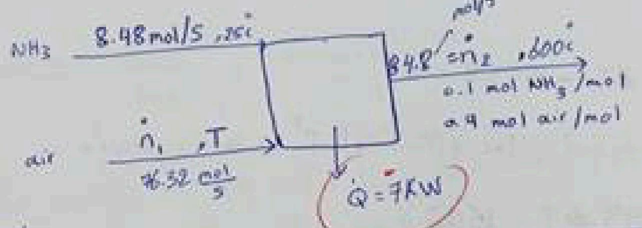
Q1 (25 POINTS)

Ammonia gas (NH_3) at **25 °C** at a rate of **8.48 mol/s** and preheated air at temperature (**T °C**) are blended in a mixer unit to form a gas stream containing **10.0 mol % NH_3** at **600°C**. The heat is lost from the mixer to its surroundings at a rate of **7 kW**. Determine the temperature to which the air must be preheated.

Remark: For the C_p use only the first two terms (*a* and *b*) of the polynomial of **Table B.2**



$\dot{n}_1 = 0.9\dot{n}_2 \rightarrow$ mole balance on air

$8.48 + \dot{n}_1 = \dot{n}_2 \rightarrow$ overall mole balance

$8.48 + 0.9\dot{n}_2 = \dot{n}_2 \Rightarrow 8.48 = 0.1\dot{n}_2$

$\dot{n}_2 = 84.8\ mol/s \Rightarrow \dot{n}_1 = 76.32\ \frac{mol}{s}$

$\Delta\dot{H} + \cancel{\Delta\dot{E}_k} + \cancel{\Delta\dot{E}_p} = \dot{Q} - \cancel{\dot{W}_s}$ ($\dot{W}=0$ no moving part; $\Delta\dot{E}_k$ no acceleration; $\Delta\dot{E}_p$ no change in height)

$\Delta\dot{H} = \dot{Q} = 7\ KW$

Refrence state for air inlet stream (g, T)

, , , NH_3 inlet , $(g, 25°)$

NH_3	8.48	$0\ \frac{KJ}{mol}$	8.48	$\hat{H}_1$
air	76.32	$0\ \frac{KJ}{mol}$	76.32	$\hat{H}_2$

$\hat{H}_1$ for $NH_3 \rightarrow (g, 600°)$

we go from $(g, 25) \rightarrow (g, 600°)$

$$\hat{H}_1 = \int_{25°C}^{600°C} (35.15\times10^{-3} + 2.954\times10^{-5}T)\,dT \quad \text{from (B.2)}$$

$$= 35.15\times10^{-3}(600-25) + \frac{2.954\times10^{-5}}{2}(600^2 - 25^2)$$

$$= 20.125 + 5.31 = 25.435\ \frac{KJ}{mol}$$

$\hat{H}_2$ for air $\rightarrow (g, 600°C)$

we go from ref $(g, T) \rightarrow (g, 600°C)$

$$\hat{H}_2 = \int_T^{600} (28.94\times10^{-3} + 0.4147\times10^{-5}T)\,dT$$

$$= 28.94\times10^{-3}\times600 - 28.94\times10^{-3}T + \frac{0.4147\times10^{-5}}{2}(600^2 - T^2)$$

$$= 17.4 - 28.9\times10^{-3}T + 0.75 - 2.1\times10^{-6}T^2$$

$$\dot{Q} = \Delta\dot{H} = \sum_{out}\dot{n}\hat{H} - \sum_{in}\dot{n}\hat{H}$$

$$7KW = (76.32\hat{H}_2 + 8.48\hat{H}_1) - (76.32\times0 + 8.48\times0)$$

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$\boxed{-3}$

$7KW = 1328 - 2.2\times10^{-3}T + 57.2 + 1.6\times10^{-4}T^2 + 8.48\ \frac{mol}{s}\times 25.435$

$\rightarrow$ خطأ حسابي

Q2 (25 POINTS)

On a rainy day in Amman, the outside air is **35 °F** with a relative humidity of **80%**. A **10 ft^3/min** of this moist air is heated in a home furnace to a comfortable **75 °F**. Assume **1 atm** total pressure. Use the psychometric chart to find the following:

1. Absolute humidity, relative humidity, wet bulb temperature, and dew point temperature of the heated air.
2. The heat requirement of the furnace in **Btu/hr**.

heated air 75 F h_r = 80% 1atm