

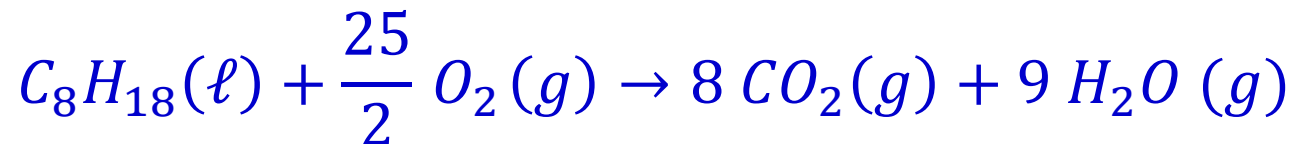
Heating of a fuel in an engine

Consider the fact that after combustion the octane fuel has been converted into CO_2 and H_2O in the vapor phase. Assuming an average value of $c_p = 33 \text{ J/mol-K}$ for vapor produced by combustion, what is the final temperature if 12 microliters of octane are combusted? ? ($\rho_{\text{oct}} = 0.7 \text{ gm/cm}^3$)

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Solution: For the reaction in which all products are in the vapor phase we can write:



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The difference in the number of moles is:

$$\Delta n = 9 + 8 - 12.5 = 4.5$$

Thus, for each mole of octane combusted there will be 4.5 moles of gas to be heated. The number of moles of octane is obtained from:

$$\begin{aligned} n &= \frac{\rho V}{M_m} = \frac{(0.7 \text{ gm/cm}^3)(1.2 \times 10^{-5} \text{ L})(1000 \frac{\text{cm}^3}{\text{L}})}{114 \text{ gm/mol}} \\ &= 7.37 \times 10^{-5} \text{ mol} \end{aligned}$$

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Therefore, the total number of moles to be heated is:

$$n_{\text{vapor}} = 3.31 \times 10^{-4} \text{ mol}$$

The total heat is obtained from the molar heat of combustion of octane, which is -5430 kJ/mol .

$$q = n\Delta H^\circ = (7.37 \times 10^{-5} \text{ mol})(-5430 \text{ kJ/mol}) = 400 \text{ J}$$

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Finally, the temperature difference is given by

$$\Delta T = \frac{q}{n_{\text{vapor}} c_p} = \frac{400 \text{ J}}{(3.31 \times 10^{-4} \text{ mol})(225.7 \text{ J/molK})}$$

$$\Delta T = 5350 \text{ K} \text{ and } T_f = 5650 \text{ K}$$

For the very small explosion that takes place there is a very high local temperature. However, this temperature is rapidly lowered by transfer to the surrounding metal.