**Experiment No 6**

***Test on Four Stroke Diesel Engine***

**AIM**:- To prepare heat balance sheet on Single-Cylinder Diesel Engine.

**APPARATUS USED :-** Single-Cylinder Diesel Engine (Constant Speed) Test Rig, Stop Watch and Digital Tachometer.

**THEORY:-** The thermal energy produced by the combustion of fuel in an engine is not completely utilized for the production of the mechanical power. The thermal efficiency of I. C. Engines is about 33 %. Of the available heat energy in the fuel, about 1/3 is lost through the exhaust system, and 1/3 is absorbed and dissipated by the cooling system.

It is the purpose of heat balance sheet to know the heat energy distribution, that is, how and where the input energy from the fuel is is distributed.

The heat balance sheet of an I. C. Engine includes the following heat distributions:

a. Heat energy available from the fuel brunt.

b. Heat energy equivalent to output brake power.

c. Heat energy lost to engine cooling water.

d. Heat energy carried away by the exhaust gases.

e. Unaccounted heat energy loss.

**FORMULE USED :-**

(i) Torque, **T = Load x Torque Arm**

(ii) Brake Power, **B P = ( 2πN T ) / 60, 000** KW

*; Where N = rpm, T = Torque N-m,*

(iii) Fuel Consumption, **m f = ( 10 cc x 10 -6 x ρFuel ) / ( t )** Kg/Sec

Here; 1 ml = 10-3 liters, and 1000 liters = 1 m3

So 1 ml = 10-6 m3

(iv) Heat energy available from the fuel brunt, **Qs = mf x C. V. x 3600** KJ/hr

(v) Heat energy equivalent to output brake power, **QBP = BP x 3600** KJ/hr

(vi) Heat energy lost to engine cooling water, **QCW = mw x Cw (two - twi) x 3600** KJ/hr

(vii) Heat energy carried away by the exhaust gases, **QEG = mfg x Cfg (tfg – tair) x 3600** KJ/hr

Where mfg = (mf + mAir) Kg/Sec, and mAir = Cd Ao √2 g ∆h ρAir ρWater Kg/ Sec

Where Cd ( Co-efficient of Discharge ) = 0.6, ρAir **=** ( Pa x 102 ) / ( R x Ta ) Kg/ m3,

Ao ( Area of Orifice ) = (πdo2)/ 4 m2, P1 = 1.01325 Bar, R = 0.287 KJ/Kg . K,

Ta = ( ta + 273 ) K, ta = Ambient Temperature OC

(viii) Unaccounted heat energy loss, **QUnaccounted = Qs – { QBP + QCW + QEG }** KJ/hr

**PROCEDURE :-**

1. Before starting the engine check the fuel supply, lubrication oil, and availability of coolingwater.

2. Set the dynamometer to zero load and run the engine till it attain the working temperature and steady state condition.

3. Note down the fuel consumption rate, Engine cooling water flow rate, inlet and outlet

temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.

4. Set the dynamometer to 20 % of the full load, till it attains the steady state condition. Note down the fuel consumption rate, Engine cooling water flow rate, inlet and outlet temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.

5. Repeat the experiment at 40 %, 60 %, and 80 % of the full load at constant speed.

6. Disengage the dynamometer and stop the engine.

7. Do the necessary calculation and prepare the heat balance sheet.

**OBSERVATIONS:-**

Rated Power = 3.5 KW

Engine Speed, N = 1500 rpm

No. of Cylinders, n = Single

Calorific Value of Fuel, C.V. = 45340 KJ/Kg

Specific Heat of Water, Cw = 4.187 KJ/Kg . K

Specific Gravity of Fuel = 0.83

Gas Constant, R = 0.287 KJ/Kg . K

Ambient Temperatu re, t a = oC

Atmospheric Pressure, Pa = 1.01325 Bar

Orifice Diameter, do = 20 mm

Co-efficient of Discharge, Cd = 0.6

Density of fuel (Diesel), ρ Fuel = 810 to 910 Kg/m3

Density of Water, ρwater = 1,000 Kg/m3

Engine Capacity = 661.55 CC

Connecting Rod Length =234 mm

Dynamometer Arm =0.185 m

**OBSERVATIONS TABLE :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SR NO** | **PARAMETER** | **LOAD** | | | |
| **LOAD 1** | **LOAD 2** | **LOAD 3** | **LOAD 4** |
| 1. **ENGINE SECTION** | | | | | |
| **1** | **Speed(N)** |  |  |  |  |
| **2** | **Time required for 10cc fuel consumption** |  |  |  |  |
| **3** | **Temp. of water inlet to engine** |  |  |  |  |
| **4** | **Temp. of water outlet to engine** |  |  |  |  |
| **5** | **Time for 1 lit. flow of water to engine** |  |  |  |  |
| 1. **CALORIMETER SECTION** | | | | | |
| **6** | **Time for 1 lit. flow of water to calorimeter** |  |  |  |  |
| **7** | **Temp. of water inlet to calorimeter** |  |  |  |  |
| **8** | **Temp. of water outlet to calorimeter** |  |  |  |  |
| **9** | **Temp. of gas inlet to calorimeter** |  |  |  |  |
| **10** | **Temp. of gas outlet to calorimeter** |  |  |  |  |

**CALCULATIONS:-**

**Result Table :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sr..  No. | Engine Speed,  N (rpm) | Brake Power,  BP (KW) | Fuel  Consumption,  mf (Kg/hr) | Heat Supplied | Thermal Efficiency |
| **1** |  |  |  |  |  |
| **2** |  |  |  |  |  |
| **3** |  |  |  |  |  |
| **4** |  |  |  |  |  |

**HEAT BALANCE SHEET :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Heat Energy  Supplied | KJ/hr | **% age** | Heat Energy Consumed  (Distribution) | KJ/hr | % age |
| **Heat energy**  **available**  **from the fuel**  **brunt** |  |  | (a) Heat energy equivalent  to output brake power. (b) Heat energy lost to  engine cooling water. (c) Heat energy carried  away by the exhaust ases.  (d) Unaccounted heat  Energy Loss. |  |  |
| **Total** |  | **100 %** | **Total** |  | **100 %** |

**Experiment No 8**

***Morse Test on Multi-Cylinder Engine***

**AIM:-**To find the indicated power (IP) on Multi-Cylinder Petrol Engine by Morse test.

**APPARATUS USED: -** Multi-Cylinder Petrol Engine Test Rig, Stop Watch, Hand Gloves, and Digital Tachometer.

**THEORY :-** The purpose of Morse Test is to obtain the approximate Indicated Power of a Multi-cylinder Engine. It consists of running the engine against a dynamometer at a particular speed, cutting out the firing of each cylinder in turn and noting the fall in BP each time while maintaining the speed constant. When one cylinder is cut off, power developed is reduced and speed of engine falls.

Accordingly the load on the dynamometer is adjusted so as to restore the engine speed. This is done to maintain FP constant, which is considered to be independent of the load and proportional to the engine speed. The observed difference in BP between all cylinders firing and with one cylinder cut off is the IP of the cut off cylinder. Summation of IP of all the cylinders would then give the total IP of the engine under test.

**FORMULE USED :-**

(i) Brake Power, **B P = ( 2πN T ) / 60, 000** KW;

(ii) Indicated Power ( IP ) of each Cylinders:

IP1 = ( BPT - BP2,3,4 ) KW

IP2 = ( BPT - BP1,3,4 ) KW

IP3 = ( BPT - BP1,2,4 ) KW

IP4 = ( BPT - BP1,2,3 ) KW

(iii) Total IP of the Engine, IPT = ( IP1 + IP2 + IP3 + IP4 ) KW

(iv) Mechanical Efficiency, ηmechanical = BPT / IPT

**PROCEDURE:-**

1. Before starting the engine check the fuel supply, lubrication oil, and availability of cooling water.

2. Set the dynamometer to zero load.

3. Run the engine till it attains the working temperature and steady state condition. Adjust the dynamometer load to obtain the desired engine speed. Record this engine speed and dynamometer reading for the BP calculation.

4. Now cut off one cylinder. Short-circuiting its spark plug can do this.

5. Reduce the dynamometer load so as to restore the engine speed as at step 3 . Record the dynamometer reading for BP calculation.

6. Connect the cut off cylinder and run the engine on all cylinders for a short time. This is necessary for the steady state conditions.

7. Repeat steps 4, 5, and 6 for other remaining cylinders turn by turn and record the

dynamometer readings for each cylinder.

8. Bring the dynamometer load to zero, disengage the dynamometer and stop the engine.

9. Do the necessary calculations.

**OBSERVATIONS:-**

Engine Speed, N = rpm

No. of Cylinders, n = Four

Calorific Value of Fuel, C.V. = 47300 KJ/Kg

**OBSERVATIONS TABLE :-**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sl. No. | Cylinders  Working | Dynamometer  Reading, (KW) | Brake Power, BP  (KW) | IP of the cut off  cylinder, (KW) |
| 1. | 1-2-3-4 |  | BPT |  |
| 2. | 2-3-4 |  | BP2,3,4 = | IP1 = |
| 3. | 1-3-4 |  | BP1,3,4 = | IP2 = |
| 4. | 1-2-4 |  | BP1,2,4 = | IP3 = |
| 5. | 1-2-3 |  | BP1,2,3 = | IP4 = |

**CALCULATIONS:-**

**RESULT:-** Total IP of the Multi-Cylinder Petrol Engine by Morse Test, IPT = KW

**Experiment No 7**

***Trial on Four Stroke Petrol Engine***

**AIM**:- To prepare heat balance sheet on Multi-Cylinder Petrol Engine.

**APPARATUS USED :-** Multi-Cylinder Petrol Engine Test Rig, Stop Watch and Digital Tachometer.

**THEORY:-** The thermal energy produced by the combustion of fuel in an engine is not completely utilized for the production of the mechanical power. The thermal efficiency of I. C. Engines is about 33 %. Of the available heat energy in the fuel, about 1/3 is lost through the exhaust system, and 1/3 is absorbed and dissipated by the cooling system.

It is the purpose of heat balance sheet to know the heat energy distribution, that is, how and where the input energy from the fuel is is distributed.

The heat balance sheet of an I. C. Engine includes the following heat distributions:

a. Heat energy available from the fuel brunt.

b. Heat energy equivalent to output brake power.

c. Heat energy lost to engine cooling water.

d. Heat energy carried away by the exhaust gases.

e. Unaccounted heat energy loss.

**FORMULE USED :-**

(i) Torque, **T = Load x Torque Arm**

(ii) Brake Power, **B P = ( 2πN T ) / 60, 000** KW

*; Where N = rpm, T = Torque N-m,*

(iii) Fuel Consumption, **m f = ( 10 cc x 10 -6 x ρFuel ) / ( t )** Kg/Sec

Here; 1 ml = 10-3 liters, and 1000 liters = 1 m3

So 1 ml = 10-6 m3

(iv) Heat energy available from the fuel brunt, **Qs = mf x C. V. x 3600** KJ/hr

(v) Heat energy equivalent to output brake power, **QBP = BP x 3600** KJ/hr

(vi) Heat energy lost to engine cooling water, **QCW = mw x Cw (two - twi) x 3600** KJ/hr

(vii) Heat energy carried away by the exhaust gases, **QEG = mfg x Cfg (tfg – tair) x 3600** KJ/hr

Where mfg = (mf + mAir) Kg/Sec, and mAir = Cd Ao √2 g ∆h ρAir ρWater Kg/ Sec

Where Cd ( Co-efficient of Discharge ) = 0.6, ρAir **=** ( Pa x 102 ) / ( R x Ta ) Kg/ m3,

Ao ( Area of Orifice ) = (πdo2)/ 4 m2, P1 = 1.01325 Bar, R = 0.287 KJ/Kg . K,

Ta = ( ta + 273 ) K, ta = Ambient Temperature OC

(viii) Unaccounted heat energy loss, **QUnaccounted = Qs – { QBP + QCW + QEG }** KJ/hr

**PROCEDURE :-**

1. Before starting the engine check the fuel supply, lubrication oil, and availability of coolingwater.

2. Set the dynamometer to zero load and run the engine till it attain the working temperature and steady state condition.

3. Note down the fuel consumption rate, Engine cooling water flow rate, inlet and outlet

temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.

4. Set the dynamometer to 20 % of the full load, till it attains the steady state condition. Note down the fuel consumption rate, Engine cooling water flow rate, inlet and outlet temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.

5. Repeat the experiment at 40 %, 60 %, and 80 % of the full load at constant speed.

6. Disengage the dynamometer and stop the engine.

7. Do the necessary calculation and prepare the heat balance sheet.

**OBSERVATIONS:-**

Make = Maruti ECCO MPFI

Rated Power = 73 HP

Capacity = 1196.16 cc

Engine Speed, N = 6000 rpm

No. of Cylinders, n = FOUR

Calorific Value of Fuel, C.V. = 47300 KJ/Kg

Specific Heat of Water, Cw = 4.187 KJ/Kg . K

Gas Constant, R = 0.287 KJ/Kg . K

Ambient Temperatu re, t a = oC

Atmospheric Pressure, Pa = 1.01325 Bar

Orifice Diameter, do = 20 mm

Co-efficient of Discharge, Cd = 0.6

Density of fuel (Diesel), ρ Fuel = 740 Kg/m3

Density of Water, ρwater = 1,000 Kg/m3

**OBSERVATIONS TABLE :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SR NO** | **PARAMETER** | **LOAD** | | | |
| **LOAD 1** | **LOAD 2** | **LOAD 3** | **LOAD 4** |
| 1. **ENGINE SECTION** | | | | | |
| **1** | **Speed(N)** |  |  |  |  |
| **2** | **Time required for 10cc fuel consumption** |  |  |  |  |
| **3** | **Temp. of water inlet to engine** |  |  |  |  |
| **4** | **Temp. of water outlet to engine** |  |  |  |  |
| **5** | **Time for 1 lit. flow of water to engine** |  |  |  |  |
| 1. **CALORIMETER SECTION** | | | | | |
| **6** | **Time for 1 lit. flow of water to calorimeter** |  |  |  |  |
| **7** | **Temp. of water inlet to calorimeter** |  |  |  |  |
| **8** | **Temp. of water outlet to calorimeter** |  |  |  |  |
| **9** | **Temp. of gas inlet to calorimeter** |  |  |  |  |
| **10** | **Temp. of gas outlet to calorimeter** |  |  |  |  |

**CALCULATIONS:-**

**Result Table :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sr..  No. | Engine Speed,  N (rpm) | Brake Power,  BP (KW) | Fuel  Consumption,  mf (Kg/hr) | Heat Supplied | Thermal Efficiency |
| **1** |  |  |  |  |  |
| **2** |  |  |  |  |  |
| **3** |  |  |  |  |  |
| **4** |  |  |  |  |  |

**HEAT BALANCE SHEET :-**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Heat Energy  Supplied | KJ/hr | **% age** | Heat Energy Consumed  (Distribution) | KJ/hr | % age |
| **Heat energy**  **available**  **from the fuel**  **brunt** |  |  | (a) Heat energy equivalent  to output brake power. (b) Heat energy lost to  engine cooling water. (c) Heat energy carried  away by the exhaust ases.  (d) Unaccounted heat  Energy Loss. |  |  |
| **Total** |  | **100 %** | **Total** |  | **100 %** |