



MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

CHEMICAL AND PROCESSING ENGINEERING DEPARTMENT

WATER PURIFICATION PROCESSES

CODE: HCHE 529

SESSIONAL EXAMINATIONS

SEPTEMBER 2021

DURATION: 3 HOURS

EXAMINER: MR. K. NYENYAYI

INSTRUCTIONS

1. Answer *any four* questions.
2. Each question carries 25 marks.
3. Total marks 100

Additional Materials:

Scientific Calculators

QUESTION ONE

- a) A Reverse Osmosis plant is required to treat 50 m³/day of a protein-containing waste stream. The waste contains 0.5 kg/m³ of protein which has to be concentrated to 20 kg/m³ so as to allow recycling to the main process stream. The tubular membranes to be used are available as 30 m² modules. Pilot plant studies show that the flux J through these membranes is given by:

$$J = 0.02 \ln\left(\frac{30}{C_f}\right) \text{ m/h}$$

where C_f is the concentration of protein in kg/m³. [15]

Due to fouling, the flux never exceeds 0.04 m/h. Estimate the minimum number of membrane modules required for a single feed and bleed stage operation of this process. Operation for 20 h/day may be assumed.

- b) Outline the causes membrane fouling as applied in reverse osmosis operations and give means of mitigating fouling. [10]

QUESTION TWO

- a) With aid of a schematic diagram, give an overview of the electro dialysis process in water purification. [10]
- b) Briefly explain parameters that influence the efficiency of electro dialysis process. [9]
- c) State any **six** applications of electro dialysis in water treatment. [6]

QUESTION THREE

- a) With aid of schematic diagrams, give descriptions of processes that occur at following multistage flash distillation sections during water desalination.
- i. brine heater section, [9]
 - ii. heat recovery section and [8]
 - iii. heat rejection section. [8]

QUESTION FOUR

- a) Define the following terms as discussed in water purification processes
- i) Permeate Flux [2]
 - ii) Concentrate [2]
 - iii) Desalination [2]
- b) Giving relevant examples, briefly discuss classes of different water pollutants and the effects of each to the properties of water? [12]
- c) Briefly outline factors that affect choice of a water purification process. [7]

QUESTION FIVE

- a) A desalination process essentially separates saline water into two parts – the permeate and concentrate. The two major types of technologies that are used around the world for desalination can be broadly classified as either thermal or membrane.

Using specific examples, give a comprehensive comparison of the thermal and membrane technologies highlighting

- i. Operational principles of each technology. [10]
- ii. Advantages and disadvantages of each technology. [8]
- iii. Respective water treatment applications. [7]

END OF EXAM