REVIEW QUESTIONS
FOR
CLASS III WASTEWATER TREATMENT PLANT OPERATOR'S EXAMINATION

Please circle your answers and show all calculations. The Class III examination is less than half the length of this review. Please use the F/M, sludge age, MCRT, etc., formulas provided.

Sludge Digestion and Handling

1. 42,000 gallons of 6% sludge containing 67% volatile matter is pumped to the digester. The digester reduces the volatile matter by 52%. What volume of sludge in gallons containing 5% solids remains after digestion?

2. The volatile acids concentration of sludge in an anaerobic digester is 195 mg/l. If the maximum volatile acids – alkalinity ratio is 0.087, what should the alkalinity be in mg/l?

3. An anaerobic digester is 37' in diameter and 27' deep with a 5,000 gallon daily sludge flow. The sludge is 6% solids and 66% volatile solids. What is the volatile solids loading in pounds per cubic foot per day?

4. An Imhoff cone result is 5.5 ml/l. Approximately how many gallons of primary sludge will need to be pumped if the flow is 0.7 MGD?

5. A sludge digester equipped with a floating cover is 31 ft. inside diameter. The corbels are 16 feet above the floor and the top of the wall is 20 feet above the floor. The digester currently has a sludge depth of 16.5 ft. How many gallons of sludge are needed to displace the cover 1 foot?

6. 10,000 gallons of sludge is pumped to an anaerobic digester/day at 4% solids (70% VS). 50% of the VS are destroyed, creating 10 $ft.^3$ of gas per lbs. of VS destroyed. How much gas is produced each day?

7. Two sludges are blended together as follows:

   15,000 gal. primary sludge at 4.1% solids.
   28,000 gal. secondary sludge at 1.3% solids.

   a. What is the combined solids concentration?
   b. If the primary sludge is 68% VS and the secondary sludge is 63% VS, how many pounds of VS are in the combined sludge?

8. 12,000 gallons of 1.8% sludge is pumped to a thickener, and is thickened to 3800 gallons of 4.9% solids. The supernatant is returned back to the head of the STP for treatment. What is the volume in gallons and solids concentration in ppm of the supernatant?

9. <u>Given:</u>

   a. sludge flow: 5500 gpd
      6.5% solids
      72% VS
   b. VS destruction is 48% in digester

   c. digester is 40 ft. dia. X 25 ft. tall

   <u>Find:</u>

   lbs. VS destroyed per 1000 gal. of digester capacity per day.

Activated Sludge Systems

10. A process control manual recommends a BOD/TKN ratio of 20:1. Your works flow is 1.8 MGD with an influent BOD of 190 mg/l and an influent TKN of 8 mg/l. How many pounds of 80% available nitrogen (if any) must be fed to your influent per day to achieve a 20:1 ratio?

11. Your aeration tank is 80 feet long, 40 feet wide and has 10.5 feet of mixed liquor depth. The MLVSS in the aeration tank is 1,850 mg/l. You are experiencing biological bulking and have read 2 pounds of chlorine per 1,000 pounds of MLVSS should control this form of bulking. How many pounds of chlorine are added to the RAS portion of the RAS/WAS splitter box to achieve this process control strategy?

12. Given a system that has 25,000 pounds of MLSS in it and the desired quantity is 23,500 pounds of MLSS, how many gallons of sludge must be wasted if the RAS and WAS concentration is 7,200 mg/l?

13. A 100,000 gallon aeration tank contains 4,200 mg/l of MLSS. The RAS and WAS are 8,500 mg/l. If the MLSS must be reduced to 4,000 mg/l, how many minutes will it take a 125 gpm pump to achieve the new MLSS?

14. An extended aeration plant is as follows: 0.28 MGD of 210 mg/l influent BOD, aeration basin volume 0.32 MG. The MLVSS is 4,450 mg/l (81% volatile) and the RAS is 9,200 mg/l. (a) What is the F/M? (b) How many pounds of suspended solids must be wasted to obtain an F/M of .06? (c) What is the new MLVSS in mg/l?

15. You need to quantify the amount of volatile solids in your aeration tanks (2). Each tank is 40 ft. long, 15 ft. wide and 12 ft. deep. The MLSS is 2500 mg/l and is found to be 69% volatile. How many total pounds of MLVSS are in the aeration basins?

16. Given the following information calculate MCRT for your WWTP. The plant is an extended aeration system with an aeration tank that has a volume of 66800 cu. ft. The MLSS is 1950 mg/l. The flow to the WWTP is 1.5 MGD and your effluent TSS is 9 mg/l. The WAS is 7000 mg/l and you waste 11990 gallons each day.

17. Your plant currently is running at an MCRT of 5 days. You want to adjust things so that the plant is operating at an MCRT of 9 days. What is the new volume in gallons you should waste everyday to achieve this? Given the following information: Aeration tank volume of 750,000 gal. MLSS of 2400 mg/l. Plant effluent SS of 7 mg/l, and a WAS concentration of 6500 mg/l. Influent flow 1.0 MGD.

18. An oxidation ditch has an influent flow of .55 MGD. Jar test results show an old sludge condition settling to 350 ml/L in 30 minutes.

a.) Calculate the return sludge <u>ratio</u>.
b.) Calculate the desired return sludge <u>rate</u> in gpm.

19. You have been asked to troubleshoot a nearby Activated sludge plant with the following conditions:
Primary effluent flow 2.35 MGD
RAS flow rate 1500 gpm
30 min. jar test result 425 ml/L

Based the above information what change in RAS flow rate (in gpm) would you recommend?

20. Plant data:
Flow – 1.5 MGD
Influent BOD – 210 mg/l
Influent TSS – 186 mg/l
Primary effluent BOD – 143 mg/l
Primary effluent TSS – 86 mg/l
Aeration basins (2) Total Volume 468,750 gal
WAS Rate – 9 gpm
MLSS – 2,350 mg/l
RAS/WAS – 5,875 mg/l
30 min. Settling test – 320 ml/L
MLSS is 85% volatile solution
Effluent BOD – 18 mg/l
Effluent TSS – 13 mg/l

a). Calculate the F/M ratio:
b). Calculate the sludge age:
c). Calculate MCRT:
d). Calculate the SVI:

21. The town of Florham Park is operating an activated sludge facility under the following parameters:

Raw flow - .47 MGD
Raw BOD – 160 ppm
Two aeration basins, each – 6,000 gal
Blower capacity – 500 cfm
Effluent BOD – 12 ppm

a). How many pounds of sludge are produced per day if 90% of the removal BOD is converted to MLSS?
b). How many cubic feet of air are added daily per pound of BOD removed?
c). How many pounds of BOD are removed per 1000 $ft.^3$ of aeration tank volume?

22. The Rosilyn wastewater plant is experiencing M.parvicella filamentous bulking. The plant has a raw wastewater flow of 2.65 MGD with an influent BOD of 215 ppm. Four aeration basins are each 40 ft. X 139 ft. X 12 ft. deep with a MLSS of 3200 ppm (72.5% volatile). Chlorine is to be dosed at 9 lbs. cl/1000 lbs. MLSS into a RAS pit.

a). What should the chlorine feed rate be in lbs/min?
b). If the MLSS was reduced to 2500 ppm, what would the chlorine feed rate be?

Pumps/Motors

23. A 240 volt motor runs an average of 8 hours a day. If the electric meter registered 6,450 kilowatt hours for a 31-day month, what is the motor horsepower?

24. A rectangular wet well is 8.5 feet wide, 12.5 feet long, and has a liquid depth of 13.5 feet. The pump shutoff is 1.5 feet from the bottom and the wet well is ½ full when the pump kicks on. The pump delivers an average discharge of 325 gpm and the average sewage influent is 150 gpm. How many minutes will the pump run, given the above information?

25. Using the time-volume method given below, determine the pump capacity in gpm in a lift station using the following data:

Inside diameter of wet well = 9 feet
Time to lower the wet well one foot with the pump on = 190 seconds
Time to refill (influent flow rate) the wet well one foot with the pump off = 410 seconds

26. Given the following information, calculate: (a) the brake horsepower, and (b) the cost per 30-day month to operate the pump, if a kilowatt hour costs $.08. The pump operates an average of six (6) hours a day, TDH = 60 feet, pump capacity = 1,000 gpm with an efficiency of 74% and a motor efficiency of 89%.

27. A simplex submersible pump is located in a 6 ft. diameter wet well. Sewage is running continually in at 210 gpm. Floats are set at 1.5 ft. off and 9.0 ft. on. Pump capacity is 300 gpm. How many minutes will the pump run each cycle? Each day?

<u>Miscellaneous</u>

28. Your engineer is upgrading your pond by providing surface aerators. She suggests you need two 7-1/2 horsepower surface aerators with an oxygen transfer rate of 1.6 pounds of oxygen per horsepower per hour. Assume only 80% of the oxygen transfer will reduce the BOD 1:1. What is the minimum number of hours these time-clocked aerators will run to remove 85% of the influent BOD, which averages 295 pounds a day?

29. A newly constructed sanitary sewer collection system has been turned over to your sewer utility. A lift station pumps wastewater from this system into a portion of your existing collection system. The lift station contains 2 pumps rated at 350 gpm each. One pump will normally handle dry weather flow and the two pumps will alternate with each cycle. During wet weather flow conditions; both pumps will run simultaneously in order to keep up with the flow. The wet well is 6 feet in diameter with a water depth of 10 feet. The lead pump comes on when the wet well is at 5 feet and turns off at 1.5 feet. When two pumps are required, the lag pump comes on at 7 feet and continues to run with the lead pump until pumping down to the 1.5 foot level.

a.) With an average dry weather inflow of 150 gpm, how many minutes will the pump run per cycle?

b.) Wet weather flow to the lift station will increase by 250%. If pumping capacity is 70% of pump rating with both pumps on, how many minutes will the pumps run after both pumps come on?

30. In order to comply with requirements contained in the NPDES Permit recently renewed for your wastewater treatment plant, it will be necessary to increase staffing. The permit now calls for your facility to administer an industrial pretreatment program, expand the biosolids land application program, and conduct activities that will reduce infiltration/inflow to the plant. Two (2) FTE administrative personnel must be added for administration of these programs at an annual average salary of $35,000 each. In addition to these administrative needed, five (5) hourly personnel must be added to conduct a Sewer System Evaluation Survey (SSES) and perform remedial construction work on the collection system. The average hourly rate for these employees is $12.35 each.

Employee fringe benefits are as follows: FICA – 7.65%, Retirement – 9.5%, Worker's Compensation – 4%, and Health Insurance - $672.00/month/employee.

It is anticipated that employees will work a 40-hour week with overtime costs for the hourly personnel running 10% above that. All overtime is to be paid at 1.5 times the hourly rate.

How much should you increase the annual budget for your facility to cover these additional costs?

Class III Review Questions – ANSWER SHEET

1. 32,841 gallons
2. 2,241 mg/l alkalinity
3. 0.057 lbs. VS/ft^3/day
4. 3,850 gallons
5. 5,643 gallons
6. 11,676 cu.ft. gas/day
7. (a) 2.28% (b) 5400.3 lbs. VS
8. 8,200 gallons; 3,634 ppm
9. 4.38 lbs. VS/1000 gallons
10. 28 lbs.
11. 7.8 lbs. Cl_2
12. 24,980 gallons
13. 18.8 minutes
14. (a) .051 F/M (b) 1785.6 lbs. MLSS (c) 3781 mg/l MLSS
15. 1549.6 lbs. MLVSS
16. 10 days
17. 29692 gallons
18. (a) .54 (b) 206.25 gpm
19. 292 gpm
20. (a) .23 (b) 8.54 days (c) 11.5 days (d) 136
21. (a) 522 lbs. (b) 1241.4 cu.ft./lbs./day (c) 361.53 lbs./1000 cu. ft.
22. (a) .33 lbs. cl/min. (b) .26 lbs. cl/min.
23. 35 hp
24. 23.9 minutes
25. 220 gpm
26. (a) 20.5 bhp (b) $247.10/month
27. (a) 17.6 minutes/day (b) 1,008 minutes/day
28. 13.1 hours
29. (a.) 3.7 minutes (b.) 10.1 minutes
30. $320,198.82/year