



UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

SCHOOL OF ENGINEERING

MAIN EXAMINATIONS: JUNE 2019

COURSE AND CODE: OIL AND MINERAL PROCESSING

ENCH20M

DURATION: 2 HOURS

TOTAL MARKS: 100

INTERNAL EXAMINER(S): PROF AH MOHAMMADI
MR MG NTUNKA

INTERNAL MODERATOR(S): MR EM OBWAKA

EXTERNAL MODERATOR: DR L MAHARAJ

INSTRUCTIONS:

1. ALL questions should be attempted.
2. Two answer books are provided. Label them Book A and Book B respectively. Answer Section A in Book A and Section B in Book B.
3. Any programmable or non-programmable calculator may be used provided it has been cleared of any information that would subvert the purpose of the examination.
4. Calculations must be shown in sufficient detail to illustrate your understanding of the procedure.
5. This examination question paper, together with all associated diagrams **MUST BE HANDED IN TOGETHER WITH YOUR SCRIPT.**

Student Number:

SECTION A

QUESTION 1

- a) Explain why catalytic cracking technology has advantages in comparison with thermal cracking technology.

(3)

- b) List two catalytic cracking units and two thermal cracking units and compare them in terms of their typical functions, feeds, catalysts and products.

(10)

TOTAL /13/

QUESTION 2

- a) Compare a steam reforming unit and a catalytic reforming unit in terms of their typical functions, feeds, catalysts and products.

(10)

- b) Explain how catalysts in a catalytic reforming unit are deactivated and how they can be regenerated.

(3)

TOTAL /13/

QUESTION 3

Explain why an alkylation unit is considered expensive and costly?

TOTAL /8/

QUESTION 4

Sulphur is a by-product of crude oil and natural gas refineries. In which unit is sulphur produced and explain in terms of the unit name, typical feeds and product.

TOTAL /6/

QUESTION 5

Determine the Reid Vapour Pressure (RVP) of a 2000 Barrel per day alcohol required to produce a gasoline blend with total Reid Vapour Pressure (RVP) = 6 psi from the gasolines listed in Table 1.

Table 1 – Gasoline Properties

Gasoline	Quantity/Volume (Barrel per day)	RVP (psi)
Isomerase	5000	5.12
Hydrocracking	3000	3.85
Alkylate	4000	5.52
Reformate	6000	4.33

Considering:

$$BI_{RVPi} = RVP_i^{1.25} \text{ and } BI_{RVP, Blend} = \sum X_{vi} \times BI_{RVPi}$$

BI_{RVPi} : RVP blending index for gasoline i

RVP_i : Reid vapour pressure (psi) for gasoline i

X_{vi} : volume fraction of gasoline i

TOTAL /10/

SECTION B**QUESTION 6**

A two-stage grinding circuit using a rod mill in open circuit and ball mill in closed circuit with a hydrocyclone classifier is used to grind 100 t/h of ore (sp. gr. 3.0). The circuit diagram is shown in Figure 1.

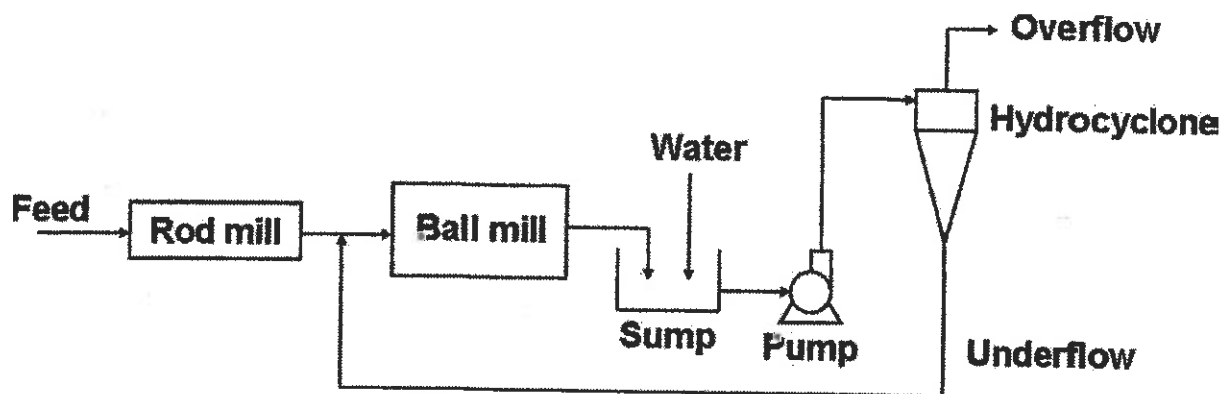


Figure 1 - Closed circuit grinding diagram

The circuit is sampled and analysed for -200 mesh material and percent solids. The results are given in Table 2.

Table 2 - Results of tests for closed circuit for Figure 1

	% -200 mesh	% solids
Rod mill discharge	5	75.18
Ball mill discharge	20	78.33
Cyclone overflow	30	40.00
Cyclone underflow	15	80.00

$$\text{Dilution Ratio} = \frac{100 - \% \text{ Solids}}{\% \text{ Solids}}$$

- Carry out a material balance and calculate the amount in t/h of dilution water added to the sump.
(10)
- Calculate the % circulating load for the circuit and give two practical recommendations in order to improve the overall performance of this comminution circuit.
(4)

TOTAL /14/

QUESTION 7

Crushed product of a primary crusher having 57 % of +1" is sent to a 1" single deck screen. The overflow of the screen is again crushed in a secondary crusher to - 1" size and transported along with underflow of the screen as final product.

- a) Draw the crushing circuit with all details. (3)
- b) Calculate the rate of the material crushed in secondary crusher if the effectiveness of the screen is 80% based on oversize material and the feed rate to a primary crusher is 100 t/h. (3)

TOTAL /6/

QUESTION 8

- a) What rotational speed, in revolutions per minute, would you recommend for a ball mill of 1200 mm in diameter charged with 75 mm balls? (3)
- b) A laboratory technician has milled twenty samples of an ore in which the particles were originally above 65 mesh in size. Each milling test was carried out for a minute and the products screened through a 65, 100 and 150 mesh sieve. The average mass percentages of the material in each size fraction after milling are shown below:

Table 3 – Particle Size Distribution

Mesh (Tyler)	Weight %
+ 65	20.0
- 65+100	14.0
- 100+150	32.0
- 150	34.0

- i. Determine the selection function for all size fraction and write the normalized breakage matrix for the four intervals. (4)
- ii. Use a population balance approach to predict the product size distribution of the grind from the mill for a residence time of one minute. (16)

$$N_c = \frac{42.3}{\sqrt{D - d}}$$

$$p_i = \frac{f_i + \tau \sum B_{ij} S_j p_j}{1 + \tau S_i}$$

TOTAL /23/

QUESTION 9

- a) South Africa's poor safety records in recent years has resulted in several mines being shut down until proper procedures were followed. Give two examples of safety concerns that affect mine workers. (2)
- b) The mining sector accounts directly for a reasonable percentage of South African's GDP (Gross Domestic Product). What was the percentage contribution of the mining sector in 2018? (1)
- c) Explain how you would reduce short-circuiting and hindered settling in a hydrocyclone unit? (2)
- d) What is the typical capacity of gyratory crusher and the feed and product size ranges? (2)

TOTAL /7/