MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, SCIENCE AND TECHNOLOGY

DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING

SOLID FLUID SYSTEMS II

CODE: CHEP 323

SESSIONAL EXAMINATIONS

APRIL 2023

DURATION: 3 HOURS

EXAMINER: MR W. CHIPANGURA

INSTRUCTIONS

1. *Answer any **four** questions.*
2. *Each question carries 25 marks.*
3. *Start each question on a fresh page*
4. *Show all your steps clearly in your calculations.*
5. *Use of scientific calculators is permitted.*

QUESTION 1

(a) Distinguish between mixing and agitation [4]

(b) Describe any three types of impellers in basic stirred tank design [6]

(c) Define mixing time and explain how it is measured [5]

(d) A fermentation broth with viscosity 10^{-2} Pas and density 1000 kg m^{-3} is agitated in a 2.7 m^3 baffled tank using a Rushton turbine with diameter 0.5 m and stirred speed 1 s^{-1}. Estimate the mixing time. [3]

(e) With the aid of a labelled diagram, explain the correlation between power number and Reynolds number for Rushton turbine without sparging [7]

QUESTION 2

(a) Describe the basic Fluidized Bed Components. [6]

(b) State any four properties of fluidized beds [4]

(c) Give any four industrial applications of fluidised beds [4]

(d) A packed bed of solids of density 2000 kg/m^3 occupies a depth of 0.6 m in a cylindrical vessel of inside diameter 0.1 m. The mass of solids in the bed is 5 kg and the surface-volume mean diameter of the particles is 300 μm. Water (density 1000 kg/m^3 and viscosity 0.001 Pas) flows upwards through the bed.

i. What is the voidage of the packed bed? [3]

ii. Use a force balance over the bed to determine the bed pressure drop when fluidised. [4]

iii. Assuming that the packed bed voidage is the same as the voidage at incipient fluidisation, use the Ergun Equation to determine the minimum fluidisation velocity. [4]

Ergun equation: $\frac{(-\Delta P)}{H} = 150\frac{(1-\varepsilon)^2}{\varepsilon^3}\frac{\mu u}{{d_{sv}}^2} + 1.75\frac{(1-\varepsilon)}{\varepsilon^3}\frac{\rho_f u^2}{d_{sv}}$

QUESTION 3

a) What is an electrostatic precipitator (ESP)? [1]

b) List any four distinguishing features that are used to classify electrostatic precipitators. [4]

c) With the aid of a clearly labelled diagram describe the operating principle of a plate electrostatic precipitators. [4]

d) The common operational problems for ESPs are resistivity, particle size, dust accumulation and wire breakage. Explain clearly how each affect the efficient operation of ESP and suggest corrective actions. [12]

e) What are the advantages and disadvantages of ESPs? [4]

QUESTION 4

a) What is Filtration? [2]

b) Describe the operating mechanism for slow sand filters. [4]

c) With the aid of clearly labelled diagrams, distinguish between cake and deep bed filtration. [6]

d) Describe the various factors to be considered when selecting filtration equipment. [9]

e) Describe the basic requirements for filtration. [4]

QUESTION 5

a) Explain centrifugation. [2]

b) Distinguish the types of centrifuges based on rotor design [6]

c) Clearly differentiate, sedimentation, coagulation and flocculation [3]

d) Explain how coagulation and flocculation is applied in water treatment operations. [6]

e) With the aid of a diagram, describe the operation of a cyclone. [4]

f) State 4 industrial applications of cyclones. [4]

END OF PAPER