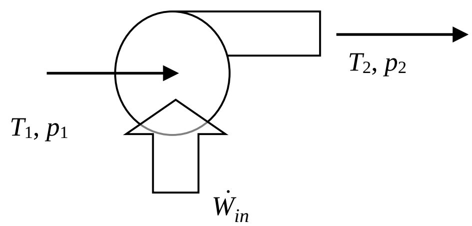
Example

A pump is used to pump water from a low pressure, p_1, to a high pressure, p_2. The temperatures at the inlet and exit are T_1 and T_2, respectively. The pump operates adiabatically and at steady state with a mass flow rate of $\dot{m}$. Show that the minimum power input to the pump corresponds to *isothermal* flow; i.e., $T_2 = T_1$. (Hint: model water as an incompressible substance.)



Example

A rigid, insulated (and therefore…) tank with a total volume of 2 m^3 contains air at 25°C and 100 kPa. Initially the air occupies 1 m^3 to one side of a thin membrane. A magic fairy then pokes a pinhole in the membrane allowing the air to eventually fill the whole tank. (c_v = 0.713 kJ/kg-K, c_p = 1.000 kJ/kg-K, R_{air} = 0.287 kJ/kg-K)

(a) Find the specific volume of the air (in m^3/kg) in its initial state.
(b) Find the final specific volume of the air.
(c) Find the *entropy generated* (in kJ/K) due to the expansion.
(d) The magic fairy then lets all the air flow back through the pinhole to the right hand chamber. Calculate the *entropy generated* (in kJ/K) for this process. Comment on the possibility of this process. Comment on the existence of fairies.