ANNOUNCED QUIZ #5 – ME 3030 — Section 002 – 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. The refrigerant R-134a enters a compressor at 1 bar and −10°C and exits the compressor at 12 bar. Determine the power for the compressor in kJ per kg of refrigerant flowing if the entropy production rate is 0.048 kJ/K per kg of refrigerant flowing. You may assume the compressor is adiabatic and kinetic and potential energy effects are negligible.

GIVEN: R-134a; P_i; T_i; P_e; S.S.; $\Delta KE = \Delta PE = 0$; $\dot{\sigma}/\dot{m}$; $\dot{Q} = 0$

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

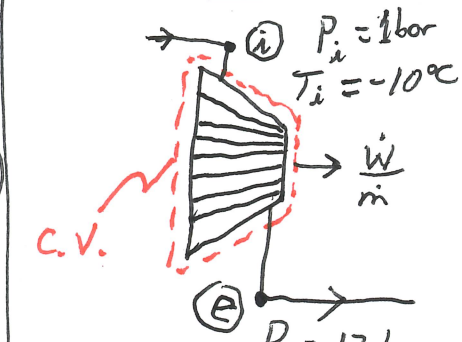
ASSUME:

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

S.S. ad. No KE or PE

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

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.

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

From Table A-11

$h_i = 244.7$ kJ/kg

$s_i = 0.9918$ kJ/kg·K

$$0.048 \frac{kJ}{kg \cdot K} = s_e - 0.9918 \frac{kJ}{kg \cdot K}$$

$$s_e = 1.0398 \frac{kJ}{kg \cdot K}$$

Interpolating for h_e using the 12 bar table gives:

$h_e = 317.63$ kJ/kg

$$\frac{\dot{W}}{\dot{m}} = 244.7 \frac{kJ}{kg} - 317.63 \frac{kJ}{kg}$$

$$\frac{\dot{W}}{\dot{m}} = -72.93 \frac{kJ}{kg} \leftarrow \text{ANS.}$$

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE