NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

SEPARATION PROCESSES 1A

TCE3104

Final Examination Paper

December 2024

This examination paper consists of four pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Dr L.B Moyo

INSTRUCTIONS

1. Answer **ALL** questions
2. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
Section A	**50**
Section B	
B1	**25**
B2	**25**
TOTAL ATTAINABLE MARK	**100**

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION.

QUESTION A1

(a) Ingwebu breweries has noted a substantial amount of suspended material as well as organic waste material in their effluent state and describe processes you would propose to treat the effluent **[10]**

(b) Outline the bio-separation processes involved in anaerobic digestion to produce biogas from cow dung **[10]**

(c) A nickel mine in Bindura has detected the presence of arsenic in their final product which compromises the quality of the final product, discuss methods you can use to improve the quality of the product. **[10]**

QUESTION A2

1. Engineers at Mimosa have noticed inefficiencies in the flocculation process for one of their clarifiers as the overflow contains a substantial number of suspended solids. Discuss what could be the source of this problem and how it can be rectified. **[5]**
2. Consumers of one of Delta beverage producers have complained about a grassy like flavour from one of the beers the source has been traced back to the hops how would you counter this problem. State the pros and cons of your method. **[5]**
3. Bulawayo City Council is considering the treatment of one of its waste-water sources to water that can be used for application by industries. The characteristics of the water are as follows
   Discuss the ideal separation processes **[5]**

Total suspended solids	80mg/L
BOD	46mg/L
COD	35mg/L
Ca^{2+}	200mg/L
Mg^{2+}	120mg/L
HCO_3^{2-}	250mg/L

4. A drum of lead based petrol leaked into the underground water at Bakers Inn production has been stopped as the water can no longer be used for baking. As a consulting engineer, outline how you can separate the unwanted components from the water.
   [5]

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION B1

(a) Outline factors that affect coagulation and flocculation processes when applied in the mining sector. **[10]**

(b) Super critical fluid extraction has been suggested as the ideal method of recovering essential oils from plant materials outline how this process works and sketch the process flow diagram **[10]**

(c) State the advantages of utilizing ionic liquids as compared to solvent extraction **[5]**

QUESTION B2

(a) State the 5 reasons for agitation or mixing in chemical industries and give an example of each. **[10]**

(b) Describe how you would scale up an agitation system, show how you would derive the scale up ratio considering volumetric similarities. **[5]**

(c) A 9.6 m^3 cylindrical tank with a flat bottom is to be converted into an agitation tank with a flat blade turbine agitator with six blades, determine the diameter of the tank (D_t) (state and justify your assumption to determine (D_t). Given that the turbine diameter (Da) is 0.61m and the width (W) is 0.122m. The tank is to contain four baffles, each having a width J of 0.15m. The turbine is operated at 90rpm and the liquid in the tank has a viscosity 12cp and a density of 929kg/m^3. Calculate the required (power) kW of the mixer. **[10]**

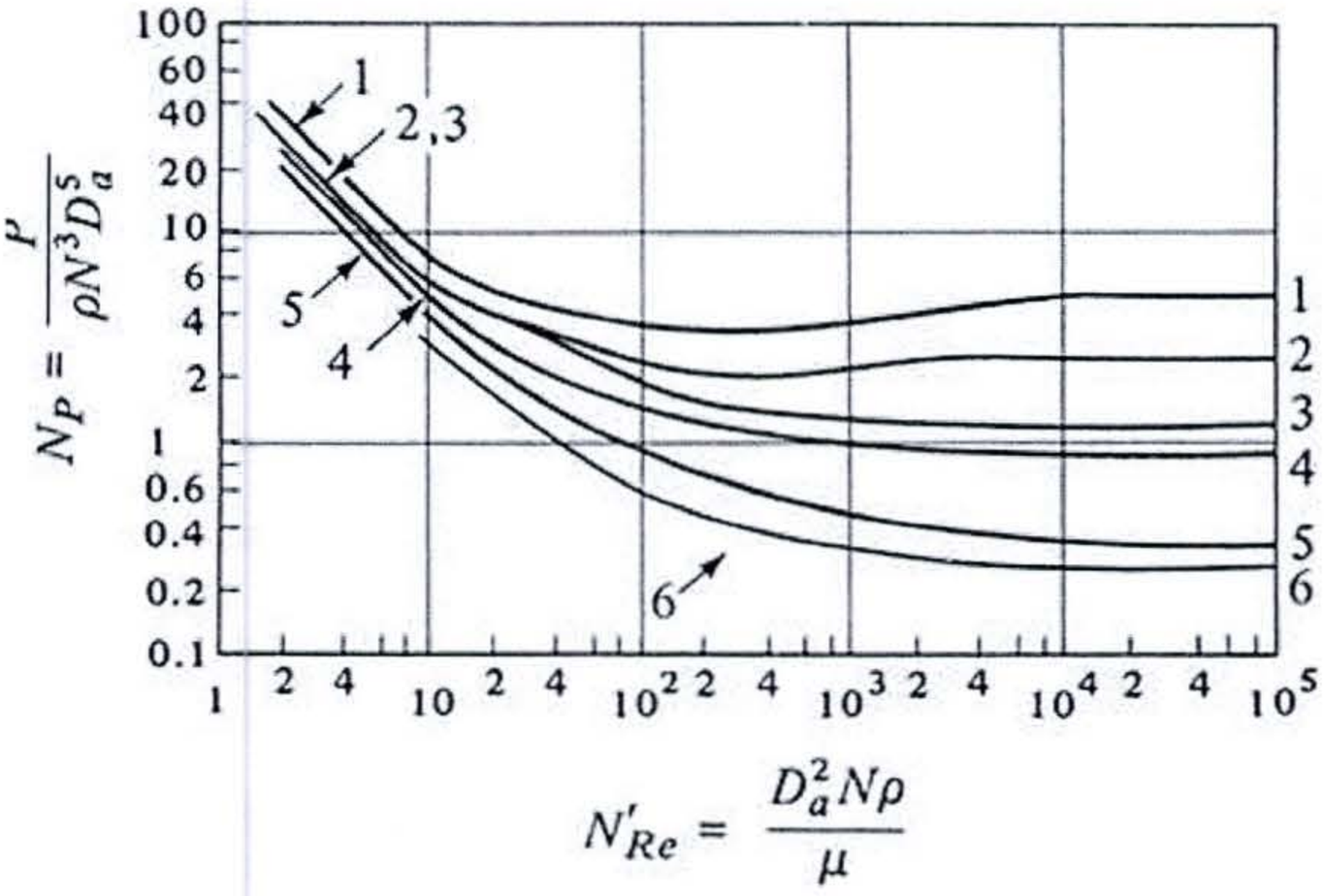

Figure Above: Power correlations for various impellers and baffles
Curve 1. Flat six-blade turbine with disk; $D_a/W = 5$; four baffles each $D_t/J = 12$. Curve 2. Flat six-blade open turbine (; $D_a/W = 8$; four baffles each $D_t/J = 12$. Curve 3. Six-blade open turbine (pitched-blade) but blades at 45°; $D_a/W = 8$; four baffles each $D_t/J = 12$. Curve 4.Propeller; pitch = $2D_a$; four baffles each $D_t/J = 10$; also holds for same propeller in angular off-center position with no baffles. Curve 5. Propeller; pitch = D_a; four baffles each $D_t/J = 10$; also holds for same propeller in angular off-center position with no baffles. Curve 6. High-efficiency impeller ; four baffles each $D_t/J = 12$.

End of Exam Paper