

Activated Sludge Math - CEU Problems Answer Key

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Chapter 12—Achievement Test

1. An aeration tank is 90 ft long, 30 ft wide, and operates at an average depth of 16 ft. What is the capacity of the tank, in gallons?

$$\text{Volume} = (90 \text{ ft})(30 \text{ ft})(16 \text{ ft})(7.48)$$

ANS 323,136 gal

2. The BOD content of the wastewater entering an aeration tank is 217 mg/L. If the flow to the aeration tank is 1,668,000 gpd, what is the lbs/day BOD loading?

$$\text{Load} = 8.34 (1.668 \text{ MGD})(217 \text{ mg/L})$$

ANS 3019 $\frac{\text{lbs}}{\text{day}}$

3. The flow to a 210,000-gallon oxidation ditch is 389,000 gpd. The BOD concentration of the wastewater is 218 mg/L. If the mixed liquor suspended solids concentration is 3250 mg/L, with a volatile solids content of 67%, what is the F/M ratio? (Round to the nearest hundredth.)

$$\text{Load} = 8.34 (0.389 \text{ MGD})(218 \text{ mg/L}) = 707. \frac{\text{lbs}}{\text{day}}$$

$$\text{MLVSS} = 8.34 (0.21 \text{ MGD})(3250 \text{ mg/L})(0.67) = 3814 \text{ lbs}$$

$$\text{F/M} = \frac{707.}{3814}$$

ANS 0.19

4. A clarifier has a diameter of 80 ft and an average depth of 10 ft. What is the capacity of the clarifier, in gallons?

$$\text{Volume} = 7.48 \left(\frac{\pi}{4} (80 \text{ ft})^2 \right) (10 \text{ ft})$$

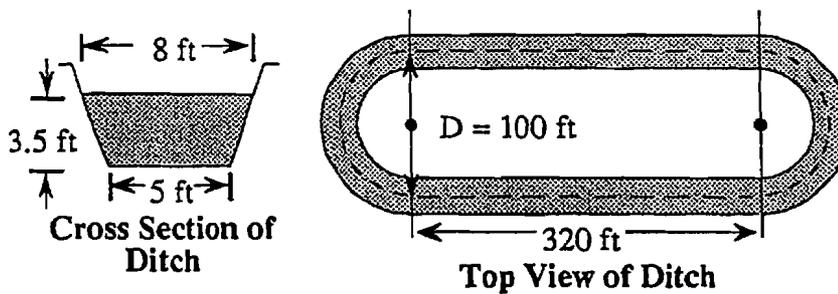
ANS 375,986 gal

5. An activated sludge aeration tank receives a primary effluent flow of 2.13 MGD with a BOD concentration of 175 mg/L. The mixed liquor volatile suspended solids concentration is 2880 mg/L and the aeration tank volume is 420,000 gallons. What is the current F/M ratio? (Round to the nearest hundredth.)

$$\begin{aligned} \text{Load} &= 8.34 (2.13 \text{ MGD}) (175 \text{ mg/L}) = 3109 \frac{\text{lbs}}{\text{day}} \\ \text{MLVSS} &= 8.34 (0.42 \text{ MG}) (2880 \text{ mg/L}) = 10,088 \text{ lbs} \\ \text{F/M} &= \frac{3109}{10,088} \end{aligned}$$

ANS 0.31

6. Calculate the cu ft capacity of the oxidation ditch shown below. The cross section of the ditch is trapezoidal.



$$\text{Volume} = \left(\frac{8^2 + 5^2}{2} \right) (3.5) (100 \pi + 2(320))$$

ANS 21,707 ft³

7. The daily flow to an aeration tank is 3,840,000 gpd. If the COD concentration of the influent wastewater is 155 mg/L, how many pounds of COD are applied to the aeration tank daily?

$$\text{Load} = 8.34 (3.84 \text{ MGD}) (155 \text{ mg/L})$$

ANS 4964 $\frac{\text{lbs}}{\text{day}}$

8. An aeration tank contains 525,000 gallons of wastewater with a MLSS concentration of 2610 mg/L. If the primary effluent flow is 1.7 MGD with a suspended solids concentration of 185 mg/L, what is the sludge age? (Round to the nearest tenth.)

$$\begin{aligned} \text{Load} &= 8.34 (1.7 \text{ MGD}) (185 \text{ mg/L}) = 2623 \frac{\text{lbs}}{\text{day}} \\ \text{Mass} &= 8.34 (0.525 \text{ MG}) (2610 \text{ mg/L}) = 11,428 \text{ lbs} \\ \text{SA} &= \frac{11,428}{2623} \end{aligned}$$

ANS 4.4 days

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9. The desired F/M ratio at a particular activated sludge plant is 0.4 lbs BOD/lb MLVSS. If the 2.78-MGD primary effluent flow has a BOD concentration of 143 mg/L, how many lbs of MLVSS should be maintained in the aeration tank? (Round to the nearest tenth.)

$$\text{Load} = 8.34 (2.78 \text{ MGD}) (143 \text{ mg/L}) = 3315 \frac{\text{lb}}{\text{day}}$$

$$\text{MLVSS} = \frac{3315}{0.4} \quad \text{ANS } \underline{8289 \text{ lbs}}$$

10. An oxidation ditch receives a flow of 0.28 MGD. If the volume of the oxidation ditch is 390,000 gallons, what is the detention time in hours?

$$\text{DT} = \frac{390,000 \text{ gal}}{280,000 \text{ gpd}} \cdot 24 \frac{\text{hr}}{\text{day}}$$

$$\text{ANS } \underline{33.4 \text{ hr}}$$

11. The desired F/M ratio at a particular activated sludge plant is 0.7 lbs COD/lb MLVSS. If the 2,390,000-gpd primary effluent flow has a COD concentration of 158 mg/L, how many lbs of MLVSS should be maintained in the aeration tank?

$$\text{Load} = 8.34 (2.39 \text{ MGD}) (158 \text{ mg/L}) = 3149 \frac{\text{lb}}{\text{day}}$$

$$\text{MLVSS} = \frac{3149}{0.7} \quad \text{ANS } \underline{4499 \text{ lbs}}$$

12. An aeration tank is 100 ft long, 45 ft wide, and operates at a depth of 13 ft. The MLSS concentration in the aeration tank is 2830 mg/L. If the influent flow to the tank is 1.1 MGD and contains a suspended solids concentration of 160 mg/L, what is the sludge age? (Round to the nearest tenth.)

$$\text{Volume} = 7.48 (100 \text{ ft}) (45 \text{ ft}) (13 \text{ ft}) = 437,580 \text{ gal}$$

$$\text{Mass} = 8.34 (0.43758 \text{ MG}) (2830 \text{ mg/L}) = 10,328 \text{ lbs}$$

$$\text{Load} = 8.34 (1.1 \text{ MG}) (160 \text{ mg/L}) = 1466 \frac{\text{lb}}{\text{day}} \quad \text{ANS } \underline{7.0 \text{ days}}$$

$$\text{SA} = \frac{10,328}{1,466}$$

13. If the volume of the oxidation ditch is 600,000 gallons, and an oxidation ditch receives a flow of 0.34 MGD, what is the detention time in hours? (Round to the nearest tenth.)

$$\text{DT} = \frac{600,000 \text{ gal}}{340,000 \text{ gpd}} \cdot 24 \frac{\text{hr}}{\text{day}}$$

$$\text{ANS } \underline{42.4 \text{ hr}}$$

14. An oxidation ditch has a volume of 250,000 gallons. The 0.3-MGD flow to the oxidation ditch has a suspended solids concentration of 195 mg/L. If the MLSS concentration is 3910 mg/L, what is the sludge age in the oxidation ditch? (Round to the nearest tenth.)

$$\text{Load} = 8.34 (0.3 \text{ MGD}) (195 \text{ mg/L}) = 488 \frac{\text{lbs}}{\text{day}}$$

$$\text{Mass} = 8.34 (0.25 \text{ MG}) (3910 \text{ mg/L}) = 8152 \text{ lbs}$$

$$\text{SA} = \frac{8152}{488}$$

ANS 16.7 days

15. If the mixed liquor suspended solids concentration is 2660 mg/L, and the aeration tank has a volume of 425,000 gallons, how many pounds of suspended solids are in the aeration tank?

$$\text{Load} = 8.34 (0.425 \text{ MG}) (2660 \text{ mg/L})$$

ANS 9428 lbs

16. The desired F/M ratio at a conventional activated sludge plant is 0.3 lbs BOD/lb MLVSS. If the 2.81-MGD primary effluent flow has a BOD of 144 mg/L, how many lbs of MLVSS should be maintained in the aeration tank?

$$\text{Load} = 8.34 (2.81 \text{ MGD}) (144 \text{ mg/L}) = 3375 \frac{\text{lbs}}{\text{day}}$$

$$\text{MLVSS} = \frac{3375}{0.3}$$

ANS 11,250 lbs

17. The aeration tank of a conventional activated sludge plant has a mixed liquor volatile suspended solids concentration of 2470 mg/L. If the aeration tank is 100 ft long, 45 ft wide, and has wastewater to a depth of 17 ft, how many pounds of MLVSS are in the aeration tank?

$$\text{Volume} = 7.48 (100 \text{ ft}) (45 \text{ ft}) (17 \text{ ft}) = 572,220 \text{ gal}$$

$$\text{Load} = 8.34 (0.57222 \text{ MG}) (2470 \text{ mg/L})$$

ANS 11,788 lbs

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18. The MLSS concentration in an aeration tank is 2740 mg/L. The aeration tank contains 705,000 gallons of wastewater. If the primary effluent flow is 1.78 MGD with a suspended solids concentration of 180 mg/L, what is the sludge age? (Round to the nearest tenth.)

$$\text{Load} = 8.34 (1.78 \text{ MGD}) (180 \text{ mg/L}) = 2672 \frac{\text{lbs}}{\text{day}}$$

$$\text{Mass} = 8.34 (0.705 \text{ MG}) (2740 \text{ mg/L}) = 16,110 \text{ lbs}$$

$$\text{SA} = \frac{16,110}{2672}$$

$$\text{ANS } \underline{6.0 \text{ days}}$$

19. Determine the solids retention time (SRT) given the following data: (Use the "core sampler" method of calculating system solids.)

Aer. Tank Vol.—1,380,000 gal	MLSS—2650 mg/L
Fin. Clar.—117,000 gal	WAS—5960 mg/L
P.E. Flow—2.9 MGD	S.E. SS—20 mg/L
WAS—75,000 gpd	CCSS—1900 mg/L

$$\text{Mass} = 8.34 [(1.38 \text{ MG})(2650 \text{ mg/L}) + (0.117 \text{ MG})(1900 \text{ mg/L})] = 32,353 \text{ lbs}$$

$$\text{Load} = 8.34 [(2.9 \text{ MGD})(20 \text{ mg/L}) + (0.0075 \text{ MGD})(5960 \text{ mg/L})] = 4212 \frac{\text{lbs}}{\text{day}}$$

$$\text{SRT} = \frac{32,353}{4212}$$

$$\text{ANS } \underline{7.7 \text{ days}}$$

20. The settleability test after 30 minutes indicates a sludge settling volume of 228 mL/L. Calculate the RAS flow as a ratio to the secondary influent flow. (Round to the nearest hundredth.)

$$\text{RAS ratio} = \frac{228 \text{ mL/L}}{1000 \text{ mL/L} - 228 \text{ mL/L}}$$

$$\text{ANS } \underline{0.30}$$

21. The desired F/M ratio at an activated sludge plant is 0.5 lbs BOD/lb MLVSS. It was calculated that 3630 lbs/day BOD enter the aeration tank. If the volatile solids content of the MLSS is 71%, how many lbs MLSS are desired in the aeration tank?

$$\text{MLVSS} = \frac{3630 \frac{\text{lbs}}{\text{day}}}{0.5} = 7260 \text{ lbs}$$

$$\text{MLSS} = \frac{7260 \text{ lbs}}{0.71}$$

$$\text{ANS } \underline{10,225 \text{ lbs}}$$

22. Calculate the solids retention time (SRT) given the following data:
(Use the "combined volume" method of calculating system solids.)

Aer. Tank Vol.—360,000 gal MLSS—2890 mg/L
 Fin. Clar.—125,000 gal WAS—6050 mg/L
 P.E. Flow—1.42 MGD S.E.—SS 22 mg/L
 WAS—28,000 gpd

$$\text{Mass} = 8.34 [(0.36 \text{ MG} + 0.125 \text{ MG}) (2890 \text{ mg/L})] = 11,690 \text{ lbs}$$

$$\text{Load} = 8.34 [(1.42 \text{ MG})(22 \text{ mg/L}) + (0.028 \text{ MGD})(6050 \text{ mg/L})] = 1673 \frac{\text{lbs}}{\text{day}}$$

$$\text{SRT} = \frac{11,690}{1673} \quad \text{ANS } \underline{7.0 \text{ days}}$$

- 23 The desired sludge age for a plant is 4.8 days. The aeration tank volume is 770,000 gal. If 3670 lbs/day suspended solids enter the aeration tank and the MLSS concentration is 2730 mg/L, how many lbs/day MLSS (suspended solids) should be wasted?

$$\text{Mass wanted} = 4.8 \text{ days} \cdot 3670 \frac{\text{lbs}}{\text{day}} = 17,616 \text{ lbs}$$

$$\text{Mass} = 8.34 (0.77 \text{ MG} \cdot 2730 \text{ mg/L}) = 17,532 \text{ lbs}$$

$$\text{Waste} = 17,532 \text{ lbs} - 17,616 \text{ lbs} = -84 \text{ lbs} \quad \text{ANS } \underline{\text{None}}$$

24. It has been determined that 4100 lbs/day of dry solids must be removed from the secondary system. If the RAS SS concentration is 6340 mg/L, what must be the WAS pumping rate, in MGD? (Round to the nearest thousandth.)

$$\text{Flow} = \frac{4100 \text{ lbs}}{8.34 (6340 \text{ mg/L})}$$

$$\text{ANS } \underline{0.078 \text{ MGD}}$$

25. Given the following data, calculate the lbs/day WAS SS to be wasted.
(Use the "combined volume" method of calculating system solids.)

Desired SRT—10 days RAS SS—5910 mg/L
 Clarifier + Aerator Vol.—1.45 MG S.E. SS—18 mg/L
 MLSS—2870 mg/L P.E. Flow—5.68 MGD

$$\text{Mass}_{in} = 8.34 (1.45 \text{ MG}) (2870 \text{ mg/L}) = 34,707 \text{ lbs}$$

$$\text{Mass}_{out} = 8.34 [(5.68 \text{ MGD}) (18 \text{ mg/L}) (10 \text{ days}) + x \cdot 10 \text{ days}] = 8527 \text{ lbs} + 10x$$

$$34,707 = 8527 + 10x$$

$$x = \frac{26,180}{10}$$

$$\text{ANS } \underline{2618 \frac{\text{lbs}}{\text{day}}}$$