ANNOUNCED QUIZ #10 – ME 3030 — Section 002 – Spring 2024

NAME: SOLUTION

This is an open book quiz. You may use a 4-function calculator. An unsigned honors pledge will result in a zero.

1. What is the exit temperature for a reactor that burns carbon in 100% theoretical oxygen where the inlets are at SRS and the heat transfer rate from the reactor to the surroundings is 300,000 kJ per kmole of fuel flowing?

GIVEN: C as fuel; 100% theo. O_2; $\dot{Q}/\dot{n}_F = -300{,}000 \frac{kJ}{kmole}$

FIND: $T_e = ?$

ASSUME: Usual combustion assumptions; S.S.

DIAGRAM

ANALYSIS:

Stoichiometry $\quad C + a\,O_2 \rightarrow b\,CO_2$

$b = 1 \quad a = 1$

$$C + O_2 \rightarrow CO_2$$

C.O.E. $\quad \frac{dE}{dt} = \dot{Q} - \dot{W} + \sum_i \dot{n}_i \bar{h}_i - \sum_e \dot{n}_e \bar{h}_e$

$$\sum_e \dot{n}_e \bar{h}_e = \sum_i \dot{n}_i \bar{h}_i + \dot{Q} \Rightarrow \left[\dot{n}_{CO_2} \bar{h}_{CO_2}\right]_e = \left[\dot{n}_C \bar{h}_C + \dot{n}_{O_2} \bar{h}_{O_2}\right]_i + \dot{Q}$$

$\dot{n}_{fuel}$

$$\left[\bar{h}_{CO_2}\right]_e = \left[\bar{h}_C + \bar{h}_{O_2}\right]_{SRS} + \dot{Q}/\dot{n}_F$$

SRS → so, $\Delta\bar{h} = 0$ for these two terms

$$\left[\bar{h}^\circ_{f_{CO_2}} + \bar{h}(T_e) - \bar{h}(298K)\right]_{CO_2} = \bar{h}^\circ_{f_C} + \bar{h}^\circ_{f_{O_2}} + \dot{Q}/\dot{n}_F$$

$$\bar{h}(T_e) = \bar{h}_{CO_2}(298k) - \bar{h}^\circ_{f_{CO_2}} + \dot{Q}/\dot{n}_F$$

$$\bar{h}_{CO_2}(T_e) = 9364 \frac{kJ}{kmole} - (-393{,}520 \frac{kJ}{kmole}) + (-300{,}000 \frac{kJ}{kmole})$$

$$\bar{h}_{CO_2}(T_e) = 102{,}884 \frac{kJ}{kmole}$$ → Interpolating for T_e

$T(K)$	$\bar{h}\left(\frac{kJ}{kmole}\right)$
2000	100,804
T_e	(102,884)
2050	103,835

$$T_e = 2034\,K$$ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE