FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

PYROMETALLURGY NON-FERROUS

EMR 3203

Final Examination Paper

August 2021

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Mr Q.D.Chingoka

INSTRUCTIONS

1. Answer **ANY FIVE QUESTIONS**
2. Each question carries 20 marks
3. Use of calculators is permissible

Additional Requirements

MARK ALLOCATION

Question 1 to 6	**20 Marks**
Part Questions	**As shown in each part question**
Total Attainable	**100**

Question 1

With the aid of chemical equations explain the following metallothermic reactions;

i. Silicothermic magnesium process (Pidgeon process). **(8 marks)**
ii. Mond carbonyl process for Nickel production. **(6 marks)**
iii. Kroll process for titanium production. **(6 marks)**

Question 2

i. State the two functions of fluxes in smelting **(2 marks)**
ii. Explain the roll of slags in smelting **(6 marks)**
iii. Give the three properties that are determined by the close control of slag composition in the submerged arc operatives. **(3 marks)**
iv. Name the four properties that a good slag must have. **(4 marks)**
v. Give one examples in each case of: (**2 marks)**
    a. network breaker and
    b. network former
vi. You are given two oxides of Manganese; MnO and Mn_2O_7, explain giving reasons which would be the network breaker and the network former.? **(3 marks)**

Question 3

i. A pyrometallurgist working at a copper matte smelting operation realizes that there is a significant copper loss to the slag. What could be causes of this and what corrective measures can he or she take? **(6 marks)**
ii. Explain how each of the following parameters can be enhanced in flash matte smelting:
    a. Temperature **(2 marks)**
    b. Slag matte immiscibility **(2 marks)**
    c. Off gas strength **(2 marks)**
iii. In flash matte smelting, rapid oxidation of the concentrate is very critical. Explain how this can be achieved. **(3 marks)**
iv. In copper matte smelting, it is essential that iron sulphide (FeS) is always present. What role does it play? Illustrate your answer with relevant equations. **(5 marks)**

Questions 4

i. State the generic reactions which govern sulphide smelting and briefly describe how sulphide smelting is achieved. What are the three major sources of heat supply in sulphide smelting? **(6 marks)**

ii. What is the process of converting? **(1 marks)**

iii. Name two un-wanted products of converting. **(2 marks)**

iv. Show by means of a well labelled balanced equation how these unwanted products are cleaned in the furnace. **(2 marks)**

v. With reference to copper, show by means of three (3) well balanced equations how the final blister copper is produced in the converter. **(6 marks)**

vi. What is the purpose of fire refining of blister copper? **(1 marks)**

vii. Write down the phases/systems involved in the fire refining of blister copper. **(2 marks)**

Question 5

i. Discuss the chrome ore properties that are normally considered when selecting the feed for smelting purposes. During smelting which oxide is reduced first between chrome oxide Cr_2O_3 and haematite (Fe_2O_3). **(5 marks)**

ii. The following data was supplied for a ferro-chromium production of a certain plant.

- Reduction of chrome oxide in the ore is 90%
- Reduction of iron oxide in the ore is 95%
- Carbon content in the alloy is 7%
- Silicon content in the alloy is 1.5%

The composition of the chrome ore is as follows; 54%-Cr_2O_3; 15.6%-FeO; 13.6%-MgO; 10%-Al_2O_3; 4.5%-SiO_2. If the chrome ore portion of the charge is 475-Kg: -

a. Calculate the weight of the alloy produced **(8 marks)**

b. The amount coke required considering that the fixed amount of carbon in the charge exceeds the stoichiometric amount by 25%. **(7 marks)**

Use the following equations in your calculations.

$Cr_2O_3 + 3C \rightarrow 2Cr + 3CO$

$FeO + C \rightarrow Fe + CO$

$SiO_2 + 2C \rightarrow Si + 2CO$

Element	Cr	Fe	Si	O	C
Atomic number	52	56	28	16	12

Question 6

In the operation of a copper convertor the first charge is 30t of 4% Cu matte the flux used is ore carrying 7%- Cu, 16%- Fe, 5%-S, 49%-SiO_2, the slag carries 28%-SiO_2, 63%-FeO, 4%-CuO. After the first slag is poured, additional matte is charged of the same weight as the FeS oxidized from the first matte charge. The time for blister forming stage 2 hrs and is given by:

$$T_{Cu\,making} = \frac{Total\,O_2\,required}{\left(O_2\,required \in Cu\,making\right)} * blister\,making\,time\left(hrs\right)$$

Calculate

i. Total amount of flux used and the amount of slag produced. **(10 marks)**
ii. The weight of the blister copper produced. **(3 marks)**
iii. Blast air in m^3. **(5 marks)**
iv. Blasting time and volume of blast supplied per min. **(2 marks)**

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