UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech MSENT | **Semester – VII**
Subject (Course): Process Plant Design for Metallurgical Operations | **Max. Marks : 100**
Course Code: MTEG431 | **Duration : 3 Hrs**
No. of page/s: 3

Instructions:
1) Internal choice in Q9 – Attempt only one part,
2) Collect graph sheet for drawing predominance diagram as part of Q10

Reference Data:
Molar weights (**g/mol**): Fe=56, Cu=63.5, Zn=65, S=32, Ca=40, Pb=207, Si=28, N=14

Cp (**J/g.K**) : CO_2= 0.9, O_2=0.92, N_2=1.04, SO_2= 0.65

Section-A (4x 5 marks=20 marks)

1. What are Chalcopyrite ores?

2. Briefly describe "Reduction Smelting" and "Matte Smelting"? Give one example of each.

3. What is the difference between "dead roasting" and "sulphatizing roasting"?

4. Discuss the purpose of carrying out selective roasting during Copper extraction.

Section-B (4x 10 marks=40 marks)

5. Compare the metal grade of two Copper ores with as given chemical composition:

Ore 1	10% Cu_2S, 20% CuS, 15% FeS
Ore 2	15% Cu_2S, 15% CuS, 15% FeS

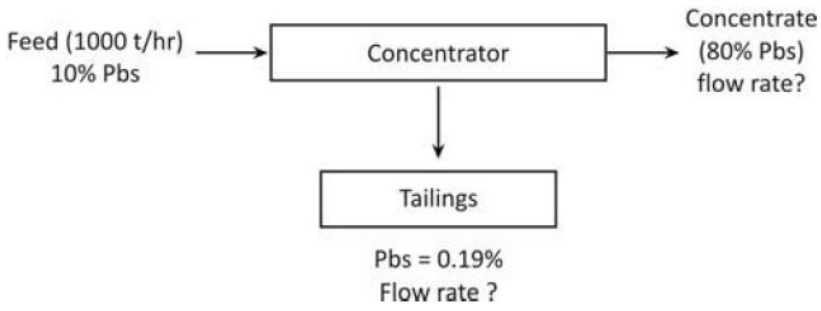
6. 10 kg lime is to be prepared by calcination of pure $CaCO_3$ in a rotary kiln.

- Composition of fuel gas used is: CO 20%, CO_2 8%, N_2 72%
- Calorific value of this fuel gas: 11 x 10^3 kcal/kgmol
- No excess air is used for combustion.

Limestone and air are supplied at 298K while producer gas is preheated to 900K. Lime is discharged at 1200K and gases at 500K.

Calculate the amount of producer gas required for production of 10kg lime.

7. Analyze the circuit below and determine the unknowns:



8. A copper converter blows copper matte into blister copper. Following data is provided:

	Chemical Analysis (wt. %)
Matte Charged	Cu-40, rest Fe and S
Flux charged	SiO_2-80, Cu_2S-4 , FeS-16
Slag produced	SiO_2-30, FeO-70
Blister produced	Cu-98.5

The weight of matte charged is 50 Tons. Rate of blowing air is 3 Nm^3/s. Assuming that both matte and flux are charged at the beginning of the process, calculate:

a) Wight of flux charged
b) Weight of slag produced
c) Weight of blister produced

Section-C (2x20 marks=40 marks)

9. Draw a schematic RIST diagram for Blast Furnace Operation based on below equation which describes the Blast Furnace stoichiometry:

$$(n_O)_B + \left(\frac{O}{Fe}\right)_x = n_C^A \left(\frac{O}{C}\right)_g$$

Apply this model to solve any one of the following problems:

a) A Blast Furnace is being operated with iron ore batch and coke batch of following composition:
Iron Ore: 80% Fe_2O_3 and 20% Fe_3O_4. Coke: 90% C
Coke Rate: 450 kg/Ton of Iron produced
Oxygen introduced at the rate of 370 kg/Ton of Iron produced
Hot metal contains 4.5% C and 95.5% Fe.
Calculate the top gas composition for this furnace.

OR

b) Iron Ore: 80% Fe_2O_3 and 20% Fe_3O_4.
Exit gas composition of Blast Furnace is 25% CO, 22% CO_2 and 53% N_2.
Air is blown at the rate of 1500 m3/Ton of iron produced.
Hot metal contains 4.5% C and 95.5% Fe.
Find the quantity of active carbon and total carbon consumption per ton of iron produced.

10. Composition of Lead Concentrate: PbS 80%, FeS 8%, SiO_2 2% and rest $CaCO_3$. Concentrate is treated by roast-reaction method to produce Lead.

Reactions during roasting stage:

$$2PbS + 3O_2 = 2PbO + 2SO_2$$
$$Pbs + 2O_2 = PbSO_4$$
$$4FeS + 7O_2 = 2Fe_2O_3 + 4SO_2$$

At the end of roasting, all FeS is oxidized but some PbS is left.
$PbSO_4$ and PbO formed are in the ratio of 1:3 by weight.
During the reaction stage, following reactions occur and they continue till all PbO and $PbSO_4$ has been consumed:

$$PbS + 2PbO = 3Pb + SO_2$$
$$PbS + PbSO_4 = 2Pb + 2SO_2$$

Taking the basis as 1 Ton of concentrate, find:
1) Weight and composition of end-product after roasting stage.
2) %Sulphur eliminated during roasting stage.
3) Draw the predominance diagram for Pb-O-S system.