HEATE ENGINE LAB

SUBJECT CODE-421

SEMESTER-5

SINGLE CYLINDER FOUR STROKE PETROL ENGINE TEST RIG WITH ROPE BRAKE DYNAMOMETER

AIM:

To conduct a performance test on single cylinder four stroke petrol engine.

DESCRIPTION:

The Rope brake Dynamometer is coupled to the Engine and the engine is mounted on a MS. Channel Frame. Panel board is used to fix burette with 3-way cock, digital temperature indicator with selector, Digital Speed indicator and 'U' tube manometer.

INSTRUMENTATION:

1. Digital Temperature Indicator to measure different temperature sensed by respective thermocouples.
2. Manometer to measure the quantity of air drawn into the engine cylinder.
3. Burette to measure the rate of fuel consumed.
4. Digital speed indicator to measure the speed of the engine.

ENGINE SPECIFICATION:

MAKE	: HONDA
BHP	: 3
SPEED	: 3000RPM
NO. OF CYLINDER	: ONE
BORE	: 67mm
STROKE	: 56mm
ORIFICE DIA	: 20mm
TYPE OF IGNITION	: SPARK IGNITION
METHOD OF LOADING	: ROPE BRAKE DYNAMOMETER
METHOD OF STARTING	: ROPE

METHOD OF COOLING : AIR COOLED

TO DETERMINE THE FOLLOWING:

1. Specific Fuel Consumption : SFC
2. Brake Horse Power : BP
3. Brake Thermal Efficiency : η_{Bth}
4. Volumetric Efficiency : η_{Vol}

The engine test rig is directly coupled to a brake drum through a shaft and a rope is wound around the drum. One end of the rope is connected to a balance and the other end to a linear balance. The load to the engine can be varied by rotating the hand wheel. Allow cooling water to the brake drum while applying the load.

H.P = (2πNT/4500) x 0.75Kw

T = Torque = W x Re

Where,

W = Net load applied in Kgs = w1 – w2

W1 = Dial balance reading in Kgs

W2 = Linear Balance reading in kgs (pocket type)

Re = Effective radius of the brake drum = D+d /2 = 0.115m

D = Diameter of the brake drum = 0.217m

D = Diameter of the rope in m (0.015m)

N = Speed of engine

FUEL MEASUREMENT

The fuel is supplied from the main fuel tank through a measuring burette with 3 way manifold system. To measure the fuel consumption of the engine, fill the burette by opening the cock from the tank. When the burette is filled with fuel, close the cock from tank. By starting a stop clock measure the time taken to consume 10cc of fuel.

Weight of fuel, wf = (10/Time) x (Specific gravity of diesel / 1000) x 3600 kg/hr

AIR FLOW MEASURMENT:

An air drum is fitted on the panel frame and is connected to the engine through an air hose. The air drum facilitates an orifice. The pressure pickup point is connected to ‘U’ tube manometer limb. The difference in manometer reading is taken at different loads and the air sucked by the engine is calculated by

$$Va = Cd\ A_o \sqrt{2ghw \left(\frac{\rho w}{\rho a}\right) x\ 3600}\ m^3/hr$$

Where,

A_o = Area of orifice = $\pi d^2/4\ m^2$

Cd of orifice = 0.62

Dia of orifice, d = 20mm

TEMPERATURE MEASUREMENT

A digital temperature indicator with selector switch is provided on the panel to read the temperature in deg.c, directly sensed by thermocouples located at different places on the engine test rig.

T1 = Exhaust gas temperature.

T2 = Temperature of air passing through engine head.

T3 = Room temperature.

DIGITAL SPEED INDICATOR

A Digital Speed indicator is provided with proximity sensor to measure the speed of the engine (Readable only when the dynamometer is coupled).

PROCEDURE

1. Connect the instruments power input plug to a 230V, single phase power source. Now the digital temperature indicator displays the respective readings.
2. Fill up the petrol into the tank.
3. Check the lubricating oil level in the sump.
4. Open the petrol cock provided underneath the petrol tank and. Also ensure the accelerator knob is in cut off position (idle condition).
5. Start the engine by pulling. Now the engine is running at idling speed.
6. Increase the speed by turning the accelerator knob clockwise until the speed reaches approx. 3000RPM.
7. Now apply the load by rotating the hand wheel of rope brake dynamometer. The load w1 is indicated on a dial type spring

balance in terms of kg and w2 is linear balance reading. Net load W = W1-W2. Now the engine speed decreases due to the application of load. Operate the acceleration knob simultaneously with the rope brake dynamometer hand wheel and set the load to ¼ of the full load ie, 5kg (approx) on the spring balance.

8. Allow the engine to run at the set load and speed for few minutes. Note down the readings. Then increase the load by repeating the same procedure up to maximum load ie 6.2kg.

FORMULAE REQUIRED

1. Brake power (BP)
   B.P = $(2\pi NT/4500) \times 0.75$Kw
2. Weight of fuel consumed (Wf) in kg/hr
   $$Wf = \frac{(Xcc \times \text{Specific gravity of fuel} \times 60 \times 60)}{(Tsec \times 1000)}$$
   Where Xcc is volume of fuel consumed in T secs
   Specific gravity of petrol is 0.780gm/cc
3. Specific fuel consumption (SFC) in **kg/Kw hr**
   SFC = Wf / BP
4. Brake Thermal Efficiency η_{Bth}
   $$\frac{(BP \times 3600)}{(Cv \times Wf)} \times 100 \text{ in } \%$$
   where calorific value of Petrol, Cv = 62802 KJ/Kg
5. Actual volume (Va) of air drawn into the cylinder at RTP in m^3/hr is calculated by

   $$Va = Cd\, A_o \sqrt{(2ghw\,(\rho w/\,\rho a) \times 3600}\ m^3/hr$$
   Where,
   Cd = 0.62
   A_0 = Area of the orifice
   g = Acceleartion due to gravity ($9.8 m/s^2$)
   h_w = Manometric head in metres of water
   ρ_w = Density of water ($1000\ kg/m^3$)
   ρ_a= Density of air ($1.293\ kg/m^3$)
6. Swept volume (Vs) in **m^3/hr**
   Vs= ALN / 60 **m^3/sec** x 3600 **m^3/hr**

7. Where, A = Area of cylinder

   L = Stroke length

   N = Speed of the engine
8. Volumetric efficiency η_{vol}
   (Actual Volume / Swept Volume) x 100 in %

TABULAR COLUMN

Sl. No.	1	2	3	4	5
Load in kg					
Time taken for 10cc of fuel consumption in sec					
Manometric difference in metres					
Speed					
BP in Kilowatts					
Total fuel consumption in Kg/hr					
Specific fuel consumption in Kg/KWhr					
Brake thermal efficiency					
T1 (exhaust gas temperature)					
T2 (temperature of air passing through the engine head)					
T3 (room temperature)					

Result

PENSKY MARTEN CLOSED CUP FLASH POINT APPARATUS

Aim :

To determine the flash & Fire point of the given oil by using close cup apparatus.

Apparatus required :

Pensky marten close cup apparatus
Thermometer
Electric heater

Flash point :
Flash point of a material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified condition of test.

Fire point :
The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test. Generally this event takes place 10º-15ºC above the flash point.

Procedure :

1. Clean the oil cup and take the given sample of oil up to the mark and place the thermometer in the required position.
2. The bitumen sample is then heated.
3. Stirring is done at the rate of approximately 60 rev per minute
4. The test flame is applied at intervals depending upon expected flash and fire points. Preferably 17ºC below the actual flash point and then at every 1ºC to 3ºC.

5. The flash point is taken as the temperature read on the thermometer at the time of the flame application that causes a bright flash in the interior of the cup in closed system.(for open cup it is the instance when flash appears first at any point on the surface of the material)
6. Heating is continued until the volatiles ignite and the material continues to burn for 5 seconds.
7. The temperature of the sample material when this occurs is recorded as the fire point.

Observation

Sl No	Temperature	Flash or fire point observation
1		Flash
2		Fire

Result

Flash point temperature of given oil=

Fire point temperature of given oil =

SINGLE CYLINDER AIR COMPRESSOR TEST RIG

Aim:

To conduct a test on single cylinder, single stage air compressor and to determine the mechanical efficiency and isothermal efficiency at various delivery pressure.

Description:

Single cylinder compressor is a reciprocating type driven by a prime mover AC motor through belt. The test rig consists of a base on which the tank (air reservoir) is mounted. The outlet of the air compressor is indicated by a pressure gauge. The electrical safety valve is provided for an additional safety. The suction is connected to the air tank with a calibrated orifice plate through the water manometer. The input to the motor is recorded by an energy meter.

Procedure:

- Close the outlet valve
- Check the manometer connections. The manometer is filled with water up to the half level.
- Start the compressor & wait till the pressure reaches 2kgs.
- The tank pressure gauge is read for a particular pressure.
- Note down the rpm of the compressor
- Note down the manometer reading
- Reading of energy meter
- Repeat the experiment for various pressure like 2,4,6,8,10 kgs

Calculations:

01. HNTP = hm=ha (ρ_w/ρ_a)

ρ_w = Density of water = 1000 kg/m^3

ρ_a = Density of air = 1.293 kg/m^3

h = Manometer reading in mm

02. Density of air at R.T.P

Air density at R.T.P = (ρa x 273)/ (273+ room temp.) kg/m^3

03. Actual volume of air drawn at RTP condition

V_a = Cd x A x 2gh (ρ_w/ρ_a) m^3 /sec

Where Cd coefficient of discharge = 0.62

Area of orifice = $\pi d^2/4$ in m^2

d = dia of orifice = 15mm (0.15m)

h = ha $(\rho_w/\ \rho_a)$ in m

ρ_a = 1.293 kg/m^3 (density of air)

ρ_w = 1000 kg/m^3 (density of water)

ha = manometer reading in m

04. Swept volume = Vs

Vs = $\pi/4\ d^2$ x L x Nc/60 in m^3/sec

D is dia of piston = in m

L is stroke length = in m

Nc is speed of the motor in rpm

05. Volumetric efficiency in %

η_{vol} = Va/Vs x 100

Tabular column

S.No	Delivery Pressure (kg/cm²)	Manometer Head Reading			Equivalent Airhead (m)	Volume at RTP*10^{-3} (m)	Theoretical Volume of Air * 10^{-3} (m^3/sec)	Volumetric Efficiency %
		H1	H2	H3				

VALVE TIMING DIAGRAM OF FOUR CYCLE DIESEL ENGINE

Aim :

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

Apparatus Required :

1. Four stroke cycle diesel engine
2. Measuring tape
3. Chalk
4. Piece of paper

Theory and Description:

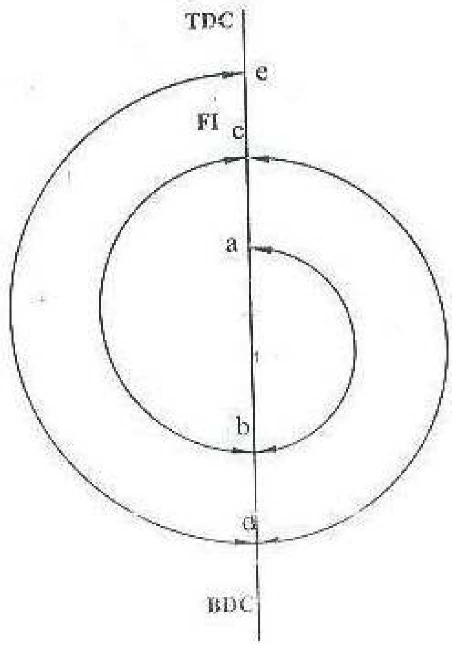
The diagram which shows the position of crank of four stroke cycle engine at the beginning and at the end of suction, compression, expansion, and exhaust of the engine are called as Valve Timing Diagram.
The extreme position of the bottom of the cylinder is called “Bottom Dead Centre” [BDC]. The position of the piston at the top of the cylinder is called “Top Dead Centre” [TDC].
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 compression stroke but in actual practice it will differ.

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, inlet valve is kept open for 25° to 40°after BDC.

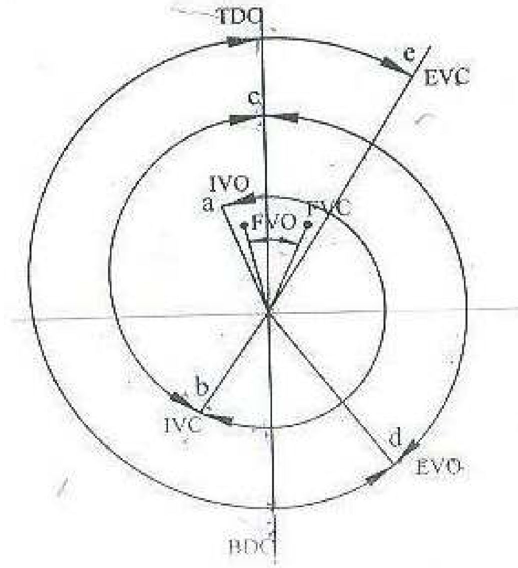
Exhaust valve opening and closing

Complete clearing of the burned gases from the cylinder is necessary to take in more air into the cylinder. To achieve this, 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 or angle of overlap.



IDEAL VALVE TIMING DIAGRAM

ab - Suction (180°)
bc - Compression (180°)
cd - Expansion (180°)
de - Exhaust (180°)
FI - Fuel Injection
(Fuel Valve open and close at TDC immediately)



ACTUAL VALVE TIMING DIAGRAM

IVO - Inlet Valve Open
IVC - Inlet Valve Close
EVC - Exhaust Valve Close
EVO - Exhaust Valve Open
FVO - Fuel Valve Open
FVC - Fuel Valve Close
ab - Suction- More than 180°
bc - Compression-less than 180°
cd - Expansion - Less than 180°
de - Exhaust - More than 180°

Procedure :

1. The inlet and exhaust valves are identified. The flywheels rotation direction has to be ascertained by observing the correct sequence of opening and closing of valves.
2. The reference point is selected near the flywheel periphery.
3. The circumference of flywheel is measured using a string and tape
4. The piston is moved to the top position by rotating the flywheel in the correct direction and a marking is made on the flywheel against a reference point. This is the top dead center (TDC).
5. Another mark is made on the flywheel at 180º from TDC and this is BDC.
6. The flywheel is rotated in the correct direction slowly and opening and closing of inlet valves are marked on the flywheel a IVO and IVC
7. The beginning and ending of fuel injection are also marked on the flywheel a FIB FIC. Similarly the opening and closing of the exhaust valves are also marked on flywheel as EVO and EVC.
8. The circumferential distance between the various marking are measured with respect to nearest dead center and length are converted in to suitable angle and tabulated.

9. The valve timing diagram is drawn. The direction in degree for which both valves remain open is noted as angle of overlap.

OBSERVATION

Sl No.	Event	Position W.R.T TDC/BDC	Subtended angle In degree
1	IVO		
2	TVC		
3	FIB		
4	FIC		
5	EVO		
6	EVC		

Result:

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

Angle of overlap is ___________

REDWOOD VISCOMETER

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

Apparatus required:

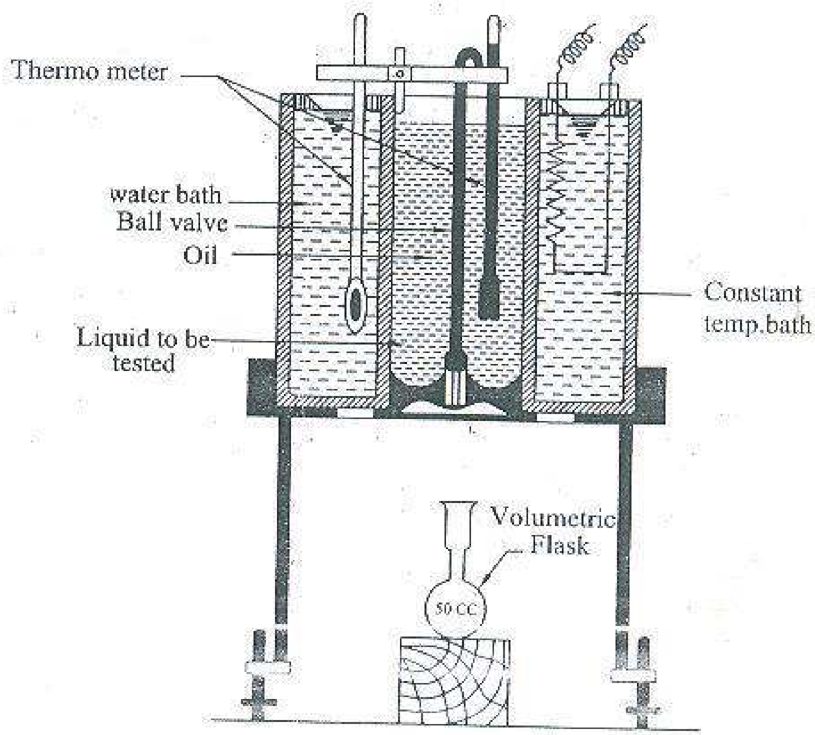
- Red wood viscometer
- Thermometer
- Stopwatch
- 50 ml standard narrow necked flask

Principle

The redwood viscometer consists of vertical cylindrical oil cup with an orifice in the centre of its base. The orifice can be closed by a ball. Hooks pointing upward serve 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 which is to maintain the uniform temperature in the water bath and to place the thermometer to record the temperature of oil and water bath. This viscometer is used to determine the kinematic viscosity of the oil.

Precautions:

- The temperature of oil during the test period should not vary more than $0 - 2^0C$.
- The temperature difference between the oil and water both should not exceed 2^0C.
- The oil should not be stirred during the test period.



Redwood Viscometer

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 cc 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

Observation:

$\rho x = 0.25$

A = 0.22

B = 171.5

$T_r = 147$

S.no	Temperature of oil 0^0C	Time for 50cc 't'	Dencity	Kinematic viscosity centistokes	Abs. Viscosity centipose
1					

Formula:

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

Kinematic viscosity = AxT – B/T Centistokes

Absolute viscosity = K.V x ρ_T Centipoises

Result:

Relative, Kinematic, Absolute viscosities are found out and graphs are plotted.

Kinematic viscosity =

Absolute viscosity =