

UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

B.Sc. Degree Programs in Environmental Health

MAIN EXAMINATION PAPER MAY 2014

TITLE OF PAPER : URBAN WATER TREATMENT

COURSE CODE : EHM 208

DURATION : 2 HOURS

MARKS : 100

INSTRUCTIONS : THERE ARE FIVE QUESTIONS IN THIS EXAM

: ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS

: EACH QUESTION CARRIES A MAXIMUM MARK OF 25

Question One (25 Marks)

(Note each question below carries 5 marks)

- A. A pump located above ground failed to abstract water from a river intake because the water level in the river reduced considerably making the suction head beyond the suction capacity of the pump. Suggest a possible solution to this problem

- B. Define thermal stratification and indicate with the help of a diagram how thermal stratification affects the water quality of lakes over the depth. State also the implication of thermal stratification on the design of lake intakes.

- C. What type of water sources are suitable for intake screening with micro-strainers?

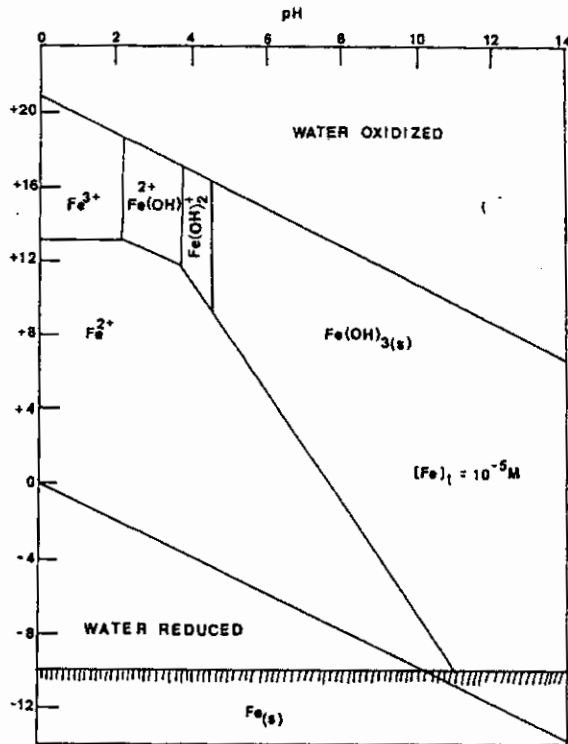
- D. Describe in detail the Nalgonda treatment technique used for the removal of fluoride from water.

- E. Write the chemical equations for the removal of magnesium hardness from water using lime-soda softening.

Question Two (25 Marks)

(Note each question below carries 5 marks)

A. For the PE-pH diagram of iron shown below, indicate the areas of corrosion, immunity and passive protection. State also whether iron is corroded spontaneously in water,



- B. It is often said that a small precipitate layer of calcium carbonate will provide a protection against internal corrosion of water pipes. Discuss the logic of such protection from the point of view of corrosion electrolysis.
- C. The saturation pH of water (pH_s) is calculated using the formula shown below. Discuss the influence of greater values of alkalinity and calcium on the saturation pH and the Langelier saturation index of water.

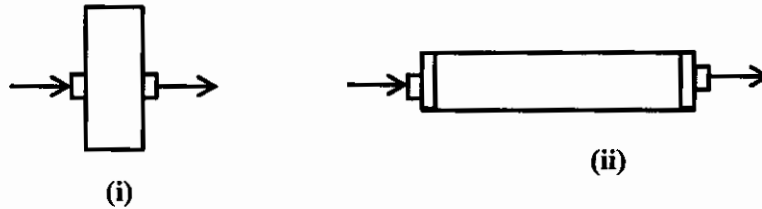
$$pH_s = pK_2 + pCa^{2+} - pK_s - \text{Log}(2[\text{Alk}]) - \text{Log}(\gamma_m)$$

- D. Describe the mechanisms by which the efficiency of tray aerators can be increased.
- E. The Henry's Law constants for ammonia and hydrogen sulphide are 0.76 and 515 respectively. Discuss the possible reasons for such a large difference in the constants and the effects that these constants have on the rate of removal of the gases from water.

Question Three (25 Marks)

(Note each question below carries 5 marks)

- A. Discuss the relevance and types of pre-treatment needed for water sources such as lakes and impounding reservoirs.
- B. A designer of a plain sedimentation tank decided to increase the depth of tank to double the original depth by building up a wall of the tank. The reason for doing so was because the discharge through the tank was doubled. Calculate the new overflow rate and detention time in terms of the original values and comment on whether the designer's approach was correct.
- C. Compare the following shapes of sedimentation tanks in terms of i) short circuiting and ii) creation of stagnant volume of water. The direction of movement of water is indicated.



- D. Describe the logic behind the provision of tilted plate or tube settlers as sedimentation tanks. Explain how the efficiency of settlement process is markedly improved by the provision of tilted plate/tube settlers.
- E. What are the design parameters that have greater influence on the performance of roughing filters?

Question Four (25 Marks)

(Note each question below carries 5 marks)

- A. Differentiate between i) hydrophilic colloids and ii) hydrophobic colloids in terms of the mechanisms of stabilization of the suspensions in water.
- B. Describe the relationship between thickness of the diffuse layer and the zeta potential.
- C. Explain the importance of the speed of mixing of coagulant with water and state what will happen if the coagulant and water are not well mixed.
- D. The pH of water has to be raised for effective coagulation of a given water with aluminum sulphate. There are two choices of chemicals for raising the pH of the water, namely lime and sodium carbonate. Compare the operational advantages of the two chemicals.
- E. Compare the advantages and disadvantages of i) mechanical flocculators and ii) hydraulic flocculators.

Question Five (25 marks)

(Note each question below carries 5 marks)

- A. What is the dominant mechanism of particle removal in slow sand filters?

- B. Describe the causes and adverse effects of media stratification in rapid sand filters.

- C. Describe the advantages slow sand filters compared to rapid sand filters.

- D. The water treatment disinfection efficiency for the inactivation of a virus is found to be a 4 log removal. If the original concentration of the virus was 100,000/100 mL what would be the expected concentration of the virus in the disinfected water?

- E. Discuss with the help of a diagram i) free residual chlorination ii) breakpoint chlorination and iii) super chlorination.