National Exams

98-MMP-B5, Mill Design & Operations

3 hours duration

NOTES:

1, If doubt exists as to the interpretation of any question, the candidate is urged to submit with answer paper, a clear statement of any assumptions made.

2, Any non-communicating calculator is permitted. This is an open book exam.

3, Any five questions constitute a complete paper.

4, All questions are of equal value.

Marking Scheme

1, (a) 5 marks, (b) 5 marks, (c) 5 marks, (d) 5 marks.
2, (a) 5 marks, (b) 5 marks, (c) 5 marks, (d) 5 marks
3, (a) 5 marks, (b) 5 marks, (c) 5 marks, (d) 5 marks
4, (a) 5 marks, (b) 5 marks, (c) 5 marks, (d) 5 marks
5, 20 marks.
6, 20 marks
7, (a) 10 marks, (b) 10 marks

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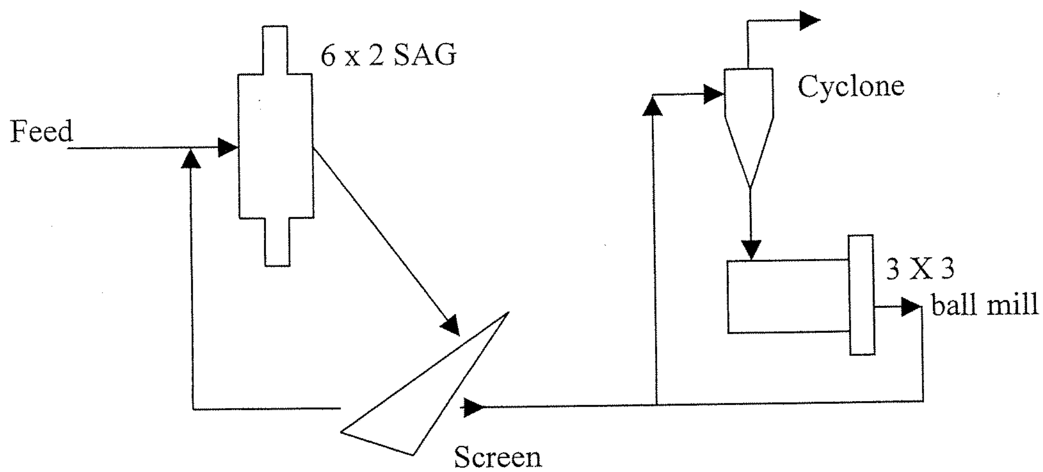
1, A 60" (152.4 cm) run-of-mine is directed at a rate of 1800 TPH to a crushing plant, which includes primary and secondary stages of crushing in open circuit and tertiary crushing in closed circuit. There is 29.84% undersize in the secondary crushing product and 70.12% undersize in the tertiary product. The final product is 1640 TPH at 80% passing ½" (1.27 cm), which is directed to a fine ore bin.

(a) Please select a primary crusher and horsepower required.
(b) Select number and size of secondary crusher and horsepower required.
(c) Select number and size of tertiary crusher and horsepower required.
(d) Indicate the material flow in each crushing stage and estimate the capital cost for all equipment required.

2, A pilot plant grinding circuit has a semi-autogenous mill-screen undersize being fed to the ball mill-cyclone circuit shown below:



The test data are summarized in the following:

Semi-autogenous mill:

Feed rate, tph	1.34
Feed size, 80% passing, µm,	75,000
Product size, 80% passing, µm,	420
Power draw, kw-hr per hr	9.35

Ball mill:

Feed rate, 53% of semi-autogenous mill	
Feed size, 80% passing, µm,	300
Product size, 80% passing, µm,	81
Power draw, kw-hr per hr	4.96

Please calculate:

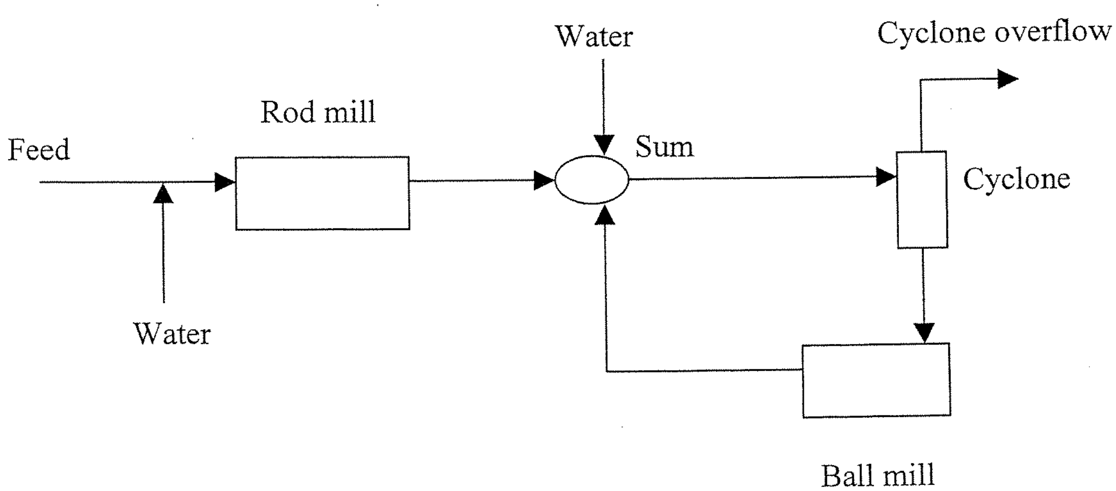
(a) Power draw by semi-autogenous mill and its operating work index
(b) Power draw by ball mill and its operating work index
(c) Total power draw by semi-autogenous and ball mill
(d) Overall operating work index.

3, A two stage grinding circuit as shown below is used in a gold mine at a capacity of 2,400 tonnes per day (dry ore). The specific gravity of the ore is 2.85. The feed from the fine ore bin is sampled and found to contain 5% moisture. Water is added in the circuit to make up the required pulp density, which is measured by mill operators every hour on the hour. The average pulp density at four points of the circuit is shown below:

Rod mill discharge	= 1638 g/L
Cyclone feed	= 1242 g/L
Cyclone underflow	= 1770 g/L
Cyclone overflow	= 1085 g/L

$$\% \text{ Solids by Weight} = \frac{S(D-1)}{D(S-1)}$$

Where: S = specific gravity, D = pulp density



The screen analysis of the cyclone feed and underflow are shown below:

Screen Size		Cumulative Weight % Passing	
Mesh	μm	Feed	Underflow
28	595	79.0	67.3
35	420	66.5	48.0
48	297	55.0	31.5
65	210	43.0	16.6
100	149	34.5	7.7
150	105	28.0	4.7
200	74	23.0	3.3
270	53	18.5	2.1
400	37	15.0	1.6

Calculate: (a) Circulating load and circulating load ratio
(b) Water added into rod mill feed
(c) Water added into cyclone feed pump
(d) D_{50} of the cyclone performance

4, A galena ore was ground and directed to a flotation rougher bank. A rougher concentrate was directed to a scavenger bank for improving the recovery. The scavenger tailing was discarded to tailing pond. Following data were collected for flotation plant design.

Feed	8.7% Pb at 1,000 tpd
Rougher concentrate	69.3% Pb
Rougher tailing	1.7% Pb
Scavenger concentrate	13.9% Pb
Scavenger tailing	0.4% Pb
Water/solid in rougher	2:1
Water/solid in scavenger	4:1
Flotation time in rougher	8 minutes
Flotation time in scavenger	15 minutes
Specific gravity of ore	2.8 g/mL
1 lb = 454.5 grams	
1,000 mL = 0.035 ft^2	

(a) Calculate tons of concentrate produced per day and recovery.
(b) The number of 100 ft^3 capacity Denver cell required for the rougher circuit
(c) Calculate the same for scavenger cells.
(d) What is the total cost of all flotation cell.

5, A copper-nickel ore was submitted for locked cycle test. The objective was to produce a copper-nickel rougher concentrate with a combined grade of Cu and Ni higher than 10%. The test result demonstrated that two cleaning stages were required and seven cycles were required to stay stable. The assay data and metals distribution are shown as the following table. Please use the results of last three (stable) cycles to predict the grade and recovery of the rougher concentrate.

Product	Weight		Assay		Distribution		Metal Unit	
	Grams	%	Cu%	Ni%	%Cu	%Ni	Cu	Ni
Cl. Con #1	125.69	1.80	6.61	7.56	13.23	11.83	11.8762	13.5890
Cl. Con #2	140.91	2.01	5.95	6.83	13.36	11.97	11.9906	13.7556
Cl. Con #3	170.51	2.44	5.24	5.91	14.22	12.54	12.7685	14.4021
Cl. Con #4	163.66	2.34	4.90	5.50	12.78	11.20	11.4716	12.8640
Cl. Con #5	168.08	2.40	5.22	5.84	13.97	12.21	12.5457	14.0262
Cl. Con #6	169.24	2.42	5.06	5.69	13.65	11.98	12.2548	13.7673
Cl. Con #7	169.10	2.42	5.10	5.73	13.74	12.06	12.3317	13.8574
1st. Cl Tail	68.78	0.98	0.53	1.01	0.58	0.86	0.5163	0.9933
2nd Cl Tail	34.76	0.50	0.26	1.00	0.14	0.43	0.1272	0.4990
Ro Tail #1	821.71	11.75	0.05	0.23	0.65	2.32	0.5875	2.6672
Ro Tail #2	844.57	12.08	0.06	0.22	0.78	2.35	0.7004	2.7052
Ro Tail #3	828.32	11.84	0.05	0.22	0.62	2.25	0.5567	2.5820
Ro Tail #4	721.52	10.32	0.03	0.15	0.38	1.33	0.3405	1.5269
Ro Tail #5	909.06	13.00	0.05	0.23	0.69	2.61	0.6239	3.0027
Ro Tail #6	811.57	11.60	0.05	0.20	0.58	1.97	0.5222	2.2629
Ro Tail #7	845.97	12.10	0.05	0.20	0.63	2.07	0.5685	2.3830
Calc. Head	6993.45	100.00	0.90	1.15	100.00	100.00	89.7825	114.8840

6, A beach sand contains quartz, hematite, monazite, zircon, rutile and ilmenite. The physical property of these minerals can found and listed as below. Please suggest two possible flow sheets to produce the multi-concentrate products. Please compare the pro's and con's of the flow sheet suggest by you.

Mineral Name	Specific Gravity	Magnetic Response		Electrostastic Response	
		P	NM	C	NC
Quartz	2.7		X		X
Hematite	5.2	X		X	
Monazite	5,2	X			X
Zircon	4.7		X		X
Rutile	4.3		X	X	
Ilmenite	4.7	X		X	

Note: P = paramagnetic; NM = non-magnetic, C = conductor, NC = non-conductor

7,(a) Pease describe the pro's and con's of following flotation circuits:

(i) Mechanical flotation cell circuit.
(ii) Column flotation cell circuit.
(iii) Mechanical cell followed by column cell circuit.
(iv) Column cell followed by mechanical cell circuit.

(b) You are assigned to select a flotation flow sheet to produce copper, lead, and zinc concentrates from a complex copper-lead-zinc sulfide ore. Please sketch two possible flotation flow sheets (selective and differential flotation) to treat this type of ore. Please compare the pro's and con's of the two potential flow sheets.

[illegible]