5.5 Modified Rankine Cycle:

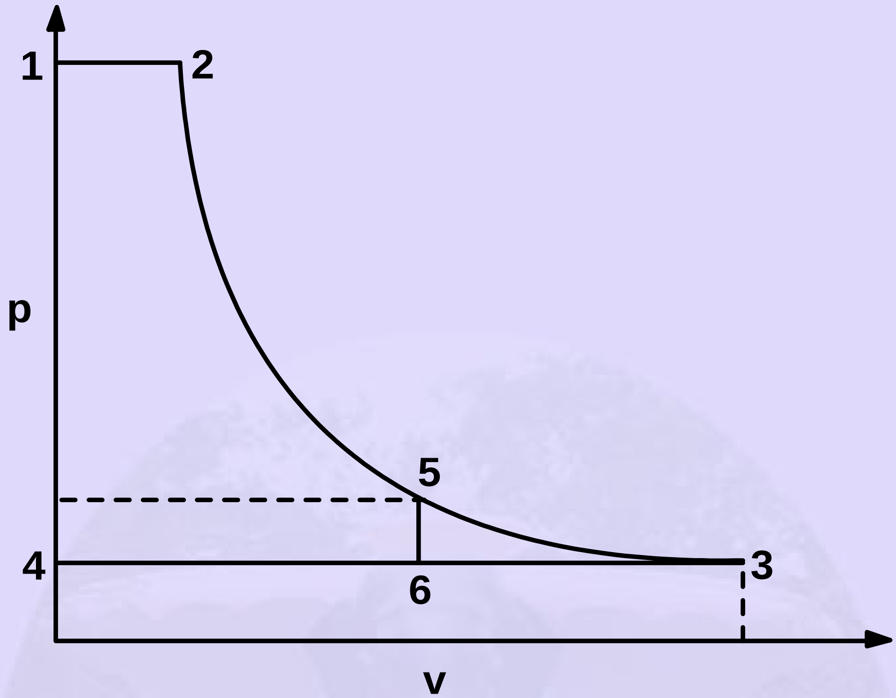

Fig.5.5(a). p-v diagram of modified Rankine cycle

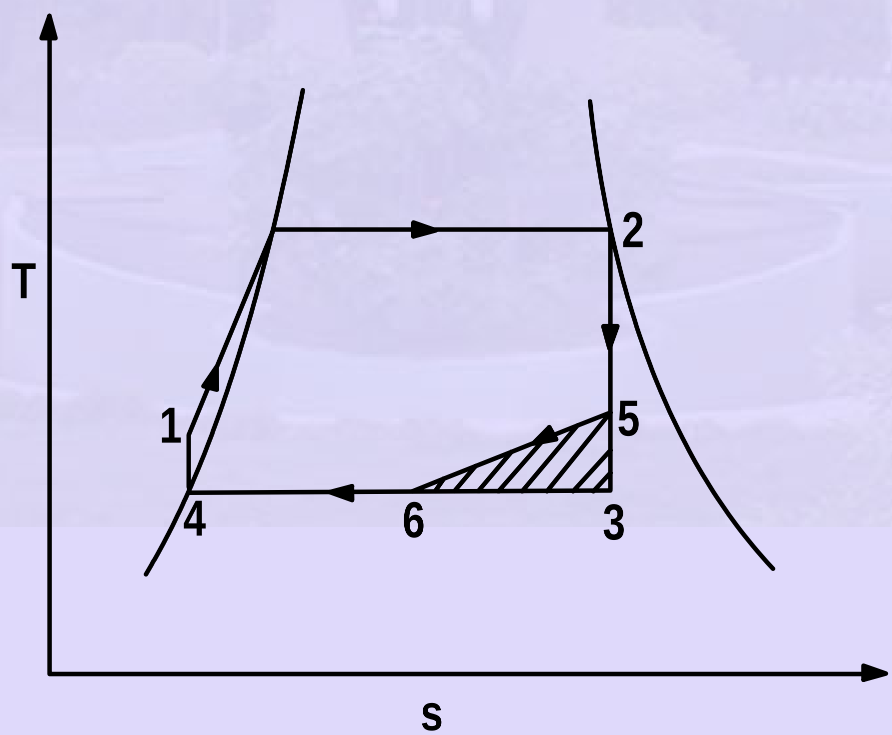

Fig.5.5(b). T-s diagram of modified Rankine cycle

Process 1-2 represents the admission of high pressure steam into the engine cylinder, process 2-3 is the reversible adiabatic expansion of steam in the cylinder and process 3-4 is the exhaust of steam into condenser. Net work done is represented by the area 1-2-3-4-1.

Observe that the area 3-6-5 is very small and in order to obtain this small work, the cylinder volume must be increased from v_6 to v_3.This makes cylinder very bulky. For this reason, the expansion process is terminated at point 5. So that indicator diagram becomes 1-2-5-6-4. The work lost is small but there is large saving in cylinder volume. Process 5-6 represents the release of steam into the condenser, thus causing the cylinder pressure to drop from P_5 to P_6. Process 6-4 is the exhaust of steam at constant pressure. Cycle 1-2-5-6-4 is called as the “modified Rankine cycle”.

Thermal Efficiency:

Considering the unit mass of working fluid,

$$\text{Heat supplied} = h_2 - h_1$$

$$\text{Net workdone} = \left\{w_{2-5} + w_{5-6} + w_{4-1}\right\}$$

$$= \left(h_2 - h_5\right) - \int_5^6 vdp + \left(h_4 - h_1\right)$$

$$= \left(h_2 - h_5\right) + v_5\left(p_5 - p_6\right) + \left(h_4 - h_1\right)$$

v_5 = specific volume of steam at state 5.

$$\eta_{th} = \frac{\text{Net workdone}}{\text{Heat supplied}} = \frac{(h_2 - h_5) + v_5(p_5 - p_6) + (h_4 - h_1)}{(h_2 - h_1)}$$

If pump work is neglected, then $h_4 \approx h_1$

$$\eta_{th} = \frac{(h_2 - h_5) + v_5(p_5 - p_6)}{(h_2 - h_4)}$$