ANNOUNCED QUIZ #10 – ME 2030 –SECTION 001 – Fall 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. Show all work.

1. An initially evacuated 200 m^3 tank is connected via a valve to a pipeline through which flows superheated steam at 10 bar and 400°C. The valve is opened and steam flows into the tank until the tank pressure is the same as that of the pipeline. If the tank is insulated, determine the final temperature of the tank in °C.

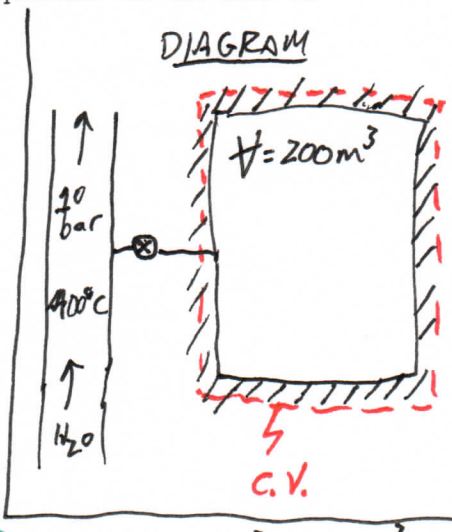
GIVEN: steam @ 10 bar, 400°C; tank initially empty and insulated

FIND: T_f for tank in °C

ASSUME: No KE or PE effects

ANALYSIS: Transient COE for a C.V.

DIAGRAM



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

No exit; ins. no shaft; No KE or PE effects

$$E = U + KE + PE$$

so $\frac{dE}{dt} = \frac{dU}{dt}$

$$\frac{dU}{dt} = \dot{m}_i h_i \rightarrow dU = \dot{m}_i h_i dt \qquad \int_1^2 dU = \int_1^2 \dot{m}_i h_i dt \rightarrow \int_1^2 dU = h_i \int_1^2 \dot{m}_i dt$$

b/c h_i is constant

$U_2 - U_1 = h_i m_i \rightarrow m_2 u_2 = h_i m_2 \rightarrow u_2 = h_i$

m_i = the mass that flowed in from 1 to 2 (e.g. from t=0 to equilibrium). evacuated

From table, $h_i = 3263.9 \frac{kJ}{kg}$

So, $\boxed{u_2 = 3263.9 \frac{kJ}{kg}}$ ← Use this to get T_2

p = 10 bar table

T(°C)	u(kJ/kg)
540	3192.6
T_2	(3263.9)
600	3296.8

Interpolate

$$\frac{(3296.8 - 3192.6)\frac{kJ}{kg}}{(600 - 540)°C} = \frac{(3263.9 - 3192.6)\frac{kJ}{kg}}{T_2 - 540°C}$$

Solving gives

$$\boxed{T_2 = 581.0°C}$$ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE