UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA EXTRACTION METALLURGY
SUBJECT	:	**HYDROMETALLURGY 3**
CODE	:	**MHD 311**
DATE	:	SUMMER EXAMINATION 2014 18 NOVEMBER 2014
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	40:60
TOTAL MARKS	:	100

ASSESSOR'S	:	PROF A MULABA
MODERATOR	:	DR W. BOLHA 5053
NUMBER OF PAGES	:	3 PAGES

INSTRUCTIONS	:	ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.
REQUIREMENTS	:	NONE

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INSTRUCTIONS TO STUDENTS

PLEASE ANSWER ALL QUESTIONS.

QUESTION 1

1.1 You have been appointed as a student assistant for S2 class which will conduct a leaching experiment in the laboratory, using a diluted hydrochloric acid as a lixiviant. One of your tasks is to prepare the leaching solution for the class. Show how you would prepare 1M and 1.5M of HCl solutions in 1000 ml, knowing that HCl concentration you are using is 32%, density is 1.16 and molecular weight is 36.46. **(10)**

1.2 Oxidised mixed cobalt-copper ore is leached in sulphuric solutions. Solids are being separated from liquids subsequently to the leaching process and the leachate is purified. LIX64 is used to remove copper (Cu) in six counter-current continuous stages. Use the law of mass action to derive an expression for Cu extraction in the above system. It is recommended to start with a three stages system then generalize the expression to six. **(10)**

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QUESTION 2

With the following fundamental background,

For start up filter:

$$\frac{t-t_s}{V-V_s}=\frac{K_1(V+V_s)}{2P}+\frac{K_2}{P}$$

For the rotary filter

$$\theta_f = k_f\theta_c$$

$$\theta_f=\frac{K_1V_f^2}{2P}+\frac{K_2V_f}{P}$$

An aqueous slurry of $CaCO_3$ is to be filtered in a rotary drum filter with 25% submergence. The available pressure drop is 70kPa and the cycle time is 5 min. The slurry contains 230kg of solids per cubic meter. Calculate the filter area required to filter 30L slurry per minute.

A sample of the slurry had been previously tested with a leaf filter using the same filter cloth as is going to be used in the rotary drum filter and the following data was obtained.

Laboratory report

The density of solids is 1800kg/m^3 and the filter cake contains10% moisture. The following results were for slurry with 230kg of solids per m^3 of solids:

Period	Time Intervals (seconds)	Interval Filtrate Volume Collected (L)
1	50	1.5
2	40	1.2
3	40	1.0

The pressure during the first period until is settled at 60kPa. The laboratory filter area is 0.1m^2.

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QUESTION 3

S5 Extraction Metallurgy students are requested to electrolytic ally extract Ni from a nickel bearing sulphide ore (4%Ni). These B-Tech students happened to know that from your Hydrometallurgy module, you have developed a systems approach to solve metallurgical problems and they contact you for assistance. You interact with them in their quest to the extraction of Ni from the above mentioned ore. They take you to the metallurgical plant erected for this project. Starting from the mineral processing you go pass the leaching section before ending at the electrowinning plant. During tea break you enter into a professional discussion with one of the foremen under your supervision.

3.1. He maintains that filtration is clarification as its objective is to remove solids. Negate **and** confirm the above. Kindly substantiate your arguments with example(s) (5)

3.2. The solution obtained during one of the steps contains copper (1% Cu) and cobalt (0.25% Co) as impurities. You are required to suggest separation routes to use for each of the above impurities so that each of them (or their salts) is sold separately. Advise (and most importantly justify) the process route to follow (up to Cu (and Co) metal extraction or their salts production. (10)

3.3. Give a related useful flowsheet associated to the above question (i.e. 3.2.) (5)

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QUESTION 4

Copper ores occur naturally with significant amounts of iron, either as sulfides incorporated in the ore mineralogy like chalcopyrite or as attached out layer oxides. The inevitable consequence of this presence of iron minerals is that iron finds its way into the leachate. There is a strong need to remove iron by precipitation, to clarify the resulting leachate, to remove the existing impurities like cobalt and possibly nickel. The resulting purified solution is sent to the electrowinning plant where copper is extracted prior to its refining through electrolysis.

4.1. Discuss with the aid of relevant equations, the iron precipitation process. (5)

4.2. You are given a strip solution from the SX plant feeding into an electrowinning (EW) tank containing 50g/l copper. The EW discharge is 40g/l copper at a flow rate of 1 m^3/min. there are 36 electrowinning cells consisting of 30 cathodes, each cathode is 1m x 1m and operates at 3.5V and 250 A/m^2 (cu=63.5g/mol; F=96500 C/mole e; charge passed=i.t.A, masse plated=CE.M.q/nF)

4.2.1. Calculate the mass of copper plated in on hour (5)

4.2.2. Using faraday's laws of electrolysis, calculate the total charge through the system for a duration of 1hour (5)

4.2.3. Calculate the current efficiency. (5)

(Given: standards reduction potentials: Co+2/Co = - 0.28V, Cu+2/Cu = 0.34V and Fe+2/Fe = - 0.44V)

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QUESTION 5

5.1. Use the (micro) structure of an activated carbon flake and explain the mechanisms involved in the uptake of gold from its cyanide solution. A drawing of the micro(structure) would assist. **(5)**

5.2. Safety and Health in any environment is of a paramount importance. A metallurgical plant and an hydrometallurgical laboratory do not escape from the above mentioned

requirement. Give and explain three Safety and Health measures /precautions that you should observe in an hydrometallurgy laboratory. **(7)**

5.3. A plant water softener has 0.1 m^3 of ion exchanger resin with a capacity of 57 kg/m^3. The plant uses 2000 l/day of water containing 280 mg/l of hardness as $CaCO_3$. If they want to soften the water to 85 mg/l of the unit, then when will the unit need to be regenerated? **(8)**

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Total: 100