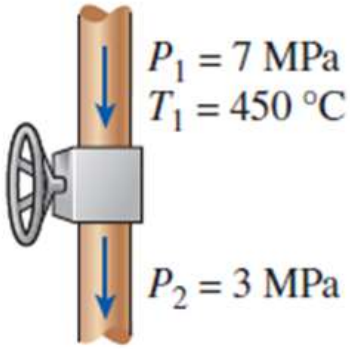
Given:
Steam at 7 MPa and 450°C is throttled in a valve to a pressure of 3 MPa during a steady-flow process.

$P_1 := 7\ \text{MPa}$ $T_1 := 450\ °\text{C}$ $P_2 := 3\ \text{MPa}$



Required:
Determine the entropy generated during this process and whether it satisfies the Second Law of Thermodynamics.

Solution:
Starting with an entropy balance for a steady flow device shows

$$\frac{d}{dt} S_{sys} = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$0 = \Sigma S'_{in} - \Sigma S'_{out} + S'_{gen}$$

$$S'_{gen} = \Sigma S'_{out} - \Sigma S'_{in} = m' \cdot \left(s_2 - s_1 \right)$$

The entropy generation on a specific basis is found by

$$s_{gen} = \frac{S'_{gen}}{m'} = \frac{m' \cdot \left(s_2 - s_1 \right)}{m'} = s_2 - s_1$$

Going to Table A-5 @ $P_1 = 7000\ \text{kPa}$ shows

$T_{sat} := 285.83\ °\text{C}$

Since $T_1 > T_{sat}$ the state is superheated. Going to Table A-6 @ $P_1 = 7.000\ \text{MPa}$ and $T_1 = 450.0\ °\text{C}$ shows

$s_1 := 6.6353\ \frac{\text{kJ}}{\text{kg K}}$ $h_1 := 3288.3\ \frac{\text{kJ}}{\text{kg}}$

It's known for a throttling value the enthalpy remains constant so

$h_2 := h_1 = 3288\ \frac{\text{kJ}}{\text{kg}}$

Going to Table A-5 @ $P_2 = 3000\ \text{kPa}$ shows

$h_g := 2803.2\ \frac{\text{kJ}}{\text{kg}}$

Since $h_2 > h_g$ the state is superheated. Going to Table A-6 @ $P_2 = 3.000\ \text{MPa}$ and $h_2 = 3288\ \frac{\text{kJ}}{\text{kg}}$ shows that interpolation is needed.

$h_a := 3231.7\ \frac{\text{kJ}}{\text{kg}}$ $h_b := 3344.9\ \frac{\text{kJ}}{\text{kg}}$

$s_a := 6.9235\ \frac{\text{kJ}}{\text{kg K}}$ $s_b := 7.0856\ \frac{\text{kJ}}{\text{kg K}}$

$s_2 := \frac{h_2 - h_a}{h_b - h_a} \cdot \left(s_b - s_a \right) + s_a = 7.005\ \frac{\text{kJ}}{\text{kg K}}$

The specific entropy generation is then

$$\boxed{s_{gen} := s_2 - s_1 = 0.3693\ \frac{\text{kJ}}{\text{kg K}}}$$

The Second Law of Thermodynamics is satisfied because sgen is not negative.

It should be noted that the increase in entropy is a result of unrestrained expansion.