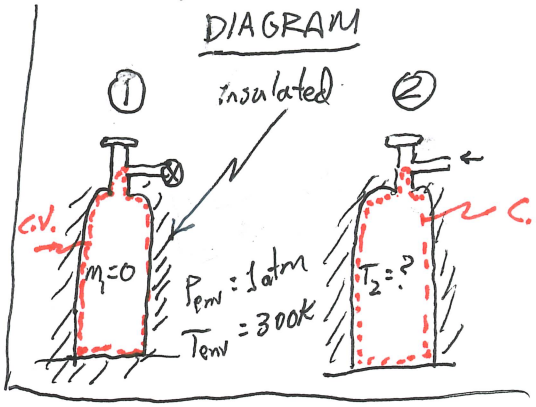
ANNOUNCED QUIZ #1 – ME 3030 — Section 002 – Spring 2024

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. An insulated, rigid tank is initially completely evacuated (its absolute pressure is zero). A valve to the tank is opened and air from the surrounding environment rushes in. The surrounding environment is at a pressure of one atmosphere and a temperature of 300K. After some time has passed, the pressure in the tank is at equilibrium with the outside air. Compute the final temperature of the air in the tank. You may assume kinetic and potential energy effects are negligible.

DIAGRAM




GIVEN: $T_{env}$, $P_{env}$, $m_1=0$, insulated

FIND: $T_2=?$

ASSUME: No KE or PE effects, ideal gas behavior

ANALYSIS: Cons. of Energy for a control volume:

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

insulated, no power; no KE or PE effects; no exit

$$E=KE+PE+U,\ \text{so}\ dE/dt=\frac{dU}{dt}$$

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

b/c h of environment is constant

$$U_2-U_1=h_i\int_1^2 \dot{m}_i\, dt \longrightarrow m_2u_2-m_1u_1=h_i(m_2-m_1)\rightarrow m_2u_2=m_2h_i$$

$$u_2=h_i \rightarrow u(T_2)=h(T_i=300K)$$

From A-22, $h(300K)=300.19\ kJ/kg$, so $u(T_2)=300.19\ \frac{kJ}{kg}$

Interpolating for $T_2$ in A-22

| $T(K)$ | $u\ (kJ/kg)$ |
|---|---|
| 410 | 293.43 |
| $T_2$ | (300.19) |
| 420 | 300.69 |

$$\frac{300.69\frac{kJ}{kg}-293.43\frac{kJ}{kg}}{420K-410K}=\frac{300.19\frac{kJ}{kg}-293.43\frac{kJ}{kg}}{T_2-410K}$$

$T_2=419.31K$ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE