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#### MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING,APPLIED SCIENCES AND TECHNOLOGY

**DEPARTMENT: MINING AND MINERAL PROCESSING ENGINEERING**

**MODULE: NON FERROUS PYROMETALLURGY**

**CODE: ENGM 311**

### SESSIONAL EXAMINATIONS

**DECEMBER 2023**

**DURATION: 3 HOURS**

**EXAMINER: MR. J. KURIRAI**

## INSTRUCTIONS

1. *This exam contain* ***ONE SECTION*** *and* ***FIVE QUESTIONS****.*
2. *Answer* ***QUESTION ONE*** *and* ***any other three******question****.*
3. *Start a new question on a fresh page*
4. *Total marks 100*

***Additional material(s):*** *Calculator*

**QUESTION 1**

1. Sintering and Pelletisation are the two common agglomeration techniques employed in pyrometallurgy. Describe in detail the two processes highlighting the strength and weaknesses of each process [10]
2. Smelting is a unit process at which heat is applied to a mixture of ore concentrate, flux and fuel (if necessary) above the melting point to separate the gangue mineral from ore in the liquid state. There are two main types of smelting. Discuss the main differences between ***matte smelting*** and ***reduction smelting.*** [5]
3. Discuss the advantages and disadvantages of producing high grade matte during matte smelting. [5]
4. Describe the principle of operation of the convertor furnace and how it is constructed to suit its purpose. [5]

**QUESTION 2**

1. 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? [8]
2. Name two un-wanted products of converting. [2]
3. Show by means of a well labelled balanced equation how these unwanted products are cleaned in the furnace? [5]
4. With aid of three (3) well balanced equations and the necessary conditions describe how the final blister copper is produced in the converter. [10]

**QUESTION 3**

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%Cr2O3; 15.6%FeO; 13.6%MgO; 10%Al2O3; 4.5%SiO2

If the chrome ore portion of the charge is 575Kg: -

1. Calculate the weight of the alloy produced [15]
2. The amount coke required considering that the fixed amount of carbon in the charge exceeds the stoichiometric amount by 25% [10]

Use the following equations in your calculations.

Cr2O3 + 3C → 2Cr + 3CO

FeO + C → Fe + CO

SiO2 + 2 C→ Si + 2CO

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

**QUESTION 4**

With the use of detailed chemical equations, the pocess flowsheet diagram and the furnaces utilised explain the pyrometallurgical extraction of Nickel from its ore. [25]

**QUESTION 5**

1. With reference to pyrometallurgy of Aluminium, explain how fused salt electrolysis works. Include chemical equations at each electrode. [10]
2. Pyrometallurgical processes produces a lot of harmful gases to the atmosphere and dust. As a production manager how would you treat waste gases and dust from the process of producing Aluminium. [5]
3. A copper ore having the following composition (wt%) on dry basis: Cu-8.8, S-36.6, SiO2-19.0, Al2O3-5.6, Fe-29.7, and CaO-0.3, was roasted down to a sulfur content of 6.8%. Assuming that :

* 5% of the copper is converted to CuO and the remainder remains un-oxidized as Cu2S,
* the iron oxidized forms only Fe2O3 and the rest remains as FeS
* the flue gases coming out of the roaster analyze: SO2-2.61, SO3-0.27, CO2-0.12, O2-17.20, and N2-79.0% (by volume).

Calculate for 1000 kg of raw ore: The weight and analysis of the roasted product. [10]

**END OF EXAMINATION**