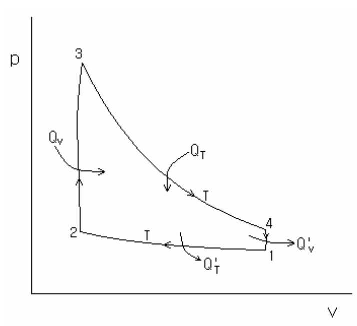
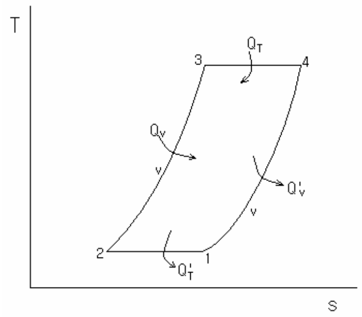
- Stirling Cycle and Ericsson Cycle
  These cycles are not extensively used, but they illustrate how a regenerator can often be incorporated in a cycle to ↑ η
- Stirling Cycle (Otto 와 유사)





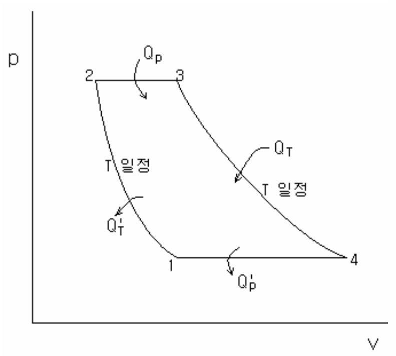
$$q_H = q_v + q_T$$
$$= c_v(T_3 - T_2) + RT_3 \ln\frac{v_4}{v_3}$$
$$= c_v(T_3 - T_2) + RT_3 \ln\frac{p_3}{p_4}$$
$$q_L = q_v' + q_T'$$
$$= c_v(T_4 - T_1) + RT_1 \ln\frac{v_1}{v_2}$$
$$= c_v(T_3 - T_2) + RT_1 \ln r_v$$

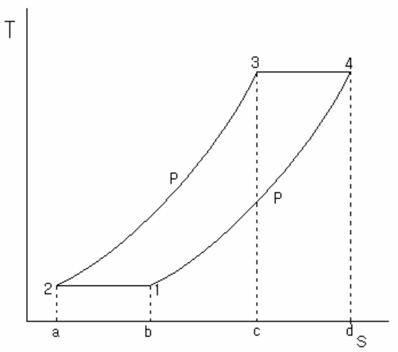
Note

$$\int(du + pdv) = \int(c_v dT + \frac{RT}{v}dv)$$

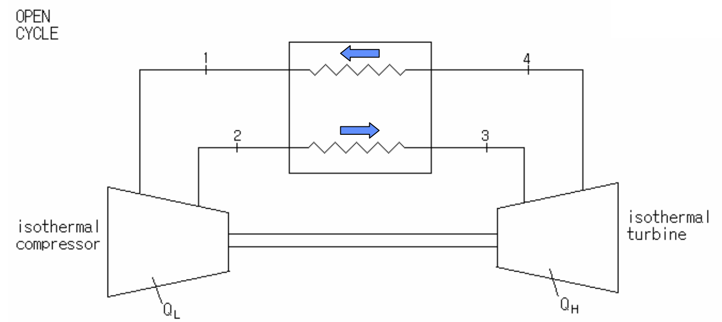
$\frac{v_3}{v_4} = \frac{p_4}{p_3}$ since $pv = RT = cons.$

- Ericsson Cycle
  (Diesel 과 유사)
  (This is gas turbine)





Here,
Constant –v of Otto are replaced by constant –p processes.
In both cycles, there is an isothermal compression and expansion.
Two end states at 2 unique temperatures → possibly as efficient as a Carnot cycle.
Use a regenerator



It is difficult to achieve an isothermal compression or expansion.

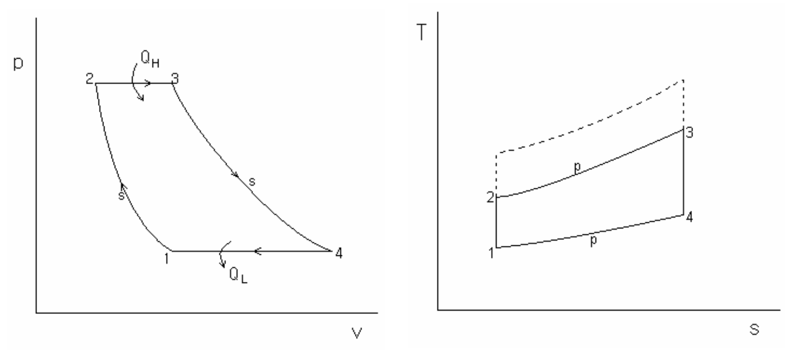
면적 2-3-c-a-2 = 면적 1-4-d-b-1

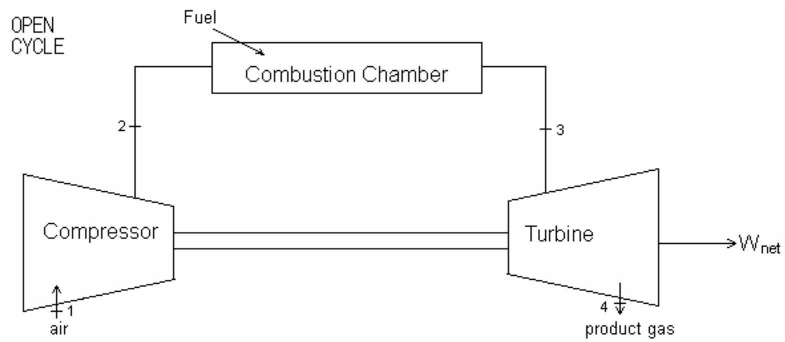
→ Carnot cycle 의 열효율을 얻을 수 있다.

$$\eta = 1 - \frac{c_p(T_4 - T_1) + RT_1 \ln p_2/p_1}{c_p(T_3 - T_2) + RT_3 \ln p_3/p_4}$$

No pressure drop across a regenerator.

- Brayton Cycle (Ideal open Gas Turbine)





$$\eta = 1 - \frac{Q_L}{Q_H}$$

$$= 1 - \frac{c_p(T_4 - T_1)}{c_p(T_3 - T_2)} = 1 - \frac{T_1\left(\frac{T_4}{T_1} - 1\right)}{T_2\left(\frac{T_3}{T_2} - 1\right)}$$

Since

$$\frac{p_3}{p_4} = \frac{p_2}{p_1}$$

$$\frac{p_2}{p_1} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma}{\gamma-1}} = \frac{p_3}{p_4} = \left(\frac{T_3}{T_4}\right)^{\frac{\gamma}{\gamma-1}}$$

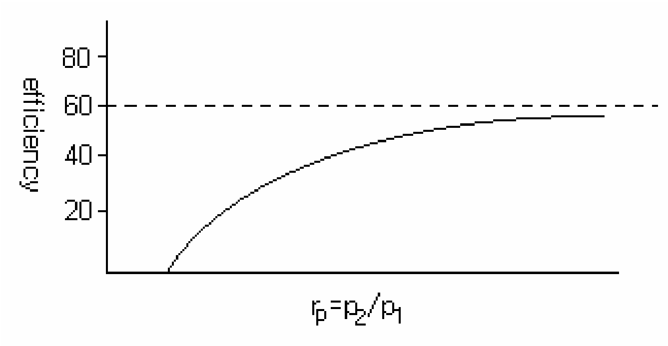
For isentropic process

Or $\frac{T_3}{T_4} = \frac{T_2}{T_1}$ Or $\frac{T_3}{T_2} = \frac{T_4}{T_1}$

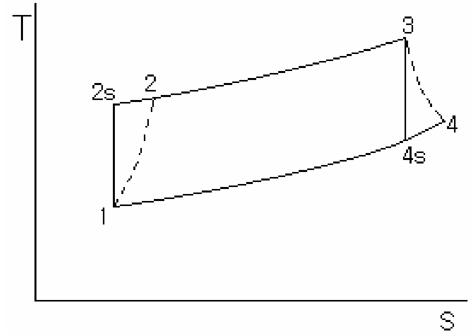
and $\frac{T_3}{T_2} - 1 = \frac{T_4}{T_1} - 1$

$$\eta = 1 - \frac{T_1}{T_2} = 1 - \frac{1}{\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}}$$

∴The efficiency of the air-standard Brayton cycle is therefore a function of the isentropic pressure ratio.



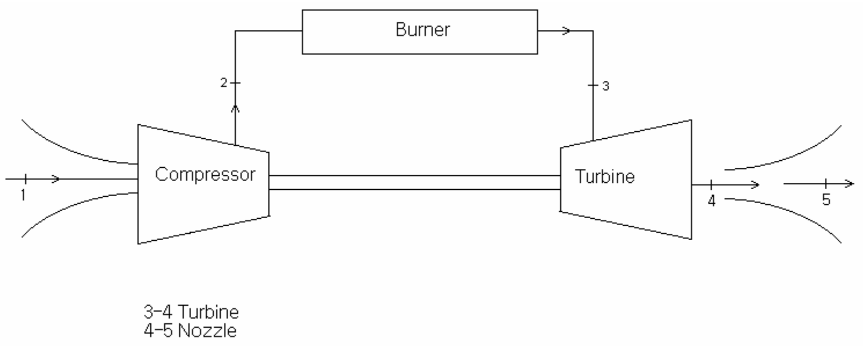
The effect of inefficiencies on the gas-turbine cycle is shown below:

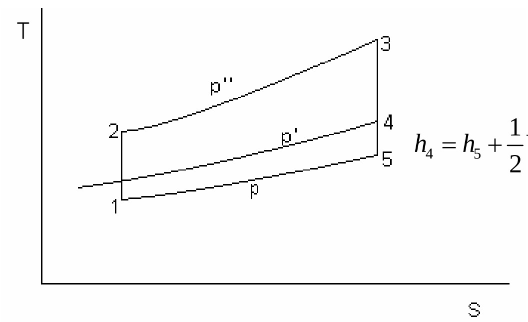


$$\eta_{compressor} = \frac{h_{2s} - h_1}{h_2 - h_1}$$

$$\eta_{turb} = \frac{h_3 - h_4}{h_3 - h_{4s}}$$

- Air-Standard Cycle for Jet Propulsion





$$h_4 = h_5 + \frac{1}{2}V_5^2; s_4 = s_5$$

p'' > p' > p

The gases are expanded in the turbine to a pressure for which the turbine work is just equal to the compressor work.

Since the gases leave at a high velocity, the change in momentum that the gases undergo gives a thrust to the aircraft in which the engine is installed.