# Combustion problems for Unified

T14

The compressor of a jet engine delivers air to the engine's combustor at a temperature of 600K. Kerosene (empirical formula $CH_{1.95}$) is then injected at a rate such that the fuel fraction (by mass) is $f = \dot{m}_f / \dot{m}_{air} = 0.03$.

As a first approximation, assume the only combustion products are CO_2, H_2O) and excess O_2 and N_2, that the reaction can be written as

$$A\ CH_{1.95} + B(O_2 + 3.76\ N_2) \rightarrow C\ CO_2 + D\ H_2O + E\ O_2 + F\ N_2$$
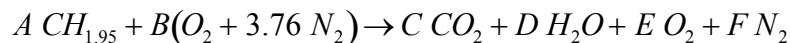
(a) Calculate A, B, C, D, E and F such that the total amount of products is 1 Kg.

(b) For an approximate calculation of the adiabatic flame temperature, it is common to use the so-called "Heat Value" of the fuel, h, as the heat liberated per kg of fuel burnt. For Kerosene, $h=43 \times 10^6$ J/kg. Assuming f<<1, the heat balance then reads $\dot{m}_f h = \dot{m}_{air} c_p (T - T_{in})$. Use this to estimate T, the adiabatic flame temperature.

T15

For the same case as Problem 1, calculate the adiabatic flame temperature using tabulated values of the molar enthalpies (including the enthalpy of formation in each case).
The specific enthalpy of the liquid kerosene (including enthalpy of formation) is approximately $-1.77 \times 10^6 J/Kg$.

Suggestion: Pre-compute the specific enthalpy (J/Kg) of the reactants, then calculate and tabulate the specific enthalpy of the products at a few temperatures in the vicinity of the estimate obtained in Problem 1. Interpolate for the flame temperature to ensure the two enthalpies are equal.