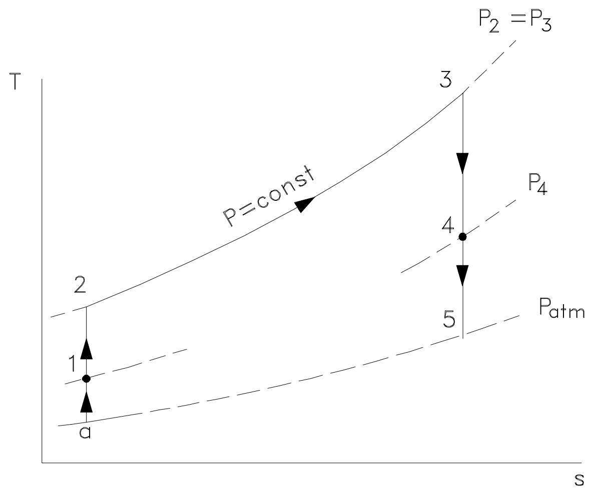
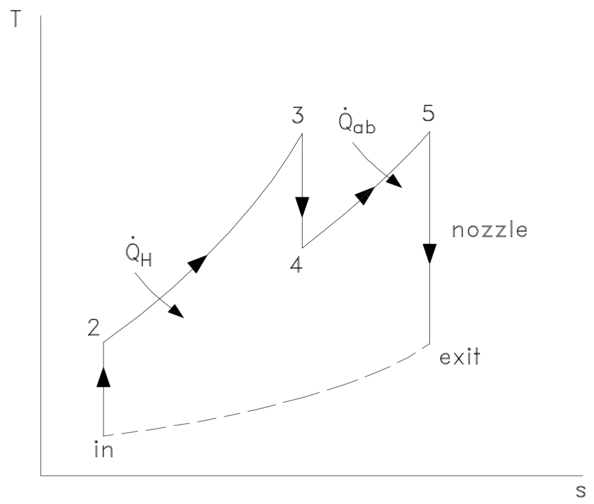
Week 9: Lecture 2

Turbojet



- **a-1**: diffuser
  - decelerates the incoming flow relative to the engine
  - a pressure rise known as a ram effect occurs
- **1-4**: gas generator
  - compressor, combustor and turbine
  - turbine power just enough to drive the compressor
  - air and fuel are mixed and burned in the combustion chamber at constant pressure
  - $P_T >> P_{atm}$
- **4-5**: nozzle
  - gases leave the turbine significantly higher in pressure than atmospheric pressure
  - gases are expanded to produce a high velocity
  - $v_e^* >> v_i^*$
  - results in a thrust

Afterburner



By performing a 1st law energy over the nozzle we can obtain an expression for the exit velocity in terms of the entrance temperature to the nozzle.

$$\frac{d\cancel{E}^{\,0}}{dt} = \cancel{\dot{Q}}^{\,0} + \cancel{\dot{W}}^{\,0} \left\{\dot{m}\left[h_4 + \frac{(v_4^*)^2}{2}\right]\right\} - \left\{\dot{m}\left[h_e + \frac{(v_e^*)^2}{2}\right]\right\}$$

If we assume that the air velocity leaving the turbine is relatively small, the kinetic energy term at 4 can be assumed to go to zero and we get

$$\begin{aligned} v_e^* &= \sqrt{2(h_4 - h_e} \\ &= \sqrt{2c_p(T_4 - T_e)} \end{aligned}$$

- exit velocity proportional to $v_e^* \propto \sqrt{2c_p(T_4 - T_e)}$
- afterburner is used to increase T_4 to T_5
- similar to a reheat device
- produces a higher temperature at the nozzle inlet