AS – 5640 Combustion, Explosion and Detonation

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Assignment – 1, Total 30, Weightage: 15%, Due: Oct 04, 2023, 11PM.

Assignments must be submitted electronically to ***murgi@smail.iitm.ac.in*** and the reports must contain:

1. Only the results in the form of plots and discussions related to them. Discussions of results include some points in the scoring. Time of email reaching me is considered submission time. Late submissions will have -2% per hour negative scores. No use submitting beyond 7.5 hours! Problems with internet/email servers wont be considered.

2. Appendix which must include the codes used or the procedures/algorithms used. The codes (preferably in MATLAB) will be checked for its running ability during evaluation.

The required thermodynamic data are available on the class website.: http://www.ae.iitm.ac.in/~murgi/Comb/Comb.html

1. Consider the combustion of Indane-LPG [C4H10(60%v/v)+C3H8(40%v/v)] with air. **[15]**

(a) Find the Adiabatic flame temperature and composition for a range of equivalence ratios [0.7:0.1:1.4] starting with 298.15K, 1 atm. Use only the Major species. Explain the variations. [4]

(b) Find the composition of minor species using Major-minor model for combustion. Explain the variations. [2]

(c) Find the Adiabatic flame temperature and composition of all species (include all species for which you can get curve fit data from the class website) using complete equilibrium. Explain the variations. [5]

(d) Are the results of (c) matching with (a) and (b)? interpret the differences. [2]

(e) Find the energy produced per kg fuel for each of the composition with all species considered. Explain the results. [2]

Solve any two out of the following three questions (2,3,4).

2. Consider the reaction: $C_3H_8 + 5(O_2+3.76\ N_2) \rightarrow 3CO_2+4H_2O+18.8N_2$.

Reaction rate is given by $RR=-k[C_3H_8]^{0.1}[O_2]^{1.65}$

Reaction rate constant is given by $k = 8.6\times10^{11}T^{0.1}\exp(-15098/T)$.

(a) Find the Volume, temperature and concentration of the species in a Constant pressure fixed mass reactor (initial Vol. = 1 ltr), for various mass flow rates at adiabatic conditions. You may have to change time steps as the reactions pick up speed. Assume ϕ=1, P=1atm, & T_{init} = 310K. Interpret the results. [7]

(b) Find the same as (a) for Qin>0 and for Qin<0. Use significant Q values to show some change. How much is significant? Interpret the results. [4]

(c) Assuming adiabatic again, give the effect of initial pressure on time to complete 99% of fuel conversion. [4]

3. (a) Find the temperature and concentration of the species at the outlet of a WSR (Vol = 1 ltr), for various mass flow rates at adiabatic conditions, for propane air mixture. Assume ϕ=1, P=1atm, & Tin = 310K. Interpret the results. [8]

(b) Find the same as (a) for Qin>0 and for Qin<0. Interpret the results. [7]

4. Consider a duct of 10cm square cross section made of perfect insulator. The duct is 0.5 m long. Develop a PFR model for the combustion of same mixture as in problem 2. Tin=1200K, Pin=1 atm. **[5]**

Determine the inlet velocity for which the fuel is 99% consumed by the end of the duct, for a range of equivalence ratios [0.7 to 1.2]. Interpret the results. [10]

5. [Bonus] Use the expression, $\frac{d}{dt}[NO] = 1.4\times10^{14}\exp(-38300/T)[O][N2]$, and estimate (and interpret):

(a) NO production rates as a function of equivalence ratio ϕ, in problem 1(a+b). **[3]**

(b) Concentration of NO in problem 3 for various mass flow rates, with the concentrations of the species at the outlet. Find [O] from CO, CO2, O equilibrium at outlet temperature and composition of CO2, then use residence time to estimate the concentrations of NO. **[5]**