be provided between electrodes in a spark plug?
28. What is the range of voltage that has to be supplied to the spark plug?
29. What is the range of A:F ratio that a petrol engine can fire?
30. Why the inlet valve is larger than exhaust valve in four stroke engine?
31. Compare diesel engine with petrol engine.
32. On this basis which engine is efficient?
33. What are the applications of diesel engines?
34. In heavy vehicles and marine engines , diesel engines are preferred. Why?
35. What are the different types of injectors used?
36. What is the range of A:F used in diesel engines?

37. Write T-S and P-V diagram of diesel cycle and explain how it is accordance with II law of thermodynamics?.
38. What is the difference between a governor and fly wheel?
39. What is a silencer?
40. Why you cannot run a petrol engine with diesel?
41. What is supercharging ?
42. What are the applications of compressed air?
43. What type of compressor used in i) aero engine ii) pneumatic drills iii) automobile service station and paint shops iv) vapour compression refrigerator
44. When does the work of compression be minimum?
45. What is an inter-cooler? Why do we use this in multi stage compressor?
46. What do you mean by FAD?
47. How do you define mechanical efficiency in case of compressor? How it is different that of an IC engine?
48. How does the clearance volume effect on volumetric efficiency of a compressor?
49. How do you identify LPC from HPC?
50. Why does the pressure reduce in a storage tank after a period of time?
51. How do you differentiate a blower, fan and a compressor?
52. Where do you use a blower?
53. What are the different types of casings provided for a compressor>
54. To create artificial drought in a power plant blower is preferred. Why?
55. What is a pitot tube?
56. What do you mean by static pressure and total pressure?
57. Which type of pressure does a pitot tube measure?
58. Is the manometer used for measuring head? Will it give absolute pressure or gauge pressure?
59. What do you understand by i) backwardly curved ii) forwardly curved iii) radial impellers?
60. What is a diffuser?
61. What is the importance of valve timing diagram?
62. What is the difference between theoretical and actual valve timing diagrams?

63. What do you mean by valve lag, valve lead and valve overlap?
64. What are the various factors that have to be taken in designing of the valve timings in an IC engines?
65. What is viscosity?
66. Define absolute viscosity and kinematic viscosity? State their SI and metric units.
67. What is viscosity index? What is its significance?
68. What is the effect of temperature on viscosity of the oil?
69. How do you grade the oils?
70. What does SAE-40 represents?
71. What is a multi-grade oil?
72. Mention the different properties of oil.
73. What is Say-bolt second?
74. What is the purpose of stirring water in Say-bolt viscometer?
75. What are the types of apparatus used for determining the viscosity of an oil?
76. What do you mean by flash and fire point?
77. What is the significance of flash and fire point?
78. What do you mean by pour and cloud point?
79. Name the apparatus used for determining the flash and fire point of petrol.
80. Is there any relation between fire point and compression ratio?
81. Flash and fire point of petrol cannot be determined in open place. Why?
82. What are the different methods used for determining the area of an irregular planes?
83. Name the parts of planimeter with their respective functions.

FLUID MECHANICS LAB - VIVA QUESTION

1. Differentiate between Absolute and gauge pressures.
2. Mention two pressure measuring instruments.
3. What is the difference weight density and mass density?
4. What is the difference between dynamic and kinematic viscosity?
5. Differentiate between specific weight and specific volume.
6. Define relative density. 7. What is vacuum pressure?
8. What is absolute zero pressure?
9. Write down the value of atmospheric pressure head in terms of water and Hg.
10. Differentiate between laminar and turbulent flow.
11. How will you classify the flow as laminar and turbulent?
12. Mention few discharge measuring devices
13. Draw the venturimeter and mention the parts
14. Why the divergent cone is longer than convergent cone in venturimeter?
15. Compare the merits and demerits of venturimeter with orifice meter.
16. Why Cd value is high in venturimeter than orifice meter?
17. What is orifice plate?
18. What do you mean by vena contracta?
19. Define coefficient of discharge.
20. Write down Darcy -weisback's equation.

21. What is the difference between friction factor and coefficient of friction?
22. What do you mean by major energy loss?
23. List down the type of minor energy losses.
24. Define turbine
25. What are the classifications of turbine
26. Define impulse turbine.
27. Define reaction turbine.
28. Differentiate between impulse and reaction turbine.
29. What is the function of draft tube?
30. Define specific speed of turbine.
31. What are the main parameters in designing a Pelton wheel turbine?
32. What is breaking jet in Pelton wheel turbine?
33. What is the function of casing in Pelton turbine
34. Draw a simple sketch of Pelton wheel bucket.
35. What is the function of surge tank fixed to penstock in Pelton turbine?
36. How the inlet discharge is controlled in Pelton turbine?
37. What is water hammer?
38. What do you mean by head race?
39. What do you mean by tail race?
40. What is the difference between propeller and Kaplan turbine?
41. Mention the parts of Kaplan turbine.
42. Differentiate between inward and outward flow reaction turbine
43. What is the difference between Francis turbine and Modern Francis turbine?
44. What is mixed flow reaction turbine? Give an example.
45. Why draft tube is not required in impulse turbine?
46. How turbines are classified based on head. Give example.
47. How turbines are classified based on flow. Give example
48. How turbines are classified based on working principle. Give example.
49. What does velocity triangle indicates?
50. Draw the velocity triangle for radial flow reaction turbine.
51. Draw the velocity triangle for tangential flow turbine.

52. Mention the type of characteristic curves for turbines.
53. How performance characteristic curves are drawn for turbine.
54. Mention the types of efficiencies calculated for turbine.
55. Define pump.
56. How pumps are classified?
57. Differentiate pump and turbine.
58. Define Rotodynamic pump.
59. Define Positive displacement pump.
60. Differentiate between Rotodynamic and positive displacement pump.
61. Define cavitation in pump.
62. What is the need for priming in pump?
63. Give examples for Rotodynamic pump
64. Give examples for Positive displacement pump.
65. Mention the parts of centrifugal pump.
66. Mention the type of casing used in centrifugal pump.
67. Why the foot valve is fitted with strainer?
68. Why the foot valve is a non return type valve?
69. Differentiate between volute casing and vortex casing.
70. What is the function of volute casing?
71. What is the function of guide vanes?
72. Why the vanes are curved radially backward?
73. What is the function of impeller?
74. Mention the types of impeller used.
75. Define specific speed of pump.
76. Mention the type of characteristic curves for pump
77. How performance characteristic curves are drawn for pump.
78. Mention the parts of reciprocating pump.
79. What is the function of air vessel?
80. What is slip of reciprocating pump?
81. What is negative slip?
82. What is the condition for occurrence of negative slip?

83. What does indicator diagram indicates?
84. What is the difference between actual and ideal indicator diagram?
85. Briefly explain Gear pump.
86. Differentiate between internal gear pump and external gear pump.
87. Briefly explain vane pump.
88. What is rotary pump?
89. Draw the velocity triangle for centrifugal pump.
90. Draw the indicator diagram fro reciprocating pump.

VIVA- QUESTIONS

1. What is Viscosity?

Ans: Viscosity is resistance for fluids to flow (one layer over other layer)

2. Where do you require the property viscosity?

Ans: Viscosity is single important property lubricating oils should support load, carry away the heat and provide a fluid film between parts, which have relative motion thereby reducing friction. This viscosity decreases with increase in temperature.

3. Do the instruments you use give the viscosity directly?

Ans: No, they the time taken for the collection of a fixed quality of oil while passing through a standard orifice in a standard flask. It is known as SUS (say bolt Universal seconds when universal tip is used with say bolt viscometer or say bolt seconds when furol tip(thick oil)
Reword seconds when redwood viscometer is used. It is also known as viscosity index or specific viscosity.

4. What are the types of viscosity?

Ans: Absolute viscosity and dynamic viscosity

5. What is SAE?

Ans: SAE means Society of Automobile Engineers. SAE40 is more viscous than SAE30 at high temperatures but at low temperatures SAE30 is more viscous than SAE40, some standard values are SAE 20 – 58 sus ; SAE 30- 70 SUS; SAE 40-85 SUS;SAE 50- 110 SUS; at 98.80C etc.,

6. What is the influence of structural composition on viscosity of oils?

Ans: Larger the number of carbon atoms the higher the viscosity. Out of two compounds having the same number of carbon atoms, the one with lower content of hydrogen will be more viscous.

7. What is the quantity of oil to be collected with Redwood viscometers?

Ans: 50 ml.

8. What is the quantity of oil to be collected with Saybolt viscometer?

Ans: 60 ml.

9. Why castor oil is not used as lubricating oil in IC engines? **Ans:** Even though it is highly viscous at low temperatures as the temperature increases the viscosity decreases very rapidly. Hence this is not used as lubricating oil in IC engines.

10. What is Flash point?

Ans: It is the minimum temperature at which oil vapors give a momentary flash when a naked flame is introduced into the vapors.

11. What is Fire point?

Ans: It is the minimum temperature at which oil vapors burn continuously when a naked flame is introduced into the vapors.

12. What is the significance of the flash and fire point test?

Ans: Comparing the flash and fire point with standard values one can find out any adulteration of oil. Crank case dilution can also determined.(When rings are worn out the compression gases leaks into crake case and get mixed with lubricating oil in the sump which reduces the flash point. The test also informative in giving the storage temperature for safety. This test is usually conducted for lubricating oils.

13. What are the different instruments used to determine flash point?

Ans: Cleveland (Open cup) apparatus Pensky Marten"s (closed cup apparatus Abel"s (closed cup) apparatus.

14. Which flash and fire point apparatus gives more accurate values?

Ans: Abel‟s flash point apparatus. In this the heating is very slow. First water surrounding the oil cup is heated. Energy will be transmitted to the oil cup through air present between the outer jacket and the oil cup. Closed cup instruments give accurate values. However, the fire point determination by closed cup has no significance.

15. Out of flash point and fire point, which shall be higher /

Ans: Fire point will be greater than flash point by 2 to 50 C.

16. How can you identify flash point /

Ans: When a naked flame is introduced into the vapors, the vapors give a momentary bluish flash followed by audible sound and then go out for want of more vapors.

17. What is the main difference between Pensky Marten‟s flash point apparatus and Abel‟s flash point apparatus?

Ans: The heating is very fast in the case of Pensky Marten‟s apparatus where as in Abel‟s flash point apparatus the heating is very slow.

18. When naked flame is introduced in to the vapors‟ in the case of closed cup apparatus?

Ans: The flame should be introduced into the vapors at every degree raise in temperature.

19. What is calorific value?

Ans: It is deified as the amount of heat energy liberated by the complete combustion of 1 kg fuel or 1m3of fuel

20. What is HCV?

Ans: Higher calorific value or higher heating value is defined as the amount of heat energy liberated by the complete combustion of 1 kg of fuel or 1m3of fuel (at STP)When the products of combustion are cooled to room temperature and pressure or standard temperature and pressure.

21. What is L.C.V?

Ans: Lower calorific value is defined as the amount of heat energy liberated by the complete combustion of 1kg of fuel or 1m3of fuel (at STP)When the products of combustion are not cooled.

22. Why H C V is greater than L.C.V?

Ans: Most of the fuel consists of hydrogen which combines with oxygen to form steam when the products of combustion are cooled .Water vapor steam present will condense liberating latent heat of condensation which can be made use.

23. For What type of fuels bomb calorimeters used?

Ans: For the determination of H.C.V of liquid and solid fuels bomb calorimeter is used.

24. What calorific value you get when Junker"s gas calorimeter is used?

Ans: H.C.V. of gaseous fuel

25. For Which gas you have determined HCV using Junker"s gas calorimeter?

Ans: L.P.G

26. What is pressure?

Ans: Pressure is the external force exerted per unit area by the substance.

27. What is absolute pressure?

Ans: Absolute pressure is the total pressure which is equal to the sum of atmospheric pressure and gauge pressure. If gauge pressure is greater than atmospheric, it will be taken as +ve. If gauge pressure is less than atmospheric; it is taken as -ve

28. What is the type of pressure gauge you have calibrated?

Ans: Dead weight pressure gauge.

29. Why calibration is required?

Ans: During usage of the pressure gauge, it may indicate wrong values, because of inertia and worn out of parts. Hence frequently the pressure gauges are to be calibrated with standard gauges.

30. What is a thermocouple?

Ans: Thermocouple is a device which consists of two dissimilar metal wires and fixed together at their ends. When the ends are kept at different temperatures e.m.f. (D.C.Microvolts) will be induced. These are used to determine temperature rapidly.

31. What are the materials that are used as Thermocouple materials?

Ans: Copper-constantan, Iron-constantan, Chrome-Alumel

32. What is V.T.D?

Ans: Valve time diagram which is drawn for 4-stroke engines

33. Why V.T.D. is obtained for engines?

Ans: During the operation, some of the parts are worn out, tappet clearance will be changed, because of which the valves will not be opened and closed as specified by the manufacturer.

In actual engines only tappet clearance will be checked both hot and cold with respect to the standard manufacturer‟s specification with the help of feeler gauges.

34. How valves opening and closing is checked?

Ans: By feeling the push rods or by using feeler gauges which shall be placed between rocker arm and valve stem (lappet clearance)

35. How can you say when the value is about to open?

Ans: Feeler gauge and push rod will get tightened.

36. When the valves open and close?

Ans: Even though theoretically valves are to be opened and closed at dead centre position, in actual practice valves are opened before dead centre positions and closed after the other dead centre positions. Because of inertia, valves cannot be opened and closed at dead centre positions instantaneously. Due to this they are made to open early, hence as the dead centre position is reached, valves will be fully opened. Valves are made to close after the other dead centre so as make use of the momentum associated.

37. When the inlet valve will be opened and closed?

Ans: Inlet valve will be opened 100 to 250 before TDC (IDC) and closed 25 to 400 after B.D.C. The suction process shall take place 2250 to 2500 The aim is to supply more quantity of charge as possible.

38. When the exhaust valve will be opened and closed?

Ans: Exhaust value will be opened 25 to 400 before B.D.C. and closed 10 to 150 after TDC. The exhaust process shall take place 2250 to 2400 C.A. The aim is to force out large quantity of products of combustion as possible.

39. What is valve over lap?

Ans: It is the period during which both the valves are opened simultaneously.

40. What is charge in S.I or petrol engine?

Ans: Air-Petrol mixture.

41. What is charge in C.I. or Diesel engine?

Ans: Air is the charge.

42. What is the charge of an I.C. Engine?

Ans: The quantity that enters the engine cylinder during suction stroke.

43. What are T.D.C. & B.D.C. for a horizontal engine?

Ans: Corresponding to TDC the dead centre is called inner dead centre and corresponding to BDC it is outer dead centre in horizontal engine.

44. What are the main differences between S.I and C.I engines?

Ans: In S.I. engine fuel is supplied with the help of carburetor during suction stroke .Ignition is done with the help of ignition coil, spark plug, compression ratio is 6 to 10 and follows Otto cycle. The S.I. engine is compact and high speed engine.

In C.I. engine fuel is supplied with the help of fuel injector just before the completion of compression stroke. The high pressures and temperature existing in the cylinder assisted by turbulence causes the ignition at number of favorable spots. Compression ratio is 12 to 25. Follows diesel cycle. Presently high speed C.I. engine has the compression ratio of 8 to 12 and works on dual cycle. The C.I. engine is bulky and is suitable for heavy vehicles or heavy duty power plant generator sets.

45. What the differences between 2-stroke and 4-stroke engines?

Ans: As the load on the engine decreases, the speed increases and as the load increases, the speed decreases. If the engine is run at rated speed, the performance will be the best.

53. What is governing?

Ans: Governing is the process of running the engine at constant speed.

In S.I. engine quantity of air fuel mixture is varied to get constant speed, hence it is quantitative governing or throttle governing.

In C.I. engine qualitative governing is adopted as the quantity of fuel is varied for the same quantity of air.

54. What is the range of air-fuel ratio for S.I & C.I. engines?

Ans: For S.I. Engines 6:1 to 18:1 as rich, 22:1 is the lease limit

For C.I engines it varies from 90:1 to 25:1

55. Define relative efficiency.

Ans: It is defined as the ratio of the brake thermal efficiency or indicated thermal efficiency to the air standard efficiency.

56. How do you identify air cooled engines from water cooled engines?

Ans: Air cooled engines have fins (extended surfaces) which increases the heat transfer from the cylinder by providing more area. Water cooled engines have water jacket around the cylinder and a radiator.

57. What is compression ratio?

Ans: It is the ratio of the total cylinder volume (stroke volume +Clearance volume) to the clearance volume.

58. What is clearance ratio?

Ans: It is the ratio of clearance volume to the stroke volume.

59. What is a compressor?

Ans: Compressor is a device which increases the pressure of the working fluid by pressure ratio greater than 2.5.

60. What is reciprocating air compressor?

Ans: Low pressure air is drawn into the cylinder of a compressor and is compressed to high pressure with the help of piston and it delivers high pressure air. It is a positive displacement machine (working fluid is confined positively).

61. What is the expression for volumetric efficiency of compressor?

volumetric efficiency brake thermal efficiency are high, requires less lubricating oil, larger fly wheel & un even turning moment.

In 2-stroke engines the working cycle will be completed in 2-strokes of the piston or one revolution of the crank shaft. Mechanical efficiency is high. Volumetric efficiency & brake thermal efficiency are low. Because of power in every revolution develops twice the power than that of-stroke engine. Requires more lubricating oil. Occupies less space.

46. Define mechanical efficiency of an engine.

Ans: It is the ratio of BP to IP or brake thermal efficiency to indicated thermal efficiency or the ratio of brake mean effective pressure to the indicated mean effective pressure.

47. What is SFC? Why it is determined?

Ans: SFC is the ratio of mass of fuel consumed to BP per hour .i.e. it is fuel consumed per unit power developed per hour. It is determined to compare the performance of different capacity engines.

It is 0.2 kg/kWh for CI engines.

0.35 kg/kWh for SI engines.

48. What is brake thermal efficiency?

Ans: It is the ratio of the BP to the energy supplied. It is also known as overall efficiency. It is about 35% for CI engines.15 to 20% for SI engines.

49. What is volumetric efficiency?

Ans: It is the ratio of the actual volume of charge drawn into the cylinder to the theoretical volume of charge drawn or stroke volume of the engine cylinder.

It is about 80% for CI engines and for SI engines it increases with increase of load.

In the case of compressor, the volumetric efficiency decreases with increase of pressure.

50. What is indicated power & brake power?

Ans: Indicated power is the power available or actual heat power in the engine cylinder, where as brake power is the power available at the crank shaft or power out shaft. IP-BP.=FP (frictional power)

51. What is maximum load for an engine?

Ans: The load calculated at the rated speed for the maximum power developed by the engine (as specified by the manufacturer).

52. Why the engine has to be run at the rated speed?

Ans: In 4-stroke engine the working cycle will becompleted in 4-stroke of the piston or in two revolutions of the crank shaft. Requires valve mechanism, mechanical efficiency is low,