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

B.Sc. Degree Program in Environmental Health

MAIN EXAMINATION PAPER MAY 2015

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%

EHM 208 May 2015

Question One (5 marks each)

1A)   List five water treatment methods for the removal of fluoride from water.

1B)   Describe possible water treatment methods for the removal of colors in water intended for potable uses.

1C)   Explain with the help of a diagram how reverse osmosis technology works and may be used to remove dissolved substances from water.

1D)   What treatment methods are available for the removal of hardness from water?

1E)   What water treatment methods are available for the removal of organic matter in water?

Question Two (5 marks each)

2A.   Figure Q2A below show a layout of a storage pond which is provided for water supply purposes. If you are asked to be a designer , describe briefly what you would provide at the locations designated A, B, C D and E
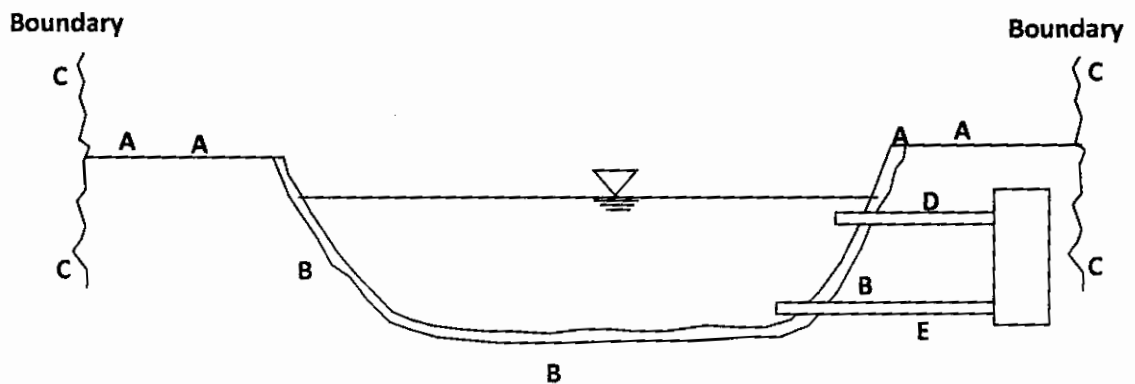

Figure Q2A

2B. Suggest a suitable design guideline for a horizontal flow sedimentation tank with respect to each of the following criteria:

    i.   Tank dimensions to achieve a target % removal of suspended solids.

    ii.   Tank geometry

    iii.   Prevention of resuspension of settled particles throughout the bottom of the sedimentation tank.

    iv.   Continuity of service during periodic cleaning of the tank.

    v.   Minimization of turbulence at the outlet.

2C. Figure Q2B below shows an aeration device used for water treatment purposes. Name this type of aerator. If this aerator is to be used for iron and manganese removal, describe useful design features to maximize their removal.
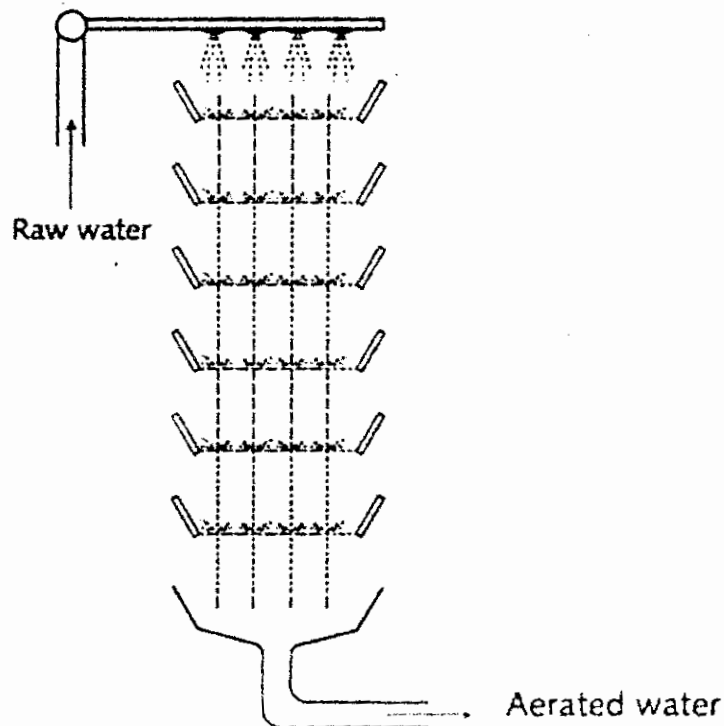

Figure Q2B

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2D. An intake structure consisting of infiltration gallery is to be constructed on a certain river. The river bottom is located 5 meters below the adjoining ground surface level. The ground below the bottom a mixture of silt and clay. Describe with the help of a sketch a suitable design for this intake.

2E. Referring to the pE – pH diagram of iron shown in Figure Q2C below, answer the following questions, sketch on the figure, the areas of corrosion, immunity and passivation.
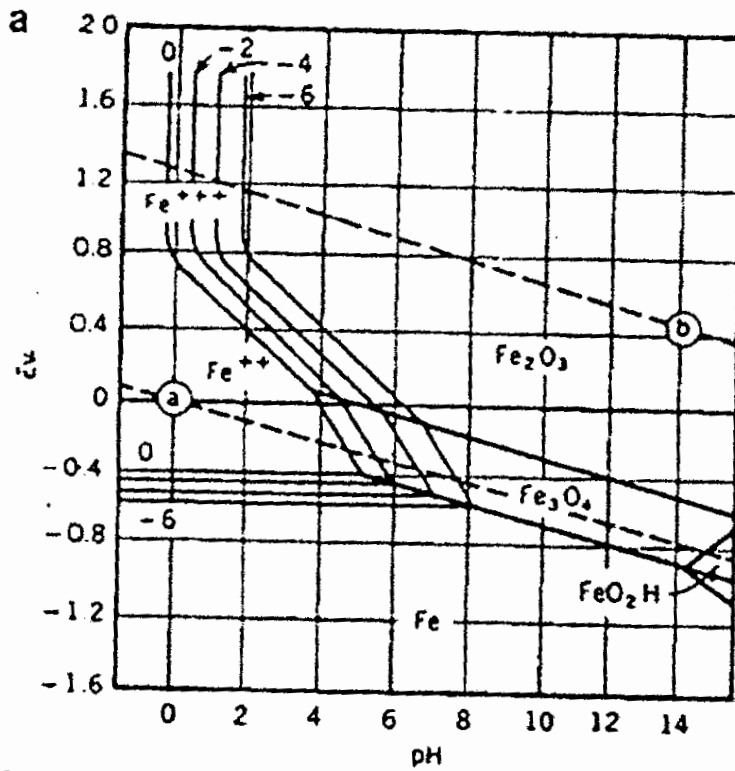

Fig Q2C

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Question Three (25 Marks)

3A. State the dominant mechanisms for the formation of hydrophilic colloids in water...[4 Marks]

3B. Compare the performances of aluminum sulphate and ferric chloride as coagulants for the removal of colloidal solids from water. ....[5 Marks]

3C. Describe the mechanisms by which hydrophobic colloids may be stabilized in water. ....[4 Marks]

3D. Describe the four major mechanisms of destabilization of colloids in water ....[6 Marks]

3E. Compare the advantages and disadvantages of i) hydraulic rapid mixing and ii) mechanical rapid mixing. ....[6 Marks]

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Question Four (25 Marks)

(Note: Each question below carries 5 marks)

4A. What is the dominant mechanism by which solids are removed in i) rapid sand filters and ii) slow sand filters?

4B. Discuss in the context of slow sand filtration the impact of choice of filter media that is i) too fine ii) too coarse

4C. What are the advantages of maintaining the outlet weir levels above the top level of sand in the filter?

4D. Discuss the operational features of declining rate filters including their advantages and disadvantages.

4E. List the major possible problems that may be encountered in the course of operating a rapid sand filter.

Question Five (5 marks each)

5A. Discuss the importance of the ratio Cl_2/NH_3 in the chloramination process for the disinfection of water. Indicate the optimum ratio Cl_2/NH_3 and give reasons for your choice.

5B. Discuss the advantages and disadvantages of excess chlorination beyond the break point.

5C. Develop a break point chlorination curve for a water sample that contains 1.5 mol/L of ammonia in addition to organic matter that has a chlorine demand of 1 mol/L.

5D. A treated water after disinfection has 40% OCl^- and 60% HOCl. The concentration versus contact time for 99% inactivation of *E.coli* is given in Figure Q5-1 below. For a contact time of 5 minutes, determine the total amount of chlorine that will have to be added to water to achieve the desired inactivation, i.e., 99% inactivation of *E.coli*.
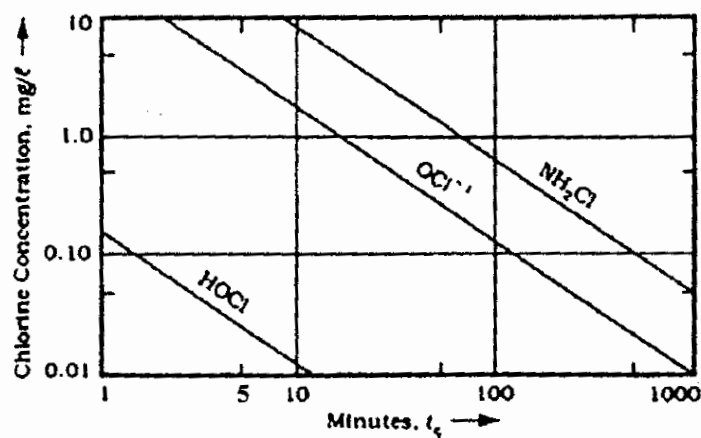

Figure Q5-1

5E. Compare the advantages of and disadvantages of Ozone and Chlorine as disinfectants.

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