FACULTY OF SCIENCE & TECHNOLOGY

#### MIDLANDS STATE UNIVERSITY

**Mining and Mineral Processing Engineering Department**

**MINERAL PROCESSING 1**

**CODE: HMIE 213**

### SESSIONAL EXAMINATIONS

**DECEMBER 2016**

**DURATION: 3 HOURS**

**EXAMINER: Mr. I Nikai**

## INSTRUCTIONS

1. *Answer* ***All*** *questions*
2. *Total marks 100*

***MATERIALS***

*Log-linear graph paper.*

**Question 1**

The following assay data was collected from a copper–zinc concentrator:

Feed 0.7% copper, 1.94% zinc
Cu concentrate 24.6% copper, 3.40% zinc
Zn concentrate 0.4% copper, 49.7% zinc

Mass flow measurement showed that 2.6% of the feed weight reported to the copper concentrate, and 3.5% to the zinc concentrate.

1. Calculate the total NSR under the following simplified smelter terms:

**Copper:**
Copper price: $4600/t
Smelter payment: 90% of Cu content
Smelter treatment charge: $45/t of concentrate
Transport cost: $30/t of concentrate

**Zinc:**
Zinc price: $2300/t
Smelter payment: 85% of zinc content
Smelter treatment charge: $150/t of concentrate
Transport cost: $30/t of concentrate

Assuming that all the copper is contained in the mineral chalcopyrite, $CuFeS\_{2}$ and that all the zinc is contained in the mineral sphalerite, $ZnS$.

**Given:** $A\_{r,Cu}=$***63.546,*** $A\_{r,Fe}=$***55.847 and*** $A\_{r,S}= $***32.066***$A\_{r,Zn}=$***65.39***

 [9 Marks]

1. State 5 important exploitable characteristics used in separation of valuable minerals from unwanted minerals. [5 Marks]
2. Consider the flow sheet shown in Figure 1. The cyclone overflow line is instrumented with a magnetic flow meter and nuclear density gauge, and the mass of dry ore fed to flotation is 25 t/h. The feed from the fine ore bins is sampled, and is found to contain 5 % moisture. The cyclone feed contains 33 % solids, the cyclone underflow 65 % solids, and the overflow 15 % solids.



Figure 1: Conventional closed circuit grinding flow sheet

Calculate

1. the circulating load on the circuit,
2. the circulating load ratio, and
3. the amount of water required to dilute the ball mill discharge.

 [6 Marks]

**Question 2**

1. With the aid of diagrams, show the difference between an open grinding circuit and a closed grinding circuit. [4 Marks]
2. What are the two methods of closing a grinding circuit? [2 Marks]
3. What are the advantages of using a closed grinding circuit? [4 Marks]
4. Prove that the critical speed of a ball mill $N\_{c}$(rpm) is related to the diameter of grinding media, $d$ by the Equation: $N\_{c}={42.3}/{\sqrt{\left(D-d\right)}}$ where $D$ is diameter of ball mill. [10 Marks]

**Question 3**

A screen with an aperture of 125 mm square handles a material which is split in undersize and coarse products according to the results shown in Table 1:

Table 1

|  |  |  |
| --- | --- | --- |
|  | **Undersize** | **Coarse** |
| **Mass flow (tph)** | 8.09 | 11.17 |
| **Particle size (mm)** | **Accumulated % finer in undersize** | **Accumulated % finer in coarse** |
| 177 | 100 | 63.6 |
| 125 | 100 | 41.4 |
| 88 | 87.2 | 6.1 |
| 63 | 74.1 | 1.5 |
| 44 | 62.8 | 0.5 |
| 30 | 56.1 | 0.3 |
| 20 | 48.9 | 0.2 |
| 10 | 40.1 | 0.1 |

1. Calculate the feed particle size distribution
2. Plot the size distribution for under size, coarse and calculated feed in a size distribution diagram.
3. Calculate the size by size recovery of coarse material to the coarse product.
4. Plot the Tromp curve on a linear-logarithmic diagram.

 [20 Marks]

**Question 4**

1. Define free-settling ratio as used in classification. [2 Marks]
2. Calculate the equal settling ratio for ore containing chromite and quartz, falling in water at 20 oC and obeying Stoke’s law.

$ρ\_{chromite}=ρ\_{1}=4.2 g/cm^{3}$and $ρ\_{quartz}=ρ\_{2}=2.65 g/cm^{3}$*.* [4 Marks]

1. Explain why it is preferable to use open circuit rod mills for grinding feed to a gravity concentration circuit. [4 Marks]
2. With the aid of sketches, describe the mechanism of classification that occurs in a hydrocyclone. [10 Marks]

**Question 5**

1. Define the following terms as used in sampling theory:
	1. Sample,
	2. Sub-sample,
	3. Sampling unit, and
	4. Sampling increment.

 [4 Marks]

1. State any *three* requirements for a well-designed sampling protocol to minimize distribution variance. [3 Marks]
2. State the *three* types of models used in computer simulation. [3 Marks]
3. State any *two* advantages of using computer simulation in mineral processing. [2 Marks]
4. During **shift 1**, a plant treats 210 t of material assaying 2.5 % Cu, to produce a concentrate of 40 % Cu, and a tailing of 0.20 % Cu. During **shift 2**, 275 t of material assaying 2.3 % Cu is treated producing a concentrate assaying 38 % Cu and a tailings assaying 0.17 % Cu.

Tabulate the metallurgical balance for the two shifts and for the day.

 [8 Marks]

**END OF PAPER**