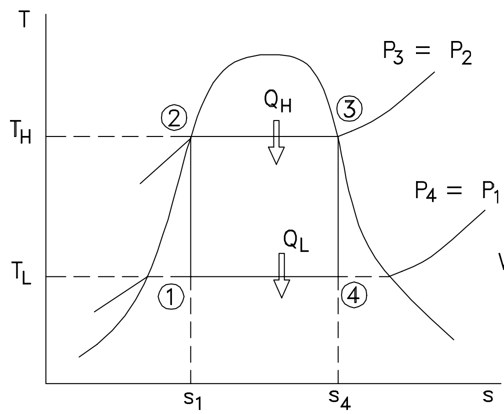
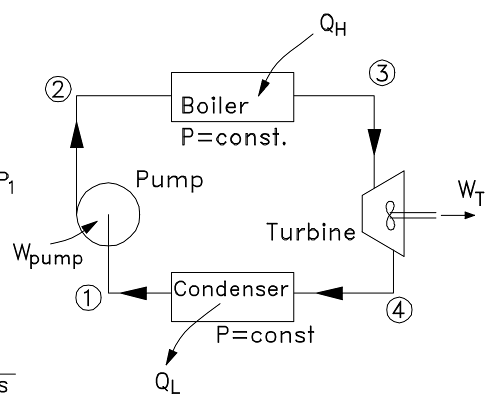
Week 4: Lecture 1

Carnot Cycle

- an ideal theoretical cycle that is the most efficient conceivable
- based on a fully reversible heat engine
- in practice the thermal efficiency of real world heat engines are about half that of the ideal Carnot cycle





Process	State Points	Description
Pump	1 → 2	isentropic compression from $T_L \rightarrow T_H$ to return vapour to a liquid state
Heat Supply	2 → 3	heat is supplied at constant temperature and pressure
Work Output	3 → 4	the vapour expands isentropically from the high pressure and temperature to the low pressure
Condenser	4 → 1	the vapour which is wet at 4 has to be cooled to state point 1

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Cycle Efficiency

- defined as the net work output divided by the gross heat supplied

$$\begin{aligned}\eta &= \frac{W_{net}}{Q_H} \\ &= \frac{Q_H - Q_L}{Q_H} \\ &= 1 - \frac{T_L}{T_H}\end{aligned}$$

Practical Problems

- at state point 1 the steam is wet at T_L and it is difficult to pump water/steam (two phase) to state point 2
- the pump can be sized smaller if the fluid is 100% liquid water
- the pump is smaller, cheaper and more efficient
- can we devise a Carnot cycle to operate outside the wet vapour region
  - between state points 2 and 3 the vapour must be isothermal an at different pressures - this is difficult to achieve
  - the high temperature and pressure at 2 and 3 present metallurgical limitations

The net effect is that the Carnot cycle is <u>not</u> feasible for steam power plants.