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A Solution Manual for:
COMBUSTION, 4th Ed.

by

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CHAPTER 1

Problem 1

Calculate the heat of reaction when methane and air in stoichiometric proportions are brought into a calorimeter at 500 K. The product composition is brought to the ambient temperature (298 K) by the cooling water. The pressure in the calorimeter is assumed to remain at 1 atm, but the water formed has condensed.

Solution: The heat of reaction can be calculated using Eqn. (10) in the text. However, as also suggested in the textbook, this equation can be simplified for the general case when $H_{T_1}^o = H_{T_{amb}}^o$. The modified equation becomes:

$$-Q = \Delta H = \sum_{i \in \text{prod}} n_i \left[(H_{T_2}^o - H_{T_{amb}}^o) + (\Delta H_f^o)_{T_{amb}} \right] - \sum_{j \in \text{react}} n_j \left[(H_{T_1}^o - H_{T_{amb}}^o) + (\Delta H_f^o)_{T_{amb}} \right] \quad (1)$$

In this Equation, T_2 and T_1 are the temperatures of the products and reactants respectively. The general equation for the complete combustion of one mole of methane in air is:



where a_{air} is a coefficient describing how much air is needed for stoichiometric combustion. Balancing the above reaction one has:



In order to apply Eqn. (1) to the above reaction, the following properties from Tables in the textbook are needed (note that for this problem $T_2 = 298 \text{ K}$ and $T_1 = 500 \text{ K}$):

gases	ΔH_f^o (kJ/mol)	$H_{T_1}^o - H_{T_{amb}}^o$ (kJ/mol)	$H_{T_2}^o - H_{T_{amb}}^o$ (kJ/mol)
CH ₄	-74.90	8.21	0.0
O ₂	0.0	6.09	0.0
N ₂	0.0	5.92	0.0
H ₂ O _(liq)	-286.04	0.0	0.0
CO ₂	-393.77	0.0	0.0

Equation (1) then becomes:

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LL Leslie



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