

Steady Flow Energy Equation

Mechanical Engineering

The first law rewritten for a device with fluid flowing through it.

Heat and shaft work balance the change in enthalpy, kinetic energy and height of the stream.

$$Q - W_s = m(\Delta h + \Delta V^2 \div 2 + g\Delta z), m = \text{mass flow}$$

Adiabatic turbine

Heat term drops out.

$$W_s = m(h_1 - h_2)$$

Nozzle

No work, no heat.

$$V_2^2 = V_1^2 + 2(h_1 - h_2)$$

Throttling valve

No work, no heat.

$$h_1 = h_2$$

THE COMMON MISTAKE

✗ Using internal energy for a flow device

✓ Use enthalpy, $h = u + pv$

The pv term is the work needed to push fluid across the boundary. Dropping it under-reads turbine and compressor work badly.

Assumes steady state, uniform inlet and outlet properties, and one stream in and one stream out.