Assignment - 1

Combustion Explosion and Detonation (AS 5640)

Department of aerospace Engineering, IIT Madras

Due date: **04/02/2019**

assignment is to be submitted **latest by 4:30 pm** on the due date

1. Consider the combustion of a) hydrogen and air (consider only oxygen and nitrogen) and b) hydrogen and oxygen (no nitrogen), with initial reactants at temperature of 298K and total pressure of 1 atmosphere. Assuming constant pressure combustion and that there is no dissociation of products. Compute the adiabatic flame temperatures for the following reaction/s

$$\phi H_2 + \frac{1}{2}\left(O_2 + \frac{79}{21}N_2\right) \rightarrow \varphi H_2O + \left(\frac{1}{2} - \frac{\varphi}{2}\right)O_2 + \frac{79}{42}N_2 \quad for\ \varphi \le 1$$

$$\phi H_2 + \frac{1}{2}\left(O_2 + \frac{79}{21}N_2\right) \rightarrow H_2O + (\varphi - 1)H_2 + \frac{79}{42}N_2 \quad for\ \varphi > 1,$$

where φ *is the equivalence ratio* (0.1, 0.3, 0.5, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2,1.5, 2.0, 2.5)

Take heat of formation, $\Delta H_{f^0_{H_2O}} = -241845 kJ/kmol$ and constant specific heat,

$C_{P(H_2O)} = 40 kJ/kmolK, C_{P(H_2)} = 30 kJ/kmolK, C_{P(O_2)} = 35 kJ/kmolK\ and\ C_{P(N_2)} = 33 kJ/kmolK$ (all are at 1000K).

If we relax the assumption of constant specific heat capacity calculate again the adiabatic temperature using CEA software. Compare the flame temperature for the two cases (air and pure oxygen) for both constant C_P and variable C_P.

Allow for dissociation of products and obtain flame temperature for the two cases (air and pure oxygen).

2. Consider combustion of a fuel (see the table below for your fuel) is air at initial temperature of 298.16K and at constant pressure of 1atm. Use Gordon-McBride chemical equilibrium program (CEA software) to carry out thermochemical calculations for equilibrium compositions and flame temperature for equivalence ratios of 0.5 to 2.5 (take increments of 0.1 in equivalence ratio). Plot adiabatic flame temperature (T_f) and mole fractions of *CO, NO* and NO_2 with equivalence ratio.

Discuss the following:

a) What is the maximum adiabatic temperature and at what equivalence ratio. Explain your observations.

b) What equivalence ratio would you suggest to minimize NO and NO_2. Similarly what will be your strategy to reduce CO pollutants? Can you comment on challenge one is faced to reduce both NOx and CO simultaneously.

Sl. No	**RollNo**	**First Name**	
1	AE09B028	Vasireddy Saiashwin	CH_4 (Methane)
2	AE14B041	Harshal Mankar	C_2H_2 (Acetylene)
3	AE14B044	Pratik Sutar	C_2H_4 (Ethene)
4	AE15B008	APOORVA BANERJEE	C_2H_6 (Ethane)
5	AE15B031	RAJEEV KRISHNA S	1-Propanol(C_3H_8O)
6	AE15B055	RAPARTHI SAITEJA	Ethanol(C_2H_6O)
7	AE16B103	AKKHIL VANNAN M	Carbon Monoxide (CO)
8	AE16B109	RAKESH RAUSHAN	C_3H_6
9	AE17D001	PINTO ROCKY SIMON	C_3H_8
10	AE18D005	VIPIN KUMAR	C_4H_8
11	AE18D012	SUMIT SARMA	C_4H_{10}
12	AE18D014	ANUSAI R	C_5H_{10}
13	AE18D409	CHAUN BRIJ JAYDEEPBHAI	C_5H_{12}
14	AE18D410	GOMATHINAYAGAM N	C_6H_6
15	AE18M007	VALLURI RAVI PRASAD	C_6H_{12}
16	AE18M010	ADITYA WALIYA	C_6H_{14}
17	AE18M011	ANKIT SAHAY	C_7H_{14}
18	AE18M012	ARMAL NIKHIL DATTU	C_7H_{16}
19	AE18M016	GAUTHAM KRISHNAN	C_8H_{16}
20	AE18M027	SAURABH ROY	C_8H_{18}
21	AE18M028	SIBANANDA PANIGRAHY	C_9H_{18}
22	AE18M038	SHUBHAM KUMAR	C_9H_{20}
23	AE18S021	ROHITH S K	$C_{10}H_{20}$
24	AE18S025	KINGSHUK CHAKRABORTY	$C_{10}H_{22}$
25	AE18S026	VISHAL SRIVASTAV	$C_{11}H_{22}$
26	AE18S046	GAGANA S	$C_{11}H_{24}$
27	ME16B067	RAGHAV KAKANI	Methanol(CH_4O)