MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

Chemical and Processing Engineering Department

PARTICULATE TECHNOLOGY

CODE: HCHE 325

SESSIONAL EXAMINATIONS
APRIL 2021

DURATION: 3 HOURS

EXAMINER: K. NYENYAYI (MR)

INSTRUCTIONS

1. Answer ***all questions*** **in Section A and** ***any three*** **from Section B.**
2. Each question carries 20 marks.
3. Total marks 100

ADDITIONAL MATERIALS

Calculators.

This question paper consists of 4 printed pages

SECTION A

QUESTION ONE

a) Fully explain the meaning of the following terms as applied to particulate technology:

i. Aspect ratio

ii. Solidity

iii. Circularity

iv. Convex hull perimeter [4]

b) Cubic gold ore particles at a How mine gold processing plant have average length of 2.45 μm. Calculate the average surface equivalent sphere diameter ($D_{surface}$) of the particles. [4]

c) State any **six** applications of dilute phase conveying systems. [6]

d) State the factors that determine the settling velocity of particles during centrifugation. [6]

QUESTION TWO

a) List five types of impellers which are used in chemical industries for mixing solutions. [5]

b) Draw a fully labelled schematic diagram showing a basic stirred tank. [5]

c) A packed bed of solid particles of density 2500 kg/m^3, occupies a depth of 1 m in a vessel of cross-sectional area 0.04 m^2. The mass of solids in the bed is 59 kg and the surface-volume mean diameter of the particles is 1 mm. A liquid of density 800 kg/m3 and viscosity 0.002 Pas flows upwards through the bed.

i. Calculate the voidage (volume fraction occupied by voids) of the bed.

ii. Calculate the pressure drop across the bed when it becomes fluidized.[7]

d) Briefly explain what is meant by *incipient fluidization point.* [3]

SECTION B

QUESTION THREE

a) Identify the three basic views that all laser diffraction instruments rely on.[3]
Briefly explain wet dispersion and dry dispersion approaches to sample dispersion during particle characterisation. [6]

b) Outline the criteria that need to be considered on deciding characterization techniques to be applied in analysing solid ores from a cement manufacturing plant. [7]

c) With aid of diagram describe the *freeboard, bed* and *fluidisation vessel* components of a fluidised bed system. [4]

QUESTION FOUR

a) Define the terms *distribution, eddies* and *dispersion* that are used to describe mixing mechanisms**.** [3]

b) A Rushton turbine used to stir 20 L paint tank at 250 rpm using an impeller of 0.5 m diameter. The Reynolds number of the turbine is 11000. If the viscosity of paint slurry is 4 Pa. s, calculate the mixing time and density of the paint if the stirring speed is 3 s^{-1}. [6]

c) Paint slurry of viscosity 0.05 Pa s and density 2000 kg m^{-3} is agitated in a 20 m^3 baffled tank using a marine propeller 95 cm diameter. Calculate the power required for a stirred speed of 0.1 min^{-1}. Assume that the Np value for turbulent regime is 8. [6]

d) In what ways are glass centrifuges different from plastic centrifuges? [5]

QUESTION FIVE

a) Outline the advantages and disadvantages of using pneumatic conveying systems over mechanical conveying. [8]

b) What are the key differences between dilute phase pneumatic conveying system and dense phase pneumatic conveying? [12]

QUESTION SIX

a) Identify any four industrial applications of centrifugation. [4]

b) Fully describe the different types of centrifuges based on rotor design and intended use. [6]

c) Compare circulating fluidised bed scrubber to the wet flue gas desulphurisation. [10]

THE END