MECH4450 Aerospace Propulsion

Major Assignment - Part 1

Muirhead, Alex
s4435062

Watt, Robert
s4431151

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The following finite rate chemistry mechanisms provide an accurate model of fuel combustion within a scramjet engine.

$$\mathrm{C_2H_4} + 2\,\mathrm{O_2} \longrightarrow 2\,\mathrm{CO} + 2\,\mathrm{H_2O} \tag{1}$$

$$\mathrm{CO} + \frac{1}{2}\,\mathrm{O_2} \longleftrightarrow \mathrm{CO_2} \tag{2}$$

The rates of formations for the individual species are given as:

$$\frac{\mathrm{d}[\mathrm{C_2H_4}]}{\mathrm{d}t} = -k_1[\mathrm{C_2H_4}]^{0.5}[\mathrm{O_2}]^{0.65} \tag{3a}$$

$$\frac{\mathrm{d}[\mathrm{O_2}]}{\mathrm{d}t} = -2k_1[\mathrm{C_2H_4}]^{0.5}[\mathrm{O_2}]^{0.65} - \frac{1}{2}k_{2f}[\mathrm{CO}][\mathrm{O_2}]^{0.5} + \frac{1}{2}k_{2r}[\mathrm{CO_2}] \tag{3b}$$

$$\frac{\mathrm{d}[\mathrm{CO}]}{\mathrm{d}t} = 2k_1[\mathrm{C_2H_4}]^{0.5}[\mathrm{O_2}]^{0.65} - k_{2f}[\mathrm{CO}][\mathrm{O_2}]^{0.5} + k_{2r}[\mathrm{CO_2}] \tag{3c}$$

$$\frac{\mathrm{d}[\mathrm{H_2O}]}{\mathrm{d}t} = 2k_1[\mathrm{C_2H_4}]^{0.5}[\mathrm{O_2}]^{0.65} \tag{3d}$$

$$\frac{\mathrm{d}[\mathrm{CO_2}]}{\mathrm{d}t} = k_{2f}[\mathrm{CO}][\mathrm{O_2}]^{0.5} - k_{2r}[\mathrm{CO_2}] \tag{3e}$$

where k_1 is the rate of reaction for Eq. 1, and k_{2f} and k_{2r} are the forward and backward reaction rates for Eq. 2 respectively.