VALVE TIMING DIAGRAM OF 4S ENGINE

Ex.No:1
Date :

AIM:

To draw the valve timing diagram for the given four stroke engine.

EQUIPMENTS REQUIRED:

1. Measuring tape
2. Scale
3. Thread
4. feeler gauge

FORMULA:

$$\text{Required angle} = \frac{\text{Distance} \times 360}{\text{Circumference of the flywheel}}$$

Where,

Distance = Distance of the valve opening or closing position marked on flywheel with respect to their dead centre.

PROCEDURE:

1. First the TDC and BDC of the engine are found correctly by rotating the flywheel and the positions are marked on the flywheel.
2. Now the circumference of the flywheel is found by using the measuring tape.
3. The flywheel is rotated and the point at which the inlet valve starts opening is found out and its position is marked on the flywheel.
4. Similarly the position at which it closes is also found out.
5. The distances are measured by using thread with respect to their dead centre and converted into angles.
6. The same procedure is repeated for the exhaust valves also.

RESULT:

Thus the valve timing for the given four stroke engine is found out and is drawn.

Inlet valve opens =

Inlet valve closes =

Exhaust valve opens =

Exhaust valve closes =

TABULATION:

Event	Distance from their respective dead centres in "cm"	Valve opening period in degrees
Inlet valve opens		
Inlet valve closes		
Exhaust valve opens		
Exhaust valve closes		

PORT TIMING DIAGRAM OF 2S ENGINE

Ex.No :02

Date :

AIM:

To draw the port timing diagram for the given two stroke engine.

TOOLS REQUIRED:

1. Measuring tape
2. Scale
3. Thread

FIXING THE DEAD CENTRES:

For fixing up the dead centre a chalk mark is made on the piston. The fly wheel is rotated. When the chalk mark coincides with the end of the cylinder a mark is made on the flywheel and it represents TDC.

Now the flywheel is again rotated and the position at which the piston reaches the lower most position is noted on flywheel and it represents the BDC.

IDENTIFICATION OF PORTS:

The port which has more area and is nearer to the TDC is the exhaust port and the other is the inlet port.

DIRECTION OF ROTATION:

As the port opening and closing are symmetrical about the dead centre any arbitrary direction of rotation may be selected.

FORMULA:

$$\text{Required angle} = \frac{\text{Distance} \times 360}{\text{Circumference of the flywheel}}$$

Where,

Distance = Distance of the valve opening or closing position marked on flywheel with respect to their dead centre.

PROCEDURE:

1. The flywheel is turned in any arbitrary direction.
2. During the downward traverse position when it just uncovers a port it is marked as the opening of the port on the flywheel.
3. The rotation is further continued until the piston covers the port during its upward travel.
4. A mark is made on the flywheel against the fixed mark. This gives the closing of the port.
5. The same procedure is repeated for other ports also.

RESULT:

Thus the port time for the given two stroke engine is found out and the port timing diagram is drawn.

Transfer port opens =

Transfer port closes =

Exhaust Port opens =

Exhaust port closes =

TABULATION:

Event	**Distance from their respective dead centres in "cm"**	**Port opening period in degrees**
Exhaust port opens		
Exhaust port closes		
Transfer port opens		
Transfer port closes		

LOAD TEST ON FOUR STROKE SINGLE CYLINDER VERTICAL DIESEL ENGINE

Exp No: 03
Date :

AIM:

To find the load characteristics of four stroke single cylinder vertical diesel engine.

APPARATUS REQUIRED:

Engine test rig, Tachometer, Stop watch, Measuring tape

ENGINE DETAILS:

Power :

Bore :

Stroke :

Calorific value :

Specific gravity :

FORMULAE:

1. Brake power:

$$B.P = \frac{2 \pi N R (W-S)}{60} \quad kW$$

Where,

N= Engine speed in rpm

R = Brake drum radius in cm

W = Dead weight added in Kg

S = Spring Balance reading in Kg

2.Total Fuel consumption :

$$T.F.C = \frac{cc}{t_f} \times \text{Specific gravity} \times \frac{3600}{1000} \quad kg / hr$$

Where,

t_f = Time taken to consume 10cc of fuel in seconds

cc = Amount of fuel consumption measured in cc

3. Specific fuel consumption:

$$S.F.C. = \frac{T.F.C}{B.P} \quad kg / kW\text{-}hr$$

4. Friction power:

Values taken from graph

5. Indicated power:

$$I.P = B.P + F.P \quad kW$$

6. Mechanical efficiency:

$$\eta_{mech} = \frac{B.P}{I.P} \times 100 \quad \%$$

7. Indicated thermal efficiency:

$$\eta_{ith} = \frac{I.P \times 3600}{T.F.C \times C.V} \times 100 \quad \%$$

8. Brake thermal efficiency:

$$\eta_{bth} = \frac{B.P \times 3600}{T.F.C \times C.V} \times 100 \quad \%$$

Where,

C.V = Calorific value of fuel in kJ / kg

9. Indicated mean effective pressure:

$$I.M.E.P = \frac{I.P \times 60000}{L . A . N . k} \quad N/mm^2$$

10. Torque = $\frac{B.P \times 60}{2 \pi N}$

11. Brake mean effective pressure:

$$B.M.E.P = \frac{B.P \times 60000}{L . A . N . k} \quad N/m^2$$

Where,

L = Stroke length, m

A = Area = $\pi /4 D^2$ D = Bore dia in m

N = Speed /2

k = Number of cylinders

DESCRIPTION:

The engine is four stroke, single cylinder, water cooled vertical diesel engine. The engine is connected to rope brake dynamometer. The burette is connected to the engine through three way cock to measure the fuel consumption.

PROCEDURE:

1. The fuel is first filled in the fuel tank
2. Then the cooling arrangements are made.
3. Before starting the engine the brake drum circumference is noted.
4. Before starting check and assure that there is no load on the weight hanger.
5. Now the engine is started and the time taken for 10cc of fuel consumption is noted with the help of a stop watch. This reading corresponds to no load condition.
6. Now place weight in the weight hanger and take the above mentioned readings. The spring balance reading is also noted down.
7. The above procedure is repeated for various loads and the readings are tabulated.
8. The calculations are done and various graphs are plotted.

GRAPH:

1. B.P vs. T.F.C.
2. B.P vs. S.F.C.
3. B.P vs. η_{mech}
4. B.P vs. η_{ith}
5. B.P vs. η_{bth}
6. B.P vs Torque
7. B.P vs BMEP

RESULT:

Thus the load test on single cylinder four stroke vertical diesel engine is performed and its load characteristics are obtained.

TABULAR COLUMN :

Spring Balance Error =
Circumference of Brake drum =

Serial number	Speed N rpm	Dead weight(W) Kg	Spring Balance Weight (S) Kg	Time taken for 10cc of fuel consumption(tf)	Brake power kW	Torque (N-m)	Frictional power (F.P) Kw	Indicated Power (I.P) Kw	Total fuel consumption (TFC) Kg/hr	Specific fuel consumption (SFC) Kg/Kw-hr	BMEP (N/ m^2)	Indicated thermal efficiency %	Brake thermal efficiency %
1													
2													
3													
4													
5													

HEAT BALANCE TEST ON TWIN CYLINDER DIESEL ENGNE WITH ELCTRICAL DYNAMOMETER

Exp No: 4
Date :

AIM:

To prepare the heat balance sheet and to draw a heat balance chart for a twin cylinder four stroke, diesel engine.

APPARATUS REQUIRED:

Tachometer, Stop watch, Thermometer, Water flow meter.

ENGINE DETAILS:

Power	:	
Bore	:	
Stroke	:	
Calorific value	:	46350 kJ / kg
Specific gravity	:	0.8275
Efficiency of Generator	:	70 %

FORMULAE:

1. Brake Power (P) = $\frac{V \times I}{\eta}$ → KW.

Where,

V = Voltmeter reading in volts

I = Ammeter reading in amps

η = Generator efficiency = 0.85

2. Total Fuel consumption :

$$T.F.C = \frac{cc}{t_f} \times \text{Specific gravity} \times \frac{3600}{1000} \quad kg / hr$$

Where,

t_f = Time taken to consume 10cc of fuel in seconds

cc = Fuel consumption in cc

2. Total heat supplied:

$$T.H.S = \frac{T.F.C \times CV}{60} \quad kJ / min$$

Where,

CV = Calorific value of fuel in KJ

3. Heat equivalent to brake power:

= Brake power x 60 → kJ/min

Where,

Brake power is in KW.

4. Mass of air entering the cylinder:

$$= C_d \times a\,(\sqrt{2g\, h_w\, \rho_w\, \rho_a}\,) \rightarrow \text{Kg / min}$$

Where,

C_d - Coefficient of discharge of orifice meter = 0.62

a - Area of orifice meter in m^2

g - Acceleration due to gravity in m / sec^2

h_w - difference in manometer reading in m

ρ_w - Density of water in kg / m^3

ρ_a -Density of air in kg / m^3 = 1.23

5. Mass of exhaust gas:

$$m_g = m_a + m_f \rightarrow \text{kg / min}$$

Where,

m_a = Mass of air consumed per minute

m_f = Mass of fuel consumed per minute

6. Heat carried by exhaust gas:

$$= m_g \times C_{pg}\,(T_e - T_a)\quad \text{kJ / min}$$

Where,

T_a & T_e – Temperature of air inlet & Temperature of exhaust gas

m_g = Mass of exhaust gas

C_{pg} = Specific heat capacity of exhaust gas = 1.001 KJ/Kg-K

7. Heat carried by Cooling water

$$= m_w \times C_{pw} (T_{out} - T_{in}) \quad kJ / min$$

Where,

m_w = Mass of cooling water circulated per minute.

C_{pw} = Specific heat capacity of water = 4.19 KJ/Kg-K

T_{out} = Temperature of outlet water

T_{in} = Temperature of water inlet.

8. Unaccounted heat loss:

= Total heat – (Heat to B.P + Heat carried by cooling water + Heat carried by exhaust gas)

DESCRIPTION:

The engine is four stroke twin cylinder vertical diesel engine. A water rheostat is connected as the loading device. The water flow meter is connected to measure the mass flow rate of water. Fuel consumption can be measured by a burette connected in a three way cock from fuel tank. There is a provision for finding various temperatures at different positions simply by connecting thermocouple at different locations. A U-tube is fitted and it measures the head of air supplied to the engine.

PROCEDURE:

Before starting the engine is supplied with cooling water. The engine is started by means of hand cranking method constant load is applied to the engine.

Open the inlet valve of the cooling water and note the amount of water circulated per minute.

Ensure no load on the engine. The time taken for consumption of 10 cc of fuel is noted.

The exhaust gas temperature, cooling water, inlet and outlet is noted. The difference in the U-Tube in manometer is noted.

The voltmeter and ammeter readings of the electric dynamometer are noted.

The above said readings are taken again by operating the engine at various load conditions.

Heat balance sheet is drawn as per the readings.

RESULT:

Thus the heat balance sheet for the four stroke twin cylinder diesel engine is drawn and distribution of heat can be seen from pie chart/graph.

Observation:

Orifice diameter =

Weight of water circulated =

Inlet temperature of cooling water =

Atmospheric temperature =

TABULAR COLUMN :

Serial number	Ammeter Reading (I) amps	Voltmeter reading (V) volts	Manometer difference in cm	Time taken for 10cc of fuel consumption sec	Exhaust gas temp C	Cooling water outlet temp. C	Brake Power Kw	Heat supplied Kw	Heat equivalent to B.P in Kw	Heat carried by cooling water Kw	Heat carried by exhaust gas Kw	Unaccounted Loss Kw	Heat equivalent to B.P (%)	Heat carried by cooling water (%)	Heat carried by exhaust gas (%)	Unaccounted loss (%)
1																
2																
3																
4																
5																

TEMPERATURE DEPENDENCE OF VISCOSITY OF LUBRICATION OIL BY REDWOOD VISCOMETER

Ex.No.8

Date:

AIM:

To determine the viscosity of given lubrication oil by Redwood viscometer.

APPARATUS REQUIRED:

i. Redwood viscometer
ii. Thermometer
iii. Conical flask
iv. Stop watch

DESCRIPTION:

Viscosity is the property of a fluid or liquid by virtue of which it offers resistance to its own flow. It is measured in poise. The kinematic viscosity of a liquid is the ratio of absolute viscosity to its density at the given temperature and the unit for kinematic viscosity is centistokes. Viscosity is the most important single property of any lubricating oil, because it is the main determinant of the operating characteristics of the lubricant. if the viscosity of the oil is too low, a liquid oil film cannot be maintained between two moving or sliding surfaces, and consequently excessive wear will take place. On the other hand if the viscosity is too high, excessive friction will result due to fluid friction.

Measurement of viscosity of lubricating oil is made with the help of an apparatus called the viscometer. In a viscometer, a fixed volume of the liquid is allowed to flow from a given height through a standard capillary tube under its own weight and the time of flow in seconds is noted. The time is proportional to true viscosity. The redwood viscometer is commonly used in commonwealth countries.

Redwood viscometer is of two types: Redwood viscometer No.1 is commonly used for determining viscosities of thin lubricating oils and it has a jet of bore diameter 1.62mm and length 10mm. Redwood viscometer No.2 is used for measuring viscosities of highly viscous oils. It has a jet of diameter 3.8mm and length 15mm.

FORMULA:

1. Density (ρ) = ρ_{15} [1-α (T-15)] kg/m^3

   Where,

   ρ_{15} = Density of the given oil = 866 kg/m^3

   α = 0.00036 a constant

   T = Temperature of oil

2. Kinematic viscosity (ν) = At – B/t x 10^{-6} m^2/ s

   Where,

   A= 0.247, B= 65 , for t = 85 to 200 seconds

   t = time taken to collect 50ml in seconds

   A = 0.264 , B = 190 , for t = 40 to 85 seconds.

3. Dynamic Viscosity (μ) = ρ x ν NS / m^2

PROCEDURE:

1. The leveled oil cup is cleaned and ball valve rod is placed on the gate jet to close it.
2. Oil under test, free from any suspension and dust is filled in the cup upto the pointer level.
3. An empty conical flask is kept just below the jet.
4. Water is filled in the bath and side-tube is heated slowly with constant stirring of the bath.
5. When the oil is at the desired temperature, the ball valve is lifted and suspended from thermometer bracket.
6. The time taken to collect 50ml of oil in the flask is noted and the valve is immediately closed to prevent any overflow of oil.
7. The result is expressed in redwood No.1 seconds at particular temperature.
8. Similarly the above procedure is repeated for the oil at various temperatures and the viscosity is found out.
9. Now a graph is drawn between the temperature and viscosity of oil.

GRAPH:

i. Temperature Vs Kinematic viscosity

ii. Temperature Vs Dynamic Viscosity

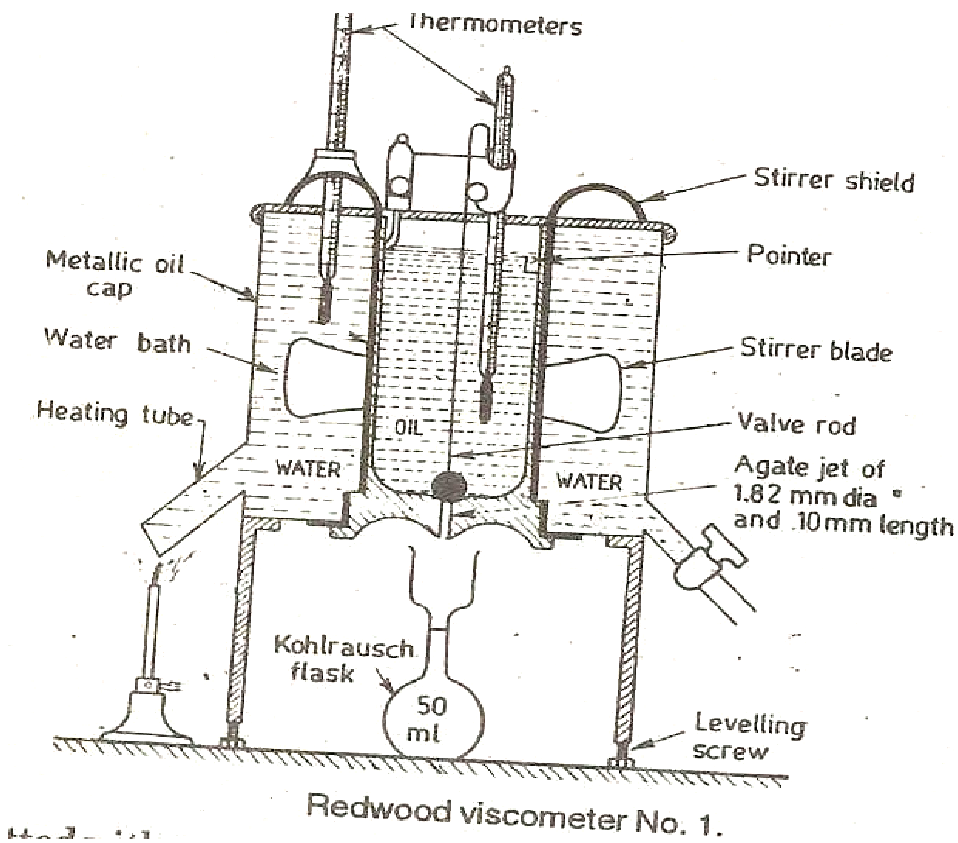
RESULT:

Thus the viscosity of the lubrication oil is found out using Redwood viscometer and the graphs are drawn.

Tabular Column:

S.N0.	Temperature of oil °C	Time taken for 50ml collection in seconds	Density (ρ) kg/m^3	Kinematic viscosity (ν) m^2/s	Dynamic viscosity (μ) NS/m^2
1					
2					
3					
4					
5					

DIAGRAM:



Redwood viscometer No. 1.

FLASH AND FIRE POINTS OF FUELS

Ex.No : 9

Date :

AIM:

To determine the flash and fire point of the given fuel.

APPARATUS REQUIRED:

1. Pensky Martens closed cup flash-point apparatus
2. Thermometer

DESCRIPTION:

Flash point is the lowest temperature at which the fuel gives off enough vapours that ignite for a moment, when a small flame is brought near it. Fire point is the lowest temperature at which the vapours of the oil burn continuously for atleast 5 seconds when a tiny flame is brought near it. In most cases fire points are 5°C to 40°C higher than the flash point. The flash and fire-points are usually determined by using Pensky-Marten's apparatus.

PROCEDURE:

1. The fuel under examination is filled upto the mark in the oil cup and then heated by heating the water-bath by a burner.
2. Stirrer is worked between tests at a rate of about 1 to 2 revolutions per second.
3. Heat is applied so as to raise the oil temperature by about 5°C per minute.
4. At every 1°C rise of temperature, flame is introduced for a moment by working the shuttle.
5. The temperature at which a distinct flash (a combination of a weak sound and light) appears is noted and is the flash point.
6. The heating is continued thereafter and the test-flame is applied as before.
7. When the oil ignites and continues to burn for atleast 5 seconds, the temperature reading is noted and is the fire point.

RESULT:

Thus the flash and fire-point of the given fuel is found out experimentally.

Flash Point_______________

Fire point _________________

Tabulation:

Sl.No.	Temperature °C	Observation

<u>EMISSION TEST ON A SINGLE CYLINDER CONSTANT SPEED DIESEL ENGINE</u>

AIM: -

To determine the exhaust emissions from a single cylinder of constant speed diesel engine at various loads by flue gas analyzer and smoke meter.

APPARATUS REQUIRED: -

1. Diesel engine with a loading device
2. Smoke chamber
3. Smoke measuring meter
4. Flue gas analyzer
5. U- Tube Manometer
6. Tachometer
7. Nose mask
8. Ear plug

INTRODUCTION: -

Emissions may be divided into two groups viz., invisible and visible emissions. The exhaust of an engine may contain one or more of the following:

1. Carbon dioxide (CO_2)
2. Water vapour (H_2O)
3. Oxides of Nitrogen (NO_x)
4. Unburnt Hydrocarbons (HC)
5. Carbon Monoxide (CO)
6. Aldehydes
7. Smoke and
8. Particulate

Out of the eight the first six may be grouped as invisible emissions and the last two as visible. The principle by which the composition of each emission to be found is given below.

(i) NO_x composition: (Chemiluminescence analyzer)

The principle of measurement is based on chemiluminescence reaction between ozone and NO resulting in the formation of excited NO_2. This excited NO2 emits light whose intensity is proportional to NO concentration then by photo multiplier the intensity of light is found.

(ii) CO composition: (Non Dispersive Infrared analyzer)

Selective absorption of the infrared energy of a particular wavelength peculiar to a certain gas, which will by absorb by that gas.

(iii) HC composition: (Flame ionization detector)

Ionization is a characteristic of HC ionized carbon atoms from the hydrocarbons in hydrogen – oxygen flame is achieved in the FID analyzer. Current flow in micro amperes is a measure of the concentration of HC.

(iv) SMOKE Composition:

1. Comparison Method
2. Obscuration Method

Comparison Method:

The smoke composition is measured by measuring the density of the smoke in the chamber.

Obscuration Method:

a. Light extinction type
b. Continuous filtering type
c. Spot filtering type

a. Light extinction type:

In this method a beam of light is passed through the smoke emitted, the intensity of light reduced will give the smoke concentration

b. Continuous Filtering: (Van Brand Smoke meter)

Measurement of smoke intensity is achieved by continuously passing exhaust gas through a moving strip of filter paper and collecting particles.

c. Spot Filtering: (Bosch Smoke meter)

A smoke stain obtained by filtering a given quantity of exhaust gas through a fixed filter paper is used for the measure of smoke intensity.

ENGINE SPECIFICATIONS: -

Make	---	Meenakshi ISI
Bore	---	80 mm
Stroke	---	110 mm
R.P.M	---	1500

B.H.P.	---	5 (Single cylinder) 10 (Twin cylinder)
Compression Ratio	---	16:1
Fuel oil	---	H.S. Diesel Oil
Specific Gravity	---	0.8275
Calorific Value	---	10,833 K cal /Kg.

PROCEDURE: -

1. Before starting the experiment, follow the safety rules to work near the engine environment like using nose mask, ear plug etc.,
2. Ensure the water circulation of engine, engine load, engine speed and fuel etc.
3. Start the engine by manual cranking of flywheel.
4. Some part of the exhaust gases are collected in the smoke chamber, by suitably adjusting the exhaust pipe outlet lever which is provided after the smoke chamber in line of smoke pipe, maintain the smoke pressure in the chamber as 6cm to 7cm.
5. Ensure Leak check in Exhaust gas analyzer before measuring.
6. Switch on the heater unit in the smoke meter and maintain a temperature of 60 ^{o}C
7. After keeping the operating unit of smoke meter from CAL mode to TEST mode, the probe is inserted in the port provided in smoke chamber. Similarly the probe of the gas analyzer is also inserted in another port of smoke chamber.
8. The display of gas analyzer and operating unit of smoke meter shows the corresponding values of smoke percentage and emissions at zero loads.
9. By varying the engine load and keeping the constant engine speed, take the various smoke and exhaust emissions compositions at corresponding loads and tabulated the values.
10. Remove the probes from chamber, stop the engine and switch off the instruments

GRAPH:-

The following are graphs to be drawn

BP Vs CO, HC, NO_X

λ Vs CO, HC, NO_X

BP Vs SMOKE

λ Vs SMOKE

TABULATION

S.No.	LOAD (Amps)	Exhaust Gas temp. (^{o}C)	Water outlet Temp. (^{o}C)	**EXHAUST GAS ANALYSER**						**SMOKE (N)**
				CO (%vol)	HC (ppm)	CO_2 (%vol)	NO_X (ppm)	O_2 (%vol)	λ	

1.										
2.										
3.										
4.										
5.										
6.										
7.										

ENGINE SPEED: 1500 rpm

BRAKE POWER = (V*I) / (1000*0.8) kW

Where

V= voltage

I= current

RESULT:-

Thus the various emissions obtained from engine outlet are measured by using smoke meter and gas analyzer at different loads of the engine.