

Thermodynamics 1: Rates of Change & Mollier Diagrams

Nozzles, Diffusers, Turbines, and Compressors/Pumps

Rates of Change:

- Mass Balance:

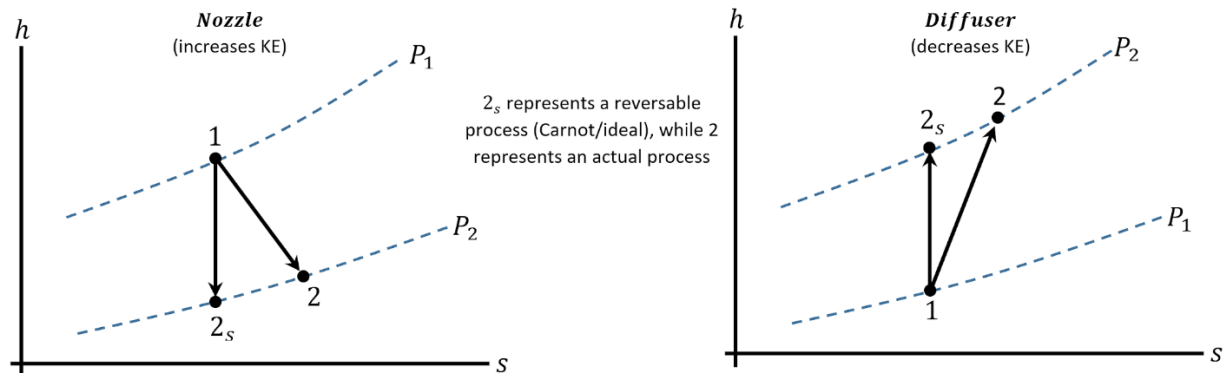
$$\frac{dm_{cv}}{dt} = \sum_{in} \dot{m}_{in} - \sum_{exit} \dot{m}_{exit}$$

- Energy Balance:

$$\frac{dE_{cv}}{dt} = \dot{E}_{in} - \dot{E}_{out} = \dot{Q} - \dot{W} + \dot{m}_{in} \left(h_{in} + \frac{v_{in}^2}{2} + gz_{in} \right) - \dot{m}_{out} \left(h_{out} + \frac{v_{out}^2}{2} + gz_{out} \right)$$

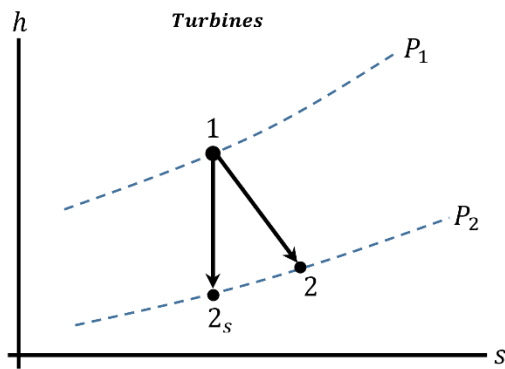
Based on the assumptions, many terms will cancel out (such as $\frac{v^2}{2}$ and gz when changes to kinetic and potential energy are assumed to be zero).

Mollier Diagrams:



Where the energy balance equation reduces to:

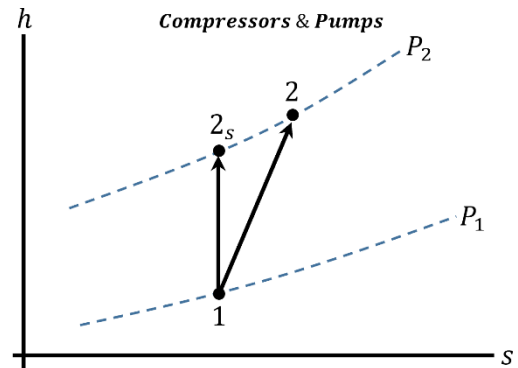
$$h_{in} - h_{exit} = \frac{1}{2}(v_{out}^2 - v_{in}^2)$$



$$\dot{W}_{out} = \dot{m}(h_{exit} - h_{in}) - \dot{Q}_{out}$$

Isentropic efficiency:

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



$$\dot{W}_{in} = \dot{m}(h_{exit} - h_{in})$$

Isentropic efficiency:

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

For more information on rates of change and Mollier diagrams, make an appointment with a [content tutor](#). Appointments are available in person at the [Student Success Center](#) or online.