Assignment 9

1. Heptane ($C_7 H_{16}$) is burnt with 50% excess air. Determine (a) Stiochiometric air- fuel ratio, (b) actual air-fuel ratio, (c) Oxygen present in products, by volume and by mass, and (d) calorific value. (Ans.: (a) 15.17 kg air/kg fuel, (b) 22.76 kg air/kg fuel, (c) 0.067 and 0.074, (d) 46.74 MJ/kg fuel)
2. Coal having the gravimetric composition of C=74.4%, H_2=12%, O_2=2%, rest of ash is burnt with 180% theoretical air. Compute (a) calorific value (b) Stiochiometric air-fuel ratio, (c) actual air-fuel ratio, and (d) exhaust gas composition by mass on dry basis assuming complete combustion. (Ans.: (a) 38.79 MJ/kg fuel, (b) 12.60 kg air/kg fuel, (c) 22.69 kg air/ kg fuel (d) CO_2=12.1%, N_2=77.5%, O_2=10.4)%
3. A gas sample analysed by Orsat's apparatus gave the following percentage values: CO_2 = 7.20, CO = 1.00, O_2 = 10.00, N_2 = 81.8. (a) Express this volumetric composition on mass basis, (b) Assuming that the fuel is a hydrocarbon, find its approximate formula and (c) Estimate the calorific value of the fuel. (Ans.: (a) CO_2 = 10.7, CO = 9.0, O_2 = 10.8, N_2 = 77.6 (b)CH_2 or C_2H_4(c) 45.08 MJ/kg fuel)
4. A sample of coal has the following gravimetric composition: C = 87%, H_2 = 4%, ash = 9%. Find (a) stiochimetric air-fuel ratio assuming complete combustion without excess air, determine (b) gravimetric and (c) volumetric composition of the products, and (d) calculate the calorific value. (Ans.: (a) 11.38 kg air / kg fuel, (b) CO_2=26.0%, N_2=71.1%, H_2O=2.9%(mass basis), (c) CO_2=18.0%, N_2=77.0%, H_2O=5.0%(mole basis), (d) 33.32 MJ/ kg fuel)
5. During the burning of coal in Ex. 4, the dry flue gas indicates a CO_2 content of 12.6%, using ORSAT's apparatus. Determine the excess air factor. (Ans.: 48.3%)
6. Producer gas having the volumetric percentage composition of H_2= 14, CH_4= 3, CO= 24, CO_2= 6, O_2=2, N_2= 50.3, (rest moisture) is burnt in a process boiler. The volumetric percentage composition of the dry flue gasses determined by Orsat's apparatus is CO_2=15, O_2=4.7, and N_2= 80.3. What is the excess air factor. (Ans. 2.0)
7. CO is burnt in adiabatically in a steady flow at atmospheric pressure with 100% excess air. The CO is supplied to the burner at 150 ^oC and the air at 40 ^oC . The standard enthalpy of the reaction at 1 atm., 25 ^OC, is -283177 X 10^6 J/k-mol of CO. Calculate the temperature of the combustion products. Use the following mean specific heats at constant pressure. CO-1038 J/kg-K, O_2-1120 J/kg-K, N_2-1171 J/kg-K, CO_2-1185 J/kg-K and air-1000 J/kg-K.
8. A mixture having a volumetric composition of CO_2 = 0.1, CO = 0.4 and air 0.5, is contained in a rigid vessel at a temperature of 0^oC When the mixture is exploded by a spark, estimate the gravimetric composition of the products, and (b) the temperature they would reach, assuming that no dissociation takes place and the process is adiabatic. Take the meat c_v for the gases are as follows. CO-888 J/kg-K, O_2-830 J/kg-K, N_2-870 J/kg-K, and CO_2-1045 J/kg-K.
   [Ans (a) CO_2 = 0.4543, CO = 0.1773, N_2 = 0.3684, (b) 2069 ^OC]
9. Ethane (C_2H_6), when burnt with oxygen, at constant pressure has the enthalpy of the reaction at 25 ^oC equal to -47590 kJ/kg. (a) Find the enthalpy of reaction at 540 ^oC, if the mean c_p values between 25 ^oC to 540 ^oC (in kJ/kg-K) are C_2H_6 = 2.800, O_2 = 0.989, CO_2 = 1.049, H_2O (vap) = 1.987, N_2 = 1.066. (b) Calculate the heat transferred when 0.2 kg of ethane is burnt at constant pressure in a cylinder containing 4 kg of dry air, if the temperature of the reactants and products are 40 ^oC and 540 ^oC respectively and the mean c_p values in the range 25 ^oC to 40 ^oC (in kJ/kg-K)are: C_2H_6 = 1.788, O_2 = 0.919, N_2 = 1.040. [Ans -47510 kJ/kg of C_2H_6, -7120 kJ]