UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA CHEMICAL ENGINEERING
SUBJECT	:	**CHEMICAL PLANT III A**
CODE	:	**ACPA 321**
DATE	:	SUPPLIMENTARY EXAMINATION 2014 15 JULY 2014
VENUE	:	DFC JOHN ORR BUILIDING 2120
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40: 60
TOTAL MARKS	:	100
FULL MARKS	:	100

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NUMBER OF PAGES 6 PAGES (INCLUDING THIS COVER PAGE)

INSTRUCTIONS
- NON- PROGRAMMABLE CALCULATORS PERMITTED.
- ANSWER ALL THE QUESTIONS.

QUESTION 1: CORROSION [20]

1. A steel tank used to hold hot oil is discovered to leak after two years in operation. The tank was designed corrosion allowance thickness for a lifespan of 30 years. Upon close examination, the tank was found to have small pits of various dimensions and depth on the surface. A nearby factory is known to spray fine droplets of hydrochloric acid in the air from time to time.

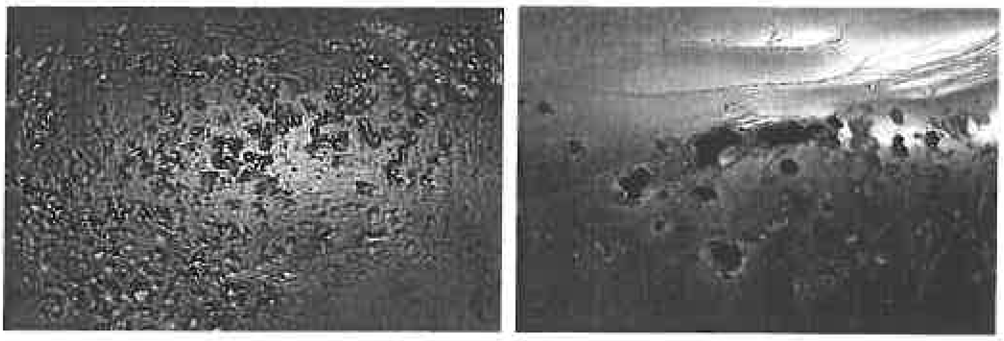

Figure 1: Corrosion of a tank

i.	Describe what form of corrosion is occurring in this case.	[3]
ii.	Use a diagram to show the mechanism and the flow of electrons on the sketch.	[9]
iii.	How can it be prevented from happening	[8]

QUESTION 2: STRENGTH OF MATERIALS [20]

A pipe has an outside diameter of 25 mm, an inside diameter of 15 mm and length 0.40 m and it supports a compressive load of 40 kN. The pipe shortens by 0.5 mm when the load is applied. Determine:

a) The compressive stress [10]
b) The compressive strain in the pipe when supporting this load. [10]

QUESTION 3: THEORY OF SIZE REDUCTION [20]

Calculate the shape factors, *'λ'* for model systems in which the particles are given below. First calculate the correct values of *'p'* and *'q'* for each shape model

(a) Cubes with side dimension L,

- i. The value of *'p'* is [1]
- ii. The value of *'q'* is [1]
- iii. The value of the shape factor is then [2]

(b) Spheres of diameter D,

- i. The value of *'p'* is [1]
- ii. The value of *'q'* is [1]
- iii. The value of the shape factor is then [2]

(c) Cylinders with L = 2D,

- i. The value of *'p'* is [2]
- ii. The value of *'q'* is [2]
- iii. The value of the shape factor is then [2]

(d) Tetrahedra with their sides being equilateral triangles (the volume of a tetrahedron being the area of the base multiplied by 1/3 the vertical height)

- i. The value of *'p'* is [2]
- ii. The value of *'q'* is [2]
- iii. The value of the shape factor is then [2]

QUESTION 4: ENVIRONMENTAL PROTECTION [20]

4.1 Define pollution. [8]

4.2 Give any of the three forms of pollutions and discuss them. [12]

QUESTION 5: CONVEYOR BELT APPLICATION [20]

A belt conveyor 915 m long and 0.9 m wide is loaded with ore of bulk density 1.2 t/m^3 at two points. 350 t/h at the tail end of the conveyor, and 250 t/h at a point 305 m from the tail end. The gradient of the conveyor is 1 in 50 against the loads. The idler friction coefficient is 0.03 for both empty belt and material, and the two-drum drive-head has a total angle of wrap of 440°, with a coefficient of grip of 0.25. The average material section is one twelfth of the belt width squared and the mass of the moving part per meter is taken to be 60 times the belt width. An efficiency of 90 % for the gearing at the drive head is to be considered.

Determine the following;

a) The capacity of the belt in kg/s. [2]
b) Speed of the belt m/s. [3]
c) Power (in kW) required to drive empty belt across the entire length. [3]
d) Power (in kW) required to convey the material across the entire length. [6]
e) Power (in kW) required to raise the material to the required height across the entire length of the belt. [6]
f) Power (in kW) required at the motor. [2]
g) The non-slip ratio of the belt. [3]
h) The maximum belt tension in kN. [3]
i) Maximum permissible stress (in kN/m) if the belt has 5 plies. [2]

END OF EXAM

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FORMULA SHEET

STRENGTH OF MATERIALS

$$\sigma = E \cdot \varepsilon \qquad \sigma = \frac{F}{A}$$

PARTICLE SIZE REDUCTION

Kick's Law $E = K_K \cdot f_c \cdot \log_e\left(\frac{L_1}{L_2}\right)$ *or* $E = K_K \cdot f_c \cdot \ln\left(\frac{L_1}{L_2}\right)$

Rittinger's Law $E = K_R \cdot f_c \cdot \left(\frac{1}{L_2} - \frac{1}{L_1}\right)$

Bond's Law $E = E_i \cdot \left({100}/{L_2}\right)^{1/2} \cdot \left(1 - 1/q^{1/2}\right)$ with $q = \frac{L_1}{L_2}$

Specific surface area $V_P = p \cdot D_P^3$ $A_P = 6 \cdot q \cdot D_P^2$ **Shape factor** $\lambda = \frac{q}{p}$

MATERIAL HANDLING

Tensions ratio for a flat conveyor belt $T_1 = T_2 e^{\mu\theta}$

Tensions ratio for a v-conveyor belt $T_1 = T_2 e^{\frac{\mu\theta}{\sin(\frac{\phi}{2})}}$ **Effective belt tension** $T_e = T_1 - T_2 = \frac{P_T}{v}$

Maximum belt tension $T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1} \Rightarrow T_1 = T_e \frac{e^{\mu\theta}}{e^{\mu\theta} - 1}$ with $n = e^{\mu\theta}$

Maximum permissible belt stress $\sigma = \frac{T_1}{W \cdot p}$

Power required at the driving drum $P_T = T_e v = (T_1 - T_2)v = T_1\left(1 - \frac{1}{e^{\mu\theta}}\right)v$ & $P_T = P_e + P_m \pm P_r$

Motor power $P = \frac{P_T}{\eta}$

Power required to drive the empty belt $P_e = F_e v = m_i(l + 45)g\mu_e v$

Power required to convey material $P_m = m_m g l \mu_m v$

Power required to raise material $P_r = (Cap)gh$

GALVANIC SERIES: The following is the galvanic series for stagnant (that is, low oxygen content) water. The order may change in different environments.

CATHODIC OR MOST NOBLE(PROTECTED END)
Graphite
Palladium
Platinum
Gold
Silver
Titanium
Stainless steel 316 (passive)
Stainless Steel 304 (passive)
Silicon bronze
Stainless Steel 316 (active)
Monel 400
Phosphor bronze
Admiralty brass
Cupronickel
Molybdenum
Red brass
Brass plating
Yellow brass
Naval brass 464
Uranium 8% Mo
Niobium 1% Zr
Tungsten
Stainless Steel 304 (active)
Tantalum
Chromium plating
Nickel (passive)
Copper
Nickel (active)
Cast iron
Steel
Lead
Tin
Indium
Aluminum
Uranium (pure)
Cadmium
Beryllium
Zinc plating (see galvanization)
Magnesium
ANODIC OR LEAST NOBLE (CORRODED END)