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Sem III

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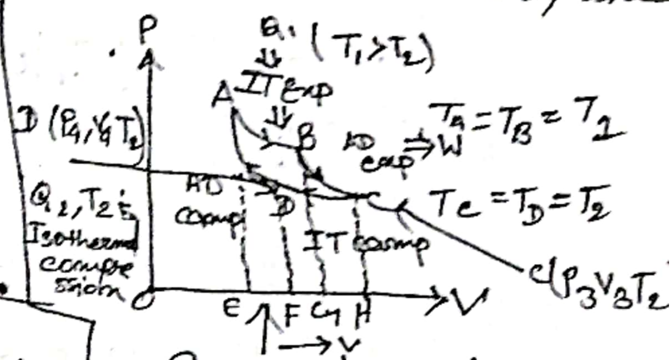
Carnot cycle

The Enclosed area represent work done by the engine –



Carnot cycle.

Here $A(P_1, V_1, T_1)$ Isothermal expansion
$B(P_2 V_2 T_1)$ Adiabatic expansion
$D(P_4, V_4, T_2)$ Adiabatic compression

1) It is a hypothetical engine because the working substance is an ideal gas.

2) Its Efficiency is maximum but not 100%.

3) This Cycle process has two isothermal and two adiabatic processes.

Carnot cycle working and Derivation →:

1) Isothermal Expansion →

First, place the cylinder on the source so that the gas acquires its tempture T_1. The slow outward motion of the piston allows the gas to expand, causing the gas's temperature to fall. As the gas absorbs the required heat from the source, it expands isothermally.

And Second process is, if Q_1 heat is absorbed from the source and w_1 work is done by the gas in isothermal expansion which takes it state from (P_1, V_1, T_1) to (P_2, V_2, T_2) then

$$W_1 = Q_1 = nRT_1 \log\left(\frac{V_2}{V_1}\right) = \text{area } ABGEA$$

2) Adiabatic Expansion →

first, The gas is placed on the insulating stand and allowed to expand slowly. untill its temperature fall to T_2.

∴ And in Second process, If the gas does W_2 work in the adiabatic expansion, which takes its state from (P_2, V_2, T_1) to $(P_3 V_3 T_2)$ then

$$W = \frac{nR(T_1 - T_2)}{\gamma - 1}$$

3) Isothermal Compression →

The gas is now placed in thermal contact with the sink at temperature T_2, it is slowly compressed so that as heat is produced, it quickly flows to the sink. The gas maintains a constand. ~~to~~ Temperature T_2 throughout. In Second process of this ~~cony~~ topic is, If the gas releases to Q_2 the sink and W_3 work is done on the gas by the surrounding in the isothermal compression, which takes its state from (P_3, V_3, T_2) to (P_4, V_4, T_2) Then, $W = nRT_2 \log\left(\frac{V_3}{V_4}\right)$ = area CDFHC

4) Adiabatic compression →:

The cylinder is positioned on the insulating stand. The gas is further compressed slowly till it returns to its initial state (P_1, V_1, T_1) and after them, If W_4 work done in the adiabatic compression from (P_4, V_4, T_2) to (P_1, V_1, T_1) then

$$W = \frac{nR(T_1 - T_2)}{\gamma - 1} = \text{area } DAEFD$$

Net work done by the gas per cycle is →:

Total work done by the gas $= W_1 + W_2$

Total Work done On the gas $= W_3 + W_4$

Net work is done by gas in one complete cycle is

$$W = W_1 + W_2 - (W_3 + W_4) \quad (\because W_2 = W_4)$$

then $W = W_1 - W_3 = Q_1 - Q_2$

$$W = \text{area } ABCDA$$

In the carnot engine, the work done by the gas per cycle is numerically equivalent to the area enclosed by the carnot cycle on a pressure - Volume ~~de~~ figure.