Test Your Knowledge of Biosolids Management

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1. Given the following data of $36.51 polymer per dry ton of sludge processed, is this an acceptable cost of polymer usage for a gravity belt thickener (GBT)?
   a. Yes, very reasonable.
   b. No, it is too high.
   c. There is not enough data to calculate this parameter.
   d. This piece of information is not relevant to GBT operation.

2. Given the following data, how many lbs/day of centrate solids will this centrifuge produce?
   · Sludge feed rate is 250 gpm
   · Sludge feed solids concentration is 1.5 percent total solids (TS)
   · Centrate volume is 95 percent of sludge feed rate
   · Centrate solids content is 50 mg/L total suspended solids (TSS)
   · Centrifuge operating time is 16 hrs/day
   a. 159 lbs/day b. 143 lbs/day
   c. 4,036 lbs/day d. 95 lbs/day

3. What are the two reaction forming stages of anaerobic digestion?
   a. Foam and oxygen
   b. Acid and methane
   c. Volatile solids and total solids
   d. Nitrogen and methanol

4. What is the specific oxygen utilization rate (SOUR) in an aerobic digester, given the following data?
   · OUR test starting D.O. is 7.2 mg/L
   · OUR test ending D.O. is 4.0 mg/L
   · OUR test time is 10 minutes
   · Digested sludge total solids concentration is 1.75 percent
   a. 2.1 mg/hr/gm TS b. 1.1 mg/hr/gm TS
   c. 1.6 mg/hr/gm TS d. 0.1 mg/hr/gm TS

5. Which digester, in a two-stage anaerobic digestion process, is normally not mixed and/or heated?
   a. Primary digester
   b. Secondary digester
   c. Neither is normally mixed or heated.
   d. Both are normally mixed and heated.

6. Given the following data, how much gas is being produced per pound of volatile solids destroyed in this anaerobic digester?
   · Gas production 200,575 cu ft per day (cf/day)
   · Sludge feed volume is 125,000 gpd
   · Sludge feed total solids is 3.2 percent and the volatile solids (VS) content is 81 percent
   · Digested sludge removal volume is 122,000 gpd
   · Digested sludge total solids is 2.3 percent and the VS content is 73 percent
   a. 2.0 cf gas per lb VS destroyed
   b. 0.049 cf gas per lb VS destroyed
   c. 20.2 cf gas per lb VS destroyed
   d. 18.4 cf gas per lb VS destroyed

7. What does the following formula represent?

$$\frac{\text{OUR, mg/L/hr}}{\text{TS, gm/L}} = \text{mg/hr/gm}$$

   a. Oxygen uptake rate
   b. Specific oxygen utilization rate
   c. Sludge volume index
   d. Fecal coliform

8. What is a typical range for gas production in a properly operated anaerobic digestion process?
   a. 1 to 2 ft^3 per lb VS reduced
   b. 5 to 7 ft^3 per lb VS reduced
   c. 11 to 20 ft^3 per lb VS reduced
   d. 40 to 60 ft^3 per lb VS reduced

9. What could be the cause of a "stuck" or "sour" digester?
   a. High acid production
   b. High alkalinity in the sludge
   c. Sludge feed rate too low
   d. Sludge temperature swings less than 1°F per day

10. What is the primary function of polymer conditioning in the belt filter press process?
    a. To decrease solids content.
    b. To promote rapid water release.
    c. To sterilize the microorganisms.
    d. To disinfect the sludge particles.

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Certification Boulevard Answer Key

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1. **B) No, it is too high.**

No – polymer usage of $36.51 per dry ton of sludge processed in a GBT is typically too high and unacceptable. It is not uncommon for a GBT to thicken waste activated sludge consuming polymer at a rate of about $10 to $20 per dry ton of sludge processed. Polymer usage depends on several variables, including, but not limited to: solids retention time (SRT), F/M ratio, and sludge volume index (SVI) of the activated sludge process; sludge feed rate and concentration to the GBT; polymer solution strength; mixing efficiency of the polymer solution and the sludge feed; belt speed; and others.

2. **B) 143 lbs/day**

Pounds per day centrate:
= Centrate flow, mgd x TSS concentration, mg/L x 8.34 lbs/gal

Centrate flow, mgd:
= Sludge feed rate, gpm x 1,400 min/day ÷1,000,000 x 0.95
= 250 gpm x 1,440 min/day ÷ 1,000,000 x 0.95
= 0.342 mgd centrate flow

Pounds per day centrate:
= Centrate flow 0.342 mgd x TSS concentration 50 mg/L x 8.34 lbs/gal
= 142.6 lbs/day

3. **B) Acid and methane**

The first reaction is when volatile solids in the feed sludge are converted to volatile acids; this is known as the acid phase of anaerobic digestion, and it can happen in as little as 24 hours. The second reaction is when methane-forming bacteria use volatile acids and convert them into methane gas, carbon dioxide, water, and other trace gases. Alkalinity is abundant as a result of the methane-forming phase. Anaerobic digestion is not complete until the second reaction of digestion takes place, which can take up to 15 to 20 days at 95°F.

4. **B) 1.1 mg/hr/gm TS**

SOUR, mg/hr/gm TS = OUR, mg/L/hr ÷ gm/L TS

OUR, mg/L/hr
= Start dissolved oxygen (D.O.) - End D.O. ÷ Test min x 60 min/hr
= 7.2 mg/L - 4.0 mg/L ÷ 10 min x 60 min/hr
= 19.2 mg/L/hr

gm/L TS
= TS, mg/L ÷ 1,000 ml/L
= 1.75 percent x 10,000 ÷ 1,000
= 17.5 gm/L TS

SOUR, mg/hr/gm TS
= OUR 19.2 mg/L/hr ÷ TS 17.5 gm/L
= 1.097 mg/hr/gm TS

5. **B) Secondary digester**

Typically, the secondary digester in a two-stage anaerobic digestion process is not mixed or heated. This tank is typically used as a gas and sludge holding tank.

6. **C) 20.2 cu ft gas per lb VS destroyed**

cf/day gas produced ÷ lbs/day volatile solids destroyed = cf gas per lb VS destroyed

Volatile solids in feed sludge, lbs/day:
= Feed sludge flow, mgd x VS conc., ppm x 8.34 lbs/gal
= 0.125 mgd x (3.2 x 10,000 x 0.81) x 8.34 lbs/gal
= 27,021.6 lbs/day VS in feed sludge

Volatile solids in digested sludge, lbs/day:
= Digested sludge flow, mgd x VS conc., ppm x 8.34 lbs/gal
= 0.122 mgd x (2.3 x 10,000 x 0.73) x 8.34 lbs/gal
= 17,083.5 lbs/day VS in digested sludge

Volatile solids reduced, lbs/day
= Feed sludge, lbs/day - Digested sludge, lbs/day
= 27,021.6 lbs/day feed - 17,083.5 lbs/day digested
= 9,938.1 lbs/day VS reduced (or destroyed)

cf gas per lb VS destroyed:
= 200,575 cf/day gas ÷ 9,938 lbs VS reduced
= 20.18 cf gas produced per lb VS destroyed

7. **B) Specific Oxygen Utilization Rate**

The specific oxygen utilization rate, or SOUR, is calculated by dividing the oxygen uptake rate (OUR) test results by the total solids content of the sample in grams per liter. The SOUR is used to determine potential for additional volatile solids reduction that is remaining in a sample. Typically, the SOUR results of aerobically digested sludge should be no greater than 1.5 mg/hr/gm TS to meet Class B standards for vector attraction reduction.

8. **C) 11 to 20 ft³ per lb VS reduced**

Typically, gas produced in an anaerobic digester that is close to about 11 to 20 cu ft per pound of volatile solids destroyed is considered acceptable.

9. **A) High acid production**

A sour (or stuck) anaerobic digester may be the result of high acid production. High acid production is typically the result of something inhibiting the growth of the methane forming bacteria. This could be temperature swings of greater than 1°F per day in the digested sludge, inadequate mixing of the digester contents, or an overloaded volatile solids feed rate to the primary digester.

10. **B) To promote rapid water release.**

The result of polymer conditioning of the feed sludge is a release of water in the gravity section of the belt filter press. This is accomplished by neutralizing the charge of the sludge, which allows bound water to be released and drained from the sludge slurry.