Certification Boulevard

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Test Your Knowledge of Wastewater Process Topics

1. Given the following data, what is the Specific Oxygen Utilization Rate (SOUR) in an aerobic digester?
   - OUR test starting D.O. is 7.2 mg/L.
   - OUR test ending D.O. is 3.5 mg/L.
   - OUR test time is 10 minutes.
   - Digested sludge total solids concentration is 1.5 percent.

   a. 2.1 mg/hr/gm TS
   b. 1.1 mg/hr/gm TS
   c. 1.5 mg/hr/gm TS
   d. 10.9 mg/hr/gm TS

2. Given the following data, how much WAS should be wasted from this activated sludge facility?
   - Aeration tank volume is 0.77 mg.
   - Two aeration tanks are in service.
   - MLSS is 2,700 mg/L.
   - Mixed liquor is 75 percent volatile.
   - WAS TSS is 5,250 mg/L.
   - Desired MLSS is 2,200 mg/L.

   a. 0.073 mg b. 59,267 gal
   c. 0.147 mg d. 14,671 gal

3. Given the following data, what is the percent volatile solids reduction in an anaerobic digester using the Approximate Mass Balance (AMB) formula?
   - Feed Sludge Total Solids = 3.4%
   - Feed Sludge Volatile Solids = 2.7%
   - Feed Sludge Daily Flow = 90,000 gpd
   - Digested Sludge Out Total Solids = 2.4%
   - Digested Sludge Out Volatile Solids = 1.5%
   - Digested Sludge Out Flow = 0.09 mgd

   a. 40.1% b. 37.0%
   c. 34.5% d. 44.4%

4. Given the following data, what is the volatile solids loading rate in an anaerobic digester?
   - Digester tank diameter is 75 feet.
   - Digester side water depth is 24 feet to overflow.
   - Volume in cone is 35,000 gallons.
   - Digester sludge feed rate is 125 gpm for 8 hrs/day.
   - Sludge feed total solids concentration is 3.2 percent.
   - Sludge feed volatile content is 81 percent.

   a. 0.12 lbs per day VS per ft^3
   b. 0.34 lbs per day VS per ft^3
   c. 0.17 lbs per day VS per ft^3
   d. 1.5 lbs per day VS per ft^3

5. What does the term loading refer to?
   a. The pounds of MLVSS under aeration.
   b. The cfm of air supplied to the aeration tank.
   c. The pounds of BOD entering the aeration tank.
   d. The amount of waste sludge removed from the system.

6. What action should be performed to permanently reduce the F/M ratio from 0.4 to 0.3?
   a. Decrease WAS b. Increase RAS
   c. Increase RAS d. Increase WAS

7. Which adjustment will normally improve denitrification in an aeration tank?
   a. Increase the air supply.
   b. Increase the D.O.
   c. Decrease the D.O.
   d. Shut off the RAS.

8. What is the cost of polymer used, in dollars per dry ton processed, given the following data?
   - Total sludge feed to the GBT is 76,750 gpd.
   - Feed sludge concentration is 0.75 percent.
   - Total polymer used is 6.5 gpd.
   - Polymer specific gravity is 1.03.
   - Polymer cost is $1.02 per pound.

   a. $45.24 / dt b. $15.50 / dt
   c. $23.73 / dt d. $35.44 / dt

9. What is the HRT in days of an aerobic digester, given the following data?
   - Tank diameter is 75 feet.
   - Tank is 20 feet deep.
   - TWAS feed is 15,500 gpd.
   - Tank depth averages 85 percent full during the calculation period.

   a. 62.6 days b. 31.3 days
   c. 23.5 days d. 36.2 days

10. What is the $CBOD_5$ concentration, given the following data?
    - BOD bottle volume is 300 ml.
    - Sample volume is 15.0 ml.
    - Initial D.O. is 8.0 mg/l.
    - Final D.O. after incubation is 4.0 mg/l.

    a. 20 mg/l b. 80 mg/l
    c. 60 mg/l d. 96 mg/l

ANSWERS ON PAGE ??

Readers are welcome to submit questions or exercises on water or wastewater treatment plant operations for publication in Certification Boulevard. Mail your question (with the answer) or your exercise (with the solution) to Roy Pelletier, City of Orlando Public Works Department, 5100 L.B. McLeod Road, Orlando, FL 32811. Or send it by e-mail to roy.pelletier@cityoforlando.net.

Equipment & Services Directory

Certification Boulevard Answer Key

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1. **c. 1.5 mg/hr/gm TS**

SOUR, mg/hr/gm TS
= OUR, mg/L/hr ÷ TS, gm/L
= (7.2 mg/l – 3.5 mg/L) ÷ 10 minutes x 60 mins/hr
= 22.2 mg/L/hr OUR
gm/L TS = mg/L TSS ÷ 1,000
= 1.5% TS x 10,000 = 15,000 mg/L TSS
= 22.2 mg/L/hr ÷ (15,000 ÷ 1,000)
= 1.48 mg/hr/gm TS

2. **c. 0.147 mg**

Excess Pounds Aeration Inventory to Waste
= 0.77 mg x 2 tanks x (2,700 mg/L – 2,200 mg/L) x 8.34 lbs/gal
= 6,422 lbs MLSS
= 6,422 lbs to waste ÷ (5,250 mg/L x 8.34)
= 0.1466712 mg x 1,000,000
= 146,671 gal

3. **d. 44.4%**

Approximate Mass Balance formula
% VS reduction = (VS in, lbs/day – VS Out lbs/day) ÷ VS in, lbs/day x 100
VS in, lbs/day
= 0.09 mgd x 27,000 mg/L x 8.34 lbs/gal
= 20,266 lbs/day
VS out, lbs/day
= 0.09 mgd x 15,000 mg/L x 8.34 lbs/gal
= 11,259 lbs/day
= (20,266 – 11,259) ÷ 20,266 x 100
= 44.4% VS reduction

4. **a. 0.12 lbs per day VS per ft³**

VS loading rate, lbs VS per day per ft³ digester capacity = lbs/day VS feed to digester ÷ ft³ digester capacity
flow to digester
= 480 mins/day x 125 gpm
= 60,000 gpd
= 0.06 mgd
volatile solids fraction
= 3.2% TS x 81% volatile
= 2.592% volatile fraction
lbs/day VS feed
= 0.06 mgd x 25,920 mg/L VS x 8.34 lbs/gal
= 12,970 lbs/day VS feed to digester
digester ft³ capacity
= (π r² x SWD, ft) + (cone volume, gals ÷ 7.48 gal/ft³)
= (3.14 x 37.5 ft x 37.5 ft x 24 ft SWD) + (35,000 gallons in cone ÷ 7.48 gal/ft³)
= 105,975 ft³ + 4,679 ft³ = 110,654 ft³
= 12,970 lbs/day VS ÷ 110,654 ft³
= 0.117 lbs/day VS per ft³ digester capacity

5. **c. The pounds of BOD entering the aeration tank**

The term loading refers to the pounds of $CBOD_5$ entering the aeration system. A highly, or overloaded, plant typically has a high F/M ratio and a low SRT.

6. **a. Decrease WAS**

A decreased F/M ratio means that there is less food available for the active microorganisms. In most plants, the operator doesn't have any control over the amount of food that is available on a daily basis, but does have direct control over the amount of active bugs in the system. Altering the rate of WAS has a permanent effect on the amount of bugs ("M") in the process. With a constant influent concentration of $CBOD_5$, decreasing the WAS rate, which increases the bug population, will allow less food to be available, which reduces the F/M ratio. This action will also increase the process SRT.

7. **c. Decrease the D.O.**

Denitrification is an anoxic reaction and is best accomplished when the dissolved oxygen level is low, so decreasing the aeration tank D.O. will typically improve biological denitrification.

8. **c. $23.73 / dt**

Dry tons of sludge processed:
= Sludge feed, mgd x feed concentration, mg/l x 8.34 lbs/gal ÷ 2,000 lbs/ton
= (76,750 gals ÷ 1,000,000) x (0.75 x 10,000) x 8.34 lbs/gal ÷ 2,000 lbs/ton
= 2.4 dry tons of sludge processed
Pounds of polymer used:
= Gallons polymer used x (8.34 lbs/gal x 1.03 S.G.)
= 6.5 gpd x (8.34 lbs/gal x 1.03)
= 55.84 pounds polymer used
Cost of polymer used:
= Pounds polymer used x cost per pound
= 55.84 lbs polymer used x $1.02 per pound
= $56.96 polymer consumed
Cost of polymer per dry ton of sludge processed:
= Cost of polymer used ÷ dry tons of sludge processed
= $56.96 cost of polymer ÷ 2.4 dry tons sludge processed
= $23.73 polymer per dry ton of sludge processed

9. **d. 36.2 days**

Aerobic digester HRT, days
= Volume of tank, gals ÷ Feed sludge, gpd
Volume of tank, gallons
= πr² x depth, ft. x 7.48 gal/ft³ x % full
= 3.14 x 37.5 x 37.5 x 20 ft x 7.48 gal/ft³ x 0.85
= 561,490.9 gallons
Sludge Feed, gpd = 15,500
Aerobic digester HRT, days
= 561,491 gals ÷ 15,500 gpd
= 36.2 days

10. **b. 80 mg/l**

$CBOD_5$, mg/l = (Initial D.O. - Final D.O.) ÷ (300 ml ÷ sample volume)
= (8.0 mg/l - 4.0 mg/l) ÷ (300 ml ÷ 15 ml)
= 80 mg/l