ANNOUNCED QUIZ #5 – ME 3030 — Section 001 – Spring 2024

NAME: SOLUTION

This is an open book quiz. You may use a four function calculator. An unsigned honors pledge will result in a zero.

1. Propane enters a compressor at 0.1 MPa and 20°C, and exits the compressor at a pressure of 0.4 MPa. If the entropy production rate is 0.136 kJ/K per kg of propane flowing, what is the power for the compressor in kJ per kg of propane flowing? You may assume the compressor is adiabatic and kinetic and potential energy effects are negligible.

GIVEN: $P_i, T_i, P_e, \frac{\dot{\sigma}}{\dot{m}}, \dot{Q}=0, \Delta KE=\Delta PE=0$, propane, S.S.

FIND: $\dot{W}/\dot{m} = ?$ kJ/kg

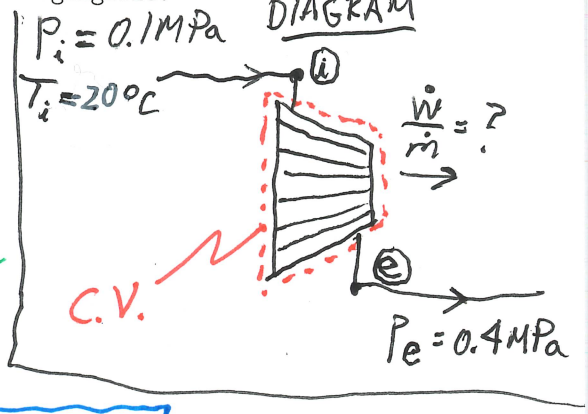
ASSUME:

ANALYSIS: $\frac{dE}{dt} = \dot{Q} - \dot{W} + \sum_i \dot{m}_i\left(h_i + \frac{V_i^2}{2} + gz_i\right) - \sum_e \dot{m}_e\left(h_e + \frac{V_e^2}{2} + gz_e\right)$

S.S. ad. No KE or PE

$$\dot{W}/\dot{m} = h_i - h_e$$

DIAGRAM



$$\frac{dS}{dt} = \sum_j \frac{\dot{Q}_j}{T_j} + \sum_i \dot{m}_i s_i - \sum_e \dot{m}_e s_e + \dot{\sigma}$$

S.S. ad.

$$\frac{\dot{\sigma}}{\dot{m}} = s_e - s_i$$

$0.136 \frac{kJ}{kg\cdot K} = s_e - 2.194 \frac{kJ}{kg\cdot K}$

$s_e = 2.330 \frac{kJ}{kg\cdot K}$

Table A-18

$h_i = 517.6$ kJ/kg

$s_i = 2.194 \frac{kJ}{kg\cdot K}$

Interpolating for h_e in the 0.4 MPa table gives

$$h_e = 646.61 \frac{kJ}{kg}$$

$$\frac{\dot{W}}{\dot{m}} = 517.6 \frac{kJ}{kg} - 646.61 \frac{kJ}{kg}$$

$$\frac{\dot{W}}{\dot{m}} = -129.01 \frac{kJ}{kg}$$ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE