King Saud University
College of Engineering
Civil Engineering Department

CE 442 Water & Wastewater Treatment
1st Semester 1425-1426H / 2004-2005G
Section: 1026, Dr. W. Zahid

Final Examination

(aid sheet is provided)

Time allowed: 3 hours

Student Name: …….

Student Number: ……...….

الأعمال الفصلية:.....

الإمتحان النهائي: .....

الدرجة النهائية: .....

Question One (20%)

Answer with true (T) or false (F):

( ) (1) The presence of coliform bacteria in water supplies indicates fecal contamination of water.

( ) (2) Temporary hardness is caused by the presence of calcium and magnesium sulfates and chlorides.

( ) (3) Both the BOD and COD are used to determine the organic strength of wastewater.

( ) (4) Water alkalinity is a measure of its ability to resist changes in pH when a strong acid is added.

( ) (5) Groundwater is usually more hard than fresh surface water.

( ) (6) Addition of alum (aluminum sulfate) to water decreases its pH.

( ) (7) Soda ash (Na_2CO_3) is used to remove carbonate hardness of water.

( ) (8) Softening of water by the ion exchange process can reduce hardness to zero.

( ) (9) The reverse osmosis process involves the forced transfer of water through a semi-permeable membrane from a solution of a lower to one of higher concentration.

( ) (10) Ozone is the most widely used disinfectant for drinking water.

( ) (11) Chlorine existing in water as hypochlorous acid and hypochlorite ion is called “combined available chlorine”.

( ) (12) Due to the low pH involved, excess-lime softening assists in removing pathogens if any is present.

( ) (13) Stabilization ponds are suitable for treating small flows of wastewater.

( ) (14) The main objective of the secondary treatment of wastewater is to reduce the level of soluble inorganics remaining after the primary treatment.

( ) (15) The main disadvantage of anaerobic treatment of wastewater is the large production of sludge.

( ) (16) Disinfection of water with chlorine is more effective at a pH of 7.5 than at pH 6.5.

( ) (17) A mixed liquor having a SVI (sludge volume index) in the range 50-150 exhibits good settling.

( ) (18) The main purpose of sludge stabilization (digestion) is the removal of water.

( ) (19) In the activated sludge process, a portion of the settled solids in final settling tanks is returned to aeration tanks in order to maintain the desired concentration of micro-organisms in the aeration tanks.

( ) (20) Bacteria are the most common microorganisms found in domestic wastewater (sewage).

Question Two (10%)

Note one method/process only (without explaining) by which each of the following can be reduced or controlled:

(1) Pathogens in water: ……

(2) Dissolved gases in water: ……

(3) Excess calcium and magnesium bicarbonates in water: ……..

(4) Inorganic suspended solids in wastewater: …….……

(5) Iron and manganese in water: ……...

(6) Nitrate in water: ……

(7) Taste and odor in water: ……...

(8) Turbidity in water caused by clay: ……...

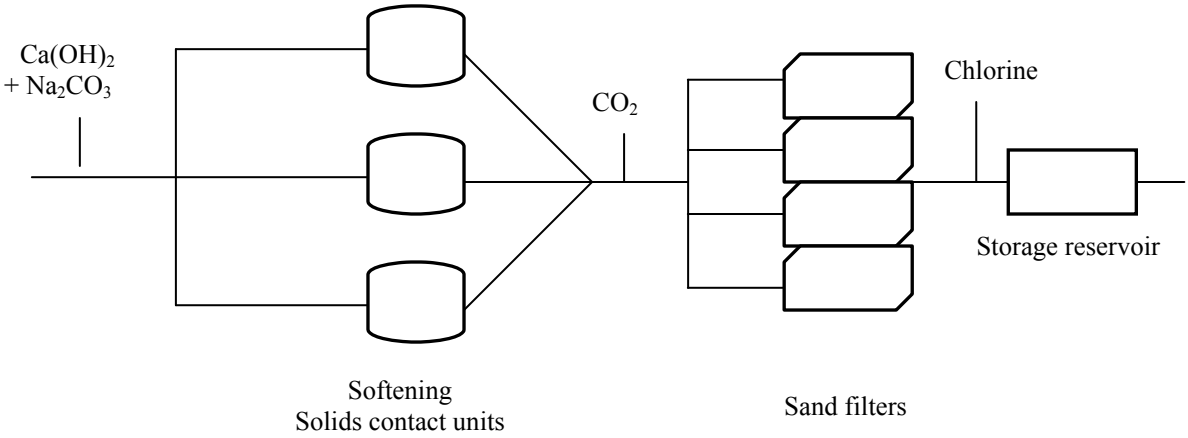
(9) Salts in drinking water: ……

(10) Dissolved organics in wastewater: …….

Question Three (35%)

A schematic flow diagram is shown below for a treatment plant processing 80,000 m^3/day of groundwater with the following characteristics:

Parameter	Concentration/value
pH	7.3
Total dissolved solids	760
Turbidity	1.0 NTU
Ca^{++}	30 mg/L
Mg^{++}	18.3 mg/L
HCO_3	122 mg/L
SO_4^{--}	48 mg/L
CO_2	11 mg/L
Total coliform	10 /100 mL



(1) Determine the required *dosages* of *lime as CaO* and *soda ash as* Na_2CO_3 (in *ton/day*) to soften this water by *excess lime treatment*.

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(2) What is the *diameter* of each solid contact unit if the overflow rate is not to exceed $100\ m^3/m^2.day$ and the detention time is at least *1.0 hour*. The water depth should not be over *3.0 m*.

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(3) Determine the amount of *daily sludge* produced (*ton/day*) from the solid contact units if the solids removal efficiency of the units is *85%*. Assume that the practical limit of hardness removal for $CaCO_3$ is 30 mg/L and that for $Mg(OH)_2$ is 10 mg/L as $CaCO_3$.

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(4) Determine the size of each sand filter (*length and width*) provided that the *filtration rate* should not exceed $200\ m^3/m^2.day$ with one filter out of service and one filter being backwashed. Use a *length:width* ratio of *2:1*.

If each filter needs to be backwashed once every 24 hours at $1.0\ m^3/m^2.min$ for *10 minutes*, calculate the *percentage* of treated water used for backwashing

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Question Four (12%)

Determine the *capacity* (m^3) of *three* aeration tanks of an activated sludge system required to treat *18,000* m^3/day with BOD_5 of *160 mg/L* provided that the *detention time* must be at least *3.5 hours*, the *F/M* ratio must not exceed *0.3 g* BOD_5*/day per g MLSS*, and an *MLSS* concentration of *2500 mg/L* will be maintained.

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Question Five (13%)

A single stage biological filter plant is proposed for treating a municipal wastewater flow of *40,000* m^3/day with an average BOD_5 of *250 mg/L*.

(1) Assuming *35% BOD* removal in the primary settling tanks, calculate the diameter for *four 6-m depth filters* with a *BOD loading* of *600* $g/m^3.day$.

(2) Calculate the BOD concentration in the effluent using the NRC formula.

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Question Six (10%)

Draw a schematic flow diagram for a conventional activated sludge plant treating domestic wastewater. Show all units and processes involved in the treatment of wastewater and sludge and mention the function of each treatment unit.

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