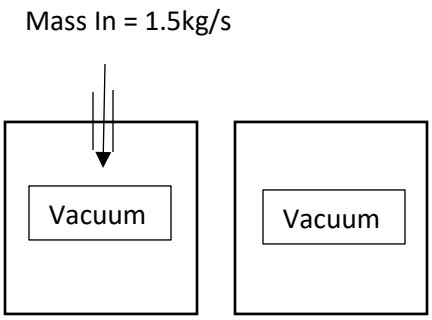

Figure 1

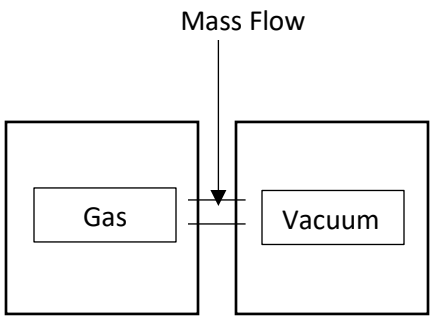

Figure 2

You are an engineer studying the second law of thermodynamics at the local university. You have 2 separate boxes that are both sealed to vacuum. You begin to add Mass In, which is water vapor, to the system in Figure 1 until 2 seconds go by. We can assume this process is reversible and adiabatic. The pressure of the Mass In is 10 KPa and can be assumed that it is saturated vapor. Once Mass In stops, Mass Flow begins into the second open Vacuum box illustrated in Figure 2 until they reach equilibrium. Both boxes are identical in shape. There is a heat flow into the system with the Gas in figure 2 at room temperature and equal to 15KJ.

1. What is the change in Entropy from the first process in Figure 1.
2. What is S_{gen}?

Charlie Nitschelm

HW 6 Solution

Given: Mass In = 1.5 kg
Mass In Pressure = 10 kPa and Saturated Vapor
Process 1 is reversible and adiabatic

1. Find: ΔS for the left box in figure 1

Solution:

$$\Delta S = \int \frac{\delta Q}{T} + \sum m_{in} s_{in} - \sum m_{out} s_{out} + S_{gen}$$

From Given - $\int \frac{\delta Q}{T}$ and S_{gen} are zero

$$\Delta S = \sum m_{in} s_{in} - \sum m_{out} s_{out}$$

From Diagram - No m_{out}

$$\Delta S = m_{in} s_{in}$$

Given $P = 10$ kPa and $\dot{m} = 1.5$ kg/s
for a total of 2 seconds
and it's a saturated vapor

$s_{in} = 8.15$ kJ/kgK
$m_{in} = 3$ kg

$$\Delta S = 3\text{ kg} \cdot 8.15\text{ kJ/kg K} = \boxed{24.45 \frac{\text{kJ}}{\text{K}} = \Delta S}$$

2. Find S_{gen} for Process 2:

System: Entire Figure 2.

Given: • ΔS for whole Figure 2 does not change.

• Equilibrium implies half of mass travels to the second box in vacuum

Solution:

$$\Delta S = \int \frac{\delta Q}{T} + \sum m_{in} s_{in} - m_{out} s_{out} + S_{gen}$$

Because we look at the entire system, which is the hard decision for this problem, $m_{in} = m_{out}$ and $s_{in} = s_{out}$. ΔS also is zero.

So,

$$-\int \frac{\delta Q}{T} = S_{gen}$$

Only one flow into the system and S_{gen} can not be zero!

$$\frac{-15\,KJ}{293\,K} \rightarrow S_{gen} \text{ can not be negative.}$$

Not Possible