LABORATORY MANUAL

ON

MECHANICAL ENGINEERING LAB-II

4TH SEMESTER,

DEPT OF MECHANICAL ENGG.

GOVERNMENT POLYTECHNIC SONEPUR

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LIST OF EXPERIMENTS

1. Study about 2 stroke, 4 stroke petrol and diesel engine models.
2. Determine the brake thermal efficiency of single cylinder petrol engine.
3. Determine the brake thermal efficiency of single cylinder diesel engine.
4. Determine the BHP, IHP and BSFC of multi cylinder petrol engine by Morse test.
5. To determine the mechanical efficiency of an air compressor.
6. Study of pressure measuring devices like Manometer & Bourdon tube pressure gauge.
7. Verification of Bernoulli's theorem.
8. Determination of the co-efficient of discharge (C_d) from venturimeter.
9. Determination of C_c, C_v and C_d from orifice meter.
10. Determination of Darcy's coefficient from flow through pipe.

EXPERIMENT - 1

AIM: To study two stroke and four stroke petrol engines.

APPARATUS: Model of two stroke and four stroke petrol engine.

THEORY: The engine which converts the heat energy into mechanical energy is known as heat engine.

1. WORKING PRINCIPLE OF FOUR STROKE PETROL ENGINES

There are four strokes which are as follows:

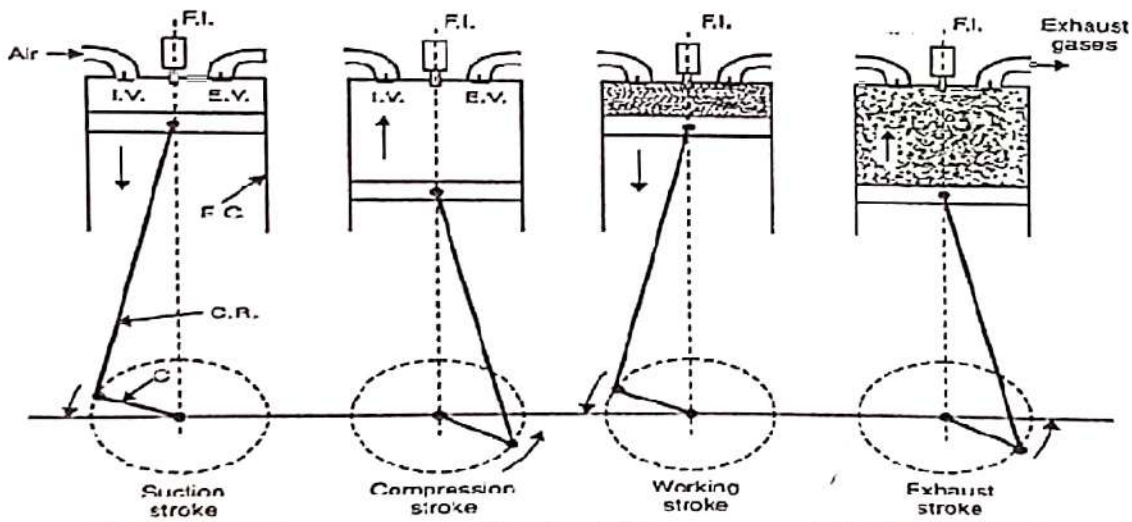
i) Suction stroke

ii) Compression stroke

iii) Expansion or working or power stroke

iv) Exhaust stroke

i) SUCTION STROKE: The suction stroke starts with the piston at top dead centre position. During this stroke, the piston moves downwards by means of crank shaft. The inlet valve is opened and the exhaust valve is closed. The partial vacuum created by the downward movement of the piston sucks in the fresh charge (mixture of air and petrol) from the carburetor through the inlet value. The stroke is completed during the half revolution (180°) of the crank shaft, which means at the end of the suction stroke, piston reaches the bottom head centre position.



F.I. = Fuel Injector I.V. = Inlet valve E.V. = Exhaust valve

Figure of Four Stroke SI Engine Cycle

ii) COMPRESSION STROKE: During this stroke the inlet and exhaust valves are closed and the piston returns from bottom dead centre position. As the piston moves up, the charge is compressed. During compression the pressure and temperature rises. This rise in temperature and pressure depends upon the compression ratio (in petrol engines the compression ratio generally varies between 6:1 and 9:1). Just before the completion of the compression stroke, the charge is ignited by means of an electric spark, produced at the spark plug.

iii) WORKING OR EXPANSION STROKE: The ignition of the compressed charge. Just before the completion of compression stroke, causes a rapid rise of temperature and pressure in the cylinder. During this stroke the inlet and exhaust values remain closed. The expansion of gases due to the heat of combustion exerts pressure on the piston due to which the piston moves downward, doing some useful work.

iv) EXHAUST STROKE: The exhaust value is opened and the inlet valve remain closed. The piston moves upward (from its BDC position) with the help of energy stored in the flywheel during the working stroke. The upward movement of the piston discharges the burnt gases through the exhaust value.

At the end of exhaust stroke, piston reaches its TDC position and the next cycle starts

Working Principles of 2-Stroke petrol engine

The working principle of 2-Stroke petrol engine is discussed below:-

1) 1st Stroke: To start with let us assume the piston to be at its B.D.C. position. The arrangement of the ports is such that the piston performs two jobs simultaneously.

As the piston starts rising from its B.D.C. position it closes the transfer port and the exhaust port. The charge (mixture, of the air and petrol) which is already there in the cylinder, as the result of the previous running of the engine is compressed at the same time with the upward movement of the piston vacuum is created in the crank case (which is gas tight). As son as the inlet port is uncovered; the fresh change in sucked in the crank case. The charging is continued until the crank case and the space in the cylinder beneath the piston is filled with the charge. As the end of third stroke, the piston reached the T.D.C. position.

2) 2nd Stroke: Slightly before the completion of the compression stroke, the compressed charge is ignited by means of a spark produced at the spark plug.

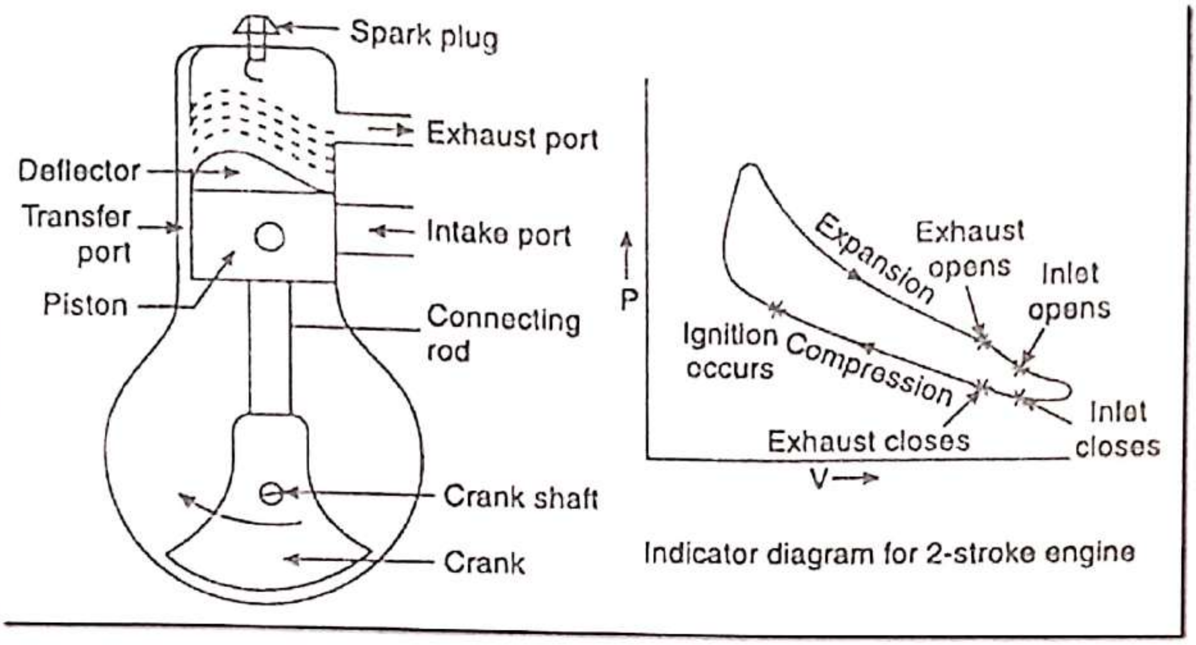


Figure of Two stroke SI Engine

Pressure is exerted on the crank of the piston due to the combustion of the piston is pushed in the downward direction producing some useful power. The downward movement of the will first close the inlet port and then it will compress the charge already sucked in the crank case.

Just the end of power stroke, the piston uncovered the exhaust port and the transfer port simultaneously the expanded gases start escaping through the exhaust port and the same time the fresh charge which is already compressed in the crank case, rushed into the cylinder through the transfer port and thus the cycle is repeated again.

The fresh charge coming into the cylinder also helps in exhausting the burnt gases out of the cylinder through the exhaust port. This is known as scavenging.

CONCLUSION: -

From the above experiment we have successfully studied about the two stroke and four stroke petrol engine.

AIM: To study two stroke and four stroke Diesel engines.

APPARATUS: Model of two stroke and four stroke Diesel engine.

THEORY: The engine which converts the heat energy into mechanical energy is known as heat engine.

Working principle of four stroke Diesel engine.

There are four strokes as:

1. Suction Stroke
2. Compression stroke
3. Expansion stroke
4. Exhaust stroke

1. Suction stroke: This stroke starts with the piston at top dead centre position. The inlet value is opened and the exhaust value is closed. The downward movement of the piston creates vacuum in the cylinder due to which air is drawn into the cylinder. The movement of the piston is obtained either by the starter motor or by the momentum of the fly wheel.

2. Compression stroke: This stroke starts with the piston at B.D.C. position. Both the inlet and exhaust values are closed.

The air sucked during the suction stroke is compressed as the piston moves in the upward direction. A few degree before the completion of compression stroke, a very fine spray of diesel is injected into the compressed air. The fuel ignites spontaneously.

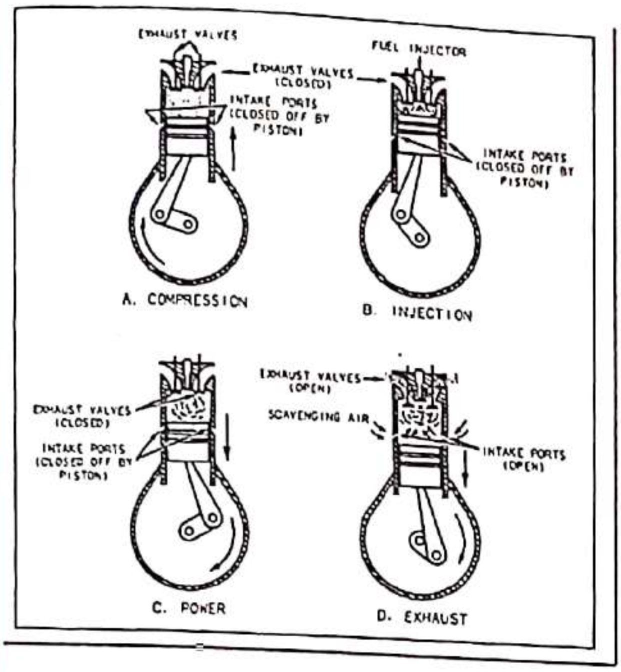


Figure of CI Engine Cycle

3. Expansion stroke: Both the inlet and exhaust valves remain closed. The heat energy released by the combustion of the fuel, results in the rise in pressure of the gases. This high pressure rise drives the piston in the downward direction, thereby producing some useful work. This stroke is called as power stroke.

4. Exhaust stroke: This stroke starts with the piston at the B.D.C. position. The inlet value remains closed whereas the exhaust value is opened. The upward movement of the piston pushes the burnt gases out of the cylinder through the exhaust valve. At the end of exhaust stroke, the exhaust valve is also closed.

The four-strokes complete one cycle which may repeat again to produce power.

WORKING PRINCIPLE OF 2 STROKE DIESEL ENGINE

1. 1st Stroke – As the piston starts rising from its B.D.C. position, it closes the transfer and the exhaust port. The air which is already there in the cylinder is compressed. At the same time with the upward movement of the piston, vacuum is created in the crank case. As soon as the inlet port is uncovered the fresh air is sucked in the crank case. The charging is continued until the crank case and the space in the cylinder beneath the piston in filled with the air.

2. 2nd Stroke – Slightly before the completion of the compression stroke a very fine spray of diesel is injected into the compressed air (which is at a very high temperature). The fuel ignites spontaneously.

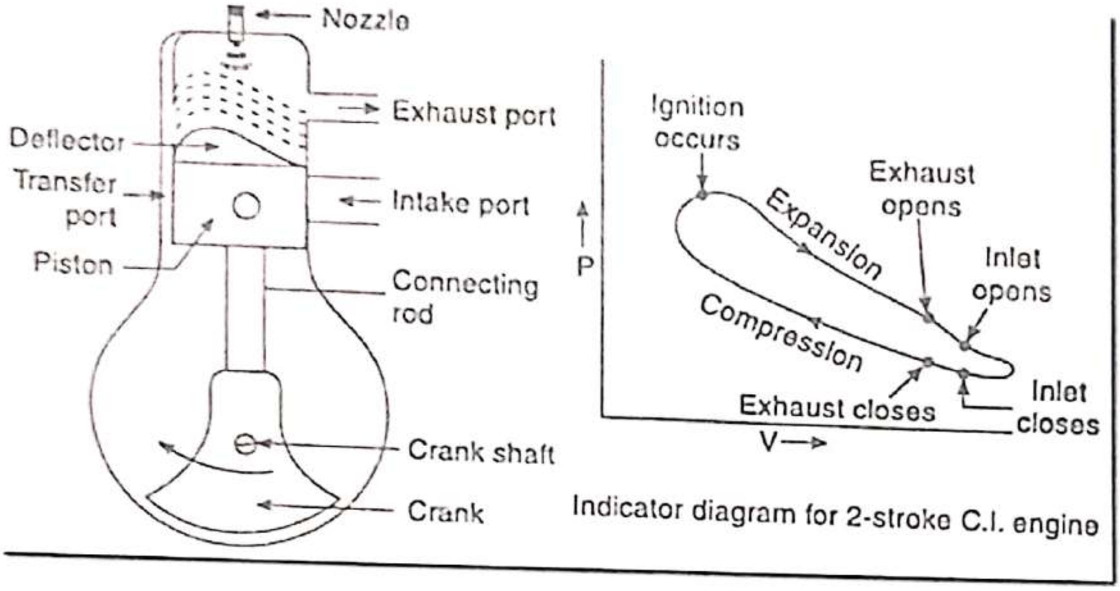


Figure of Two stroke CI Engine

Pressure is exerted on the crown of the piston due to the combustion of the air and the piston is pushed in the downward direction producing some useful power. The downward movement of the piston will first close the inlet port and then it will compress the air already sucked in the crank case.

Just at the end of power stroke, the piston uncovers the exhaust port and the transfer port simultaneously. The expanded gases start escaping through the exhaust port and at the same time the fresh air which is alredy compressed in the crank case, rushes into the cylinder through the transfer port and thus the cycle is repeated again.

CONCLUSION: -

From the above experiment we have successfully studied about the two stroke and four stroke diesel engine.

POST LAB QUESTION:

1. What are the different stages in two stroke petrol engine?
2. What are the different stages in two stroke diesel engine?
3. What are the different stages in four stroke petrol engine?
4. What are the different stages in four stroke diesel engine?
5. Define stroke.
6. What is the function of spark plug?
7. What is the function of fuel injector?
8. What is the function of inlet and outlet valve?
9. Define piston speed.
10. What is the function of transfer port?

EXPERIMENT - 2

AIM OF THE EXPERIMENT: -

To determine the brake thermal efficiency of the single cylinder petrol engine.

APPARATUS REQUIRED: -

SL. NO.	EQUIPMENT	SPECIFICATION	
1	SINGLE CYLINDER PETROL ENGINE	Make	Honda
		BHP	2HP
		Speed	3000RPM
		no of cylinder	1
		Bore	50mm
		Stroke	49.5mm
		orifice diameter	20mm
		ignition type	spark ignition
		types of cooling	Air cooled
		types of starting	Kick starting
2	ROPE BRAKE DYNAMOMETER	MAKE	TTT BANGALORE
		MATERIAL	CI
		TYPE	WATER COOLER
		LOADING RADIUS	108MM
		PAN WEIGHT	1KG

THEORY: -

LOADING SYSTEM:

The engine test rig is directly coupled to a brake drum and a rope is wounded around the drum. One end of the rope (top end) is connected to a spring balance and the other end to a weighting plate form. The load to the engine can be varied by adding slotted weights provided .Please see to that the platform is above the base (hanging) while the engine is loaded, this can be achieved by using the hand wheel provided on loading frame.

PROCEDURE: -

1. Put on main penal board socket to a 5 amp/230 V AC plug point near the rig.

2. Check the lubricating oil level lubricating oil level in the sump once while (for every 10 hour of running)

3. Fill up the tank mounted on the panel frame.

4. Open the cock provided at burette for fuel measurement.

5. Start the engine by wounding the rope around the pulley of magneto fly wheel and pull the rope at once start (if not started try once again)

6. Now the engine will run at approximate 3000rpm approximately.

7. Now load the engine by placing the necessary dead weights on the weighting hanger ,to load the engine in steps of ¼,1/2,3/4 and full load .Allow the engine to stabilize onevery load change.

8. Record the following parameters indicated on the panel instruments on each load step

   i. Speed of the engine (N) from digital RPM indicator

   ii. Rate of fuel from burette.

   iii. Quantity of air sucked into the engine cylinder from manometer.

   iv. Exact load in kg (W) on the engine by adding the amount of weight added .On the pan in kg (w_1) plus weight of pan in kg (w_2) minus spring balance reading in kg(w_3)

9. To stop the engine after the experiment is over reduce the load gradually and switch off engine using off switch provided on the flywheel magneto cover.

CALCUATION: -

1.

$$BHP = \frac{2 \pi N (W-S)(D+d)/2}{4500} \text{ HP}$$

Where, W=dead weight in kgs

S= spring balace reading in kgs

D=diameter of drum in mts = .2 mts

d= diameter of rpe in mts = .016 mts

N = speed of engine in RPM

2. **WEIGHT OF FUEL.** W_r in kg/hr

$$\frac{X_{CC} \times .720 \times 3600}{T_{sec} \times 1000} = kg/hr$$

Where X_{cc} is the volume of fuel in secs.
Density of fuel for petrol = 0.720 gms/cc

3. **BRAKE THERMAL EFFICIENCY**

Brake thermal efficiency is given by

$$\frac{BHP \times 4500 \times 60}{427 \times C_V \times w_r} \times 100\ \%$$

Where, Cv = Calorific value of fuel = 10500 Kcal/kg
w_{fr}= Weight of fuel consumed in kg/hr
Mechanical equivalent of heat =427 kg-m =1 kcal

)NCLUSION: -

The brake thermal efficiency of single cylinder petrol engine is found to be_______________.

OST LAB QUESTIONS: -

i) Explain the working of petrol engine.
ii) Draw P-V & T-S diagram of petrol engine.
iii) Which device is used to measure the brake power?
iv) State different strokes of petrol engine.
v) What type of loading is taken in this experiment?
vi) Define brake thermal efficiency.

EXPERIMENT - 3

AIM OF THE EXPERIMENT: -

To determine the brake thermal efficiency of the single cylinder diesel engine.

OBJECTIVE: -

After performing this experiment student will be able to:

— Know about single cylinder diesel engine.

— Find the brake thermal efficiency of the single cylinder diesel engine

APPARATUS REQUIRED: -

SL. NO.	EQUIPMENT	ENGINE SPECIFICATION	
01	Single Cylinder Diesel Engine Test Rig	Make	Honda
		BHP	5
		Speed	1500 RPM
		No. of Cylinder	One
		Compression Ratio	~~16.5:1~~ 17.5:1
		Bore	~~80mm~~ 87.5mm
		Stroke	110mm
		Orifice Diameter	17mm
		Type of Ignition	Compression Ignition
		Method of Loading	Rope brake
		Method of Starting	Crank Start
		Method of Cooling	Water

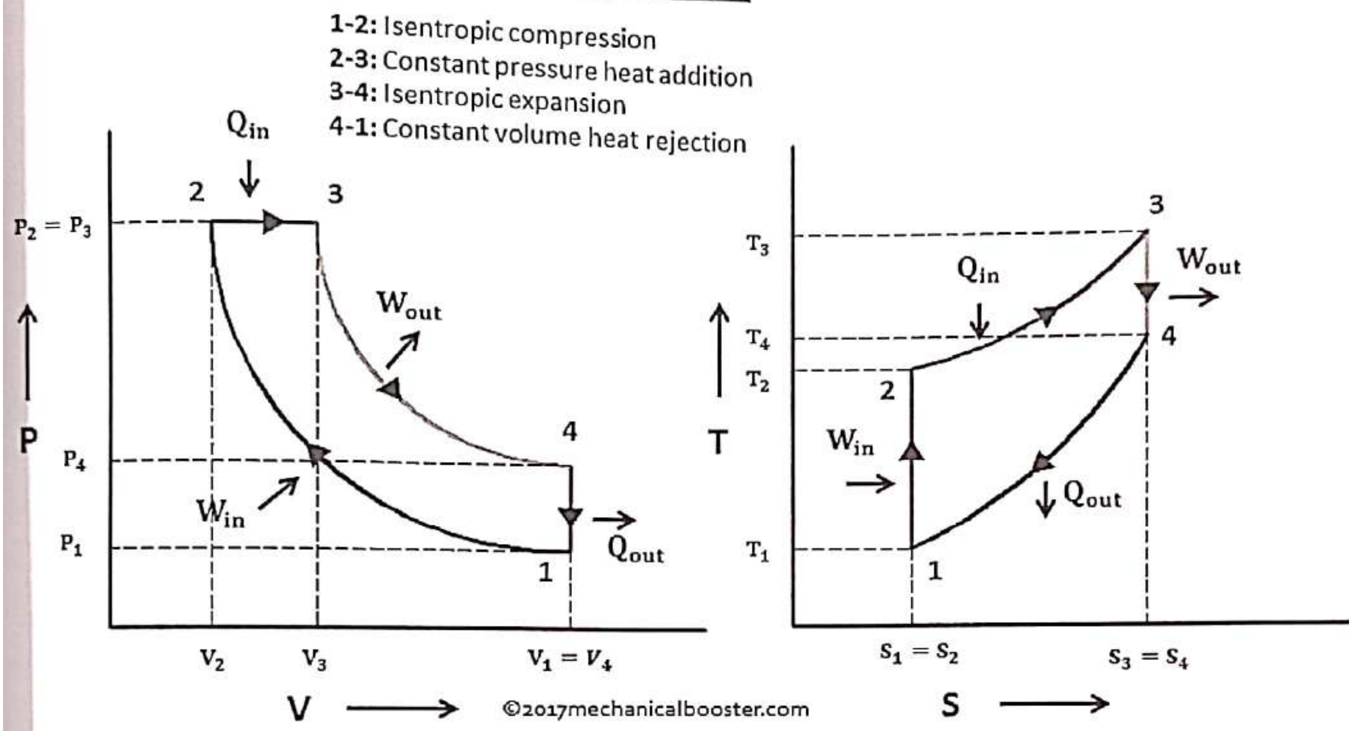
THEORY: -

Diesel engine use diesel as the working fluid. Here high compression ratio of the fuel ignites the fuel. Diesel cycle consist of four different stages i.e suction, compression, expansion and exhaust. Here only air which is sucked in the suction stroke is compressed in the compression stroke. Then fuel from the fuel injector enters in to the engine cylinder at the end of compression and combustion of fuel takes place. After combustion, in the exhaust stroke, the burnt out gases escapes from the engine cylinder.

BRAKE THERMAL EFFICIENCY:

Brake thermal efficiency is the ratio of energy in the brake power (BP) to the input fuel energy in appropriate units.

DIAGRAM:



P-V and T-S Diagram of Diesel Cycle

PROCEDURE: -

1. Fill fuel into the fuel tank mounted on the panel frame.
2. Check the lubricating oil in the engine sump with the help of dipstick provided.
3. Open the fuel lock provided under the fuel tank and ensure that no air is trapped in the fuel line connecting fuel tank and engine.
4. De-compress the engine by decompression lever provided on the top of the engine head. (Lift the lever for decompression)
5. Crank the engine slowly, with the help of handle provided, and ascertain proper flow of fuelinto the pump and in turn through the nozzle into the engine cylinder.

6. When maximum cranking speed is attained, pull the decompression lever down, now. The engine starts. Allow the engine to run and stabilize. (Approximately 1500 RPM. The engine is a constant speed engine fitted with centrifugal governor)
7. Now lead the engine by placing the necessary dead weights on the weighing hanger, to load the engine in steps of 1/4, 1/2, 3/4, full and 10% over load. Allow the engine to stabilize on every load change.
8. Record the following parameters indicated on the panel instruments on each load step.
   A) Speed of the engine from RPM indicator.
   B) Rate of fuel from burette.
9. Exact load in kg (*W*) on the engine by adding the amount of weight added on the pan in kg (W_1) plus weight of pan in kg (W_2) minus spring balance reading in kg (W_3)
10. To stop the engine after the experiment is over push/pull the governor lever towards the engine cranking side.

CALCULATION: -

In this experiment, we have to calculate the brake thermal efficiency of the Single Cylinder Four Stroke Diesel engine:

$$B.P = \frac{\pi N(W-S)(D+d)}{60 \times 1000}\ \text{KW}$$

where, *W* = Dead Weight in N,
S = Spring Balance reading in N,
D = Diameter of Brake drum in meter,
d = Diameter of rope in meter
N = Speed of the engine

$$\text{Brake Thermal Efficiency} = \frac{\text{Brake Power}}{\text{Energy supplied to the engine}}$$

$$\eta_{bth} = \frac{B.P}{m_f \times C_v}$$

where, C_V = Calorific value of fuel (Diesel) = 46200 kJ/kg
Density of petroleum diesel = 850.8 kg/m^3

CONCLUSION: -

The brake thermal efficiency of single cylinder diesel engine is found to be____________.

POST LAB QUESTIONS: -

1. Explain the working of Diesel engine.
2. Draw P-V & T-S diagram of Diesel engine.
3. State different strokes of Diesel engine.
4. Define brake thermal efficiency.

PROCEDURE: -

1. Connect the water inlets of the engine jacket calorimeter and hydraulic dynamometer to a 0.5 kg/cm^2constant head water source.
2. Open the inlet gate valves of the engine jacket and calorimeter to suitable desired flow rate.
3. Connect the battery terminals to a well charged 12V battery with the terminals marked "+" and "– "respectively to the engine cableterminals.
4. Connect the instrumentation power input plug to a 230V single phase power supply. Now all the digital meters namely rpm, fuel weight and flow rate and air flow rate and temperature indicator display the respective readings.
5. Fill up petrol into the petrol tank provided mounted on a 5kg capacity load cell until the fuel weight meter reads approximately 4000gms.
6. Open the petrol cock provided underneath the petrol tank and ensure all the knife switches provided for the Morse test are in engaged position. Also ensure the accelerator knob is in off position.
7. Insert the ignition key into the starter switch and turn it clock wise to hear a click sound by which the negative deflection will be shown at the bottom of the panel. Turn the key further clockwise to start the engine. Now the engine is running at idle speed (600- 800) on the digital rpm indicator. Ensure the oil pressure gauge reads $2kg/cm^2$ to $3kg/cm^2$.
8. Increase the speed by turning the accelerator knob clockwise until the rpm indicator reads 1500 rpm.
9. Now open the dynamometer inlet gate valve to load the engine through hydraulic dynamometer. The load is indicated on a dial type spring balance in terms of kgs.the dynamometer arm having a length of r=0.32m gives the torque.
10. Load the engine to full load at rated speed. Allow it to run for few minutes cut off the power to one cylinder by pulling the knife switch provided on the engine panel. Now the engine is running on 3 cylinders only. As a result, the speed of the engine drops down by operating the water inlet valveto reduce the load slowly so that the speed of the engine comes back to its rated speed(1500rpm). Record the spring balance reading.
11. Pull out the next knife switch immediately and observe the engine speed

EXPERIMENT – 4

AIM OF THE EXPERIMENT

To determine the B.H.P , I.H.P and BSFC of multi cylinder engine by morse test.

APPARATUS REQUIRED

Computerized 4 stroke 4 cylinder petrol engine test rig.

SL. NO.	EQUIPMENT	SPECIFICATION	
01	Four cylinders Petrol Engine Test Rig.	MAKE	MARUTI
		BHP	5 to 7 (derated)
		Speed	1500 RPM
		No of cylinder	4
		Compression Ratio	7.8: 1
		Bore	68 mm
		Stroke	75 mm
		Orifice Dia	24mm
		Type of ignition	Spark Ignition
		Type of cooling	Water Cooling
		Type of loading	Water Loading
		Type of starting	Self Starting

THEORY: -

The Morse test is used to find out the indicated power of a multi cylinder reciprocating engine.

- The engine is run at a particular speed and the torque is measured by cutting out the firing of each cylinder in turn and noting the fail in brake power each time while maintaining the set engine speed by reducing load.
- The observed difference in brake power between all cylinder firing and with one cylinder cut out is the indicated power of the cut out cylinder.

PROCEDURE

Load the engine as mentioned in items 10 to full load at rated speed. Allow it to run for few minutes. Cut off power to one cylinder by pulling the knife switch provided on the engine panel. Now the engine is running on 3 cylinders only. As the result, the speed of the engine decreases, by opening the water inlet gate valve of the hydraulic dynamometer reduce the load slowly, so the speed of the engine come back to its rated speed (1500rpm), record the spring balance reading. Now without altering the position of the water inlet to the hydraulic dynamometer the position of water inlet to its original position, then the speed increases pulled out the next knife switch immediately and observe the engine speed. If the speed. If the speed of the engine does not reach the rated speed increases or decreases the load applicable (If the speed is more increases the load and vice versa).Record the spring balance reading after attaining the rated speed. Follow the similar procedure for rest of the cylinder.

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CALCULATION:

Calculate the BHP when all the four cylinders are working. Similarly calculate the BHP of four cylinder when each of the cylinder is disconnect. By this indicated horse power of the engine is calculated.

Let W = Dynamometer load in Kg
N = RPM of the engine
B = BHP of 4 cylinder
IHP = Indicated horse power
BHP = Brake horse power
B1 = BHP of 3 cylinder when 1st is cut off
B2 = BHP of 3 cylinder when 2^{nd} is cut off
B3 = BHP of 3 cylinder when 3^{rd} is cut off
B4 = BHP of 3 cylinder when 4^{th} is cut off

IHP Calculation:

IHP of 1^{st} cylinder = B-B1
IHP of 2^{nd} cylinder = B-B2
IHP of 3^{rd} cylinder = B-B3
IHP of 4^{th} cylinder = B-B4

Total IHP Calculation:

Total IHP of the engine = IHP (1^{st} + 2^{nd} + 3^{rd} +4^{th})

1. BHP= $2\pi NT/4500$

Where ,

T=R X S

R= Distance from centre of dynamometer shaft to centre of spring balance in meter = 10.32 meter

N= sped of the engine in rpm

S= spring balance reading in kgs

2. Weight of fuel consumed (kg/hr)(W_f)

X_{cc} X 0.72 X 3600/T_{sec} X 1000

Where X_{cc} is the volume of fuel in t sec

0.72 is the density of fuel in gms/cc (petrol)

3.BRAKE SPECIFIC FUEL CONSUMPTION(kg/BHP hr)

BSFC= W_f/BHP

Where W_f fuel consumed in kg/hr

TABULATION: -

SL. NO.	CONDITION	N (rpm)	W (kg)	BHP	IHP	BSFC
1	A	1500				
2	B	1500				
3	C	1500				
4	D	1500				

CONCLUSION: -

The B.H.P, I.H.P and BSFC of multi cylinder engine was found out to be______________.

POST LAB QUESTIONS: -

i) Define BHP?
ii) Define IHP?
iii) Define BSFC?
iv) What is the purpose of conducting morse test?

EXPERIMENT – 5

AIM OF THE EXPERIMENT: -

To determine the mechanical efficiency of a two stage air compressor.

OBJECTIVE: -

After performing this experiment student will be able to understand:

i) About air compressor.

ii) Different components and working of air compressor.

APPARATUS REQUIRED: -

SL.NO.	EQUIPMENT	SPECIFICATION	QUANTITY
01	Air compressor test rig		01
02	Tachometer		01
03	Stop watch		01

THEORY: -

An air compressor is the machine which compress the air and to raise its pressure. The air compressor sucks air from atmosphere, compresses it and then delivers the same under a high pressure to a storage vessel. From the storage vessel, it may be converged by the pipe line to a place where the supply of compressed air is required, since the co mpression of air required some work to be done on it. Therefore, a compressor must be driven by some prime mover.

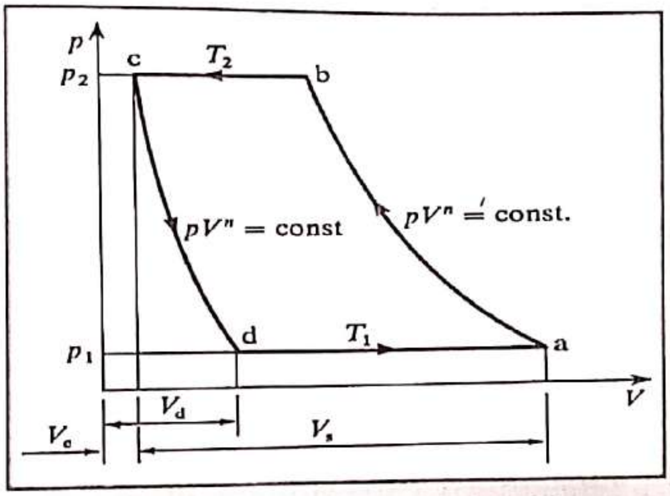
CONSTRUCTION:

An air compressor consists of the following components:

1. Cylinder
2. Piston
3. Inlet valve
4. Outlet valve
5. Pressure gauge
6. Pressure vessel

WORKING PROCEDURE:

- When the piston moves downward the pressure inside the cylinder falls below the atmospheric pressure.
- Due to this pressure difference the I.V. gets opened and the air is sucked into the cylinder.
- Now when the piston moves upward the pressure inside the cylinder goes on increasing till it reaches the discharge pressure. At this stage the discharge valve gets opened and air is delivered to the container.
- At the end of delivery stroke a small quantity of air at high pressure is left in the clearance space. As the piston start its suction stroke, the air contained in the clearance space expands till pressure reaches upto the required limit.
- At this stage the inlet valve gets opened as a result of which fresh air is sucked into the cylinder and the cycle is repeated.



Indicator diagram for a reciprocating compressor

CALCULATION: -

Mechanical efficiency of compressor,

$$\square_{\square\square\square\square} = \square.\square / \square.\square$$

$$\square.\square = \frac{\square \times \square}{60 \times 1000} \square\square$$

Work done by the compressor,

$$\square = \frac{\square}{\square - 1} \square\square\square_1 \{(\frac{\square_2}{\square_1})(\frac{\square}{\square - 1} - 1)\}$$

$$\square.\square = \frac{\square \times \square}{2000} \square\square$$

where W = Work done

N = Number of revolution in RPM

P_1 = Pressure of air at the inlet of the compressor

P_2 = Pressure of the air at the outlett of the compression

T_1 = Absolute temp. of air the inlet of the compressor

T_2 = Absolute temp. of air the outlet of the compressor

TABULATION: -

SL. NO.	P1	P2	T1	T2	I.P	B.P	MECH EFFICIENCY
1							
2							
3							

CONCLUSION: -

The mechanical efficiency of a two stage air compressor was found to be__________.

PRECAUTION: -

i) Handle the set up carefully.

i) Before Starting the setup check all connections are tight.

ii) Wear safety shoes.

iii) Follow the instructions properly.

POST LAB QUESTION: -

i) What is multistage air compressor?

ii) What is the need of intercooler in air compressor?

iii) Define mechanical efficiency of air compressor?

iv) Draw the P-V diagram of single stage air compressor.

EXPERIMENT – 6

AIM OF THE EXPERIMENT: -

Study of pressure measuring devices like Manometer & Bourdon tube pressure gauge.

APPARATUS REQUIRED: -

SL.NO.	EQUIPMENT	SPECIFICATION	QUANTITY
01	Manometer	U-tube	01
02	Bourdon tube pressure gauge		01

THEORY: -

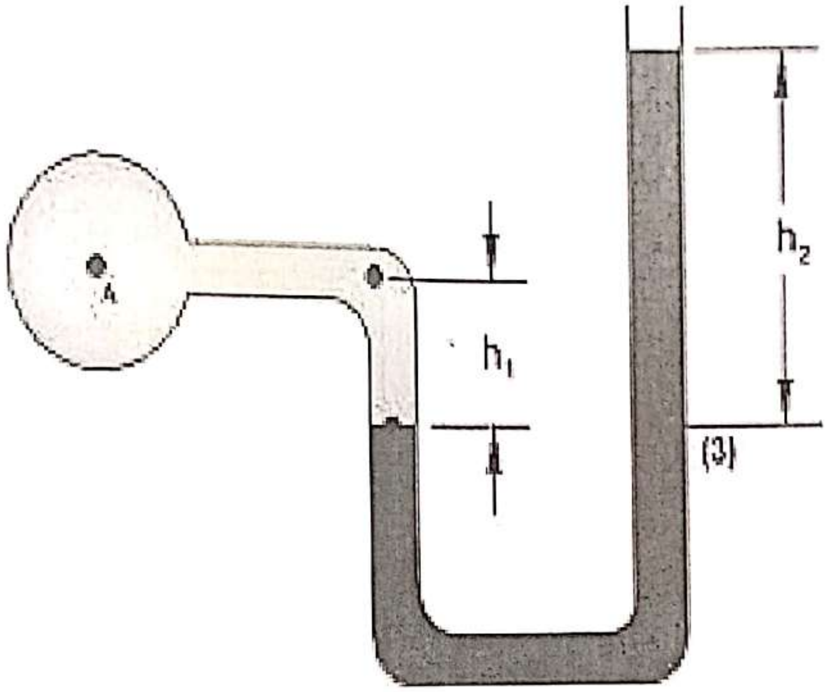
MANOMETER:

- A Manometer is slightly improved form of a piezometer tube for measuring high as well as negative pressure.
- A simple manometer, in its simplest form, consists of a tube bent in U-shape, one end of which is connected to the vessel containing the liquid whose intensity of pressure is to be measured and other end is open to the atmosphere.
- The liquid used in the bent tube is generally Mercury (Hg) which is 13.6 times heavier than water.
- The pressure of the liquid containing in the vessel will force the manometric liquid in the left hand vertical limb of the U-tube downward and will force the manometric liquid to rise up in the right hand vertical limb of the U-tube through equal distance. This will happen when the pressure in the vessel is greater than atmospheric pressure.
- If pressure of liquid in the vessel is less than atmospheric pressure, the deflection of manometric liquid will be observed in the left hand limb of the u-tube.
- Since below the surface A-B, the liquid is homogenous and since the liquid is at rest, the pressure along the plane A-B in the left hand limb of the U-tube is equal to the pressure in the right hand limb of the U-tube along the plane A-B.
- Then by measuring the difference in mercury level above line A-B, and equating the pressure at A and pressure at B we can measure pressure of liquid flowing in the pipe.

DIFFERENT TYPES OF MANOMETER:

1. U-Tube Manometer:

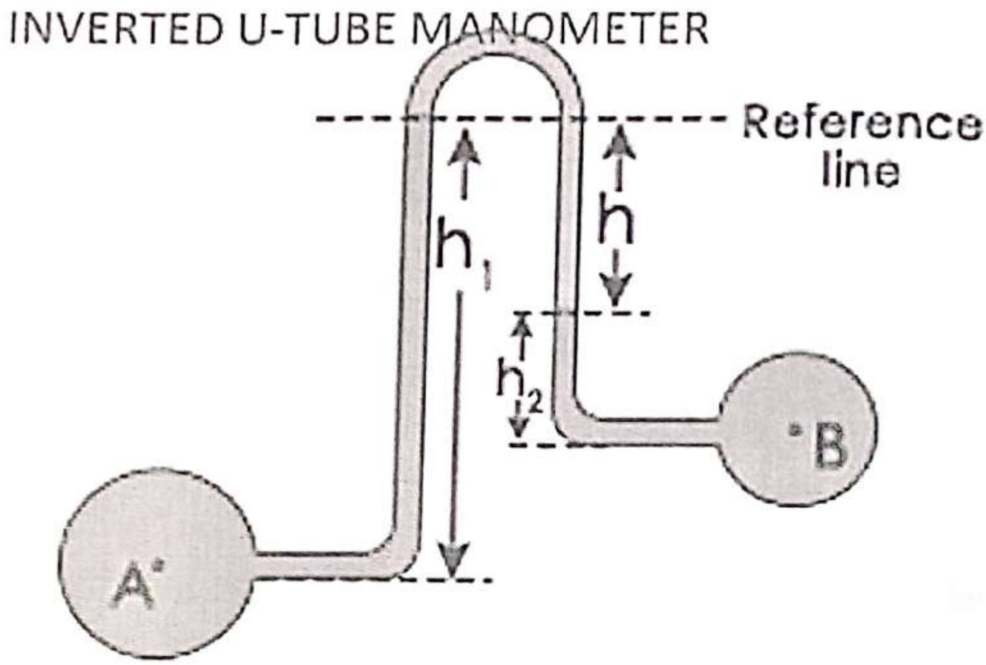
U-Tube manometer consists of a U – formed bent tube whose one end is hooked up to the gauge Location 'A' and alternative Location is receptive the atmosphere. it's then stuffed with a Liquid. The density of the Liquid dictates the vary of pressures that may be observed.



U-TUBE MANOMETER

2. Inverted U-Tube Manometer:

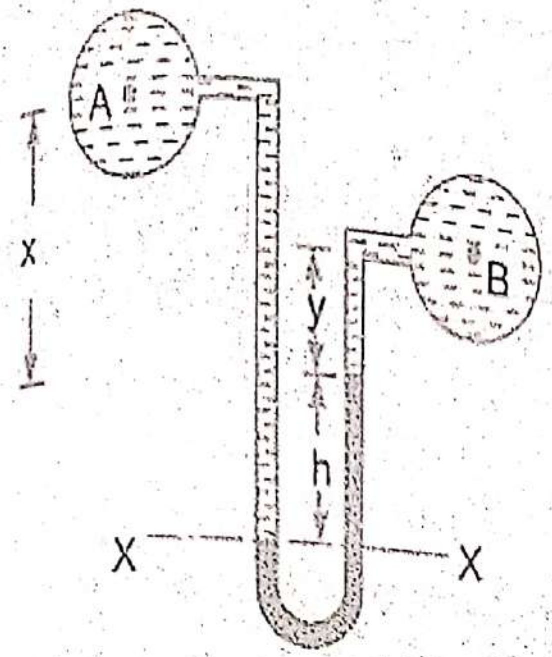
Inverted U-Tube manometer is employed for the measuring of tiny pressure differences in liquids. It consists of associate inverted U – Tube containing a light-weight liquid. this is often used to observe the differences of low pressures between 2points wherever higher accuracy is needed. It typically consists of associate air cock at prime of Mano-metric Liquid kind.



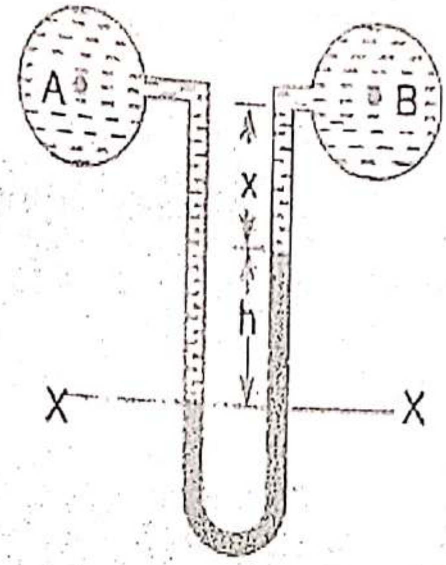
INVERTED U-TUBE MANOMETER

3. Differential U-Tube Manometer:

Differential U-tube manometer is extremely similar to the U-tube manometer. Here one open Location (which was thought-about as atmospheric Location in U-Tube manometer) is connected to a different pressure Location. This manometer is largely used to observe the differences between to totally different points otherwise you will say we tend to calculate the difference.



(a)Two pipes at different levels



(b) A and B are at the same level

DIFFERENTIAL MANOMETER

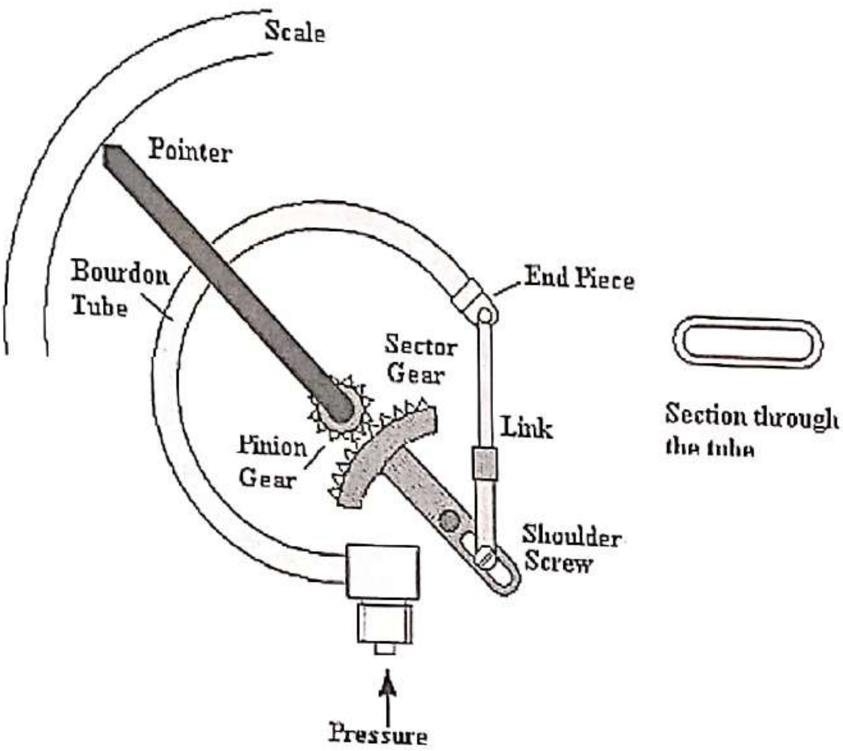
BOURDON TUBE PRESSURE GAUGE:

- Bourdon pressure gauge consists of a circular spring tube A, called Bourdon tube.
- The Bourdon tube is made up of special quality bronze and oval in cross section.
- One end of the Bourdon tube is closed and connected to a link L and the other end is secured in a vertical tube B.
- The link L connects the closed end of the Bourdon tube to a toothed sector C which is hinged at O.
- The toothed sector C gears with a pinion D which is mounted on a central spindle carrying a pointer P.
- The pointer moves on a dial graduated in pressure unit (i.e. bar)
- The pressure gauge is connected to the vessel containing fluid under pressure.
- Due to fluid pressure in the Bourdon tube, it has tendency to achieve a circular shape. But before the tube can do so, it must be straighten itself.
- This tendency of straightening moves the free end of the Bourdon tube outwards.
- As a result, the toothed sector moves about the hinge O and causes the pinion D to rotate

which, inturn moves the pointer F to move on a dial graduated in bar.

- The movement of the free end of the Bourdon tube is proportional to the difference between the external atmospheric pressure and internal fluid pressure.

- Hence the pressure gauge records the gauge pressure which is the differencebetween fluid



pressure and outside atmospheric pressure.

CONCLUSION: -

Hence we successfully studied about Manometer and Bourdon tube pressure gauge.

EXPERIMENT – 7

AIM OF THE EXPERIMENT: -

Verification of Bernoulli's theorem.

APPARATUS REQUIRED: -

SL NO	EQUIPMENTS	SPECIFICATION	QUANTITY
01	Bernoullis Apparatus test rig		01
02	Stop watch	DIGITAL	01
03	Steel rule	30cm	01
04	Discharge tank	35 cm x 35 cm x 40 cm	01

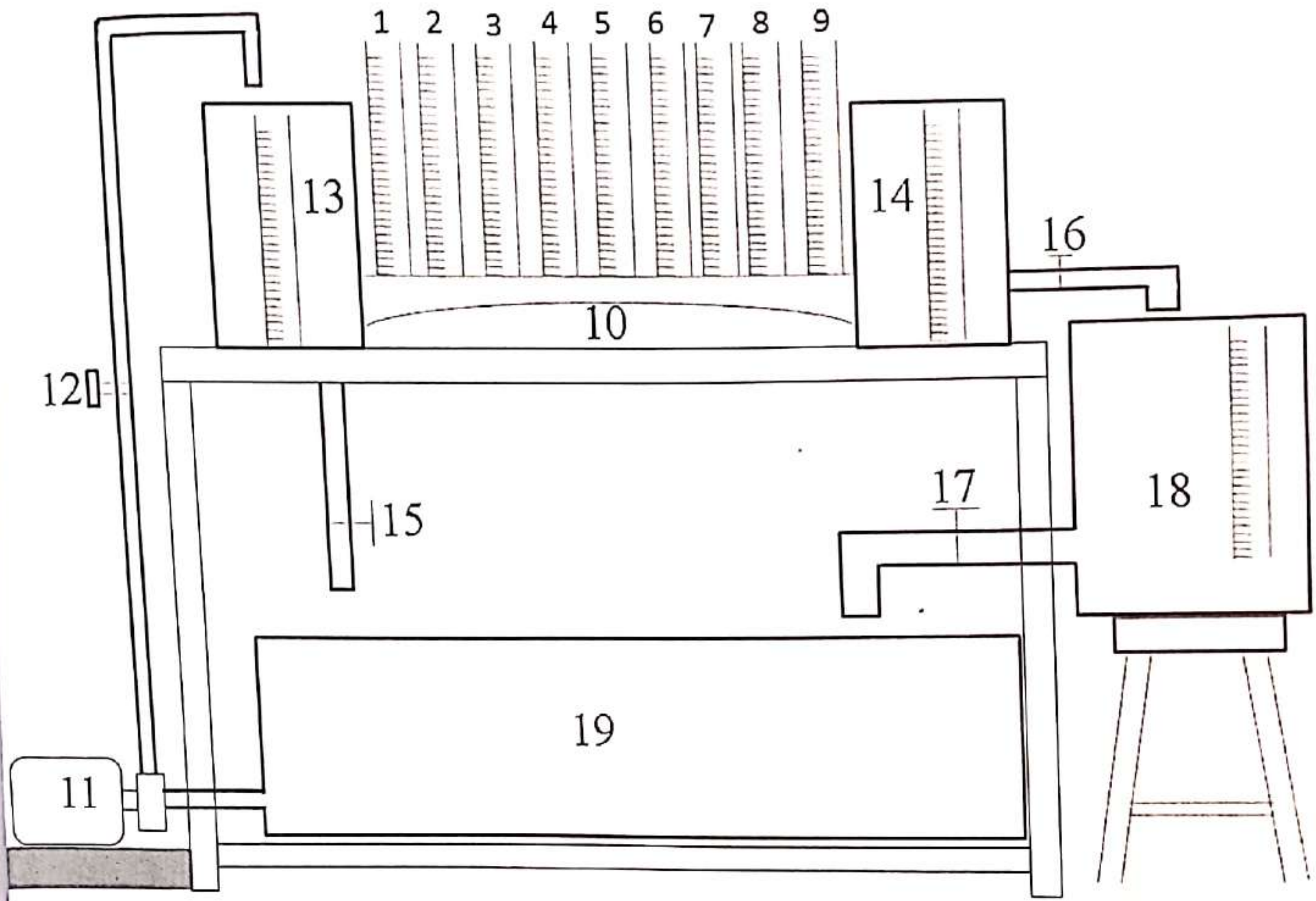
THEORY: -

Bernoulli's theorem states that "For a steady, continuous, incompressible, &non viscous fluid flow, the total energy or total head remains constant at all the sections along the fluid flow provided there is no loss or addition of energy".

i.e.-

$$p/w + v^2/2g + z = \text{constant}$$

where p/w = pressure head
$v^2/2g$ =velocity head
z = potential head



Part names:

1-9: Piezometers (A transparent tube with scale) are connected at various cross sections of the Duct.
10: Stainless Steel duct (for low friction).
11: Single Phase motor with pump(pump capacity is 0.5 HP, single phase 20 volts
12: Flow control ball valve.
13: Supply tank with piezometer.
14: Delivery Tank with piezometer.
15: Supply tank drain control valve.
16: Out flow Control valve.
17: Drain valve from discharge tank.
18: Discharge measuring tank (0.3m X 0.3m Area).
19: Water storage tank.

PROCEDURE:

1. Before starting the experiment, do priming of the pump to remove the air bubbles.
2. Open the inlet valve of the piping system of the pump.
3. Open the outlet valve of the piezeometer tube.

4. Start the motor and keep the water level constant in the supply tank by operating various valves.
5. Then note down the pressure head from the piezeometer scale directly
6. Close the outlet valve of the mercury tank and note down the time for 100 mm raise of water level note down the valves for pressure head, velocity head for different areas of piezeometer and calculate the total head

OBSERVATION:

1. *If V is the velocity of a flow at a particular section of the duct and Q is the discharge, then by continuity equation:*

V=Q/ area of section

Area of collecting tank, cm =35cm x 35 cm =1225 cm²

Increase in depth of water , cm =

Time , sec =

Discharge , cm³/sec =

2. *Calculate velocity head and total head.*
3. *Plot piezometric head (P/ω + Z), velocity head (v² 2g) , total head (P/ω + Z + v² 2g) v/s distance of piezometer tubes from same reference point.*

CALCULATION TABLE: -

Tube No.	Distance from inlet section (cm)	Area of flow of tubes, A (m^2) cm²	Discharge, $Q = q/t$ (m^3/s)	Velocity of flow, V (m/s) $V= Q/A$	Velocity Head, $V^2/2g$ (m)	Pressure Head, P/w (m)	Datum Head, Z (m)	Total Head, H = P/w+ $V^2/2g$ + Z (m) (v +vi + vii)	Remark
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
01	7.5	14.67							
02	15.0	13.33							
03	22.5	12.0							
04	30.0	10.67							
05	37.5	9.33							
06	45.5	8.0							
07	52.5	9.33							
08	60.0	10.67							
09	67.5	12.0							
10	75.5	13.33							
11	82.5	14.67							

CONCLUSION: -

Hence we have successfully verified Bernoulli's Theorem and we see that the total head in all the sections of the Bernoullis apparatus test rig (venturimeter) is constant. The slight variation if any is due to losses.

EXPERIMENT – 8

AIM OF THE EXPERIMENT: -

Determination of the Co-efficient of Discharge (*Cd*) from venturimeter.

APPARATUS REQUIRED: -

SL. NO.	EQUIPMENT	SPECIFICATION	QUANTITY
01	Venturimeter test rig		01
02	Stop Watch	Digital	01
03	Steel Rule	L=30cm	01

THEORY: -

A venturimeter is an instrument used to measure the rate of discharge at different sections of the pipe line. A venturimeter consists of 3-parts: -

- Converging section
- Throat section
- Divergent Section

The inlet section of the venturimeter is of the same diameter as that of pipe which is followed by a convergent cone. The convergent cone is a short pipe which tapers from the original size of pipe to that of throat of venturimeter. The throat of a venturimeter is a short parallel size tube having its cross-sectional area smaller than that of the pipe. The divergent cone of the venturimeter is gradually diverging pipe its cross-sectional area increasing from that of the throat to the original size of the pipe.

PROCEDURE

a) Fill in the sump tank with clean water.
b) Keep the delivery valve closed.
c) Connect the power cable to 220v, 10amp with earthing .
d) Switch on the pump and open the delivery valve.
e) Open the corresponding ball valve of the venturimeter pipe line.
f) Adjust the flow through the control valve of the pump.
g) Open the corresponding ball valves fitted to venturimeter tapping.
h) Note down the differential head reading in the manometer.
i) Operate the butterfly valve to note down the connecting tank reading against the known time.

j) Change the flow rate and repeat the experiment.

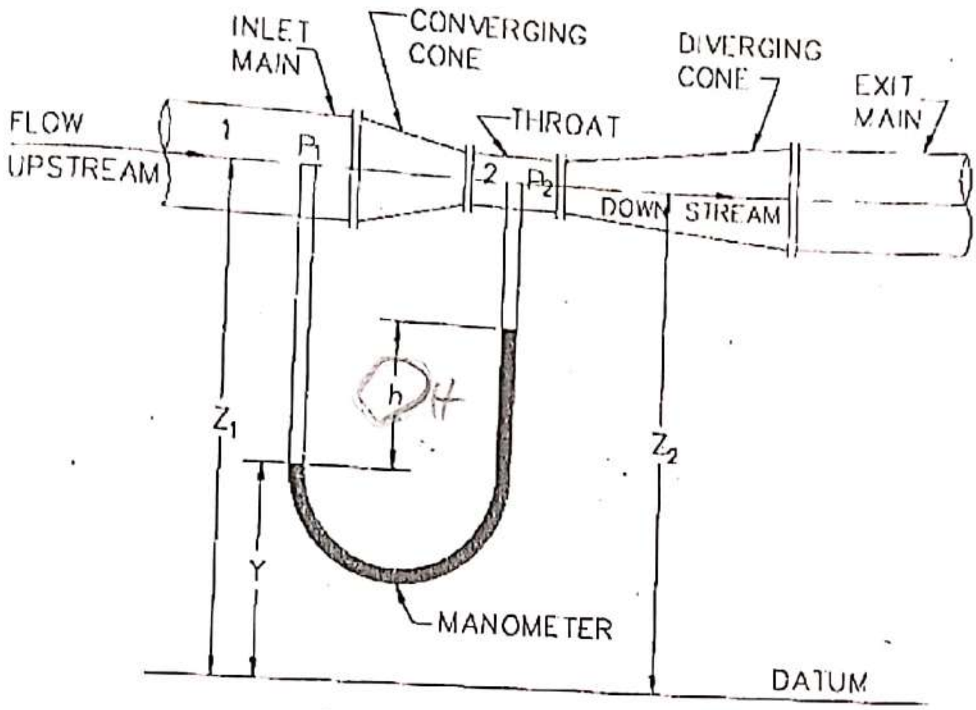


Fig. 18.1. Venturimeter.

CALCULATION

Area of measuring tank (A) = 35cm x 35 cm =1225 cm^2

Diameter of venturimeter(d_2) =12.5mm=1.25cm = d_2

Diameter of inlet pipe of venturimeter (d_1)=25mm=2.5cm = d_1

Q_{act} = Q_{out} = Al/t

$Q_{th} = A_1A_2\sqrt{2gh}/\sqrt{A_1^2-A_2^2}$

Cross section of throat of venturimeter A_2=π/4 d_2^2=π/4 $(1.25)^2$= cm^2

Cross section area of pipe =π/4 d_1^2=π/4 $(2.5)^2$= cm^2

$Q_{act} = Q_{th} \times C_d$

$C_d = \frac{Q_{act}}{Q_{th}}$

Q_{act} $h = \left(\frac{S_m}{S} - 1\right) H$

OBSERVATION TABLE

SL NO	Actual Discharge measurement				Theoretical Discharge measurement				C_d	Mean C_d
	Initial (cm)	Final (cm)	Time(sec)	Q_{act} cm^3/sec $=Al/t$	Left limb h_1(cm)	Right Limb h_2(cm)	Diff. of head $h=12.6(h_1-h_2)$cm	$Q_{th} = A_1A_2\sqrt{2gh}/\sqrt{A_1^2-A_2^2}$	Q_{act}/Q_{th}	

CONCLUSION: -

From the above experiment, the Co-efficient of Discharge (C_d) of venturimeterwas found out to be____________.

EXPERIMENT –9

AIM OF THE EXPERIMENT

Determination of C_c , C_v and C_d from orifice meter.

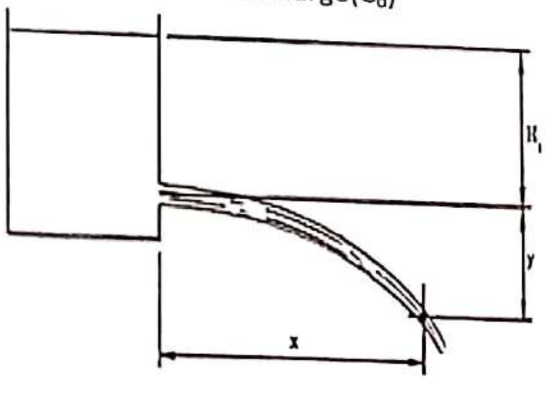
APPARATUS REQUIRD

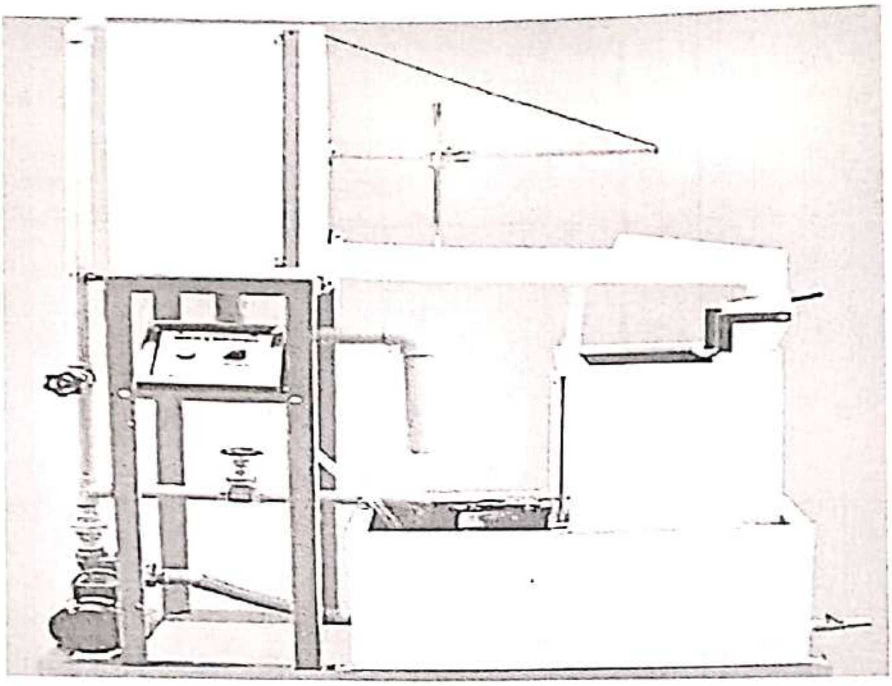
1) A supply tank with circular orifice, scales and sliding apparatus.
2) Measuring tank.
3) A stopwatch.

THEORY

When flow takes place through an orifice from the supply tank, the water jet leaving the orifice gets contracted at the downstream of the orifice and the point where its gets maximum contraction is called as vena-contract. Following area three hydraulic coefficient of orifice .

1) Coefficient of contraction(C_c)
2) Coefficient of velocity(C_v)
3) Coefficient of discharge(C_d)





1. Coefficient of contraction(C_c)

It is the ratio of area of water jet at vena contract to the area of the orifice.

$C_c = a_c / a$

Where , a_c=Area of jet at venacontracta

a = Area of the orifice

4) Coefficient of velocity(C_v)

It is the ratio of velocity of water jet at vena-contract to the theoretical velocity.

$C_v = \sqrt{(x^2/4yh)}$

Where, x= Horizontal ordinate

Y= vertical ordinate

5) 3. Coefficient of discharge(C_d)

It is the ratio of actual discharge to the theoretical discharge.

$C_d = Q/a(\sqrt{2gh})$

Q= Actual discharge

a= Area of the orifice

g= acceleration due to gravity

coefficient of discharge =coefficient of contraction X coefficient of velovity

$$C_d = C_c \times C_d$$

ROCEDURE

he procedure to determine hydraulic coefficient of an orifice is as follows.

- Fill the supply tank with water and allow the water to flow through the orifice.
- Maintain a constant head in the water supply valve provided.
- At vena-contracta , measure the diameter of jet using micrometer contraction gauge.
- Adjust the vertical scale to the position of vena-contracta such that the hook provided at the bottom of the vertical scale should touch the centre of water jet. Note down the initial coordinates(x_1 y_1)
- Take the stopwatch and note down the time taken for the rise of water up to a certain height in the measuring tank and calculate the discharge.
- Repeat the above procedure for various constant heads and calculate the average values of hydraulic coefficient of an orifice.

CALCULATION

Size and Shape of the orifice=

Area of cross section of orifice (a) cm^2 =

Area of cross section of collecting tank cm^2=

Area of cross section of supply tank A cm^2=

TABULATION

(I) Determination of C_d

SL NO	Cross sectional area of orifice	Value of h	Discharge of measurement				$C_d = Q/a\sqrt{2gh}$
			Initial (cm)	Final(cm)	Time (sec)	Discharge Q=vel/sec	

(I) 2) Determination of C_v

SL NO	h(cm)	x(cm)	y(cm)	$C_v=x^2/\sqrt{4yh}$

Therefore $Cc= C_d/ C_v$

$$[C_d= C_c \times C_d]$$

CONCLUSION: -

From the above experiment, the value of C_d, C_c and C_v of orificemeter was found to be ______,________&_______respectively.

POST LAB QUESTION: -

1. Define orifice.
2. Define venacontracta.
3. Define coefficient of contraction.
4. Define relation between C_d, C_c and C_v.

EXPERIMENT – 10

AIM OF THE EXPERIMENT

Determine of Darcy's coefficient from flow through pipe.

APPARATUS REQUIRD

- Pipe friction test apparatus
- Stop watch

THEORY

The energy loss in a pipe can be determined by applying the energy equation to the section of a straight pipe with a uniform cross-section.

$P_1/w + V_1^2/2g + z_1 = P_2/w + V_2^2/2g + z_2 + h_f$

If the pipe is horizontal , $z_1 = z_2$, $V_1 = V_2$

$[Q_1=Q_2, \quad a_1v_1=a_2v_2$

$a_1=a_2 \quad , v_1=v_2]$

Then $h_f=p_1/w - p_2/w$

The pressure head difference between two points in the pipe is due to the frictional resistance, and the head lies hf is directly proportional to the pressure difference.

Calculate from Darcy's equation

$h_f = 4f.l.v^2/2gD$

where ,

h_f=head loss due to resistance

f= Darcy's coefficient

D=pipe diameter

V=average velocity

g= gravitational acceleration

PROCEDURE

1. Open the inlet valve and keep the outlet closed. Removed the air bubbles from the manometer tubes.
2. Open partially the outlet valve of one of the two pipes and keep the common inlet valve full open.
3. Wait for some time so that the flow is stabilized. Take the manometer readings h_1 and h_2
4. Measure the discharge.
5. Repeat steps (2) to (4) for different discharge.
6. Repeat steps (2) to(5) for other also.

OBSERVATION TABLE

	Pipe -1	Pipe -2
Area of cross section, A		
Distance between pressure point, 2		
Hydro dynamically Rough/smooth		

Pipe no	Sl No	Discharge measurement					Manometer reading		h_f	f
		Initial level	Final level	Rise ΔH	Time t	Q=vol/t	h_1	h_2		

CONCLUSION: -

From the above experiment, the value of Darcy's coefficient from flow through pipewas found out to be____________.

POST LAB QUESTION: -

1. Define Darcy's coefficient.
2. What are the different types of energy losses in flow through pipe?
3. Define Darcy's formula.

(iii) Idling and slow speed running

In this circuit, the pilot jet (n) is taken from the main jet. At the idling, the throttle (h) is almost closed and hence engine suction is applied at the pilot jet. Fuel is drawn there from and mixed with a small amount of air from pilot air bleed orifice (o). This mixture is conveyed down the vertical passage and discharged into the throttle body through the idling screw (p). The idling screw permits variation of the slow running jet's

delivery of petrol and allows the richness of the mixture.

(iv) Acceleration

In order to, provide extra quantity of fuel during acceleration, this carburettor is provided with a diaphragm pump system. When accelerator pedal is pressed for acceleration, the pump lever (t) connected to it is also pressed. Due to this movement, the fuel is compressed and it flows through pump jet (u) and accelerator pump injector (s) to mixing chamber. When the force on lever is removed; the diaphragm retains its original position due to spring. Due to this movement of diaphragm a suction is created, thus opening the pump valve (e) and admitting the fresh fuel into the pump.

Conclusion

From the above experiment we have successfully studied about of solex carburetor.