METHODIST
COLLEGE OF ENGINEERING & TECHNOLOGY
Estd: 2008
UGC AUTONOMOUS Institution Affiliated to Osmania University, Accredited by NBA & Naac with A+
Abids, Hyderabad, Telangana, 500001

DEPARTMENT OF MECHANICAL ENGINEERING

LABORATORY MANUAL

APPLIED THERMODYNAMICS LABORATORY

BE IV Semester

AUTONOMOUS

Name: ....

Roll No: ....

Branch:...SEM:.........................

Academic Year: ....

Empower youth - Architects of Future World

Estd: 2008

METHODIST

COLLEGE OF ENGINEERING & TECHNOLOGY

Approved by AICTE New Delhi | Affiliated to Osmania University, Hyderabad

Abids, Hyderabad, Telangana, 500001

VISION

To produce ethical, socially conscious and innovative professionals who would contribute to sustainable technological development of the society.

MISSION

To impart quality engineering education with latest technological developments and interdisciplinary skills to make students succeed in professional practice.

To encourage research culture among faculty and students by establishing state of art laboratories and exposing them to modern industrial and organizational practices.

To inculcate humane qualities like environmental consciousness, leadership, social values, professional ethics and engage in independent and lifelong learning for sustainable contribution to the society.

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DEPARTMENT OF MECHANICAL ENGINEERING

LABORATORY MANUAL

APPLIED THERMODYNAMICS LABORATORY (6PC453ME)

Prepared by

Dr. P. Ravichander, Associate Professor. Mech. Engg.
Mr. Y. Madhu Maheswara Reddy, Assistant Professor. Mech. Engg.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a reputed centre of excellence in the field of mechanical engineering by synergizing innovative technologies and research for the progress of society.

MISSION

- To impart quality education by means of state-of-the-art infrastructure.
- To involve in trainings and activities on leadership qualities and social responsibilities.
- To inculcate the habit of life-long learning, practice professional ethics and service the society.
- To establish industry-institute interaction for stake holder development.

DEPARTMENT OF MECHANICAL ENGINEERING

After 3-5 years of graduation, the graduates will be able to:

PEO1: Excel as engineers with technical skills, and work with complex engineering systems.

PEO2: Capable to be entrepreneurs, work on global issues, and contribute to industry and society through service activities and/or professional organizations.

PEO3: Lead and engage diverse teams with effective communication and managerial skills.

PEO4: Develop commitment to pursue life-long learning in the chosen profession and/or progress towards an advanced degree

DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM OUTCOMES

Engineering Graduates will be able to:

Po1. Engineering knowledge: Apply the basic knowledge of mathematics, science and engineering fund a mentals along with the specialized knowledge of mechanical engineering to understand complex engineering problems.

PO2. Problem analysis: Identify, formulate, design and analyse complex mechanical engineering problems using knowledge of science and engineering.

Po3. Design/development of solutions: Develop solutions for complex engineering problems, design and develop system components or processes that meet the specified needs with appropriate consideration of the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Formulate engineering problems, conduct investigations and solve using research-based knowledge.

PO5. Modern tool usage: Use the modern engineering skills, techniques and tools that include IT tools necessary for mechanical engineering practice.

Po6.Theengineerandsociety: Apply the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities during professional practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communication: Communicate effectively on complex engineering activities to various groups, ability to write effective reports and make effective presentations.

PO11. Project management and finance: Demonstrate and apply the knowledge to understand the management principles and financial aspects in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in Independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

Mechanical Engineering Graduates will be able to:

PSO1: Apply the knowledge of CAD/CAM/CAE tools to analyse, design and develop the products and processes related to Mechanical Engineering.

PSO 2: Solve problems related to mechanical systems by applying the principles of modern manufacturing technologies.

PSO 3: Exhibit the knowledge and skill relevant to HVAC and IC Engines.

CODE OF CONDUCT

1. Students should report to the concerned labs as per the time table schedule.
2. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
3. After completion of the experiment, certification of the concerned staff in-charge in the observation book is necessary.
4. Staff member in-charge shall award marks based on continuous evaluation for each experiment out of maximum 15 marks and should be entered in the evaluation sheet/attendance register.
5. Students should bring a note book of about 100 pages and should enter the readings/observationsintothenotebookwhileperformingtheexperiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate last session should be submitted and certified by the staff member in-charge.
7. Not more than three students in a group are permitted to perform the experiment on a setup for conventional labs and one student in case of computer labs.
8. The components required pertaining to the experiment should be collected from stores in-charge after duly filling in the requisition form.
9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
10. Any damage of the equipment or burn-out of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.
11. Students should be present in the labs for the total scheduled duration.
12. Students are required to prepare thoroughly to perform the experiment before coming to Laboratory.

DO'S

1. All the students are instructed to wear protective uniforms, shoes & identity cards before entering into the laboratory.
2. Please follow instructions precisely as instructed by your supervisor.
3. Students should come with thorough preparation for the experiment to be conducted.
4. Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the previous class.
5. Practical records should be neatly maintained.
6. Students should obtain the signature of the staff-in-charge in the observation book after completing each experiment.
7. Theory regarding each experiment should be written in the practical record before procedure in your own words.
8. If any laboratory equipment is malfunctioning, making strange noise, sparking, smoke, or smell, inform the instructor or staff immediately. It is imperative that the instructor or staff knows of any equipment problems.

DON'TS

1. Don't operate any machine without getting concerned staff member's prior permission.
2. Using the mobile phones in the laboratory is strictly prohibited.
3. Do not leave the experiments unattended while in progress.
4. Do not crowd around the equipment & run inside the laboratory.
5. Do not wander around the lab and distract other students
6. Do not use any machine that smokes, sparks, or appears defective.

COURSE OBJECTIVES

The objectives of this course are to:

1.	Find the efficiency of single cylinder Petrol and Diesel engines by testing.
2.	Find the viscosity, flash point and fire point of fuels/lubricants.
3.	Find the valve timing diagram for four stroke petrol and diesel engine, two stroke petrol engine.
4.	Conduct experiments on multi cylinder spark ignition (petrol) engines.
5.	Conduct experiments on Reciprocating Air Compressor.

COURSE OUTCOMES

CO No.	Course Outcomes	PO
CO 1	Determine volumetric efficiency and isothermal efficiency of a two stage reciprocating air compressor.	1,2,9,12
CO 2	Construct port timing diagram of two stroke engine, valve timing diagram of four stroke engine	1,2,9,12
CO 3	Evaluate the performance of internal combustion engines	1,4,5,9,12
CO 4	Develop heat balance sheet of internal combustion engine	1,4,5,9,12
CO 5	Determine the properties of (flash point, fire point, viscosity, etc---) given lubricating oil	1,4,5,9,12

COURSE OUTCOMES VS POs MAPPING

S. NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
6PC453ME.1	3	3	-	-	-	-	-	-	3	-	-	3	-	-	3
6PC453ME.2	3	3	-	-	-	-	-	-	3	-	-	3	-	-	3
6PC453ME.3	3	-	-	3	3	-	-	-	3	-	-	3	-	-	3
6PC453ME.4	3	-	-	3	3	-	-	-	3	-	-	3	-	-	3
6PC453ME.5	3	-	-	3	3	-	-	-	3	-	-	3	-	-	3
Avg	3.0	1.2	-	1.8	1.8	-	-	-	3.0	-	-	3.0	-	-	3.0

LIST OF EXPERIMENTS

LIST OF ADDITIONAL EXPERIMENTS

Note: At least ten experiments should be conducted in the Semester

INDEX

Experiment No	Experiment Name	Date	Page No	Marks				Remarks/ Signature
				P	R	V	T	

Experiment No	Experiment Name	Date	Page No	Marks				Remarks/ Signature
				P	R	V	T	

EXPERIMENT - 01

REDWOOD VISCOMETER APPARATUS

AIM:

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

APPARATUS:

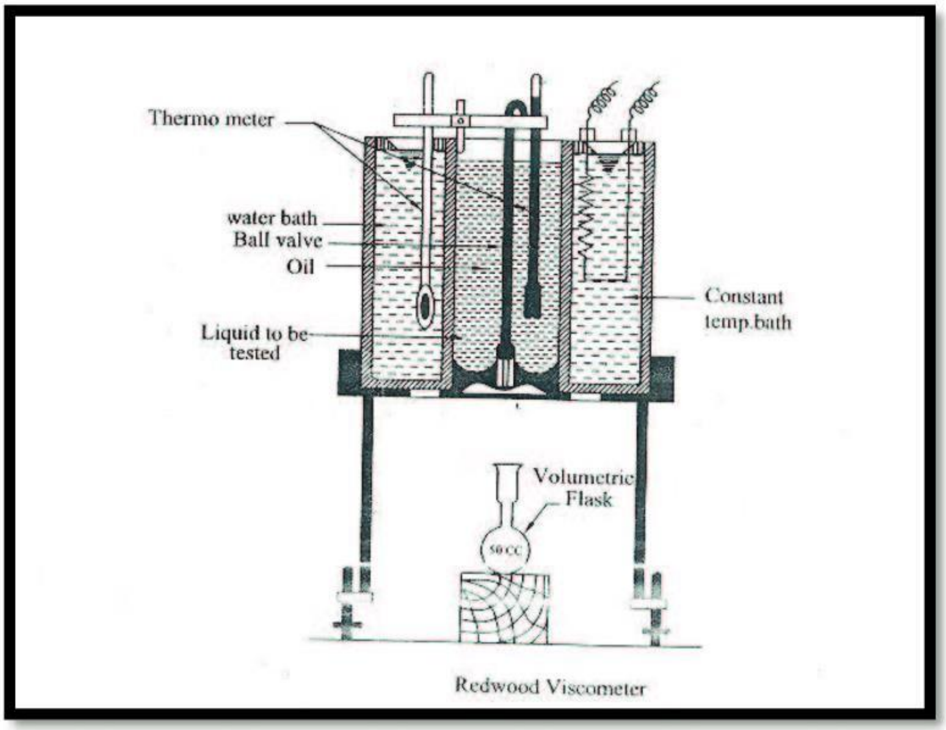
1. Redwood Viscometer
2. Thermometer 0-100°c
3. Stop watch
4. flask Given Sample of oil

THEORY:

The redwood viscometer consists of vertical cylindrical oil cup with an orifice in the center of its base. The orifice can be closed by a ball. A hook pointing upward serves as a guide mark for filling the oil. The cylindrical cup is surrounded by the water bath. The water bath maintains the temperature of the oil to be tested at constant temperature. The oil is heated by heating the water bath by means of an immersed electric heater in the water bath, The provision is made for stirring the water, to maintain the uniform temperature in the water bath and to place the thermometer it record the temperature of oil and water bath. The cylinder is 47.625mm in diameter and 88.90mm deep. The orifice is 1.70mm in diameter and 12mm in length, this viscometer is used to determine the kinematic viscosity of the oil. From the kinematic viscosity the dynamic viscosity is determined.

Viscosity is the property of fluid. It is defined as “The internal resistance offered by the fluid to the movement of one layer of fluid over an adjacent layer. It is due to the Cohesion between the molecules of the fluid. The fluids which obey the Newton law of Viscosity are called as Newtonian fluid.

The dynamic viscosity of fluid is defined as the shear required producing unit rate of angular deformation.



***Tabular column**:*

S.no	Temperature of oil	Time taken For collecting50cc oil in flask	Kinematic viscosity in stokes	Dynamic viscosity in stokes
1				
2				
3				
4				
5				

Formulae used:

Kinematic Viscosity= γ = At –B/t(Stokes)

A = 0.0026
B = 1.72
t = second Density

The kinematic viscosity of the fluid is defined as the ratio of the dynamic viscosity toss density of the fluid. Its symbol is 'γ'

$$\gamma = \mu / \rho$$

μ = Dynamic Viscosity (Stokes)
ρ = mass density of oil

PROCEDURE:

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

Graph:

The following graph has to be drawn

(1) Temperature Vs Redwood seconds
(2)Temperature Vs Kinematic Viscosity
(3)Temperature Vs Dynamic Viscosity

Space For Calculations

RESULT & CONCLUSIONS:

The kinematic and dynamic viscosity of given oil at different temperatures were determined and graphs were drawn.

VIVA QUESTIONS:

- How to measure viscosity ?
- Difference between Dynamic and Kinematic Viscosity
- What is the effect of temperature on viscosity ?
- Define S.I units of Viscosity
- Explain the working principal of redwood viscometer ?
- What do mean by cohesive force ?
- Define Newton's Law of Viscosity

EXPERIMENT - 02

PENSKY MARTEN'S FLASH AND FIRE POINT APPARATUS

AIM:

To determine the flash and fire point of given fuel oil by using Pensky Marten's flash and fire point apparatus.

APPARATUS:

Pensky Marten's flash and fire point apparatus, thermometer of suitable range.

THEORY:

The temperature at which oil gives off inflammable vapor is on the greatest importance in the case petroleum products & lubricating oils. If these oils are sufficiently volatile at ordinary temperatures, the issuing vapors will form an explosive mixture with air and cause fire hazards to ensure safety and to avoid this risk certain minimum temperatures are laid down for burning and lubricating oils below which it should not give off inflammable vapors. Flash point and fire point give these values of temperature.

PROCEDURE:

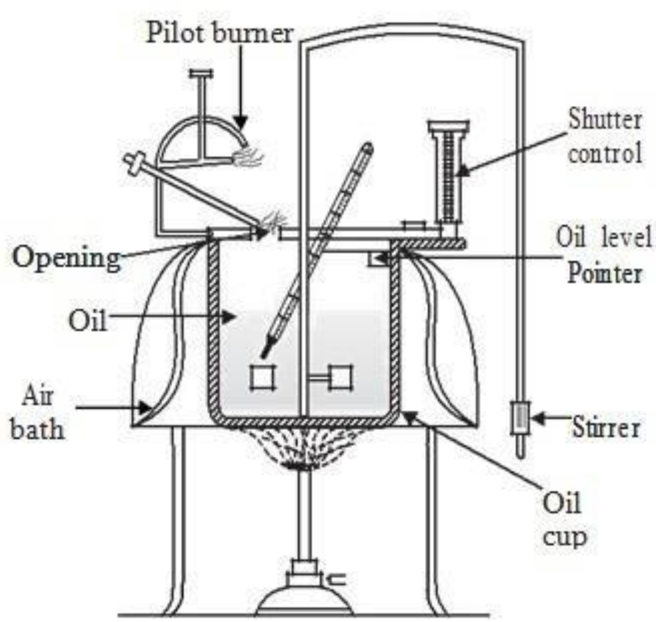
1. Install the apparatus on a table near a 230V, 50Hz, 5amps single-phase power source. Keep the electrical heater on the table with an asbestos sheet under it. Position the CI cup holder (air bath) on the heater. Insert the oil cup into the bath and position it.
2. Pour the oil to be tested up to the mark into the oil cup.
3. Close the lid.
4. Connect the heater to the electrical power source and heat the oil at a slow steady rate of 1^0 to 2^0C /min with the help of the regulator. Keep stirring the oil with the stirring mechanism.
5. Maintain a small flame on the wick.
6. Introduce the flame to the oil surface by operating the circular handle, which makes the maintained flame to dip into the oil cup by opening the shutter. This is done at every half minute, only after the sample oil reaches around 15^0 C to 17 ^{0}C or before the expected flash point. (Flash point is different for different oils)
7. Record the temperature at which first flash occurs and report as flash point of the sample oil.
8. To stop the experiment, switch of the heater and allow it to cool.

Observation:

Type of oil used:

Tabular Column:

S.No	Oil temperature in ^{0}C	Observations (Yes or No)	
		Flash point	Fire point
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			



Pensky Martens Flash and Fire Point

RESULT & CONCLUSIONS:

1. Flash Point of given oil = ------- ^{0}C
2. Fire Point of given oil = ------- ^{0}C

VIVA QUESTIONS:

- What is the objective of the experiment ?
- Difference between flash and fire point
- at what temperature flash and fire point occurs in petrol and diesel
- Working principal diesel engine ?
- Working principal diesel engine ?

EXPERIMENT - 03

VALVE TIMING DIAGRAM OF FOUR STROKE DIESEL ENGINE

AIM:

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

APPARATUS:

1. Four stroke cycle diesel engine

THEORY:

The diagram which shows the position of crank of four stroke cycle engine at the beginning and at the end of suction, compression, expansion, and exhaust of the engine are called as Valve Timing Diagram.

The extreme position of the bottom of the cylinder is called “Bottom Dead Centre” [BDC].IN the case of horizontal engine, this is known as “Outer Dead Centre” [ODC]. The position of the piston at the top of the cylinder is called “Top Dead Centre” [TDC].In case of horizontal engine this is known as “Inner Dead Centre” [TDC].In case of horizontal engine this is known as “inner dead centre”[IDC]

Inlet Valve opening and closing:

In an actual engine, the inlet valve begins to open 5°C to 20 °C before the piston reaches the TDC during the end of exhaust stroke. This is necessary to ensure that the valve will be fully open when the piston reaches the TDC. If the inlet valve is allowed to close at BDC, the cylinder would receive less amount of air than its capacity and the pressure at the end of suction will be below the atmospheric pressure. To avoid this, the inlet valve is kept open for 25° to 40°after BDC.

Exhaust valve opening and closing

Complete clearing of the burned gases from the cylinder is necessary to take in more air into the cylinder. To achieve this, the exhaust valve is opens at 35° to 45° before BDC and closes at 10° to 20° after the TCC. It is clear from the diagram, for certain period both inlet valve and exhaust valve remains in open condition. The crank angles for which the both valves are open are called as overlapping period. This overlapping in diesel engine is more than the petrol engine.

Fuel valve opening and closing:

The fuel valve opens at 10° to 15 °before TDC and closes at 15° to 20 ° after TDC. This is because better evaporation and mixing fuel.

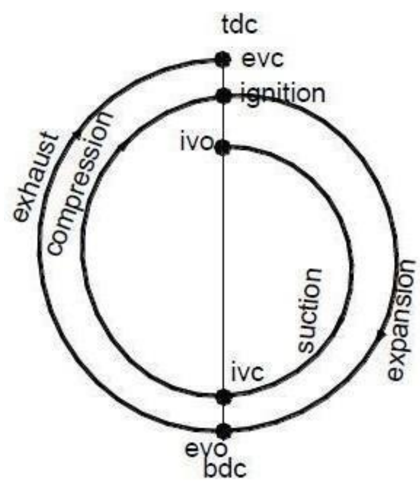
Tabular Column:

EVENT	Piston of crank w.r.t to BDC or TDC	Distance from their respective dead centers in "cm"	Angle in degrees
Inlet valve opens	before TDC		
Inlet valve closes	after BDC		
Exhaust valve opens	before BDC		
Exhaust valve closes	after TDC		
Fuel injection begin	before TDC		
Fuel injection close	after TDC		

Circumference of the fly wheel = X cm = 360^0

Then 1cm = $\frac{360}{x}$ degree

Theoretical Valve Timing Diagram:



PROCEDURE:

1. Remove the cylinder head cover and identify the inlet valve, exhaust valve and piston of particular cylinder.
2. Mark the BDC and TDC position of flywheel

   This is done by rotating the crank in usual direction of rotation and observe the position of the fly wheel, when the piston is moving downwards at which the piston begins to move in opposite direction. i.e. from down to upward direction . Make the mark on the flywheel with reference to fixed point on the body of the engine. That point is the BDC for that cylinder .Measure the circumference. That point is TDC and is diametrically opposite to the BDC.
3. Insert the paper in the tappet clearance of both inlet and exhaust valves
4. Slowly rotate the crank until the paper in the tappet clearance of inlet valve is gripped .make the mark on fly wheel against fixed reference. This position represent the inlet valve open (IVO). Measure the distance from TDC and tabulate the distance.
5. Rotate the crank further, till the paper is just free to move. Make the marking on the flywheel against the fixed reference. This position represents the inlet valve close (IVC). Measure the distance from BDC and tabulate the distance.
6. Rotate the crank further, till the paper in the tappet clearance of exhaust valve is gripped. Make the marking on the flywheel against fixed reference. This position represents the exhaust valve open (EVO). Measure the distance from BDC and tabulate.
7. Then convert the measured distances into angle in degrees.

Space For Calculations

RESULT & CONCLUSIONS:

The valve timing diagram for the given four stroke Diesel engine was drawn.

VIVA QUESTIONS:

- How the valves are different from ports?
- What are the advantages of four stroke engines over two stroke engines?
- Why four stroke engines are more fuel efficient than two stroke engines?
- Explain the lubrication system of four stroke engines.
- What do you mean by valve overlap? What are their effects in SI engines?
- How the cylinder numbers assigned in multi-cylinder I.C. engines?
- Give firing order for a four and six cylinder engines.
- Explain how the correct direction of rotation is found before starting the valve timing experiment.
- How do you identify an engine is working on two stroke or four stroke principle?
- How do you identify whether it is petrol or diesel engine?

EXPERIMENT - 04

VALVE TIMING DIAGRAM OF FOUR STROKE PETROL ENGINE

AIM:

To draw valve timing diagram of a petrol engine and study of its impact on the performance of an IC engine.

APPARATUS:

Four stroke cycle petrol engine.

THEORY:

A valve timing diagram is a representation of the positions of the crank when the various operations as inlet valve opening, closing, exhaust valve opening and closing and also the beginning and end of various strokes.

The extreme position of the bottom of the cylinder is called “Bottom Dead Centre” [BDC]. The position of the piston at the top of the cylinder is called “Top Dead Centre” [TDC].

Theoretically it may be assumed that the valves open and close and the spark occurs at the engine dead centers. However, in actual operation, the valves do not operate at dead center positions but operate some degree on either side of the dead centers. The opening occurs earlier and the exhaust continues even at later crank angles. The ignition is also timed to occur in advance of the completion of compression stroke.

The timing of these events, referred in terms of crank angles from dead center positions, is represented on a valve timing diagram. The correct timings are of fundamental importance for the efficient and successful running of the I.C. engine.

Inlet Valve opening and closing:

In an actual engine, the inlet valve begins to open 5°C to 20°C before the piston reaches the TDC during the end of exhaust stroke. This is necessary to ensure that the valve will be fully open when the piston reaches the TDC. If the inlet valve is allowed to close at BDC, the cylinder would receive less amount of air than its capacity and the pressure at the end of suction will be below the atmospheric pressure. To avoid this, the inlet valve is kept open for 25° to 40°after BDC.

Ignition:

The TDC would be proper time to produce spark if the charge could burn instantaneously. However, there is lag between the timing of spark and that of actual ignition. For best result with regard to power and economy, and to avoid explosion knock, the ignition of charge is timed to occur as early as the engine permits. At higher speeds the ignition timing is called ignition advance.

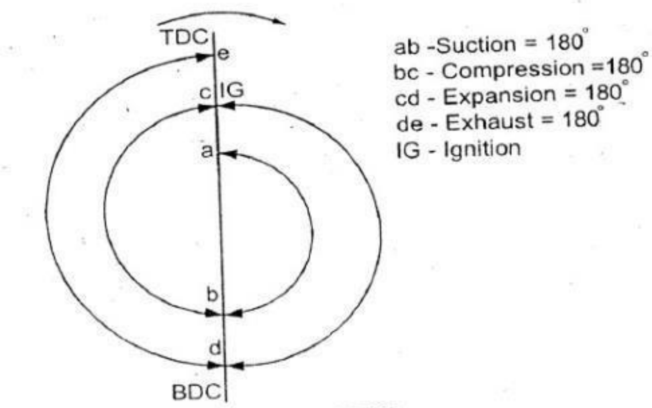
With too early ignition, the complete ignition may occur before the piston reaches the TDC and this may cause back explosion. The back explosion will cause the engine to run in the reversed direction of rotation.

The injection of fuel is timed to occur about 10-15^{0}C before TDC. So that by the time the piston reaches TDC the actual combustion of fuel starts.

Exhaust valve opening and closing:

Complete clearing of the burned gases from the cylinder is necessary to take in more air into the cylinder. To achieve this, exhaust valve is opens at 35° to 45° before BDC and closes at 10° to 20° after the TDC. It is clear from the diagram, for certain period both inlet valve and exhaust valve remains in open condition. The crank angles for which the both valves are open are called as overlapping period.

Theoretical Valve Timing Diagram:



Tabular Column:

EVENT	Piston of crank w.r.t to BDC or TDC	Distance from their respective dead centers in "cm"	Angle in degrees
Inlet valve opens	before TDC		
Inlet valve closes	after BDC		
Exhaust valve opens	before BDC		
Exhaust valve closes	after TDC		
Fuel injection begin	before TDC		
Fuel injection close	after TDC		

Circumference of the fly wheel = X cm = 360^0

Then 1cm = $\frac{360}{X}$ degree

PROCEDURE:

1. Remove the cylinder head cover and identify the inlet valve, exhaust valve and piston of particular cylinder
2. Mark the BDC and TDC position of flywheel. This is done by rotating the crank in usual direction of rotation and observe the position of the fly wheel, when the piston is moving downwards at which the piston begins to move in opposite direction. i.e. from down to upward direction . Make the mark on the flywheel with reference to fixed point on the body of the engine. That point is the BDC for that cylinder Measure the circumference. That point is TDC and is diametrically opposite to the BDC.
3. Insert the paper in the tappet clearance of both inlet and exhaust valves.
4. Slowly rotate the crank until the paper in the tappet clearance of inlet valve is gripped. make the mark on fly wheel against fixed reference. This position represent the inlet valve open (IVO). Measure the distance from TDC and tabulate the distance.
5. Rotate the crank further, till the paper is just free to move. Make the marking on the flywheel against the fixed reference. This position represents the inlet valve close (IVC). Measure the distance from BDC and tabulate the distance.
6. Rotate the crank further, till the paper in the tappet clearance of exhaust valve is gripped. Make the marking on the flywheel against fixed reference. This position represents the exhaust valve open (EVO). Measure the distance from BDC and tabulate.
7. Then convert the measured distances into angle in degrees.

Space For Calculations

RESULT & CONCLUSIONS:

The valve timing diagram for the given four stroke Petrol engine was drawn.

VIVA QUESTIONS:

- How the valves are different from ports?
- What are the advantages of four stroke engines over two stroke engines?
- Why four stroke engines are more fuel efficient than two stroke engines?
- Explain the lubrication system of four stroke engines.
- What do you mean by valve overlap? What are their effects in SI engines?
- How the cylinder numbers assigned in multi-cylinder I.C. engines?
- Give firing order for a four and six cylinder engines.
- Explain how the correct direction of rotation is found before starting the valve timing experiment.
- How do you identify an engine is working on two stroke or four stroke principle?
- How do you identify whether it is petrol or diesel engine?

EXPERIMENT - 05

SINGLE ACTING MULTI STAGE RECIPROCATING AIR COMPRESSOR

AIM:

To study the working of double stage air compressor and determination of volumetric efficiency, mechanical efficiency and isothermal efficiency.

THEORY:

When the motor is started, air is sucked from the atmosphere through the inlet air filter and orifice meter and compressed in the LP Cylinder. The hot and compressed air is cooled in the intercooler and again compressed in the HP Cylinder Finally, high pressure air passes into air receiver tank through after collar and non-return valve.

The compressor motor unit consists of a AC motor. The AC motor body frame is mounted on trunnion bearing which swivels on application of load/torque on the motor. The torque/load developed is measured at the torque arm of 0.2m using a spring balance. The encoders (speed pick-ups) are provided for both motor and compressor shafts for measurement of RPM. A toggle switch and digital RPM indicator are provided in the control panel

The control console consists of digital speed indicator, temperature indicator, double column manometer for air flow measurement, pressure gauges for pressure rise measurement after each stage separately, energy meter to measure electrical input to the motor. The necessary mains ON indicators and switches are provided for completeness of the instrumentation.

The complete unit is built-in. Foundation is not necessary for installation of the test rig. The pressure tapings and temperature sensors after each stage are connected to pressure gauges and indicators in the control panel. Air volume measuring chamber with orifice of 15mm diameter is fixed beneath the control console and tapings connected to double column manometer for air intake measurements.

PROCEDURE:

1. Release the pressure of air fully from tank, if previously pressurized.
2. Check zero level in the double column.
3. Switch –ON the mains and observe the light indicators ON.
4. Keep the outlet valve closed.
5. Switch-ON the starter and allow motor to run full speed.
6. As the pressure in the receiver tank increases, set the pressure by obtaining the delivery valve to 1,2,3 Kg/ cm2 as observed from the pressure gauge and note the readings.
7. Note down the flow rate manometer readings at different pressures.
8. Note down pressure after LP cylinder, after HP cylinder, temperatures after LP cylinder, after inter cooler, after HP cylinder and at the inlet.
9. Note down the energy meter reading, speed and air temperature.
10. Tabulate the above readings as shown.
11. Stop the compressor and release the pressure from the tank after the experiment is completed.

Observations:

T1= Air inlet temperature
T2= After first stage
T3=After inter cooler
T4=After second Stage

E.M Constant=150 Rev/ KWH
Orifice Dia=15mm
Torque arm=0.2m

Tabular Column:

S.NO	P1(LP) Pressure after first stage in ‘kg/cm^2’	P2(HP) Pressure after second stage in ‘kg/cm^2’	'n' Energy meter no. of ‘rev/sec’	Air flow across orifice in ‘mm of H2O’		Speed of compressor in ‘RPM’	Temperature points (°C)			
				H1	H2		T1	T2	T3	T4

Calculations:

1. Density of air at 30°C (ρ_a) = 1.293Kg/m^3
2. Density of water (ρ_w) =1000Kg/m^3
3. Acceleration due to gravity (g) =9.81m/sec^2
4. Orifice diameter = 0.015m
5. Co-efficient of discharge of orifice = 0.64
6. Torque arm distance (r) =0.2m
7. Compressor input = Moto input X 0.95 X0.8…KW
8. Electrical input to motor I P $= \dfrac{n}{K} \times \dfrac{3600}{t}$ KW

   Time for 'n' number of rev. = t sec.

   Where 0.80 is efficiency of motor

   0.95 if efficiency of belt

   K = Energy meter constant = 200 revolutions/kW – hr
9. Compressor output (brake power BP)= $\dfrac{\rho_a g\, Q\, H}{1000}$ KW

   Where ,ρ_a= 1.293 Kg/m^3
10. H = (P/W_a) x 10^5

    Where $W_a = \rho_a g$

    Head is in meters of air and P is read on after HP cylinder pressure Kg/cm^2
11. Q (flow rate) = C_d A $\sqrt{(2\, g\, H_a)}$m^3/sec
12. A = area of orifice = (πd^2)/4m^2

    Where, d = diameter of orifice = 0.015m
13. $H_a = \dfrac{h_w}{1000} \times \dfrac{\rho_w}{\rho_a} - 1$

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

    ρ_a = density of air = 1.293 Kg/m^3

    Therefore H_a = 0.772 h_w
14. Q = 0.64 x A $\sqrt{(2 \times 9.81 \times 0.772 h_w)}$ m^3/s

    Where h_w = head measured in 'mm' of water across orifice plate
15. $\%\eta_{comp}$(mechanical)= $\dfrac{\text{Compressor output (BP)}}{\text{Input power (IP)}}$ 100
16. Swept volume of piston (LP) = area of piston x stroke
17. $V_{s1} = \pi(0.07)^2 / 4 \times 0.085 = 3.2711 \times 10^{-4}$m^3
18. Swept volume of piston (HP) = area of piston x stroke

19. $V_{s2} = \pi(0.05)^2 / 4 \times 0.085 = 1.6689\times10^{-4}\ m^3$

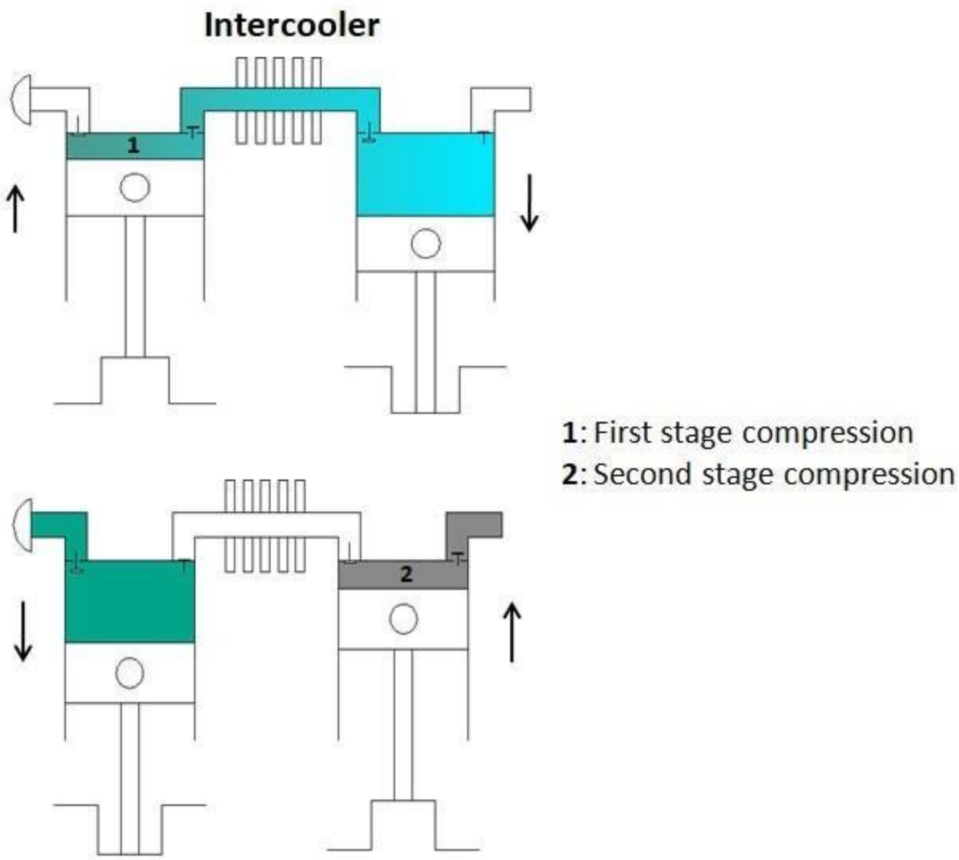
Therefore, $V_s = V_{s1} + V_{s2} = 4.9399\times10^{-4}\ m^3$

20. Actual air swept,

$$V_a = \frac{Q \times 60}{\text{RPM of compressor}}\ m^3/sec$$

21. % volumetric efficiency= $\eta_v = \frac{V_a}{V_s} 100$

22. Isothermal efficiency= $\frac{\text{Compressor output}}{\text{Compressor input}}$ 100



RECIPROCATING AIR COMPRESSOR

Tabular Column:

S.No	Electrical input power in 'kw'	Discharge Q 'm^3 / sec'	H in 'meters of air'	Compressor o/p in 'kw'	Theoretical swept volume (V_s) in 'm^3'	Actual swept volume (V_a) in 'm^3'	η_{mech}	η_{vol}	η_{iso}

Space For Calculations

RESULT & CONCLUSIONS:

The volumetric efficiency of compressor found to be ……..
The mechanical efficiency of compressor found to be ……
The isothermal efficiency of compressor found to be ……..

VIVA QUESTIONS:

- Explain working principal of compressor ?
- What is the use of Inter Cooler in air compressor ?
- Difference between engine and compressor
- Define Isothermal efficiency ?
- Define Volumetric efficiency ?
- Difference between swept volume and actual volume?

EXPERIMENT - 06

PORT TIMING DIAGRAM OF TWO STROKE PETROL ENGINE

AIM:

To draw port timing diagram of 2-stroke petrol engine.

APPARATUS:

Two stroke petrol engine.

THEORY:

In this cycle suction, compression, expansion and exhaust take place during two stroke of the piston. It means that there is on working stroke/ power stroke for every revolution of crank shaft. A two stroke engine has port instead of valves.

During downward motion of the piston from TDC, Exhaust port opens first and then the transfer port or inlet port opens. During the upward motion of the piston from BDC, the transfer port(inlet port) closes first and the exhaust port closes.

PROCEDURE:

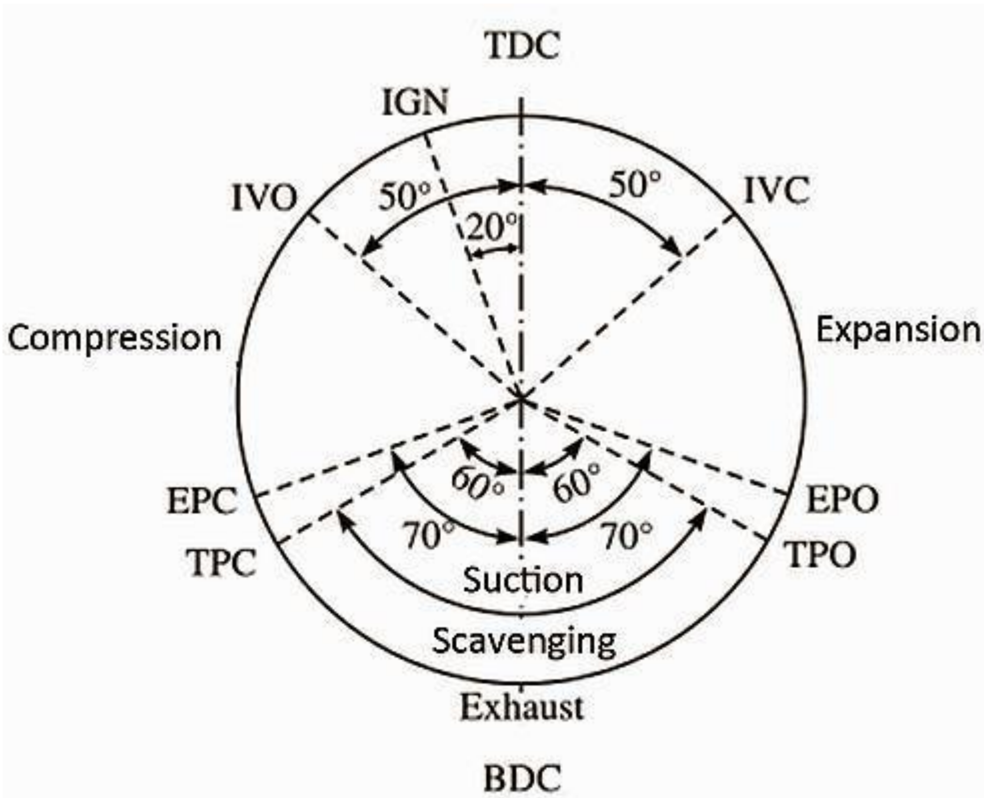
1. Observe the port opening during the movement of the piston by manually moving.
2. Note down the corresponding crank angles at the time of openings and closing of the ports.
3. Draw the port timing diagram.

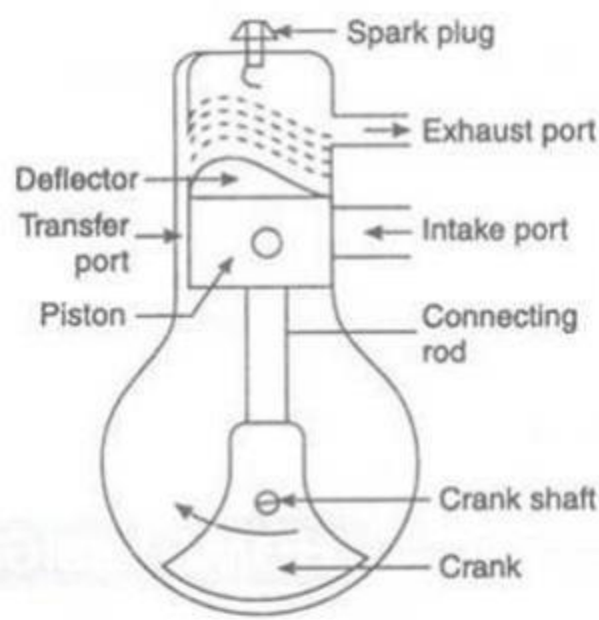
***Tabular Column**:*

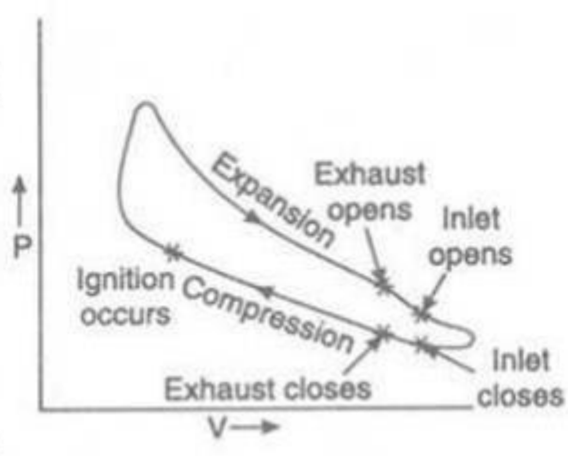
EVENT	Piston of crank w.r.t to BDC or TDC	Distance from their respective dead centers in "cm"	Angle in degrees
Inlet port opens	before TDC		
Inlet port closes	after TDC		
Exhaust port opens	before BDC		
Exhaust port closes	after TDC		
Transfer port open	before BDC		
Transfer port close	after BDC		

Circumference of the fly wheel = X cm = 360^0

Then 1cm = $\frac{360}{X}$ degree







Indicator diagram for 2-stroke engine

Space For Calculations

RESULT & CONCLUSIONS:

The port timing diagram for the given two stroke Petrol engine was drawn.

VIVA QUESTIONS:

- How the valves are different from ports?
- What are the advantages of four stroke engines over two stroke engines?
- Difference between two stroke and four stroke engine
- Why diesel bikes are not available ?
- What is the use of transfer port in two stroke engine ?

EXPERIMENT - 07

FOUR STROKE SINGLE CYLINDER DIESEL ENGINE TEST RIG

AIM:

To conduct performance test on 4-stroke diesel engine and to draw the following graphs

1. B.P vs. S.F.C.
2. Mechanical efficiency vs. B.P.
3. B.P vs. Indicated thermal efficiency.
4. B.P. vs. Brake thermal efficiency.
5. Air fuel Ratio vs. B.P.
6. Air fuel ratio vs. S.F.C.

APPARATUS:

The test rig consists of 4-stroke diesel engine, to be tested for performance, is connected to rope brake dynamometer with exhaust calorimeter. The arrangement is made for the following measurements of the set-up.

1. The rate of fuel consumption is measured by using the pipette reading against the known time.
2. Air flow is measured by the manometer connected to air box.
3. The different mechanical loading is achieved b by operating the spring balance mounted on the brake drum of the dynamometer.
4. Engine speed (RPM) is measured by electronic digital RPM indicator.
5. Temperature at different points is measured by electrical digital temperature indicator.
6. The force develop is measured by spring balance on the brake drum.
7. Water flow rate through engine and calorimeter is measured by water meter.

THEORY:

A four stroke diesel (CI) engine works on the diesel cycle. The four strokes used in proper sequence are suction, compression, expansion (power stroke) and exhaust. During the suction stroke, air alone is inducted. Due to high compression ratio, the temperature of air at the end of compression stroke is sufficient to ignite the fuel which is injected into the combustion chamber. In the C.I. engine a high pressure fuel pump and an injector are provided to inject fuel into combustion chamber at the correct time. Fuel is injected up to the beginning of the expansion stroke. After the fuel is burnt the products of combustion expand when both valves remain closed. Later the exhaust valve is open and intake valve remains closed in the exhaust stroke. Due to the development of high pressures in the diesel (CI) engine, the size of the engine is heavier than that of petrol (SI) engine and it has high thermal efficiency due to greater expansion and high compression ratio. C.I. engines are mainly used for heavy transport vehicles, power generation, industrial and marine applications. Performance test is conducted in order to verify the performance claimed by the engine manufacturer

PROCEDURE:

1. Check the diesel in the diesel tank.
2. Allow diesel, start the engine by using hand cranking.
3. The engine is set to the speed of 1500 RPM.
4. Apply load from the mechanical dynamometer by operating the hand wheel on the spring balance of the brake drum I steps.
5. Allow some time so that the speed stabilizes.
6. Now take down spring balance readings.
7. Put tank valve into pipette position and note down the time taken for particular quantity of fuel consumed by the engine.
8. Repeat the procedure (4) to (7) for different loads.
9. Tabulate the readings as shown.

Formulae:

1. Fuel Consumption in kg/min

$$m_f = \frac{10}{t} \times \frac{\text{specific gravity of diesel}}{1000} \times 60 \text{ ……kg/min}$$

Time for 10cc of fuel consumption(t)=............ Sec,
Specific gravity of Diesel fuel = 0.8275.

2. Total fuel consumption (TFC) in kg/hr

$TFC = m_f \times 60$……kg/hr

3. Air consumption in kg/min

Manometer reading(h_1)= ....cm of water
Manometer reading(h_2) =.............. cm of water

$$\text{Difference in water level } (h_w) = \frac{h_1 - h_2}{100} = \text{ ………m of water}$$

Equivalent air column (h_a) = h_w x $\frac{\text{density of water}}{\text{density of air}}$ ……m

Where, Density of water (ρ_w) = 1000kg/m^3

Density of air (ρ_a) = 1.29kg/m^3

Theoretical Volume of air intake (V_a) = 60 x C_d x A_o x $\sqrt{2gh_a}$….. m^3/min

Where C_d = 0.62

A_o = area of orifice in 'm'

= $\pi d^2/4$

'd'= dia. of orifice = 20mm

Mass of air intake (m_a) = ρ_a x V_a …….kg/min

4. Air fuel ratio

A/F = m_a/m_f

5. Useful Heat (or) Brake power(B.P)

$$BP = \frac{2\,\pi\,N\,T}{60\ x1000}\ ……\ kW$$

T = 9.81(W_1 – W_2) x R_m

Where,

N = Engine speed, rpm

T = Torque, N-m

W_1 = Load on the brake drum, kg

W_2 = spring balance reading, kg

R_m = Mean radius of the brake drum (m) = 0.19m

6. Specific Fuel Consumption(SFC)

SFC= TFC/ BP ….. Kg/kw hr

7. Heat Input the Engine

Heat Input = (TFC x Lower CV) / 3600 …. kW

Where, TFC is in Kg/hr

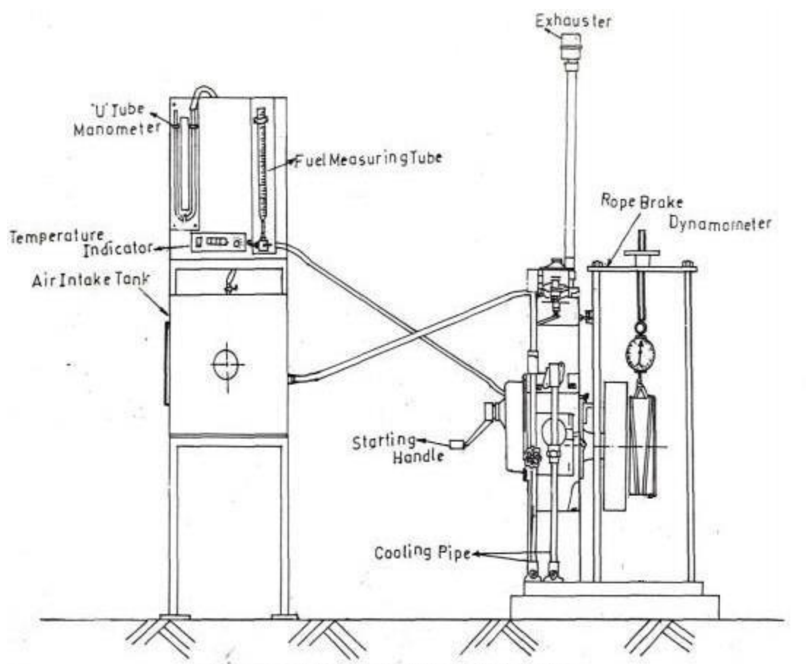
CV=43,000KJ/kg (calorific value of diesel)

8. Brake Thermal Efficiency

$$\eta_{B.Th} = \frac{\text{Useful Heat or BP}}{\text{Heat Input to the Engine}} \text{ X } 100$$

9. Mechanical Efficiency

$$\eta_{Mech} = \frac{\text{Brake Power (BP)}}{\text{Indicated Power (IP)}} \times 100$$

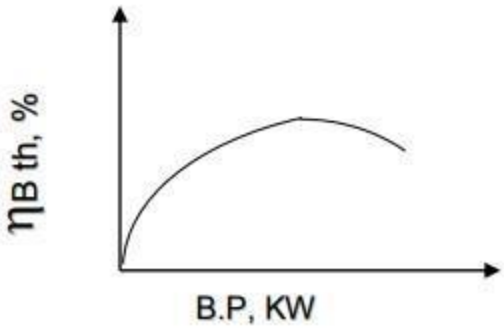


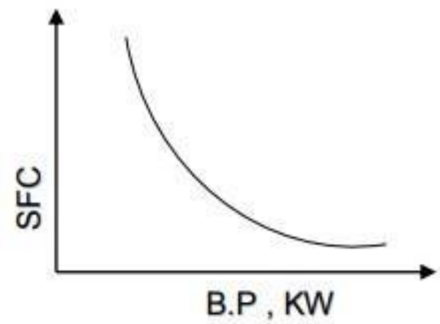
SINGLE CYLINDER DIESEL ENGINE WITH MECHANICAL DYNAMOMETER TEST RIG

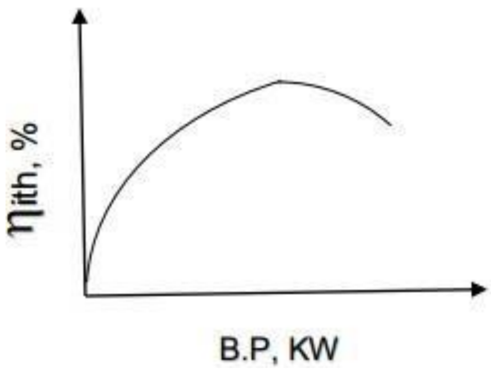
Tabular Column:

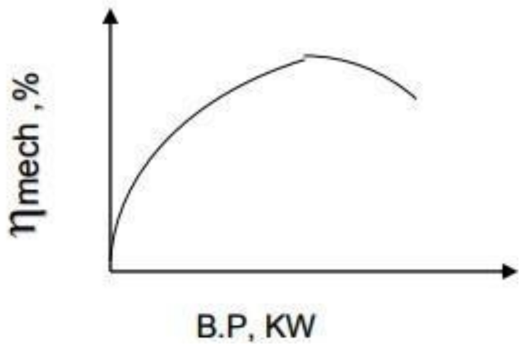
S.NO	Spring balance Force in Kgs		Engine speed in 'RPM'	Fuel Consumption for '10cc' in Sec	Air flow Reading in 'cm of Water'	
	W_1	W_2			h_1	h_2
1.						
2.						
3.						
4.						
5.						

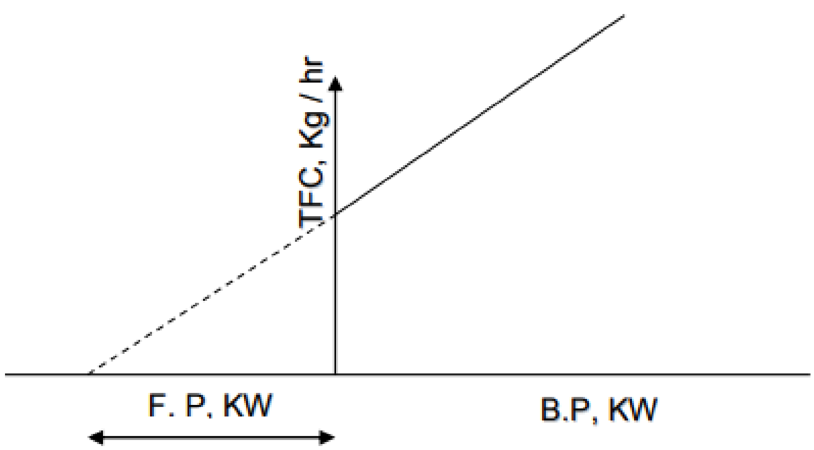
Model Graphs:











Space For Calculations

RESULT & CONCLUSIONS:

The mechanical efficiency of engine found to be ……
The break thermal efficiency of engine found to be ……..

VIVA QUESTIONS:

- What are the 4strokes of CI engines?
- What is the working cycle of CI Engine?
- List out the performance parameters?
- Indicate the different types of loads?
- Differentiate SFC and TFC?
- Concept of mass flow rate of air?
- Differentiate brake power and indicated power?
- Define brake thermal efficiency?
- Indicate mechanical efficiency in terms of BP and IP?

EXPERIMENT - 08

HEAT BALANCE SHEET FOR SINGLE CYLINDER DIESEL ENGINE TEST RIG

AIM:

To conduct heat balance test on 4-stroke diesel engine.

APPARATUS:

The test rig consists of 4-stroke diesel engine, to be tested for performance, is connected to rope brake dynamometer with exhaust calorimeter. The arrangement is made for the following measurements of the set-up.

1. The rate of fuel consumption is measured b using the manometer connected to air box.
2. Air floe is measured by the manometer connected to air box.
3. The different mechanical loading is achieved b by operating the spring balance mounted on the brake drum of the dynamometer.
4. Engine speed (RPM) is measured by electronic digital RPM indicator.
5. Temperature at different points is measured by electrical digital temperature indicator.
6. The force develop is measured by spring balance on the brake drum.
7. Water flow rate through engine and calorimeter is measured by water meter.

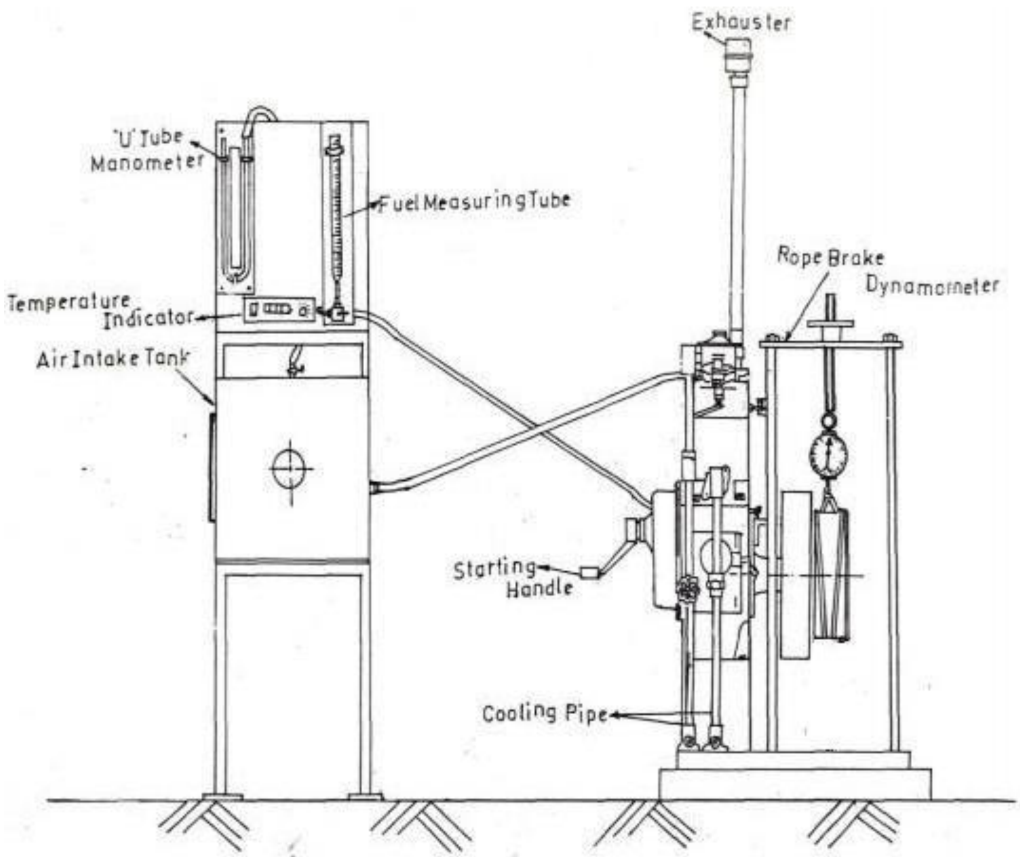
THEORY:

A four stroke diesel (CI) engine works on the diesel cycle. The four strokes used in proper sequence are suction, compression, expansion (power stroke) and exhaust. During the suction stroke, air alone is inducted. Due to high compression ratio, the temperature of air at the end of compression stroke is sufficient to ignite the fuel which is injected into the combustion chamber. In the C.I. engine a high pressure fuel pump and an injector are provided to inject fuel into combustion chamber at the correct time. Fuel is injected up to the beginning of the expansion stroke. After the fuel is burnt the products of combustion expand when both valves remain closed. Later the exhaust valve is open and intake valve remains closed in the exhaust stroke. Due to the development of high pressures in the diesel (CI) engine, the size of the engine is heavier than that of petrol (SI) engine and it has high thermal efficiency due to greater expansion and high compression ratio. C.I. engines are mainly used for heavy transport vehicles, power generation, industrial and marine applications. Performance test is conducted in order to verify the performance claimed by the engine manufacturer

PROCEDURE:

1. Check the diesel in the diesel tank.
2. Allow diesel, start the engine by using hand cranking.
3. The engine is set to the speed of 1500RPM.
4. Apply load from the mechanical dynamometer by operating the hand wheel on the spring balance of the brake drum I steps.
5. Allow some time so that the speed stabilizes.

6. Now take down spring balance readings.
7. Put tank valve into pipette position and note down the time taken for particular quantity of fuel consumed by the engine.
8. Note sown the water meter and temperature readings at different points.
9. Tabulate the readings as shown.



SINGLE CYLINDER DIESEL ENGINE WITH MECHANICAL DYNAMOMETER TEST RIG

Temperature Points:

1. Air inlet.
2. Engine head water inlet.
3. Engine head water outlet/ inlet to exhaust gas calorimeter.
4. Exhaust gas calorimeter outlet.
5. Exhaust gas inlet.
6. Exhaust gas outlet.

Formulae:

1. *Fuel Consumption in kg/min*

$$m_a = \frac{10}{t} \times \frac{\text{sp. gravity of diesel}}{1000} \times 60 \text{ ……kg/min}$$

Time for 10cc of fuel consumption(t) =........... Sec,
Specific gravity of Diesel fuel = 0.8275.

2. *Air consumption in kg/min*

Manometer reading(h_1) =…..........cm of water
Manometer reading(h_2) =… ....cm of water

Difference in water level (h_w) = $\frac{h_1 - h_2}{100}$ =...........m of water

Equivalent air column (h_a) = $h_w \times \frac{\text{Density of water}}{\text{Density of air}}$……m

Where, Density of water (ρ_w) = 1000kg/m^3

Density of air (ρ_a) = 1.29kg/m^3

Theoretical Volume of air intake (V_a) = 60 x C_d x A_o x $\sqrt{2 g h_a}$….. m^3/min
Where C_d = 0.62
A_o = area of orifice in ‘m’
= $\pi d^2/4$
‘d’= dia. of orifice = 20mm

Mass of air intake (m_a) = ρ_a x V_a ……kg/min

3. *Heat supplied in fuel (HI)* = fuel consumed in Kg/hr x CV ------------H
Where, CV= 43,000KJ/kg (calorific value of diesel)

4. *Heat carries away by engine head cooling* = m_w x $C_{pw}(T_3-T_2)$-------------h_1
Where, m_w= mass flow rate of water in LPM,
C_{pw} = specific heat of water = 4.187 kJ/kg ^{0}K

5. *Heat carries away by exhaust gas calorimeter water =* m_w x $C_{pw}(T_5-T_4)$ ------------ h_2
Where, m_w= mass flow rate of water in LPM,
C_{pw} = specific heat of water = 4.187 kJ/kg ^{0}K

6. ***Heat carries away by exhaust gases =*** $m_g \times C_{pg} (T_6 - T_1)$ ------------- h_3

Where, m_g= mass of air + mass of fuel consumed,

C_{pg} = specific heat of gas = 1.005Kj/kg ^{0}K

7. ***Heat equivalent of Brake Power (BP)***= $\frac{2 \pi N T}{60 \times 1000}$ ……..kj/sec

$T = 9.81(W_1 - W_2) \times R_m$

Where,

N = Engine speed, rpm

T = Torque, N-m

W_1 = Load on the brake drum, kg

W_2 = spring balance reading, kg

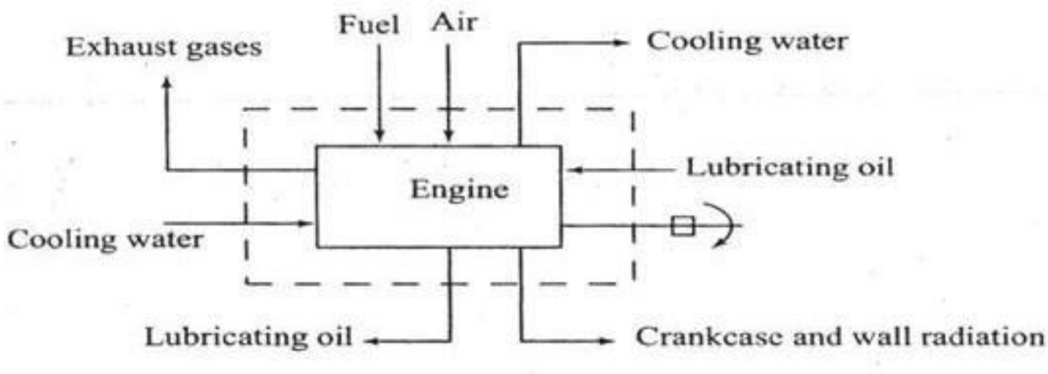
R_m = Mean radius of the brake drum (m) = 0.19m

Heat equivalent of Brake Power (kj/min) = B.Px60....Kj/min------------- h_4

8. ***Radiation and unaccounted*** -------------- h_5

$h_5 = H - (h_1 + h_2 + h_3 + h_4)$

Heat supplied 'H' = $h_1 + h_2 + h_3 + h_4 + h_5$



External Heat Balance

Tabular column:

S.NO	Spring balance Force in Kgs		Engine speed in 'RPM'	Water meter Reading Time in Sec for '1 Lit'	Fuel Consumption for '10cc' in Sec	Air flow Reading in 'cm of Water'		Temperature (^0C)						
								Air inlet	Engine water inlet	Engine water outlet	Calorimeter inlet	Calorimeter outlet	Exhaust gas inlet	Exhaust gas outlet
	W_1	W_2				h_1	h_2	T_1	T_2	T_3	T_4	T_5	T_6	T_7

HEAT BALANCE SHEET ON MINUTE BASIS:

Heat Supplied	kJ/min	%	Heat distributed	kJ/ min	%
Heat supplied by the fuel	A=	100	Heat in B.P	B=	B/ A=
			Heat carried by engine Cooling water	C=	C/ A=
			Heat Carried by exhaust gases	D=	D/ A=
			Unaccounted losses (radiation, friction, etc.,)	E=	E/ A=
Total	A=	100		A=	100

Space For Calculations

RESULT & CONCLUSIONS:

Heat Supplied by the fuel............. kg/min

VIVA QUESTIONS:

- What are the 4-strokes of CI engines?
- What is the working cycle of CI Engine?
- List out the performance parameters?
- Indicate the different types of loads?
- Differentiate SFC and TFC?
- Concept of mass flow rate of air?
- Differentiate brake power and indicated power?
- Define brake thermal efficiency?
- Indicate mechanical efficiency in terms of BP and IP?

EXPERIMENT - 09

TWO STROKE SINGLE CYLINDER PETROL ENGINE TEST RIG

AIM:

To conduct performance test on single cylinder 2-stroke petrol engine and to draw the following graphs.

1. B.P vs. S.F.C.
2. B.P. vs. Brake thermal efficiency.
3. Air fuel Ratio vs. B.P.
4. Air fuel ratio vs. S.F.C.

APPARATUS:

The test rig consists of 2-stroke petrol engine, to be tested for performance, is connected to AC alternator the arrangement made for the following measurement of the set-up:

1. The rate of fuel consumption is measured by using the pipette reading against the known time.
2. Air flow is measured by the manometer connected to air box.
3. The different electrical loading is achieved by operating electrical loading pictures.
4. Engine speed (RPM) is measured by electronic digital RPM indicator.
5. Temperature at different points is measured by electrical digital temperature indicator.

The whole instrument is mounted on a self contained unit ready for table operation.

THEORY:

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

Reciprocating engines are commonly used ones, further divided into diesel, petrol, paraffin, kerosene, gas driven once. The engine which is of our present concern falls into the category of spark ignition prime mover which produce max power for minimum range as compared other reciprocating prime movers.

PROCEDURE:

1. Check the petrol level in the petrol tank.
2. Allow petrol to start the engine by using kick start.
3. The engine is set to the speed of say 650rpm, by operating the throttle/ speed control knob.
4. Apply load by operating the electrical loading switches of the alternator in step and set the speed of the engine by operating the speed controller for every load.
5. Allow some time so that the speed stabilizes.
6. Now, take down the voltmeter and ammeter readings.
7. Put tank valve into pipette position and note down the time taken for particular quantity of fuel consumed by the engine.
8. Note down the temperature and air flow reading(manometer)
9. Repeat the procedure (4) to (8) for different loads.
10. Tabulate the readings as shown in the enclosed list.

11. After the experiment is over switch of all electrical switches, reduce the accelerator and keep the petrol control valve in closed position and switch off the engine using ignition on/off switch provide on control panel.

Temperature Points:

1. Air inlet.
2. Exhaust gas temperature.

Formulae:

1. Fuel Consumption in kg/min

$$mf = \frac{10}{t} X \frac{sp.Gravity\ of\ petrol}{1000} X\ 60 \text{.......kg/min}$$

Time for 10cc of fuel consumption(t)= Sec,

Specific gravity of petrol = 0.72.

2. Total fuel consumption (TFC) in kg/hr

TFC = m_f x 60……kg/hr

3. Engine output, BP_{elec}

$$BP_{elec} = \frac{V\ I}{1000} X \frac{1}{0.75} \text{ .... Kw}$$

Where , V= voltage reading in volts
I = current reading in amps
0.75 = Efficiency of alternator 75% (Assuming)

4. Specific Fuel Consumption(SFC)

SFC= TFC/ BP ….. Kg/kw hr

5. Heat Input the Engine

Heat Input = (TFC x Lower CV) / 3600 …. kW Where,
TFC is in Kg/hr
CV=40,000KJ/kg (calorific value of Petrol)

6. Brake Thermal Efficiency

$$\eta_{B.Th} = \frac{\text{Useful Heat or BP}}{\text{Heat Input to the Engine}} \text{ x } 100$$

7. Air consumption in kg/min

Manometer reading(h_1)= ....cm of water

Manometer reading(h_2) =............. cm of water

Difference in water level (h_w) = $\frac{h_1 - h_2}{100}$ = ... m of water

Equivalent air column (h_a) = h_w x $\frac{\text{density of water}}{\text{density of air}}$ ……m

Where, Density of water (ρ_w) = 1000kg/m^3

Density of air (ρ_a) = 1.29kg/m^3

Theoretical Volume of air intake (V_a) = 60 x C_d x A_o x $\sqrt{2g\,h_a}$ ….. m^3/min

Where C_d = 0.62

A_o = area of orifice in 'm^2'

= $\pi d^2/4$

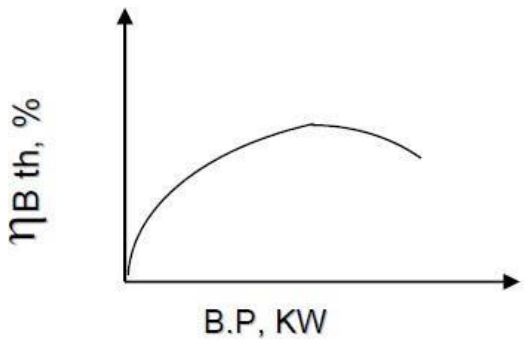
'd'= dia. of orifice = 15mm

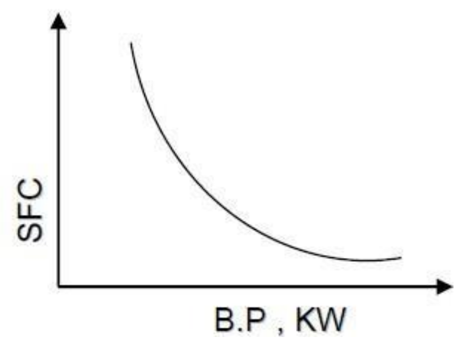
Mass of air intake (m_a) = ρ_a x V_a …….kg/min

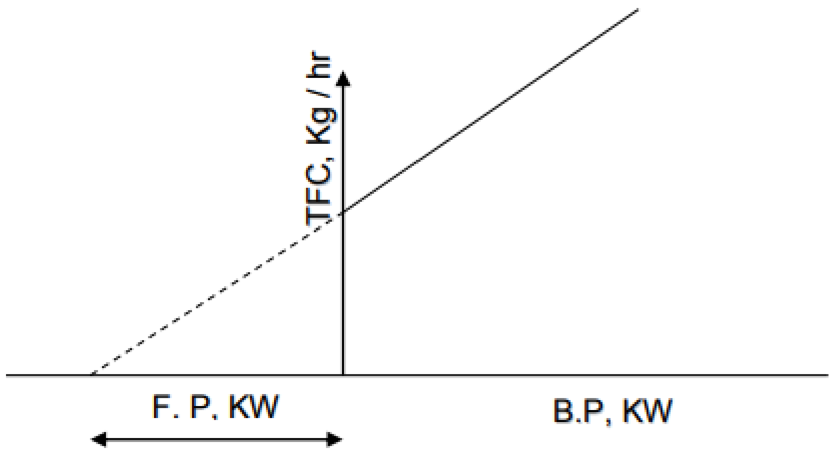
8. Air fuel ratio

A/F = m_a/m_f

Model Graphs:







Tabular Column:

S.NO	Engine speed in 'RPM'	Voltage in Volts 'V'	Current in Amps 'I'	Fuel Consumption for '10cc' in Sec	Air flow Reading in 'cm of Water'		Temperature (^0C) Air inlet	Exhaust outlet	Electriacal Load in 'kw'
					h_1	h_2	T_1	T_2	
1.									
2.									
3.									
4.									
5.									

Table of Calculations:

S.NO	Engine speed in 'RPM'	Fuel Consumed 'm_f' in Kg/min	Air Consumed 'm_f' in Kg/min	Engine Output 'kw'	Specific Fuel Consumption 'SFC' in Kg/kw-hr	Heat Input 'kw'	Break Thermal Efficiency
1.							
2.							
3.							
4.							
5.							

Space For Calculations

RESULT & CONCLUSIONS:

The break thermal efficiency of engine found to be ……..

VIVA QUESTIONS:

- What is the air fuel ratio of petrol engine ?
- Why petrol engine are lighter in weight ?
- What is the calorific value of petrol engine ?
- Why spark plug is used ?
- Explain break thermal efficiency

EXPERIMENT - 10

FOUR STROKE SINGLE CYLINDER VARIABLE COMPRESSION RATIO PETROL ENGINE TEST RIG

AIM:

To conduct performance of Single cylinder, 4-stroke petrol Engine at different Compression Ratios and to determine the BP, SFC, Mechanical efficiency, volumetric efficiency and Break thermal efficiency.

APPARATUS:

Petrol Engine Test rig

THEORY:

The Engine is a Single Cylinder, 4- stroke, Spark Ignition Petrol driven type. (Can also be used as petrol – start and kerosene-run mode). The engine is connected to electrical DC generator. The DC Generator used for loading the engine. The Brake Horse power from the engine can be calculated by measuring electrical quantities (V, A) of the generator. (by suitably assuming the efficiency of generator as 70%). The Air Intake Tank, Fuel Measuring System, and Temperature Measurement Instrumentation, Speed Indicator, Manometer, Electrical Load controller have been provided for completeness of the test rig. All measurements instrumentations are provided on an independent panel separated from the engine generator unit. Also see the details under the "Measurements" above, where the function of individual instrumentation is indicated. The auxiliary heads have been provided for changing the compression ratio.

PROCEDURE:

1. Fill the fuel tank with clean petrol.
2. Check the sufficient lubricating oil in the oil sump (crankcase).
3. Allow/Check the sufficient cooling water circulation for auxiliary engine head.
4. Connect the control panel to electrical mains 220V, 1ph, 15A, with earthing connection.
5. Select the compression ratio by rotating the hand wheel provided on engine head.
6. Put "ON" the Mains, and check "Mains ON" Indicators in the bottom of the control panel glow.
7. Switch ON the Engine ignition switch to ON position provided on control panel table.
8. Start the Engine by hand using the rope provided, so the engine get started, rotate speed control knob and set at test speed.
9. Load the engine by switching On the Electrical loading switch, note down the readings of Air flow manometer, fuel flow, engine speed, Volt and Ammeter, and temperature.
10. By switching on the electrical loading switches note down the readings as mentioned above by bringing the speed of engine for test speed by

operating the speed control Knob for every load.

11. Take down the readings for different parameters & tabulate and calculate the results as shown in tables.
12. After the experiment is over, close the petrol cock inlet to the carburetor to avoid riching for subsequent starting of the engine.
13. Push the "stop " switch to stop the engine.
14. Repeat the Experiment for different compression ratio.

Specifications of Engine :

Engine Make	:	Mk-25, Crompton Greaves, Hand Start.
Type	:	4-Stroke, Single Cylinder, Spark Ignition.
Maximum Power, 'P'	:	2.4 K W (Approx.)
Rated Speed, 'N'	:	3000 Rpm.
Bore, 'D'	:	70 Mm.
Stroke, 'L'	:	66.7 Mm.
Swept Volume, 'V'	:	256 Cm3
Compression Ratio, 'Cr'	:	2 To 10(Variable).
Clearance Volume, 'V'	:	35 Cm3 At Compression Ratio 8 (Approx.)
Starting	:	Hand Start Using Rope.
Loading	:	Electrical, Resistance Connected To D C Generator.
Cooling	:	Air Cooling. Water Cooling For Auxiliary Engine Head.

Dc Generator:

Make	:	Megha Electric Co., Bangalore.
Power	:	3.7 Kw
Speed	:	3000 Rpm

Measurements :

Air Intake	:	By Volumetric Tank with Orifice dia., d=15mm.

Engine/Generator

Output	:	By D C voltmeter and Ammeter. (Digital)
SPEED	:	By Digital RPM Indicator.
Temperature	:	T1 =Air Inlet. T2 = Exhaust Gas
Fuel Flow	:	By Burette.

Formulae Used For Calculations

1) VOLUMETRIC EFFICIENCY,

$$\%\eta_v = \frac{V_a}{V_t} \times 100.$$

Where, V_a = Actual Swept Volume,
V_t = Theoretical Swept Volume

a) V_t = Theoretical Volume

$= (\pi D^2 / 4) \times L \times (N / 2)\, m^3/min.$

Here, D = 0.07 m,
L = 0.0667m,
N = Speed in RPM.

b) actual volume of air intake is given by,

$$V_a = C_d\, a \sqrt{(2 g h_a)} \times 60\ m^3/min$$

Where, Cd =0.62, a = Area of orifice air intake

$= \pi d^2 / 4 = \pi(0.015)^2/4$

$= 3.14 \times 5.625^{-4} m^2$

$g = 9.81\ m / Sec^2$

$$h_a \text{ (in meters of air column)} = \frac{h_{water} \times \rho_{water}}{\rho_{air}}$$

$$h_a = \frac{h_w \times 1000}{1.29}$$

h_w = meters of water column from manometer.

2) TOTAL FUEL CONSUMPTION (TFC),

The mass of the fuel consumed per minute,

$$m_f = \frac{10 \times 60}{1000 \times T} \times \rho_f \quad Kg/min.$$

The fuel consumption per hour given by, TFC = $m_f \times 60$ Kg/hr.

Where, ρ_f = 0.72 specific gravity of petrol and
T is the time taken in seconds for consumption of 10

ml of petrol.

3) AIR FUELRATIO

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

Where m_a = 0.6 x a x V_a x ρ_a x60
a = area of orifice.
V_a = velocity of air = $\sqrt{2g\,(h_w/1000)\ \times (\rho_a/\rho_w)}$ m/s
h_w = air flow manometer read in mm.

4) BRAKEPOWER

$$BP = \frac{V \times I}{1000} \times 0.7 \text{ KW}$$

Where 70% to account for AC Alternator efficiency.

5) SPECIFIC FUEL CONSUMPTION(SFC)

SFC = TFC/BP Kg / KWhr.

6) HEAT INPUT,

$$HI = \frac{TFC}{60 \times 60} \times C.V \qquad KW.$$

Where, TFC is in kg /hr
C.V. = 40000 KJ /kg , Calorific Value of petrol (commercially).

10) BRAKE THERMALEFFICIENCY,
$\%\eta_{BP}$ = BP /HI x100

11) PERFORMANCE CURVES(Graphs)
a) SFC Vs BP
b) $\%\eta_{BP}$ Vs BP at fixed Compression Ratio and Speed.
c) BP Vs Compression ratio at fixed speed.
d) AF Vs BP, SFC, at fixed compression ratio.

Table of Readings

Trial No.	**Compression Ratio**	**Speed In RPM "N"**	**Fuel Flow Rate Time for 10ml in Seconds. "T"**	**Air Flow Rate in "mm" of water Column. "h_w"**	**Voltmeter Reading In Volts. "V"**	**Ammeter Reading In Amps. "I"**	**TEMPERATURES in ^oC**	
							T_1	**T_2**

Table of Calculations

Sl. No.	**Speed in RPM**	**m_a Kg/Hr.**	**m_f Kg/Hr.**	**A/F**	**TFC Kg/Kwhr**	**BP KW**	**HI KW**	**% η_{bth} Brake Thermal Efficiency**	**Remarks**

Space For Calculations

RESULT & CONCLUSIONS:

1. Mechanical efficiency of the given engine is----------------------
2. Volumetric efficiency of the given engine is---------------------
3. Break thermal efficiency of the given engine is-----------------

VIVA QUESTIONS:

- What is the air fuel ratio of petrol engine ?
- Why petrol engine are lighter in weight ?
- What is the calorific value of petrol engine ?
- Why spark plug is used ?
- Explain break thermal efficiency
- Define compression ratio ?
- Define multi stage compression

EXPERIMENT - 11

MORSE TEST ON MULTI CYLINDER PETROL ENGINE

AIM:

To conduct Morse test on four stroke four cylinder petrol engine coupled with hydraulic dynamometer.

THEORY:

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

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

PROCEDURE:

1. Check the petrol in tank.
2. Switch on the console and observe all the indicators in ON position.
3. Allow water to pass through the engine
4. Allow petrol, start the engine by operating the starting key
5. Keep the loading in minimum position
6. The engine set to the required speed by operating speed regulator Knob provided on the control panel
7. Apply load to the engine by operating needle valves in the hydraulic Dynamometer.
8. Adjust the throttle (speed regulator) to any desired speed.
9. Cut – off the spark ignition from the first cylinder by operating the Corresponding switch lever.
10. Now the speed of the engine decreases attain the normal speed by Adjusting the load without adjusting the throttle valve.
11. Now note down all the readings speed, load, temperature, petrol Flow rate And Air flow.
12. Repeat the procedure (6) to (11) for different loads by cuing – off The other cylinders, one a time.
13. Tabulate the readings as shown in the enclosed sheet.
14. After the experiment is over, keep the petrol control - Valve at closed position, and release the load

Temperature Points:-

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

Calculations

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

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

2. Brake power (BP_1) ,When first cylinder is cut – off

$$BP_1 = \frac{2\ \pi\ N\ T_1\ X\ 9.81}{60000}\ KW$$

3. Brake power (BP_2) ,When first cylinder is cut – off

$$BP_2 = \frac{2\ \pi\ N\ T_2\ X\ 9.81}{60000}\ KW$$

4. Brake power (BP_3) ,When first cylinder is cut – off

$$BP_3 = \frac{2\ \pi\ N\ T_3\ X\ 9.81}{60000}\ KW$$

5. Brake power (BP_4) ,When first cylinder is cut – off

$$BP_4 = \frac{2\ \pi\ N\ T_4\ X\ 9.81}{60000}\ KW$$

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

$$IP_1 = (BP) - (BP_1)\ KW$$

7. Similarly , when second ,third ,fourth cylinders are not firing

$$IP_2 = (BP) - (BP_2)\ KW$$

$$IP_3 = (BP) - (BP_3)\ KW$$

$$IP_4 = (BP) - (BP_4)\ KW$$

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

***Tabular column**:*

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

Precautions:

(i) Do not stop the engine by using decompression lever. It will destroy the valve seat.
(ii) Do not stop the engine by allowing the fuel tank to run dry.
(iii) Do not stop the engine when loaded. Allow the engine to run on no load for few minutes before stopping.

Space For Calculations

RESULT & CONCLUSIONS:

VIVA QUESTIONS:

- Define Indicated power
- Explain working principal of multi cylinder engine
- What is the use of dynamometer ?
- What is the objective of the experiment ?
- Define Brake power

EXPERIMENT - 12

PERFORMANCE TEST ON MULTI CYLINDER PETROL ENGINE

AIM:

The experiment is conducted to

1. To study and understand the performance characteristics of the engine.
2. To draw Performance curves and compare with standards.

APPARATUS:

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

1. The rate of fuel consumption is measured by volumetric burette reading against the known time.
2. Force / Torque indicator is mounted on a control panel.
3. air flow is measured by manometer connected to air box
4. separate cooling waterline is provided to the engine .
5. the different hydraulic loading is achieved by operating the needle valve (2 nos) On the hydraulic dynamometer.
6. The torque on the engine is measured by load cell with torque arm of the Dynamometer
7. The engine speed (RPM) is measured by electronic digital counter.
8. Temperature at different points is measured by electronic digital temperature Indicator with k - type thermocouple.

THEORY:

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

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

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

Specification:

- TYPE : 4 CYLINDER, 4 – STROKE MPFI PETROL ENGINE (WATER COOLED) SPARK IGNITION.
- MAKE : MARUTHI ZEN
- CYLINDER CAPACIY : 993 CC
- BORE AND STROKE : 74 MM X 77 MM
- COMPRESSION RATIO : 9.4 : 1
- RATED POWER OUT PUT : 49 bhp @ 6500 RPM.
- ENGINE : SAE 20 W /40 (3.5 LTRS CAPACITY
- STARTING : AUTO START
- LOADING : BY HYDRAULIC DYNAMOMETER

Temperature Points:-

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

PROCEDURE:

1. Check the petrol in tank.
2. Switch on the console and observe all the indicators in ON position.
3. Allow water to pass through the engine
4. Allow petrol, start the engine by operating the starting key
5. Keep the loading in minimum position
6. The engine set to the required speed by operating speed regulator Knob provided on the control panel.
7. Apply load to the engine by operating needle valves in the hydraulic Dynamometer.
8. Adjust the throttle (speed regulator) to any desired speed.
9. Now the speed of the engine decreases attain the normal speed by Adjusting the load without adjusting the throttle valve.
10. Now note down all the readings speed, load, temperature, petrol Flow rate And Air flow.
11. Repeat the procedure (6) to (10) for different loads.
12. Tabulate the readings as shown in the enclosed sheet.
13. After the experiment is over, keep the petrol control - Valve at closed position, and

release the load

Calculations

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

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

Where N = RPM of engine
T = Torque in Kg – m = 0.250 X F
F = Load in kgs.

2. Total fuel consumption (TFC).

m_f = The mass of fuel consumed per minute

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

Where, Density of petrol = 0.8 grams cc

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

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

3. specific fuel consumption (SFC)

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

4. Brake thermal efficiency

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

5. Air fuel ratio

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

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

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

$$V_a = 60\, C_d\, A \sqrt{2\, g\, h_a}\ m^3 / min$$

C_d = 0.62

A = Area of orifice of air intake

$$= \frac{\pi d^2}{4} m^2$$

d = Dia of orifice = 25 mm

g = 9.81 m /sec^2

h_a = Height of air column in meters of water

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

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

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

x = in cms Mercury

R = 287 Nm / kg k

Therefore,

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

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

$h_a = 909\ h_w$

where h_w = Manometer reading in mtr

6. INDICATED THERMAL EFFICIENCY

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

IP FROM MORSE TEST

Where, HI = Heat input

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

Where , TFC in Kg /Hr

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

7. Mechanical efficiency

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

Precautions:

(i) Do not stop the engine by using decompression lever. It will destroy the valve seat.
(ii) Do not stop the engine by allowing the fuel tank to run dry.
(iii) Do not stop the engine when loaded. Allow the engine to run on no load for few minutes before stopping.

Tabular column:

S.No.	Speed rpm	Load Applied	Manometer Reading			Time for 10 cc of fuel collected, t sec	Temp			
			h1	h2	hw = (h1-h2)		T_1	T_2	T_3	T_4

Tabular column:

S.No.	BP	TFC	Brake Thermal Efficiency	Mechanical Efficiency	Indicated Thermal Efficiency

Performance test on 4– stroke petrol engine (four cylinders) and to draw the following graphs:

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

Space For Calculations

RESULT & CONCLUSIONS:

Mechanical Efficiency

Brake Thermal Efficiency

Indicated Thermal Efficiency

VIVA QUESTIONS:

- Define Indicated power
- Explain working principal of multi cylinder engine
- What is the use of dynamometer ?
- What is the objective of the experiment ?
- Define Brake power
- What is meant by MPFI ?

EXPERIMENT - 13

STUDY OF BABCOCK-WILCOX BOILER

AIM:

To study Babcock-Wilcox boiler.

THEORY:

Evaporating the water at appropriate temperatures and pressures in boilers does the generation of steam. A boiler is defined as a set of units, combined together consisting of an apparatus for producing and recovering heat by igniting certain fuel, together with arrangement for transferring heat so as to make it available to water, which could be heated and vaporized to steam form. One of the important types of boilers is Babcock-Wilcox boiler.

***Observation*:** In thermal powerhouses, Babcock Wilcox boilers do generation of steam in large quantities.

The boiler consists essentially of three parts.

1. A number of inclined water tubes: They extend all over the furnace. Water circulates through them and is heated.

2. A horizontal stream and water drum: Here steam separate from the water which is kept circulating through the tubes and drum.

3. Combustion chambers: The whole of space where water tubes are laid is divided into three separate chambers, connected to each other so that hot gases pass from one to the other and give out heat in each chamber gradually. Thus the first chamber is the hottest and the last one is at the lowest temperature. All of these constituents have been shown as in fig.

The Water tubes 76.2 to 109 mm in diameter are connected with each other and with the drum by vertical passages at each end called headers. Tubes are inclined in such a way that they slope down towards the back. The rear header is called the down-take header and the front header is called the uptake header has been represented in the fig as DC and VH respectively.

Whole of the assembly of tubes is hung along with the drum in a room made of masonry work, lined with fire bricks. This room is divided into three compartments A, B, and C as shown in fig, so that first of all, the hot gases rise in A and go down in B, again rises up in C, and then the led to the chimney through the smoke chamber C. A mud collector M is attached to the rear and lowest point of the boiler into which the sediment i.e. suspended impurities of water are collected due to gravity, during its passage through the down take header.

Below the front uptake header is situated the grate of the furnace, either automatically or manually fired depending upon the size of the boiler. The direction of hot gases is maintained upwards by the baffles.

In the steam and water drum the steam is separated from the water and the remaining water travels to the back end of the drum and descends through the down take header where it is subjected to the action of fire of which the temperature goes on increasing towards the uptake header. Then it enters the drum where the separation occurs and similar process continuous further.

For the purpose of super heating the stream addition sets of tubes of U-shape fixed horizontally, are fitted in the chamber between the water tubes and the drum. The steam passes from the steam face of the drum

downwards into the super heater entering at its upper part, and spreads towards the bottom .Finally the steam enters the water box , at the bottom in a super heated condition from where it is taken out through the outlet pipes.

The boiler is fitted with the usual mountings like main stop valve, safety valve, and feed valve, and pressure gauge.

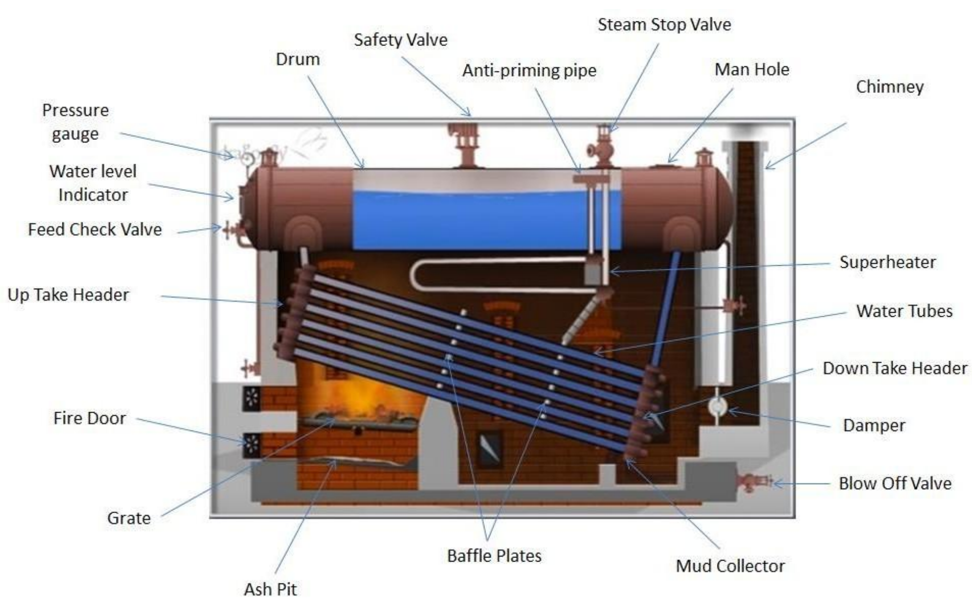
Main stop valve is used to regulate flow of steam from the boiler, to steam pipe or from one steam one steam pipe to other.

The function of safety valve is used to safe guard the boiler from the hazard of pressures higher than the design value. They automatically discharge steam from the boiler if inside pressure exceeds design-specified limit.

Feed check valve is used to control the supply of water to the boiler and to prevent the escaping of water from boiler due to high pressure inside.

Pressure gauge is an instrument, which record the inside pressure of the boiler.

When steam is raised from a cold boiler, an arrangement is provided for flooding the super heater. By this arrangement the super heater is filled with the water up to the level. Any steam is formed while the super heater is flooded is delivered to the drum ultimately when it is raised to the working pressure. Now the waterr is drained off from the super heater through the cock provided for this purpose, and then steam is let in for super heating purposes.



Babcock – Wilcox

RESULT & CONCLUSIONS:

The Babcock – Wilcox boiler is studied.

VIVA QUESTIONS:

- Explain the working principal of Boiler ?
- Define Critical temperature of water ?
- Define triple point of water ?
- Define super heated steam ?
- Use of intercooler of Boiler
- On what basis Boilers are classified
- Discuss the function of Safety, Stop, and Feed check valves

EXPERIMENT - 14

STUDY OF LANCASHIRE BOILER

AIM:

To study Lancashire boiler.

THEORY:

Evaporating the water at appropriate temperatures and pressures in boilers does the generation of system. A boiler is defined as a set of units, combined together consisting of an apparatus for producing and recovering heat by igniting certain fuel, together with arrangement for transferring heat so as to make it available to water, which could be heated and vaporized to steam form. One of the important types of boilers is Lancashire boiler.

Observation: Lancashire boiler has two large diameter tubes called flues, through which the hot gases pass. The water filled in the main shell is heated from within around the flues and also from bottom and sides of the shell, with the help of other masonry ducts constructed in the boiler as described below.

The main boiler shell is of about 1.85 to 2.75 m in diameter and about 8 m long. Two large tubes of 75 to 105 cm diameter pass from end to end through this shell. These are called flues. Each flue is proved with a fire door and a grate on the front end. The shell is placed in a placed in a masonry structure which forms the external flues through which, also, hot gases pass and thus the boiler shell also forms a part of the heating surface. The whole arrangement of the brickwork and placing of boiler shell and flues is as shown in fig.

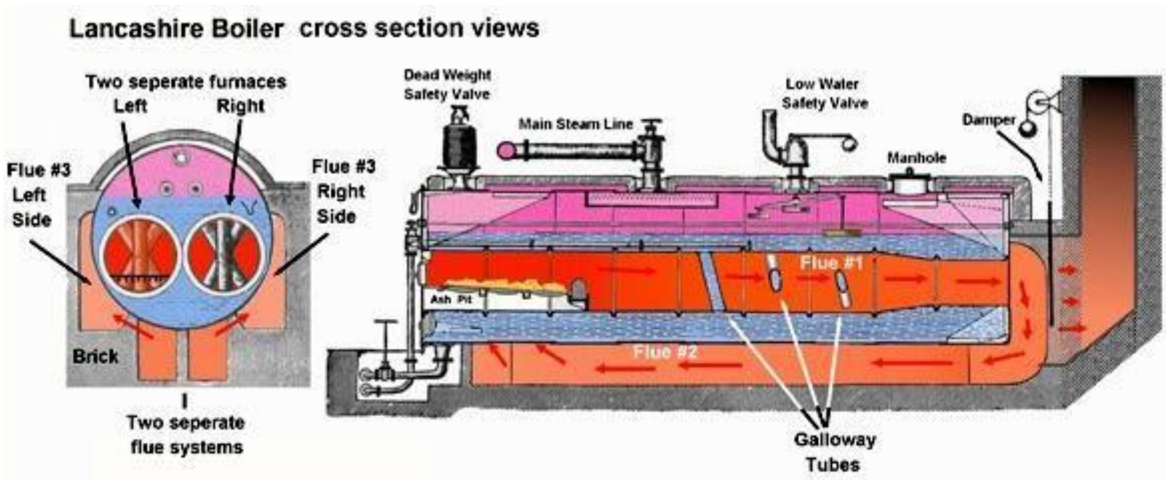
SS is the boiler shell enclosing the main flue tubes. SF are the side flues running along the length of the shell and BF is the bottom flue. Side and bottom flues are the ducts, which are provided in masonry itself.

The draught in this boiler is produced by chimney. The hot gases starting from the grate travel all along the flues tubes; and thus transmits heat through the surface of the flues. On reaching at the back end of the boiler they go down through a passage, they heat water through the lower portion of the main water shell. On reaching again at front end they bifurcate to the side flues and travel in the forward direction till finally they reach in the smoke chamber from where they pass onto chimney.

During passage through the side flues also they provide heat to the water through a part of the main shell. Thus it will be seen that sufficient amount of area is provided as heating surface by the flue tubes and by a large portion of the shell

Operating the dampers L placed at the exit of the flues may regulate the flow of the gases. Suitable firebricks line the flues. The boiler is equipped with suitable firebricks line the flues. The boiler is equipped with suitable mountings and accessories.

There is a special advantage possessed by such types of boilers. The products of combustion are carried through the bottom flues only after they have passed through the main flue tubes, hence the hottest portion does not lie in the bottom of the boiler, where the sediment contained in water as impurities is likely to fall. Therefore there are less chances of unduly heating the plates at the bottom due to these sediments.



Lancashire boiler

RESULT & CONCLUSIONS:

The Lancashire boiler is studied.

VIVA QUESTIONS:

- Explain the working principal of Boiler ?
- Define Critical temperature of water ?
- Define triple point of water ?
- Define super heated steam ?
- Use of intercooler of Boiler
- On what basis Boilers are classified
- Discuss the function of Safety, Stop, and Feed check valves

EXPERIMENT - 15

ASSEMBLY AND DISASSEMBLY OF MULTI CYLINDER ENGINE

AIM:

Operation, Disassemble and reassemble a multi-cylinder four stroke engine.

APPARATUS:

Four Stroke multi-cylinder Engine,
Tools Needed- Allen keys, Wrenches ,Open End and rings spanners & Sockets, Screwdriver, Wire Cutters, Air Pump.

THEORY:

Four Stroke Engine

The four stroke engine was first demonstrated by Nikolaus Otto in 18761 , hence it is also known as the Otto cycle. The technically correct term is actually four stroke cycle. The four stroke engine is probably the most common engine type nowadays. It powers almost all cars and trucks. The four strokes of the cycle are intake, compression, power, and exhaust. Each corresponds to one full stroke of the piston; therefore, the complete cycle requires two revolutions of the crankshaft to complete.

Intake

During the intake stroke, the piston moves downward, drawing a fresh charge of vaporized fuel/air mixture. The illustrated engine features a poppet intake valve which is drawn open by the vacuum produced by the intake stroke. Some early engines worked this way; however, most modern engines incorporate an extra cam/lifter arrangement as seen on the exhaust valve. The exhaust valve is held shut by a spring (not illustrated here).

Compression

As the piston rises, the poppet valve is forced shut by the increased cylinder pressure. Flywheel momentum drives the piston upward, compressing the fuel/air mixture.

Power

At the top of the compression stroke, the spark plug fires, igniting the compressed fuel. As the fuel burns it expands, driving the piston downward.

Exhaust

At the bottom of the power stroke, the exhaust valve is opened by the cam/lifter mechanism. The upward stroke of the piston drives the exhausted fuel out of the cylinder.

Parts of a diesel engine

Following are some of the important parts of petrol engine:

1) Cylinders Head
2) Cylinder block
3) crank case
4) flywheel &ring
5) distributor assembly &ignition coil

Cylinder Head:

Cylinder head accommodates the following parts.

(i) Valves, valve springs, valve spring plate.
(ii) Rocker shaft, shockers, springs
(iii) Inlet manifold
(iv) Exhaust manifold
(v) Tappits
(vi) Tappit cover
(vii) Studs
(viii) Head gasket

Cylinder Block

Cylinder block accommodates the following parts.

(i) 4 cylinder block, has 4 cylindrical bores.
(ii) pistons, piston pins, piston rings.
(iii) connecting rods, connecting rod bearings, or big end bearings.
(iv)crank shaft and main end bearing
(v) cam shaft and cam shaft bushes & push rods.
(vi) water pump &water pump pulley.
(vii) crank shaft gear and pulley.
(viii)cooling fan.
(ix)head gasket.

Crank Case

Crank case accommodates the following parts.

(i) Crank case.
(ii) Lubricating oil.
(iii) Oil pump.
(iv) Oil filter.

Fly Wheel

Fly wheel accommodates the following parts

(i) Fly wheel.
(ii) Fly wheel ring.

Distributor

Distributor accommodates the following parts.

(i) Distributor body at accommodates one cam shaft
(ii) Ignition coil.
(iii) C.B. point.
(iv) Condenser.
(v) Distributor cap & H.T. wires.

PROCEDURE:

1) Dismantle the following system
    a) Fuel supply system
    b) Electrical system
2) Remove the spark plug from the cylinder head.
3) Remove the cylinder head nut and bolts.
4) Separate the cylinder head from the engine block.
5) Remove the carburetor from the engine.
6) Open the crank case.
7) Remove piston rings from the piston.
8) Clean the combustion chamber.
9) Reassemble the components vice versa.

Precautions:

* Don't use loose handle of hammer.
* Care must be taken while removing the components.

RESULT & CONCLUSIONS:

A 4 – stroke diesel engine has been dismantled and reassembled.

After doing the experiment, student will be able to
i) Know the principle and working of a engine.
ii) Calculate the efficiency
iii) Know the different mechanisms of the engine
iv) Recognize the different parts of the engine

VIVA QUESTIONS:

- What is the significance of clearance volume?
- What is a stroke?
- Difference between SI and CI ?
- Difference between four stroke and two stroke
- Why four stroke is mostly preferred ?
- What is the function of piston rings
- What are functions of camshaft and crankshaft?
- What is volumetric efficiency? And it's significance
- What is indicated power, brake power?
- What is pin connecting the piston and connecting rod?
- Types of lubrication in an IC engine?
- Difference between CI and SI engine.?

EXPERIMENT - 16

ASSEMBLY AND DISASSEMBLY OF SINGLE CYLINDER ENGINE

AIM:

Operation, Disassemble and reassemble a single cylinder four stroke engine.

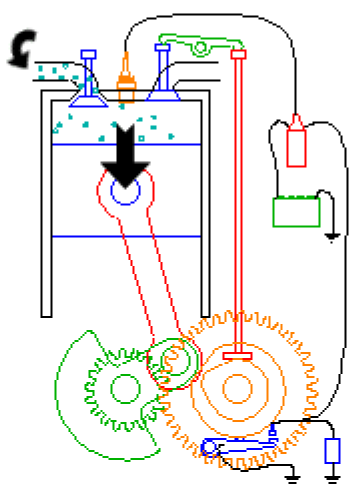
APPARATUS:

Four Stroke Single Cylinder Engine,
Tools Needed- Allen keys, Wrenches ,Open End and rings spanners & Sockets, Screwdriver, Wire Cutters, Air Pump.

THEORY:

Four Stroke Engine

The four stroke engine was first demonstrated by Nikolaus Otto in 18761 , hence it is also known as the Otto cycle. The technically correct term is actually four stroke cycle. The four stroke engine is probably the most common engine type nowadays. It powers almost all cars and trucks. The four strokes of the cycle are intake, compression, power, and exhaust. Each corresponds to one full stroke of the piston; therefore, the complete cycle requires two revolutions of the crankshaft to complete.

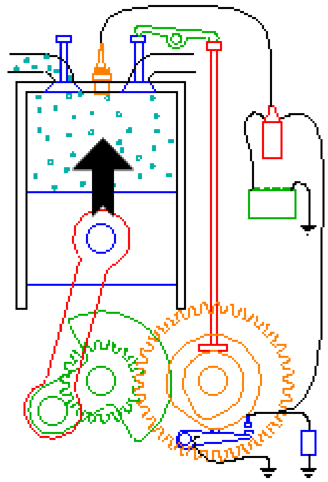


Four Stroke Engine

Intake

During the intake stroke, the piston moves downward, drawing a fresh charge of vaporized fuel/air mixture. The illustrated engine features a poppet intake valve which is drawn open by the vacuum produced by the intake stroke. Some early engines worked this way; however, most modern engines

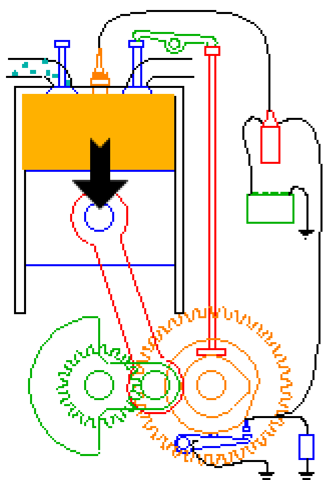
incorporate an extra cam/lifter arrangement as seen on the exhaust valve. The exhaust valve is held shut by a spring (not illustrated here).



Intake

Compression

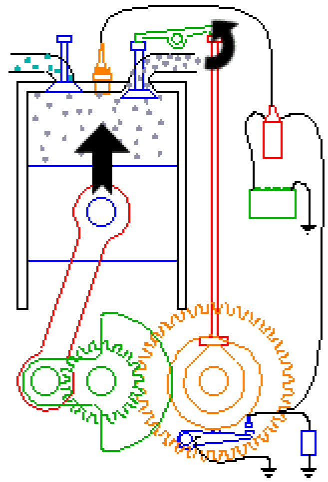
As the piston rises, the poppet valve is forced shut by the increased cylinder pressure. Flywheel momentum drives the piston upward, compressing the fuel/air mixture.



Compression

Power

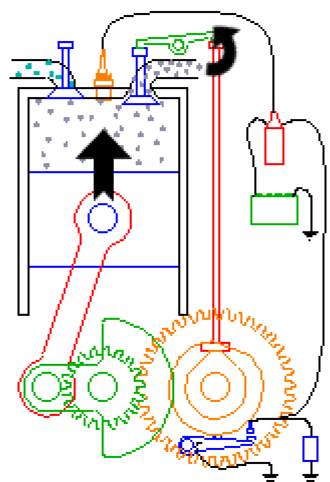
At the top of the compression stroke, the spark plug fires, igniting the compressed fuel. As the fuel burns it expands, driving the piston downward.



Power

Exhaust

At the bottom of the power stroke, the exhaust valve is opened by the cam/lifter mechanism. The upward stroke of the piston drives the exhausted fuel out of the cylinder.



Exhaust

Parts of a petrol engine

Following are some of the important parts of petrol engine:

1) Cylinders Head
2) Cylinder block
3) crank case
4) flywheel &ring
5) distributor assembly &ignition coil
6) carburetor

Cylinder Head:

Cylinder head accommodates the following parts.

(i) Valves, valve springs, valve spring plate.
(ii) Rocker shaft, shockers, springs
(iii) Inlet manifold
(iv) Exhaust manifold
(v) Tappits
(vi) Tappit cover
(vii) Studs
(viii) Head gasket

Cylinder Block

Cylinder block accommodates the following parts.

(i) 4 cylinder block, has 4 cylindrical bores.
(ii) pistons, piston pins, piston rings.
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(iv)crank shaft and main end bearing
(v) cam shaft and cam shaft bushes & push rods.
(vi) water pump &water pump pulley.
(vii) crank shaft gear and pulley.
(viii)cooling fan.
(ix)spark plugs.
(x)head gasket.

Crank Case

Crank case accommodates the following parts.

(i) Crank case.
(ii) Lubricating oil.
(iii) Oil pump.
(iv) Oil filter.

Fly Wheel

Fly wheel accommodates the following parts

(i) Fly wheel.
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Distributor

Distributor accommodates the following parts.

(i) Distributor body at accommodates one cam shaft
(ii) C.B. point.
(iii) Condenser.
(iv) Distributor cap & H.T. wires.

Carburetor.

Performance criteria

- Safe working practices are observed throughout the task according to legislative requirements. Range personal safety, safety of others, and no damage to equipment.

- Suitable tools and equipment are selected and used that enable the engine to be disassembled according to the engine or vehicle manufacturer's instructions.
- Engine assembly is inspected before disassembling to ensure exterior dirt and oil are removed.
- Engine assembly is secured on an engine stand so that it is safe.
- Cylinder head and sump are removed in a manner that minimizes damage to parts and fasteners.
- Parts and fasteners are stored in a parts tray suitable for the purpose.
- Crankshaft and piston assembly or assemblies are removed from the engine in the manner and sequence recommended by the engine or vehicle manufacturer.
- Parts are laid out and tabulated for easy identification.

PROCEDURE:

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    a) Fuel supply system
    b) Electrical system
2) Remove the spark plug from the cylinder head.
3) Remove the cylinder head nut and bolts.
4) Separate the cylinder head from the engine block.
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6) Open the crank case.
7) Remove piston rings from the piston.
8) Clean the combustion chamber.
9) Reassemble the components vice versa.

Precautions:

* Don't use loose handle of hammer.
* Care must be taken while removing the components.

RESULT & CONCLUSIONS:

A 4 – stroke petrol engine has been dismantled and reassembled.

After doing the experiment, student will be able to
i) Know the principle and working of a engine.
ii) Calculate the efficiency
iii) Know the different mechanisms of the engine
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VIVA QUESTIONS:

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- Types of lubrication in an IC engine?
- Difference between CI and SI engine ?

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METHODIST

COLLEGE OF ENGINEERING & TECHNOLOGY

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