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DEPARTMENT OF MECHANICAL ENGINEERING

17MECC85- ENGINE TESTING LAB (UG)

LAB MANUAL

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DEPARTMENT OF MECHANICAL ENGINEERING

17MECC85- ENGINE TESTING LAB (UG)

LIST OF EXPERIMENTS

1. Determination of Viscosity of the given specimen oil by using Red Wood Viscometer.
2. Determination of Flash Point and Fire Point of the given fuel sample.
3. Actual valve timing diagram of a four stroke engine and comparison with theoretical valve timing diagram.
4. Actual port timing diagram of a two stroke engine and comparison with theoretical port timing diagram.
5. Performance test on a four stroke single/ twin cylinder diesel engine.
6. Determination of frictional power of a four cylinder petrol engine by conducting a Morse test.
7. Conduct a retardation test and determine frictional power in a diesel engine.
8. Performance test on variable compression ratio engine with biofuel.

HOD/Mech

EXPERIMENT NO. 1

DETERMINATION OF VISCOSITY OF OIL USING REDWOOD VISCOMETER

Aim :

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

Apparatus Required :

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

Description :

Viscosity :

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

Redwood Viscometer :

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

Specification :

Cylinder diameter	:	47.625 mm
Cylinder depth	:	88.90 mm
Orifice diameter	:	1.70 mm
Length	:	12 mm

Formulae used :

Kinematic Visosoity :

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

A - 0.0026

B - 1.72

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

Density of Oil at particular temperature :

$$\rho = \rho_R - 0.00065\ (T - T_R)$$

T - Temperature at which the density is required in ^oC.

T_R - Room Temperature

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

Dynamic Viscosity :

$$\mu = \gamma \times \rho$$

Procedure :

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

Graphs :

The following graph has to be drawn.

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

OBSERVATION AND TABULATION

Room Temperature =

Density of oil at room temperature =

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

Result :

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

Viva Questions:

1. What is Viscosity?
2. What are different types of viscosity explain them and write the units?
3. What are factors effecting viscosity?
4. Mention some applications where viscosity is considered?
5. Relation between density and viscosity?
6. Mention different types of oils used in lubricating purposes?
7. How does SAE grade differ in lubricants oils used summer and winter?
8. How the power consumptions varies with viscosity of lubricant in rotation of shaft?
9. Selection of viscometers based on grading or viscosity of oil?
10. Which constructional feature of viscometer varies with the viscosity of oil?
11. Why stirring is done in viscometer and fire and flash point measuring apparatus?
12. Properties of good lubricant?
13. How does viscosity effects lubricants?
14. What is the temperature range for Redwood – I viscometer?

EXPERIMENT NO. 2

DETERMINATION OF FLASH POINT AND FIRE POINT OF A FUEL

Aim :

To determine the flash point and fire point temperatures of the given sample of fuel using Cleaveland Open Cup apparatus.

Apparatus Required :

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

Description :

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

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

Procedure :

1. Clean the cup and fill it with the given sample of oil up to the filling mark.
2. Insert the thermometer in the holder. Make sure that the thermometer should not touch the metallic cup.
3. Heat the oil by means of electric heater so that the sample of oil gives out vapour at the rate of 10^0C per minute.

4. When the oil gives out vapour, introduce the test flame above the oil, without touching the surface of the oil and watch for flash or flickering sound.
5. Introducing test flame should be continued at regular intervals until the first flash is observed with peak flickering sound. The temperature corresponding to this flickering sound is noticed and it is the flash point temperature of the given sample of oil.
6. Continue the process of heating and introducing the test flame until the oil begins to burn continuously and observe the temperature, This is the fire point temperature of the given sample of oil.
7. Repeat the test twice or thrice with fresh sample of oil and observe the results.
8. The observations are tabulated.

OBSERVATION TABULATION

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

Sl.No	**Temperature**	**Reaction**

Result :

The flash point and fire point of the given sample of oil were determined using Cleaveland Open Cup apparatus.

Viva Questions:

1. What is Flash point and its importance in applications point of view?
2. What is Fire point and its importance in applications point of view?
3. Constructional difference between Pensky martin & Cleaveland apparatus, which is the best one?
4. Why stirring is done in fire and flash point measuring apparatus?

EXPERIMENT NO. 3

CONSTRUCTION OF ACTUAL VALVE TIMING DIAGRAM

FOR A FOUR STROKE DIESEL ENGINE

Aim :

To construct a valve timing diagram of a four stroke diesel engine.

Apparatus Required :

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

Description :

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

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

Inlet Valve Opening and Closing :

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

Exhaust Valve Opening and Closing :

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

Formulae :

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

Procedure :

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

OBERVATION AND TABULATION

Sl.No	Events	Position with reference to Dead Centres	Arc Length (m)	Angle (degrees)
1	Inlet Valve Open (IVO)	Before TDC		
2	Inlet Valve Close (IVC)	After BDC		
3	Exhaust Valve Open (EVO)	Before BDC		
4	Exhaust Valve Close (EVC)	After TDC		

Result :

The valve timing diagram of the four stroke diesel engine is drawn after measuring the valve opening and closing positions on the flywheel.

EXPERIMENT NO. 4

CONSTRUCTION OF ACTUAL PORT TIMING DIAGRAM FOR A TWO STROKE PETROL ENGINE

Aim :

To construct a port timing diagram of a two stroke petrol engine.

Apparatus Required :

5. Four Stroke Cycle Diesel Engine
6. Measuring Tape
7. Chalk

Description :

The diagram which shows the position of crank at which the ports of a two stroke engine opens and close during a cycle is called a port timing diagram.

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

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

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

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

Formulae :

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

Procedure :

1. Identify the engine components and ports from the cut –section of the engine.
2. Mark the TDC and BDC position on the flywheel.
3. Rotate the flywheel in clockwise direction and observe the movement of piston and opening of ports as the cylinder moves up and down.

4. When the piston moves from BDC to TDC mark on the flywheel the inlet port openings as the piston's skirt uncovers bottom end of the inlet port. Similarly mark the inlet port closing as the piston's skirt covers the port as it moves from TDC to BDC.
5. In the same stroke observing the opening of transfer port and exhaust port mark the positions on the flywheel. Thus the following positions, Transfer Port Open, Exhaust Port open, Transfer Port Close and Exhaust Port Close are marked in sequence.
6. Measure the distance of Inlet Port Open and Inlet Port Close from TDC .
7. Measure the distance of Transfer Port Open, Exhaust Port Open , Transfer Port Close and Exhaust Port Close from BDC.

OBERVATION AND TABULATION

Sl.No	**Events**	**Position with reference to Dead Centres**	**Arc Length (m)**	**Angle (degrees)**
1	Inlet Port Open (IPO)	Before TDC		
2	Inlet Port Close (IPC)	After TDC		
3	Transfer Port Open (TPO)	Before BDC		
4	Exhaust Port Open (EPO)	Before BDC		
5	Transfer Port Close (TPC)	After BDC		
6	Exhaust Port Close (EPC)	After BDC		

Result :

The port timing diagram of the two stroke petrol engine is drawn after measuring the port opening and closing positions on the flywheel.

Viva Questions:

1. Differentiate valve and port?

2. Define valve timing?.

3. Explain the importance of valve timing?

4. Define mechanism of valve operation?

5. Define the cam mechanism in IC engine?

6. Define crank mechanism?

7.What are the position of inlet vale opening and closing?

8. What are the exhaust valve opening and closing positions?

9. Indicate the ignition period in the diagram?

EXPERIMENT NO. 5

PERFORMANCE TEST ON A TWIN CYLINDER DIESEL ENGINE

Aim :

To conduct a load test on a twin cylinder diesel engine to determine the following at various load conditions and to draw the performance curves.

1. Brake Power of the engine
2. Indicated Power of the engine
3. Total Fuel Consumption
4. Specific Fuel Consumption
5. Mechanical efficiency
6. Brake Thermal Efficiency
7. Indicated Thermal Efficiency

Apparatus required :

1. Twin Cylinder Diesel Engine Experimental Setup.
2. Stop Watch
3. Measuring Tape
4. Tachometer
5. Spring Balance

Description:

A performance test is conducted on a twin cylinder diesel to study the characteristics of the engine at different loads. The twin cylinder diesel engine is coupled to a 7.5 KVA alternator. The alternator and engine are directly mounted on a common rigid framework. The output of alternator is taken to a bulb loading system through proper means. Necessary measuring equipments like ammeter, voltmeter, energy meter are fitted on the panel board of total capacity of 6 KW. The engine is provided with a fuel tank of capacity 5 litres and a simple fuel measuring arrangement. The fuel is measured by a 100 cc x 0.1 cc burette with a three way cock arrangement to close and measure the time taken by the fuel to flow from the burette. A large air tank is fitted with a orifice plate of 20mm dia and a manometer to measure the rate of flow of air sucked by the engine. A dial type thermometer is counted on the panel board to read the temperature of the exhaust gases.

Specification :

Type of engine	:	Twin Cylinder Four Stroke Diesel Engine
Type of cooling	:	Water Cooled
Brake power	:	10 h.p.
Speed	:	1500 r.p.m.
Bore diameter	:	80 mm
Stroke length	:	110 mm
Type of loading	:	Alternator With Bulb Loading
Loading capacity	:	6000 W
Orifice plate of air tank	:	20 mm

Formulae used :

Brake Power :

Brake horsepower is the measure of an engine's horsepower without the loss in power caused by the gearbox, generator, differential, water pump, and other auxiliary components such as alternator, power steering pump, muffled exhaust system, etc.

$$BP = V \times I = \frac{n \times 3600}{K \times t} \text{ KW}$$

n - no. of revolutions in energy meter disc

k - Energy meter constant – 300 rev / KW hr

t - time taken for n revolutions of energy meter disc in secs.

Total Fuel Consumption :

It is the mass of fuel consumed at particular load per hour.

$$TFC = \frac{10 \times s.g \times 3600}{t \times 1000} \text{ kg / hr.}$$

s.g - specific gravity of fuel in kg/m^3

t - Average time taken for 10 cc fuel consumption in secs.

Specific Fuel Consumption:

It is defined as the mass of fuel consumed per hour per Brake Power of the engine.

$$SFC = \frac{TFC}{BP} \text{ Kg/KW–hr.}$$

Input Power or Heat Supplied :

It is the heat supplied by the fuel .

$$HS = \frac{TFC \times CV}{3600} \quad KW.$$

CV - Calorific Value of Fuel in KJ / Kg.

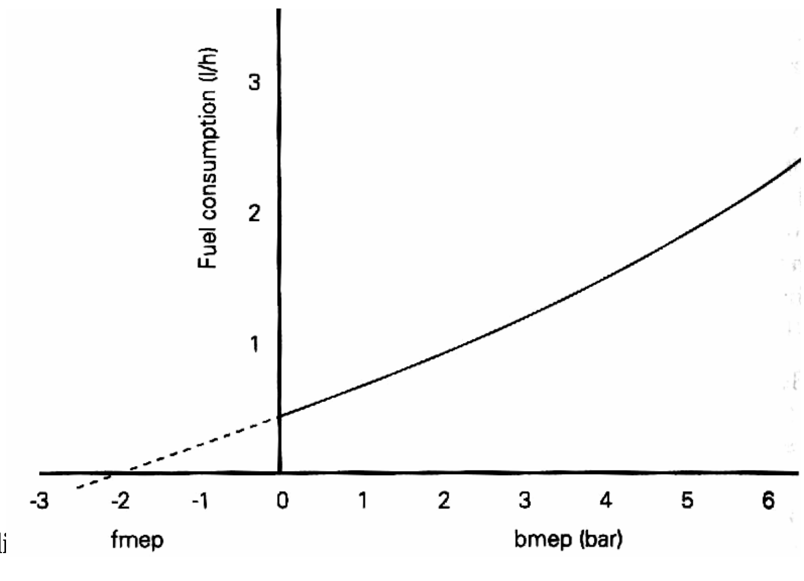
Frictional Power :

The frictional power of an engine is determined by Willan's Line Method. The concept of the Willann's line method is based on the fact that for any constant engine speed, the dependence of hourly fuel consumption vs engine brake power may be described with a suitable accuracy by a polynomial trend line of type

$$\mathbf{y=ax^2 + bx + c}.$$

It is assumed that this curve, extrapolated down to zero value of fuel consumption, intersects with the brake power axis at a point, which is taken as the mechanical losses value at the given engine speed .

According to this method, the mechanical losses are calculated for engine speed of 1500 rpm, where the data for the fuel consumption dependence on the engine brake power is taken from the engine performance tests.



Indi

The power actually developed inside the cylinder due to the combustion of fuel is called indicated power .

$$IP = Fr.P + B.P. \quad KW$$

Mechanical Efficiency :

It is defined as the ratio of Brake Power to Indicated Power.

$$\eta_{MECH} = \frac{B.P}{I.P} \times 100$$

Brake Thermal Efficiency :

It is defined as the ratio of brake power to heat supplied by the combustion of fuel (fuel power).

$$\eta_{B.T.} \text{ or } \eta_{overall} = \frac{B.P}{H.S} \times 100$$

Indicated Thermal Efficiency :

It is defined as the ratio of indicated power to heat supplied by the combustion of fuel.

$$\eta_{I.T.} \text{ or } \eta_{thermal} = \frac{I.P}{H.S} \times 100$$

Procedure :

1. Calculate the maximum load that can be applied on the engine from its specifications.
2. Check the engine for fuel availability, lubricant and cooling water connections.
3. Release the load on engine completely and start the engine with no load applied in the brakes.
4. Allow the engine to run for few minutes to attain the rated speed.
5. Adjust the flow of cooling water and maintain steady flow along the cooling water jackets by verifying the outlet.
6. Apply the desired load, from no load slowly and steadily. At the desired load condition take note of the following observations.
   i. Load on the engine.
   ii. Speed of the engine.
   iii. Time taken for 5 revolutions of energy meter disc.
   iv. Time taken for 10 cc of fuel consumption.
   v. Voltmeter Reading
   vi. Ammeter Reading
7. Repeat the procedure up to desired load conditions and tabulate the readings.
8. Bring the engine back to no load conditions and shut down the engine.

Performance Curves :

Curves are plotted for the following characteristics.

a. Brake Power (BP) vs Specific Fuel Consumption (SFC).
b. Brake Power (BP) vs Brake Thermal Efficiency
c. Brake Power (BP) vs η_{MECH}
d. Brake Power (BP) vs $\eta_{B.T}$
e. Brake Power (BP) vs $\eta_{I.T}$

OBSERVATION AND TABULATION

Sl.No	Load (Watts)	Voltage(Volts)	Current (Amperes)	Time taken for 10 cc fuel fall (secs)	Time taken for 5 revolutions of energymeter disc (Secs)

Result :

The load test was conducted and the characteristic parameters of the engine were calculated and curves were drawn.

Viva Questions

1.Actual volume of air sucked in the cylinder is given by

2.In a four stroke cycle S.I.engine the camshaft runs at______

3.The following is an S.I. engine________________ [ ]

a) Diesel engine b) petrol engine c) Gas engine d) none of the above

4.The following is C.I. engine [ ]

a) Diesel engine b) petrol engine c) Gas engine d) none of the above

5.In a four stroke cycle petrol engine , during suction stroke [ ]

a) Only air is sucked in b) only petrol is sucked in

c) Mixture of petrol and air is sucked in d) none of the above

6. In a four stroke cycle diesel engine , during suction stroke-_______[ ]

a) Only air is sucked in b) only fuel is sucked in

b) Mixture of fuel and air is sucked in d) None of the above

7. Flywheel in I.C.Engines is made of

8. Firing order of 3-cylinder engine is

9. The thermal efficiency of petrol engine as compared to diesel engine is______
10. Carburetor is used in_______ engines.

EXPERIMENT NO. 6

MORSE TEST ON A FOUR CYLINDER PETROL ENGINE

Aim :

To conduct Morse test on a multi cylinder petrol engine in order to determine the indicated power developed in each cylinder of the engine.

Apparatus required :

1. Multi Cylinder Petrol Engine Experimental Setup with Ignition cut-off arrangement.
2. Loading Arrangements.
3. Stop Watch
4. Tachometer

Description:

The Morse Test is a test conducted on a multi cylinder petrol engine to measure the indicated power and mechanical efficiency. The engine is made to run at maximum load at certain speed. The brake power is then measured when all cylinders are working. Then one cylinder is made in-operative by cutting-off the ignition to that cylinder. As a result of this the speed of the engine will decrease. Therefore the load on the engine is reduced so that the engine speed is restored to its initial value. The assumption made on the test is that frictional power depends on the speed and not on the load on the engine.

Specification :

Type of engine	:	Multi Cylinder Four Stroke Petrol Engine
Type of cooling	:	Water Cooled
Brake power	:	10 h.p.
Speed	:	1500 r.p.m.
Bore diameter	:	84 mm
Stroke length	:	82 mm
Capacity	:	1800 cc
Compression ratio	:	8.5 : 1.0
Type of loading	:	Hydraulic Dynamometer
Loading capacity	:	6000 w
Orifice plate of air tank	:	20 mm
Make	:	Isuzu

Formulae used :

Brake Power :

Brake horsepower is the measure of an engine's horsepower without the loss in power caused by the gearbox, generator, differential, water pump, and other auxiliary components such as alternator, power steering pump, muffled exhaust system, etc.

$$BP = \frac{W \times N}{C} \quad KW$$

W - Load revolutions in energy meter disc

N - Speed of the engine in r.p.m

C - Dynamometer Constant

Indicated Power :

Indicated power is the theoretical power of a reciprocating engine if it is completely frictionless in converting the expanding gas energy (piston pressure x displacement) in the cylinders. It is calculated from the pressures developed in the cylinders, measured by a device called an *engine indicator* **-** hence indicated horsepower. As the piston advances throughout its stroke, the pressure against the piston generally decreases, and the indicator device usually generates a graph of pressure vs stroke within the working cylinder. From this graph the amount of work performed during the piston stroke may be calculated. but is misleading because the mechanical efficiency of an engine means that the actual power output may only be 70% to 90% of the indicated horsepower.

Indicated Power of Cylinder # 1 :

$IP_1 = BP - BP_1$

BP - Brake Power of the engine when all four cylinders are working

BP_1 - Brake Power of the engine when cylinder # 1 is cut-off.

Similarly the Indicated Power of each of the cylinders is calculated.

Total Indicated Power = $IP_1 + IP_2 + IP_3 + IP_4$

Mechanical Efficiency :

It is defined as the ratio of Brake Power to Indicated Power.

$$\eta_{MECH} = \frac{B.P}{I.P} \times 100$$

Procedure :

1. Calculate the maximum load that can be applied on the engine from its specifications.
2. Check the engine for fuel availability, lubricant and cooling water connections.
3. Release the load on engine completely and start the engine with no load applied in the brakes.
4. Allow the engine to run for few minutes to attain the rated speed.

Adjust the flow of cooling water and maintain steady flow along the cooling water jackets by verifying the outlet.

5. Apply the load and increase the load up to maximum load. Now note the load on the engine and speed of the engine at this maximum load.
6. Cut-off the ignition of first cylinder. Now the speed of the engine will be observed to getting decreased. Reduce the load on the engine until the speed of the engine is maintained the same as before.
7. Bring all the four cylinders in working condition and repeat the same procedure by cutting-off cylinders one after the other and tabulate the load conditions. The engine is made to run at constant speed with variation in load when cylinders are cut-off.
8. Bring the engine back to no load conditions and shut down the engine.

OBERVATION AND TABULATION

Sl.No	**Conditions**	**Load (N)**	**Speed (rpm)**	**Brake Power (KW)**	**Indicated Power (KW)**
1	All cylinders are working				
2	First cylinder was cut-off and remaining are working				
3	Second cylinder was cut-off and remaining are working				
4	Third cylinder was cut-off and remaining are working				
5	Fourth cylinder was cut-off and remaining are working				

Note : The speed of the engine should be maintained constant.

Result :

Morse test is thus conducted on the multi cylinder petrol engine and indicated power developed in each cylinder is determined and mechanical efficiency is calculated

Viva Questions

1.Define the morse test?

2.What is transmission dynamometer?

3.What is need of measurement of speed of an I.C. Engine?

4.What is a smoke and classify the measurement of a smoke?

5.What is the break power of I.C. Engines?

EXPERIMENT NO.7
RETARDATION TEST ON A FOUR STROKE SINGLE CYLINDER DIESEL ENGINE BY MECHANICAL LOADING

Aim

To conduct retardation test on a four-stroke single-cylinder diesel engine by mechanical loading with specified speed to calculate frictional power.

Apparatus Required

1)Tachometer
2)Stopwatch
3) Single cylinder diesel engine.

Specification

Type of engine : Single Cylinder Four Stroke Diesel Engine
Type of cooling : Water Cooled
Brake power : 5 h.p.
Speed : 1500 r.p.m.
Bore diameter : 80 mm
Stroke length : 110 mm
Type of loading : Rope Brake Dynamometer
Rope diameter : 15 mm
Orifice plate of air tank: 20 mm
Type of loading : Mechanical Loading

Formulae Used

1. Torque(T)

$$T = BP * \frac{60000}{2\pi N} \text{ (N-m)}$$

Where,
BP = Brake Power (Kw)
N = Engine Speed (rpm)

2. Frictional Torque (Tf)

Tf = [T3 / (T2 – T3)] x (Torque)

3. Frictional Power (FP)

$$FP = BP * T3/(T2 - T3) \text{ (Kw)}$$

4. Mechanical efficiency (ηm)

$$\eta m = (B.P)/(B.Px\ FPavg)x100 \quad (\%)$$

Procedure:

1. Calculate maximum load to be applied for a selected engine.
2. Check the fuel supply, water circulation in the water system and lubricating oil in the oil sump.
3. Ensure no load condition.

4. The engine is started and allowed to run on idle speed for a few minutes.
5. Then the speed is set to the rated speed.
6. Time taken to reach the required speed is noted down at no load condition.
7. Repeat the procedure for drop in speeds 50,100,150,200 and 250.
8. Apply half of the maximum load on the brake drum.
9. Then the speed is set to the rated speed.
10. Time taken to reach the required speed is noted down at half load condition.
11. Repeat the procedure for drop in speeds 50,100,150,200 and 250.
12. After taking the readings unload the engine and allow it to run few minutes And then stop the engine.

OBSERVATION AND TABULATION

.No	Drop in Speed(rpm)	me for fall of speed at no load condition 2 Sec)	me for fall of speed at half load condition 3 Sec)	ictional Torque(Tf) m	ictional power (FP) from graph(KW)
				avg	

Result:

The retardation test on a four-stroke single-cylinder diesel engine by mechanical loading with specified speed is conducted and the following parameters were found.

Frictional power =

Mechanical efficiency (ηm) =

Viva Questions

1. What are the 4strokes of SI engines?
2. What is the working cycle of SI Engine?
3. List out the performance parameters?
4. Indicate the different types of loads?
5. Differentiate SFC and TFC?
6. What are the different methods to find frictional power?
7. Differentiate brake power and indicated power?
8. Define brake thermal efficiency?
9. Indicate mechanical efficiency in terms of BP and IP?

EXPERIMENT NO. 8

PERFORMANCE TEST ON VARIABLE COMPRESSION RATIO ENGINE WITH BIOFUEL

Aim :

To conduct a load test on variable compression ratio engine to determine the following at various load conditions and to draw the performance curves.

1. Brake Power of the engine
2. Indicated Power of the engine
3. Total Fuel Consumption
4. Specific Fuel Consumption
5. Mechanical efficiency
6. Brake Thermal Efficiency
7. Indicated Thermal Efficiency

Apparatus required:

1. VCR Engine Experimental Setup.
2. Stop Watch
3. Measuring Tape

Specification :

Type of engine	:	Twin Cylinder Four Stroke Diesel Engine
Type of cooling	:	Water Cooled
Brake power	:	10 h.p.
Speed	:	1500 r.p.m.
Bore diameter	:	80 mm
Stroke length	:	110 mm
Type of loading	:	Alternator With Bulb Loading
Loading capacity	:	6000 W
Orifice plate of air tank	:	20 mm

Formulae used :

Brake Power :

Brake horsepower is the measure of an engine's horsepower without the loss in power caused by the gearbox, generator, differential, water pump, and other auxiliary components such as alternator, power steering pump, muffled exhaust system, etc.

$$BP = V \times I = \frac{n \times 3600}{K \times t} \quad KW$$

n - no. of revolutions in energy meter disc

k - Energy meter constant – 300 rev / KW hr

t - time taken for n revolutions of energy meter disc in secs.

Total Fuel Consumption :

It is the mass of fuel consumed at particular load per hour.

$$TFC = \frac{10 \times s.g \times 3600}{t \times 1000} \quad kg / hr.$$

s.g - specific gravity of fuel in kg/m^3

t - Average time taken for 10 cc fuel consumption in secs.

Specific Fuel Consumption:

It is defined as the mass of fuel consumed per hour per Brake Power of the engine.

$$SFC = \frac{TFC}{BP} \quad Kg/KW\text{–}hr.$$

Input Power or Heat Supplied :

It is the heat supplied by the fuel .

$$HS = \frac{TFC \times CV}{3600} \quad KW.$$

CV - Calorific Value of Fuel in KJ / Kg.

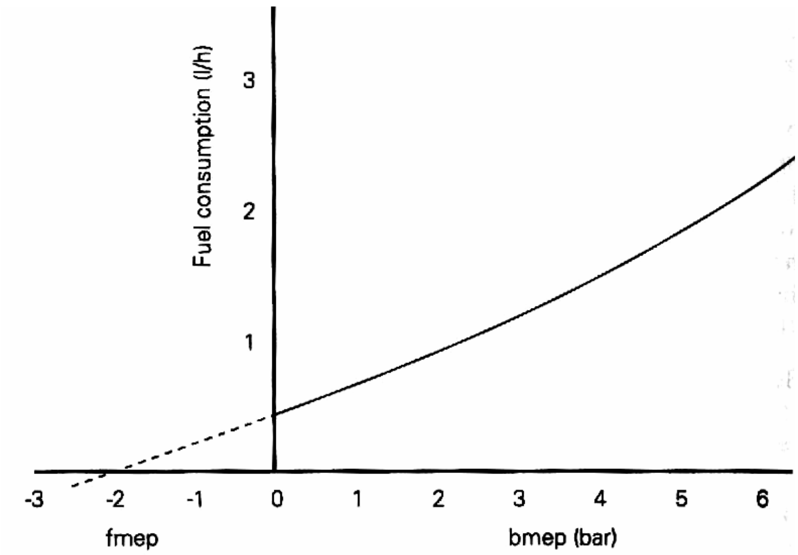
Frictional Power :

The frictional power of an engine is determined by Willan’s Line Method. The concept of the Willann's line method is based on the fact that for any constant engine speed, the dependence of hourly fuel consumption vs engine brake power may be described with a suitable accuracy by a polynomial trend line of type

$$\mathbf{y=ax^2 + bx + c}.$$

It is assumed that this curve, extrapolated down to zero value of fuel consumption, intersects with the brake power axis at a point, which is taken as the mechanical losses value at the given engine speed .

According to this method, the mechanical losses are calculated for engine speed of 1500 rpm, where the data for the fuel consumption dependence on the engine brake power is taken from the engine performance tests.



Indicated Power :

The power actually developed inside the cylinder due to the combustion of fuel is called indicated power .

$$IP = Fr.P + B.P. \quad KW$$

Mechanical Efficiency :

It is defined as the ratio of Brake Power to Indicated Power.

$$\eta_{MECH} = \frac{B.P}{I.P} \times 100$$

Brake Thermal Efficiency :

It is defined as the ratio of brake power to heat supplied by the combustion of fuel (fuel power).

$$\eta_{B.T.} \text{ or } \eta_{overall} = \frac{B.P}{H.S} \times 100$$

Indicated Thermal Efficiency :

It is defined as the ratio of indicated power to heat supplied by the combustion of fuel.

$$\eta_{I.T.} \text{ or } \eta_{thermal} = \frac{I.P}{H.S} \times 100$$

Procedure :

1. Calculate the maximum load that can be applied on the engine from its specifications.
2. Check the engine for fuel availability, lubricant and cooling water connections.
3. Release the load on engine completely and start the engine with no load applied in the brakes.
4. Allow the engine to run for few minutes to attain the rated speed.

5. Adjust the flow of cooling water and maintain steady flow along the cooling water jackets by verifying the outlet.
6. Apply the desired load, from no load slowly and steadily. At the desired load condition take note of the following observations.
    i. Load on the engine.
    ii. Speed of the engine.
    iii. Time taken for 5 revolutions of energy meter disc.
    iv. Time taken for 10 cc of fuel consumption.
7. Repeat the procedure up to desired load conditions and tabulate the readings.
8. Bring the engine back to no load conditions and shut down the engine.

Performance Curves :

Curves are plotted for the following characteristics.

a. Brake Power (BP) vs Specific Fuel Consumption (SFC).
b. Brake Power (BP) vs Brake Thermal Efficiency
c. Brake Power (BP) vs η_{MECH}
d. Brake Power (BP) vs $\eta_{B.T}$
e. Brake Power (BP) vs $\eta_{I.T}$

OBSERVATION AND TABULATION

Sl.No	Load (Watts)	Voltage(Volts)	Current (Amperes)	Time taken for 10 cc fuel fall (secs)	Time taken for 5 revolutions of energymeter disc (Secs)

Result :

The load test was conducted and the characteristic parameters of the engine were calculated and curves were drawn.

Viva Questions

1. What are the parameters calculated in load test?
2. Define indicated thermal efficiency?
3. Define brake thermal efficiency?
4. Petrol engine works on which cycle?
5. Diesel engine works on which cycle?
6. Explain working of two stroke engine with help of cut model?
7. Why the deflector is provided on the piston crown in the two stroke engine?
8. What is the air standard efficiency of otto cycle?
9. Explain working of four stroke engine with help of cut model?
10. What is the air standard efficiency of diesel cycle?
11. Define compression ratio of an I.C Engine?
12. What are the ranges of compression ratios in petrol engine and diesel engine?
13. Which number used to indicate the quality of petrol?
14. Which number used to indicate the quality of diesel?
15. What is relative efficiency?