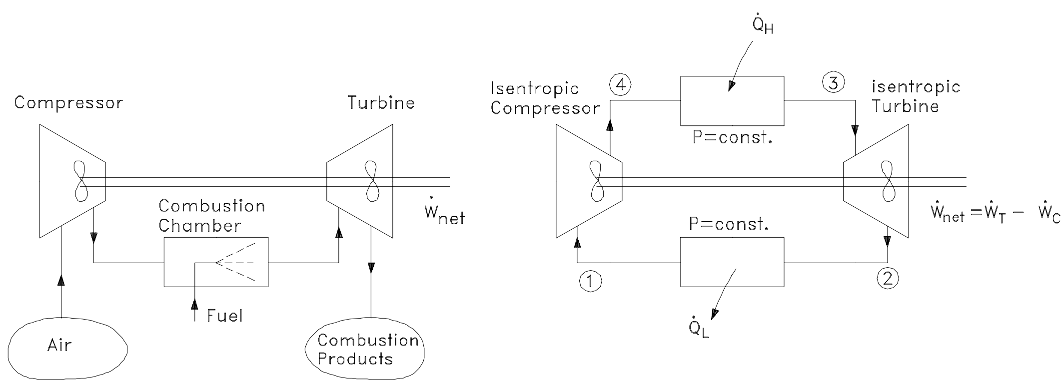
Week 8: Lecture 1

Open Cycle Gas Turbine Engines

- after compression, air enters a combustion chamber into which fuel is injected
- the resulting products of combustion expand and drive the turbine
- combustion products are discharged to the atmosphere
- compressor power requirements vary from 40-80% of the power output of the turbine (remainder is net power output)
- high power requirement is typical when gas is compressed because of the large specific volume of gases in comparison to that of liquids

Advantages

- can use different fuels
- simple in construction, easy to maintain
- small weight-to-power ratio



Open Cycle Gas Turbine   Air Standard Brayton Cycle

Idealized Air-standard Brayton Cycle

- closed loop
- constant pressure heat addition and rejection
- ideal gas with constant specific heats

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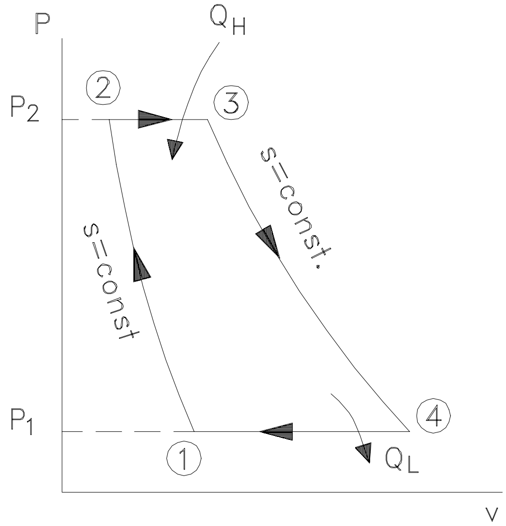

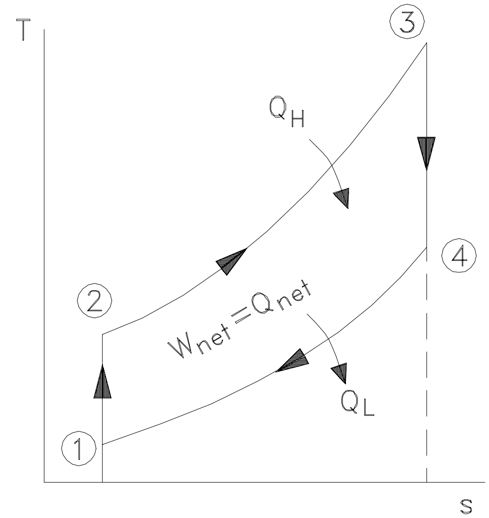

$$\text{Brayton cycle efficiency} \quad \Rightarrow \quad \boxed{\eta = 1 - (r_p)^{\frac{1-k}{k}}}$$

where $r_p = \dfrac{P_2}{P_1} = \dfrac{P_3}{P_4}$

The maximum temperature in the cycle (T_3) is limited by metallurgical conditions because the turbine blades cannot sustain temperatures above 1300 K. Higher temperatures (up to 1600 K can be obtained with ceramic turbine blades).

Optimum Work Output

The maximum work output can be achieved when the pressure ratio is:

$$r_p = \left(\frac{T_{max}}{T_{min}}\right)^{\frac{k}{2k-2}}$$