ANNOUNCED QUIZ #4 – ME 3030 — Section 002 – Spring 2024

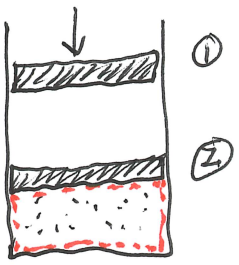
NAME: SOLUTION

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

1. Consider 0.75 kg of ammonia in a piston-cylinder setup. The ammonia is compressed from a pressure of 0.8 bar to a pressure of 2.0 bar at a constant temperature of 10°C. If the process is reversible, determine the work for the ammonia in kJ.

GIVEN: 0.75kg NH_3; $P_1 = 0.8$ bar, $P_2 = 2.0$ bar, $T = 10°C$, reversible

DIAGRAM



FIND: $W = ?$ kJ

ASSUME: No KE or PE effects.

ANALYSIS: $\Delta E = Q - W \rightarrow \Delta U = Q - W \rightarrow \boxed{W = Q - m(u_2 - u_1)}$

↑ b/c $\Delta KE = \Delta PE = 0$

C.O.E. for a closed system

Entropy balance for a closed system $\Delta_1 S = \int_1^2 \frac{\delta Q}{T} + \cancel{0}$ (0 b/c reversible)

$\Delta_1 S = \frac{1}{T}\int_1^2 \delta Q \rightarrow \Delta_1 S = \frac{Q}{T} \rightarrow \boxed{Q = Tm(s_2 - s_1)}$

↑ b/c T = constant

$$W = Q - m(u_2 - u_1) = mT(s_2 - s_1) - m(u_2 - u_1)$$

$$W = m[T(s_2 - s_1) - (u_2 - u_1)]$$

From Table A-15

$u_1 = 1358.77$ kJ/kg $\quad u_2 = 1351.87$ kJ/kg

$s_1 = 6.3192$ kJ/kg·K $\quad s_2 = 5.8473$ kJ/kg·K

$$W = (0.75\text{kg})\left[(10+273\text{k})\left(5.8473 \tfrac{\text{kJ}}{\text{kg·K}} - 6.3192 \tfrac{\text{kJ}}{\text{kg·k}}\right) - \left(1351.87 \tfrac{\text{kJ}}{\text{kg}} - 1358.77 \tfrac{\text{kJ}}{\text{kg}}\right)\right]$$

$$W = (0.75\text{kg})\left[-133.55 \tfrac{\text{kJ}}{\text{kg}} - \left(-6.900 \tfrac{\text{kJ}}{\text{kg}}\right)\right]$$

$$\boxed{W = -94.988\text{kJ}} \leftarrow \text{ANS.}$$

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE