Major Exam, 18 Nov. 2021, 9:15 -11:15 AM.

Material and Energy Balances, CLL111

Time: 2 Hours **M. Marks: 50**

1. A coal with the following composition (mass %) is burnt with 100 % excess air.

Carbon	51.22
Sulphur	0.37
Oxygen	18.04
Hydrogen	2.79
Ash	20.58
Moisture	7.00

Calculate

a. Theoretical oxygen requirement per unit mass of coal **(8)**
b. Wet and Orsat analyses of flue gas **(4,4)**

2. A flue gas has the following composition:
CO_2: 9.5 %; CO: 0.2 %, O_2: 9.6 % and N_2: 80.7 %
Assuming ideal gas behavior, calculate
a. The composition of flue gas by mass **(4)**
b. Volume occupied by 0.5 kg. of flue gas at 30^0C and 760 mm. Hg. **(4)**
c. Density of the flue gas in lb/ft^3 at condition of (b). **(4)**

3. Convert the following:
a. Superficial mass velocity of 200 lb./h.ft^2 to kg./s.m^2 **(4)**
b. 40 psig to psia **(4)**
c. 70 Btu/h.ft^2.^{0}F to cal/s.cm^2.^{0}C **(4)**

4. The C_P of a gas is 10 cal/gmol.K. Determine its value in FPS units. **(3)**

5. Calculate the Heat of Reaction at 750 K and 1 atm. for the reaction **(7)**

$$2\ SO_2 + O_2 \longrightarrow 2\ SO_3$$

Std. Heat of Formation:

SO_2: - 2,97,000 kJ/kmole

SO_3: - 3,95,000 kJ/kmole

Mean molar specific heats:

SO_2: 51.5 kJ/kmole.K

SO_3: 30.98 kJ/kmole.K

O_2: 45.67 kJ/kmole.K