HEAT BALANCE SHEET ON IC ENGINE

Ex.No. Date:

Aim:

To conduct the test on the given IC engine and to prepare the heat balance sheet.

Apparatus Required:

1. Given IC engine with loading arrangement
2. Measuring tape or thread and scale
3. Tachometer
4. Stop watch
5. Bucket
6. Spring balance
7. Thermometer (3 Nos)

Theory and Description:

A heat balance sheet is an account of heat supplied and heat utilised in various ways in the system. Necessary information concerning the performance of the engine is obtained from the heat balance sheet. The heat balance sheet is generally done on second basis or minute basis or hour basis.

The engine should be equipped with suitable loading arrangement to measure the brake power of the engine. Provisions are also made to measure the amount of air intake, amount of fuel consumed, temperature of cooling water at inlet and outlet of the engine, amount of cooling water circulated and temperature of exhaust gases.

The heat supplied to the engine is only in the form of fuel – heat and is equal to:

\[ Q_s = mf \times C.V \]

Where,

- \( mf \) = mass of fuel used in kg/min
- \( C.V \) = Calorific value of fuel in KJ/kg

The various way in which the heat is utilised are:

1. Heat equivalent to brake power of the engine.
2. Heat carried away by the cooling water.
3. Heat carried away by the exhaust gases.
4. Unaccounted heat losses.
Observation and Tabulation

1. Brake power B.P = _____ KW

2. Speed $N = ___$ RPM

3. Type of loading: _____

4. Fuel used:

5. Calorific value of fuel $CV = ____ KJ/kg$
   - For diesel: 42,000 KJ/kg to 45000 KJ/kg
   - For petrol: 41,000 KJ/kg to 44,000 KJ/kg

6. Effective Radius of the drum: $Re = ____$

7. Specific gravity of fuel:
   - For diesel: 0.83
   - For petrol: 0.78

8. Diameter of orifice $d = ____$ m.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Loading</th>
<th>Manometer Reading</th>
<th>mass of air consumed 'ma' in kg/min</th>
<th>Time taken for 10cc fuel consumption 't' in sec</th>
<th>Time for 5 ltr water collection in 't' sec</th>
<th>Cooling water Temp</th>
<th>Room Temp</th>
<th>Exhaust gas Temp</th>
<th>Engine speed 'N' in RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$W_1$</td>
<td>$W_2$ - $W_1$</td>
<td>$L_1$ - $L_2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Formulae Used:

Heat equivalent to B.P:

The brake power in KW is converted into KJ/min

\[ Q_{B.P} = B.P \times 60 = \text{_______} \text{ KJ/min} \]

Heat carried away by the cooling water : (Qw)

\[ Q_w = M_w \times C_{Pw} \left( T_\text{w} - T_\text{i} \right) \text{ in KJ/min} \]

Where,

- \( M_w \) = mass of cooling water circulated in kg/min
- \( C_{Pw} \) = Specific heat of cooling water
  = 4.186 KJ/kgK
- \( T_\text{w} \) = Temperature of cooling water at inlet in °C
- \( T_\text{i} \) = Temperature of cooling water at outlet of the engine in °C

Heat carried away by the exhaust gases : (Qg)

\[ Q_g = m_g \times C_{Pg} \left( T_\text{g} - T_\text{R} \right) \]

- \( m_g \) = mass of the exhaust gases in kg/min
- \( m_a \) = mass of air consumed in kg/min
- \( m_f \) = mass of fuel consumed in kg/min
- \( C_{Pg} \) = Specific heat of exhaust gases
  = 1.005 KJ/kgK
- \( T_\text{g} \) = Temperature of exhaust gases in °C
- \( T_\text{R} \) = Room temperature in °C

Unaccounted heat losses:

\[ Q_{un} = Q_s - (Q_{B.P} + Q_w + Q_g) \text{ in KJ / min} \]
Procedure:

1. From the name plate details, calculate the maximum load that can be applied on the given engine.
2. Check the engine for fuel availability, lubricant and cooling water connection.
3. Release the load on engine completely and start the engine with no load condition.
   Allow the engine to run for few minute to attain the rated speed.
4. Adjust the cooling water flow and maintain steady flow of water.
5. Apply the load, from no load to required load slowly. At required load slowly.
   At required load note the following:
   i) Load on the engine
   ii) Speed of the engine in Rpm
   iii) Time taken for 10 cc of fuel consumption
   iv) Manometer readings
   v) Temperature of cooling water at engine inlet and engine outlet in °C
   vi) Time taken for collection of 5 lit or 10 lit of cooling water
   vii) Room temperature and temperature of exhaust gases
Heat Balance Sheet:

<table>
<thead>
<tr>
<th>S No</th>
<th>Particulars</th>
<th>Credits</th>
<th>Debits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>KJ/min</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>Qs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Q_{BP}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Q_{w}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Qg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Q_{un}</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Result:

The test was conducted on the given IC engine and the heat balance sheet was prepared for the particular load.