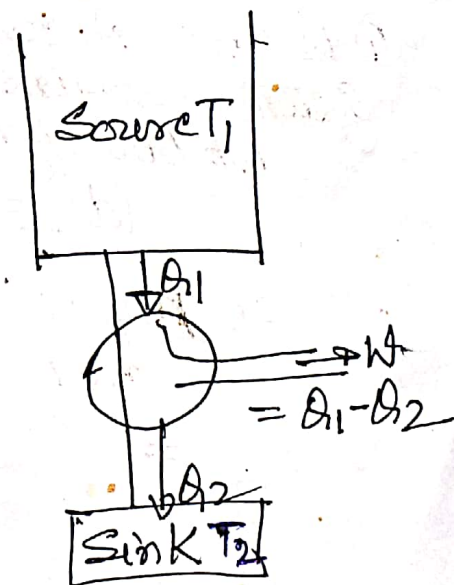
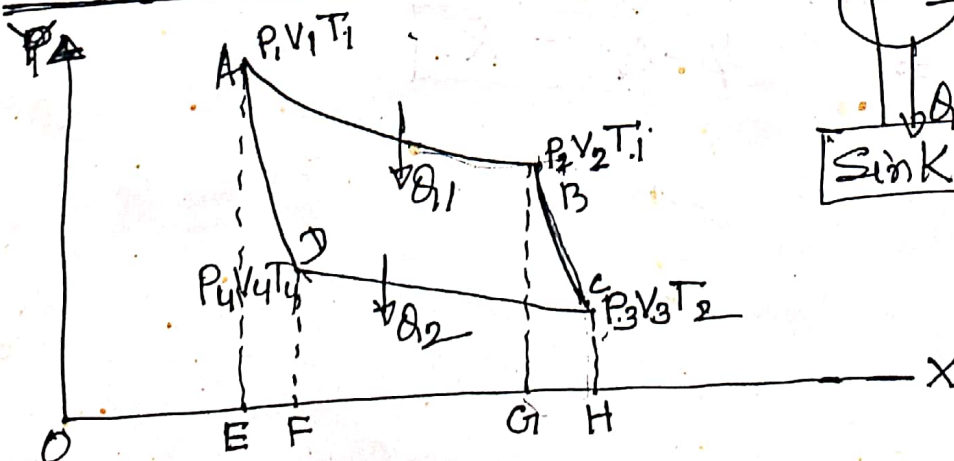


Engine is a device which converts heat energy into mechanical work. Carnot's engine consist of following parts

- ① source :- It is a hot body at temp (T_1) which gives the heat & energy to working substance.
- ② Sink :- It is a cold body at constant temp T_2 which receives the energy by working substance
- ③ Working substance :- It is a substance in the form of fluid (liquid or gases) on which the engine performs its cyclic operation.



Working of Carnot's engine



Work or Carnot cycle:-

① At first the working substance is kept at the source of temp T_1 and gas is expanded isothermally from state P_1, V_1 to state P_2, V_2

The working work done by the gas.

$$W_1 = \int_{V_1}^{V_2} P dv = RT_1 \log \frac{V_2}{V_1}$$

$$Q_1 = \text{Area ABGE}$$

② The engine is placed on the insulated stand. It is expanded adiabatically to the pressure P_3 & Volume V_3

The work done in adiabatic expansion

$$W_2 = \frac{R(T_1 - T_2)}{\gamma - 1}$$

$$= \text{Area (BCHG)}$$

③ The engine is placed on the sink T_2 and it is compressed isothermally to the pressure P_4 & Volume V_4 . The work done

$$W_3 = \int_{V_3}^{V_4} P dV = -R T_2 \log \frac{V_4}{V_3}$$

$$\text{or, } Q_2 = -R T_2 \log \frac{V_4}{V_3} = \text{Area (CDEH)}$$

④ Finally the engine is placed on the insulating stand and compressed adiabatically to pressure P_1 and volume V_1 . Work done:

$$W_4 = -R \left[\frac{T_1 - T_2}{\gamma - 1} \right]$$

$$= \text{Area (DAcd)}$$

The total work done by the engine.

$$W = W_1 + W_2 + W_3 + W_4$$

$$\text{or, } W = RT_1 \cdot \text{Log} \frac{V_2}{V_1} + \frac{R(T_1 - T_2)}{\gamma - 1} - RT_2 \text{Log} \frac{V_3}{V_4} \quad \text{--- (8)}$$

$$- \frac{R(T_1 - T_2)}{\gamma - 1}$$

$$W = RT_1 \text{Log} \frac{V_2}{V_1} - RT_2 \text{Log} \frac{V_3}{V_4}$$

$$= Q_1 - Q_2 \quad \text{--- (A)}$$

Efficiency of the engine.

$$\eta = \frac{W}{Q_1} = \frac{RT_1 \text{Log} \frac{V_2}{V_1} - RT_2 \text{Log} \frac{V_3}{V_4}}{RT_1 \text{Log} \frac{V_2}{V_1}}$$

$$\eta = 1 - \frac{T_2}{T_1} \cdot \frac{\text{Log} \frac{V_3}{V_4}}{\text{Log} \frac{V_2}{V_1}}$$

$\therefore \text{Log} \frac{V_3}{V_4} = \text{Log} \frac{V_2}{V_1}$ adiabatically Process.

$$\therefore \eta = \left(1 - \frac{T_2}{T_1}\right) \quad \text{--- (B)}$$

In general $\eta = 1 - \frac{Q_2}{Q_1}$

$$1 - \frac{T_2}{T_1} = 1 - \frac{Q_2}{Q_1}$$

$$\Rightarrow \frac{Q_1}{Q_2} = \frac{T_2}{T_1} \quad \text{--- (C)}$$