SolidsTreatmentTF

1. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
b. False
2. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
a. True
b. False
3. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
b. False
4. A high rate anaerobic digester is always heated and mixed.
a. True b.False
5. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
b. False
6. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
b. False
7. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame
a. True
b. False
8. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
9. Gas production in an anaerobic digester results from the destruction of fixed solids
a. True
b. False
10. A well operating digester will have a CO2 concentration of greater than 60%
a. True
b. False
11. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
12. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
13. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
14. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False
15. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
16. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False

17. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
18. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
19. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
20. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
21. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
22. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
23. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
24. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
25. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
26. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
27. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
28. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
29. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False
30. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
31. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.

a. True
b. False
32. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
33. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
34. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
35. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
36. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
37. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
38. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
39. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
40. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
41. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
42. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
43. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
44. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
45. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False

46. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False
47. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
b. False
48. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
a. True
b. False
49. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
50. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
a. True
b. False
51. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
b. False
52. In a decanter centrifuge, greater pond depth would produce drier cake
a. True
b. False
53. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
54. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
55. Gravity thickener is commonly used for sludge dewatering
a. True
b. False
56. Grit and screenings from the preliminary treatment are also considered as biosolids
a. True
b. False
57. In a decanter centrifuge, greater pond depth would produce drier cake
a. True
b. False
58. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
59. Grit and screenings from the preliminary treatment are also considered as biosolids
a. True
b. False
60. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
b. False
61. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True

b. False
62. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
63. Gravity thickener is commonly used for sludge dewatering
a. True
b. False
64. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False

BiosolidsTF05192018

1. Solids treated using a qualified PSRP qualify as Class A biosolids
a. True
b. False
2. Class A and Class B biosolids are two categories of vector reduction requirements of 40 CFR Part 503
a. True
b. False

Digestion5

1. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
b. False
2. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
a. True
b. False
3. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
b. False
4. A high rate anaerobic digester is always heated and mixed.
a. True b.False
5. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
b. False
6. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
b. False
7. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
8. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
9. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
10. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
11. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False

12. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
13. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
14. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
15. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
16. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
17. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
18. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
19. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
20. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
21. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
22. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
23. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
24. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
25. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
26. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True

b. False
27. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
b. False
28. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
a. True
b. False
29. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
30. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
a. True
b. False
31. In a two-stage anaerobic digestion system, it is in the secondary tank where most of the volatile solids destruction occurs
a. True
b. False
32. In a two-stage anaerobic digestion system, it is in the secondary tank where most of the volatile solids destruction occurs
a. True
b. False
33. The lower explosive limit for methane is 40%
a. True
b. False
34. Psychrophilic bacteria would be used in which kind of digester? (a) Cold digester (b) Warm digester (c) Hot digester
a. True
b. False
35. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
36. Sludge digestion is a process by which principally the inorganic matter in sludge is gasified and/or converted to a more stable form by the biological process.
a. True
b. False
37. The determination of the pH on the anaerobic digester is one of the best early warning systems of digester upset.
a. True
b. False
38. The gas produced as part of the anaerobic digestion is of little or no value
a. True
b. False
39. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
40. The pH of digested sludge in a healthy anaerobic digester will be near 7.0.
a. True
b. False
41. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.

a. True
b. False
42. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
43. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False

DigestionTF

1. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
b. False
2. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
b. False
3. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
4. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
a. True
b. False
5. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
6. The gas produced as part of the anaerobic digestion is of little or no value
a. True
b. False
7. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
b. False
8. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
b. False
9. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
a. True
b. False
10. The determination of the pH on the anaerobic digester is one of the best early warning systems of digester upset.
a. True
b. False
11. Sludge digestion is a process by which principally the inorganic matter in sludge is gasified and/or converted to a more stable form by the biological process.
a. True
b. False
12. The pH of digested sludge in a healthy anaerobic digester will be near 7.0.
a. True
b. False
13. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False

14. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
15. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
16. A high rate anaerobic digester is always heated and mixed.
a. True b.False
17. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
a. True
b. False
18. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
b. False

DigestionTF1a

1. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
2. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False
3. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
4. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
5. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
6. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
7. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
8. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
9. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
10. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True

b. False
11. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
12. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
13. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
14. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
15. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
16. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
17. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False

Biosolids0a0

1. Class A and Class B biosolids are two categories of vector reduction requirements of 40 CFR Part 503
a. True
b. False
2. Wastewater sludge stabilized using anaerobic digestion would qualify as Class A biosolid
a. True
b. False
3. Solids treated using a qualified PSRP qualify as Class A biosolids
a. True
b. False

SolidsTreatment5a

1. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
b. False
2. In a decanter centrifuge, greater pond depth would produce drier cake
a. True
b. False
3. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
4. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False
5. Gravity thickener is commonly used for sludge dewatering
a. True

b. False
6. Grit and screenings from the preliminary treatment are also considered as biosolids
a. True
b. False
7. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
b. False

Digestion

1. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
2. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
3. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
4. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
5. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
6. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
7. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7% VS and digested sludge: 57.2%VS
a. 52.3%
b. 64%
c. 16.5%
d. 42%
8. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60
a. 20%
b. 25%
c. 63%
d. 89%
9. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
10. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
11. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True

b. False
12. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft
13. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%
b. 40%
c. 57%
d. 71%
14. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
b. 24
c. 36
d. 48
15. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
e. 4,170 lbs/day
16. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day
17. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00 deg. F
18. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1
19. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column

e. none of the above
20. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
21. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
22. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
23. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
24. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above
25. In an on-line treatment facility having three aerobic digesters in series, which of the following statements would be false?
a. it is not necessary to aerate all three digesters
b. draw off supernatant from tanks #2 and #3 only
c. a dissolved oxygen level will be easier to maintain in tank #3 than in tank #1
d. sludge pumped to digester #3 must be thicker than sludge pumped to digester #2, and #2 thicker than 1
26. The volatile acid/alkalinity relationship of an anaerobic digester is an indication of the buffer capacity of the digester contents. When the ratio starts to increase, it indicates:
a. excellent digester operation
b. decreases in alkalinity
c. better methane production
d. a decrease in volatile acids
e. an increase in pH
27. For domestic wastewater, gas production in a well operated anaerobic digester should be in the vicinity of:
a. 1 cu. ft. of gas per day per pound of volatile matter destroyed
b. 10 BTU per pound of dry solids at 70% volatile
c. one cubic foot of gas per capita per day
d. 50 BTU per cubic foot
e. all of the above

28. What is the purpose of heating and mixing a primary anaerobic digester?
a. To eliminate all oxygen present
b. To increase the digestion rate
c. To keep methane gas in suspension
d. To prevent settling of grit to the bottom of the digester
29. Given the following data, what is the most likely cause of the anaerobic digester problem? DATA: Raw sludge pump on Digester gas pressure high Gas pressure relief valve open
a. Vacuum relief valve stuck open
b. Too much raw sludge feed
c. Supernatant line pugged
d. Digester cover seal broken
30. The pH in an aerobic digester may decrease due to
a. The aerobic destruction of alkalinity
b. Production of CO2 and nitrate ions
c. Oxidation of H2S to sulfuric acid
d. An increase in volatile acids
31. The proper way to start up an anaerobic digester is to fill it
a. Halfway with seed sludge, then add raw sludge slowly
b. Up first with raw sludge and wastewater
c. Up with waste activated sludge
d. With seed sludge, add lime to pH 10 and mix
32. How would you determine if a gas mixing system is plugged or otherwise malfunctioning in your anaerobic digester?
a. By measuring the blower discharge pressure
b. By measuring the temperature throughout the digester
c. By observing amount of gas production
d. By visual observation through the inspection port
33. Which gas is produced in anaerobic digesters and can be used as a fuel?
a. Propane
b. Methane
c. Ethane
d. Carbon dioxide
34. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.
35. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
36. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.

d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
37. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
38. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
39. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
40. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
41. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.
42. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
43. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
44. Anaerobic digester gas is composed mostly of:

a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
45. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
46. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False
47. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
48. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
49. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
50. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
51. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
52. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
53. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
54. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
55. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
56. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
57. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
58. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.

a. True
b. False
59. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
60. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
61. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False
62. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
63. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64%
c. 16.5%
d. 42%
64. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
65. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
66. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
67. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%

DigestionMathMC08122018

1. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?

a. 3,750 cu.ft
b. 10,000 cu.ft
c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft
2. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%
b. 40%
c. 57%
d. 71%
3. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
b. 24
c. 36
d. 48
4. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
e. 4,170 lbs/day
5. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day

SolidsThickeningMathMC08122018

1. When you spread sludge on agricultural land, the annual application rate of cadmium in the sludge should be less than 2 lbs/acre/year If your sludge contains 30 mg cadmium per kilogram of solids and your plant produces 950,000 lbs per year of dry solids, how many acres do you need?
a. 3 acres
b. 14 acres
c. 19 acres
d. 27 acres

DigestionMC08122018

1. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00 Deg. F
2. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers

e. a flowing stream with a D.O of 5 mg/1
3. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above
4. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
5. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
6. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
7. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
8. One of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above
9. In an on-line treatment facility having three aerobic digesters in series, which of the following statements would be false?
a. it is not necessary to aerate all three digesters
b. draw off supernatant from tanks #2 and #3 only
c. a dissolved oxygen level will be easier to maintain in tank #3 than in tank #1
d. sludge pumped to digester #3 must be thicker than sludge pumped to digester #2, and #2 thicker than 1
10. The volatile acid/alkalinity relationship of an anaerobic digester is an indication of the buffer capacity of the digester contents. When the ratio starts to increase, it indicates:
a. excellent digester operation
b. decreases in alkalinity
c. better methane production
d. a decrease in volatile acids
e. an increase in pH

11. For domestic wastewater, gas production in a well operated anaerobic digester should be in the vicinity of:
a. 1 cu. ft. of gas per day per pound of volatile matter destroyed
b. 10 BTU per pound of dry solids at 70% volatile
c. one cubic foot of gas per capita per day
d. 50 BTU per cubic foot
e. all of the above
12. What is the purpose of heating and mixing a primary anaerobic digester?
a. To eliminate all oxygen present
b. To increase the digestion rate
c. To keep methane gas in suspension
d. To prevent settling of grit to the bottom of the digester
13. Given the following data, what is the most likely cause of the anaerobic digester problem? DATA: Raw sludge pump on Digester gas pressure high Gas pressure relief valve open
a. Vacuum relief valve stuck open
b. Too much raw sludge feed
c. Supernatant line pugged
d. Digester cover seal broken
14. The pH in an aerobic digester may decrease due to
a. The aerobic destruction of alkalinity
b. Production of CO2 and nitrate ions
c. Oxidation of H2S to sulfuric acid
d. An increase in volatile acids
15. The proper way to start up an anaerobic digester is to fill it
a. Halfway with seed sludge, then add raw sludge slowly
b. Up first with raw sludge and wastewater
c. Up with waste activated sludge
d. With seed sludge, add lime to pH 10 and mix
16. How would you determine if a gas mixing system is plugged or otherwise malfunctioning in your anaerobic digester?
a. By measuring the blower discharge pressure
b. By measuring the temperature throughout the digester
c. By observing amount of gas production
d. By visual observation through the inspection port
17. Which gas is produced in anaerobic digesters and can be used as a fuel?
a. Propane
b. Methane
c. Ethane
d. Carbon dioxide

Biosolids

1. Per Title 40 CFR Part 503, for biosolids to qualify for EQ (Exceptional Quality Standards), it must meet
a. Pollution concentration limits
b. Class A Pathogen Standard
c. Vector Reduction Standard
d. All of the above

Digestion Question Bank

1. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
2. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
3. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%

4. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
5. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
6. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
7. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
8. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
9. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
10. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
11. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
12. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
13. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
14. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
15. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
16. Calculate the organic loading rate to two 320,000 gallon anaerobic digesters given: Primary sludge feed rate of 25,000 gallons with 6.2% TS containing 73% solids and SG of 1.03. Secondary sludge feed rate of 30,500 gallons with 3.8% TS containing 77% solids (7 points) (Answer: 0.2lbs VS/day-ft3)

17. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
18. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
19. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
20. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
a. 42,756 lbs/day
b. 24,554 lbs/day
c. 30,987 lbs/day
d. 3,256 lbs/day
21. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
a. 7,131 lbs/day
b. 17,432 lbs/day
c. 19,256 lbs/day
d. 26,244 lbs/day
22. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
a. 56%
b. 38%
c. 42%
d. 61.4%
23. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%
b. 40%
c. 57%
d. 71%
24. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
b. 24
c. 36
d. 48
25. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day

c. 2,337 lbs/day
d. 3,273 lbs/day
e. 4,170 lbs/day
26. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day
27. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
28. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
29. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
30. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
31. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft
32. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%
b. 40%
c. 57%
d. 71%
33. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
b. 24

c. 36
d. 48
34. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
e. 4,170 lbs/day
35. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day
36. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft
37. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
38. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
39. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
40. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
41. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.

d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
42. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
43. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.
44. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
45. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
46. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
47. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
48. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.

d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
49. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
50. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
51. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
52. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
53. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
54. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.
55. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
56. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:

a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
57. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
58. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
59. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
60. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
61. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
62. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
63. A gas meter in the gas line from the digester is most helpful in:
a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.

64. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
65. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00 Deg. F
66. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1
67. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above
68. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
69. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
70. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
71. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
72. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture

c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above
73. In an on-line treatment facility having three aerobic digesters in series, which of the following statements would be false?
a. it is not necessary to aerate all three digesters
b. draw off supernatant from tanks #2 and #3 only
c. a dissolved oxygen level will be easier to maintain in tank #3 than in tank #1
d. sludge pumped to digester #3 must be thicker than sludge pumped to digester #2, and #2 thicker than 1
74. The volatile acid/alkalinity relationship of an anaerobic digester is an indication of the buffer capacity of the digester contents. When the ratio starts to increase, it indicates:
a. excellent digester operation
b. decreases in alkalinity
c. better methane production
d. a decrease in volatile acids
e. an increase in pH
75. For domestic wastewater, gas production in a well operated anaerobic digester should be in the vicinity of:
a. 1 cu. ft. of gas per day per pound of volatile matter destroyed
b. 10 BTU per pound of dry solids at 70% volatile
c. one cubic foot of gas per capita per day
d. 50 BTU per cubic foot
e. all of the above
76. What is the purpose of heating and mixing a primary anaerobic digester?
a. To eliminate all oxygen present
b. To increase the digestion rate
c. To keep methane gas in suspension
d. To prevent settling of grit to the bottom of the digester
77. Given the following data, what is the most likely cause of the anaerobic digester problem? DATA: Raw sludge pump on Digester gas pressure high Gas pressure relief valve open
a. Vacuum relief valve stuck open
b. Too much raw sludge feed
c. Supernatant line pugged
d. Digester cover seal broken
78. The pH in an aerobic digester may decrease due to
a. The aerobic destruction of alkalinity
b. Production of CO2 and nitrate ions
c. Oxidation of H2S to sulfuric acid
d. An increase in volatile acids
79. The proper way to start up an anaerobic digester is to fill it
a. Halfway with seed sludge, then add raw sludge slowly
b. Up first with raw sludge and wastewater
c. Up with waste activated sludge
d. With seed sludge, add lime to pH 10 and mix
80. How would you determine if a gas mixing system is plugged or otherwise malfunctioning in your anaerobic digester?
a. By measuring the blower discharge pressure
b. By measuring the temperature throughout the digester
c. By observing amount of gas production
d. By visual observation through the inspection port
81. Part of the digester gas that can be used as a fuel?
a. Propane

b. Methane
c. Ethane
d. Carbon dioxide
82. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00 Deg. F
83. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1
84. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above
85. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
86. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
87. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
88. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
89. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above
90. A gas meter in the gas line from the digester is most helpful in:

a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.
91. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
92. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
93. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
94. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
95. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
96. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
97. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.
98. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.

b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
99. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
a. 52.3%
b. 64
c. 16.5%
d. 42%
100. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.
101. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
102. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
103. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
104. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
105. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.

b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
106. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
107. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.
108. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
109. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
110. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
111. During anaerobic digestion, at what frequency should mixing be applied?
a. 12 hours per day.
b. 2 hours per shift.
c. 45 minutes per hour.
d. Constantly.
112. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
113. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
114. Ferrous chloride solution is most often added to anaerobic digesters in order to:

a. Reduce corrosion in anaerobic digester walls
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions
115. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
116. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
117. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
118. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
119. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
120. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.

b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
121. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
122. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
123. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
c. 60%
d. 89%
124. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%
125. In a two-stage anaerobic digestion system, what is the intended function of the secondary digester?
a. Acid formation.
b. Primarily for gas production.
c. Separation of gas from supernatant.
d. Solids settling.
126. It is important to avoid adding an excess of hydrated lime to a sour anaerobic digester because this excess lime:
a. will add excess carbon dioxide to the digester gas.
b. may react violently with grease and oils.
c. may destroy desirable saprophytes.
d. adds hardness to the digester supernatant.
e. may react as follows: Ca(OH)2 + CO2 àH20 + Ca(CO)3
127. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
128. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.

d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
129. One change can reduce the fuel consumption for digester heating, increase digester detention or displacement time and reduce the volume of anaerobic supernatant to be returned to the head works of a treatment plant. That one change would be:
a. Build a bigger digester
b. Install a counter-current hear exchanger
c. Pump primary sludge more frequently
d. Install a sludge thickener
e. Double the insulation on the digester roof
130. Psychrophilic bacteria would be used in which kind of digester?
a. Cold digester
b. Warm digester
c. Hot digester
131. Range for volatile acids to alkalinity ratio for a well operating anaerobic digester
a. >0.25
b. <0.25
c. 2-4
d. >1
132. The earliest indication of biological upset or process trouble in heated anaerobic digester would usually be:
a. A significant decrease in pH.
b. An increase in the volatile solids percentage in digested sludge
c. An increase in alkalinity and a decrease in volatile acids
d. An increase in volatile acids without a corresponding increase in alkalinity
e. An increase in volatile acids and alkalinity.
133. The progress of anaerobic sludge digestion can be determined by:
a. percent volatile matter in the sludge
b. frequent alkalinity and volatile acids determinations
c. the volume and composition of gases produced
d. all of the above
e. a and b only
134. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%.
b. 40%.
c. 57%.
d. 7l%
135. What is the purpose of heating and mixing a primary anaerobic digester?
a. To prevent grit from settling
b. To eliminate all oxygen
c. To increase the reaction rate
d. To keep methane in suspension
136. What should be done if your anaerobic digester starts to go sour?
a. Release methane and aerate digester
b. Add lime or sodium bicarbonate and reduce raw sludge feed
c. Add lime and increase raw sludge feed
d. Add CO2 to reduce pH
e. Drain the tank
137. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.

c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
138. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
139. When feeding an aerobic digester, the operator can control within certain limits:
a. Amount of air available for stabilization
b. Solids concentration
c. Frequency of feeding
d. Organic concentration
e. b and d
f. b and c
140. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
b. False
141. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
a. True
b. False
142. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
b. False
143. A high rate anaerobic digester is always heated and mixed.
a. True b.False
144. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
b. False
145. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
b. False
146. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame
a. True
b. False
147. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.
148. Gas production in an anaerobic digester results from the destruction of fixed solids
a. True
b. False
149. A well operating digester will have a CO2 concentration of greater than 60%
a. True
b. False
150. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
151. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False

152. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
153. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False
154. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
155. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
156. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
157. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
158. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
159. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
160. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
161. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
162. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
163. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
164. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
a. True
b. False
165. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
166. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True

b. False
167. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
168. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False
169. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
b. False
170. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
a. True
b. False
171. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
b. False
172. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
b. False
173. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
a. True
b. False
174. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
b. False
175. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
176. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
b. False
177. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
a. True
b. False
178. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
179. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
b. False
180. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
181. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.

a. True
b. False
182. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
a. True
b. False
183. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
b. False
184. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
b. False
185. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
b. False
186. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
b. False
187. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
a. True
b. False
188. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
189. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
a. True
b. False
190. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
b. False
191. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
a. True
b. False
192. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
b. False
193. A high rate anaerobic digester is always heated and mixed.
a. True b.False
194. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
b. False
195. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
b. False
196. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test

a. True
b. False
197. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
b. False
198. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
a. True
b. False
199. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
b. False
200. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
a. True
b. False
201. In a two-stage anaerobic digestion system, it is in the secondary tank where most of the volatile solids destruction occurs
a. True
b. False
202. The lower explosive limit for methane is 40%
a. True
b. False
203. Psychrophilic bacteria would be used in which kind of digester? (a) Cold digester (b) Warm digester (c) Hot digester
a. True
b. False
204. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False
205. Sludge digestion is a process by which principally the inorganic matter in sludge is gasified and/or converted to a more stable form by the biological process.
a. True
b. False
206. The determination of the pH on the anaerobic digester is one of the best early warning systems of digester upset.
a. True
b. False
207. The gas produced as part of the anaerobic digestion is of little or no value
a. True
b. False
208. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
b. False
209. The pH of digested sludge in a healthy anaerobic digester will be near 7.0.
a. True
b. False
210. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
a. True
b. False
211. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test

a. True
b. False
212. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
b. False

Dewatering

1. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.

SolidsMC

1. A DAF thickener has effluent solids of 55 mg/L and float solids of 2.0
a. This unit is operating normally
b. Too low air to solids ratio
c. Float blanket too thick
d. Flight speed too fast
e. Flight speed too slow
2. An air flotation thickener will produce a thin float if:
a. Flight speed too high and skimmer wiper not adjusted properly
b. Excessive air/solids ratio and polymer dosages too low
c. High dissolved oxygen and flight speed too low
d. Polymer dosages too high and unit overloaded
3. An increase in the pool depth of a scroll-type centrifuge:
a. would not affect the moisture content of the cake.
b. would produce a drier cake
c. would produce a wetter cake, but produce a greater solids recovery.
d. would not affect either solids recovery, nor cake moisture content.
e. would require an increase in the cationic polymer dosage.
4. A sludge thickened from 1
a. no more than 4
b. approximately 17
c. approximately 25
d. more information is needed
5. Gravity thickeners, compared to DAFs, are best suited to:
a. Thickening primary sludge.
b. Thickening waste activated sludge.
c. Controlling sulfide odors.
d. Removing filamentous bacteria.
e. Provide highest concentration sludge.
6. Gravity thickeners, compared to DAFTs, are best suited to:
a. Thickening primary sludge
b. Thickening waste activated sludge
c. Controlling sulfide odors
d. Removing filamentous bacteria
e. Provide highest concentration sludge
7. Identify the incorrect statement regarding gravity thickeners.
a. Gravity thickeners are similar in design to primary clarifiers.
b. The sludge blanket depth and the rate of sludge withdrawal are used to calculate the sludge detention time.

c. The purpose of pickets in a sludge thickener is to gently stir settling sludge particles to release gases that may prevent the sludge particles from compacting.
d. Mixtures of primary and waste activated sludge are never thickened in a gravity thickener due to the possibilility of de-nitrification.
e. Solids loading (pounds per day per square foot) is an important guideline for a gravity thickener.
8. On a routine check of a DAF unit the operator finds suspended solids of 450 mg/L in the effluent. The float blanket appears well flocculated and concentrated. The operator should:
a. Increase the flight speed.
b. Do nothing, the unit is operating normally.
c. Reduce the air to solids ratio.
d. Increase the air to solids ratio.
e. Check unit operating pressure.
9. On a routine check of a DAFT unit the operator finds suspended solids of 450 mg/L in the effluent. The float blanket appears well flocculated and concentrated. The operator should:
a. increase the flight speed
b. do nothing, the unit is operating normally
c. reduce the air to solids ratio
d. increase the air to solids ratio
e. check unit operating pressure
10. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
d. Reduce costs of biosolids hauling
11. What zone is not involved in a belt filter press?
a. Gravity
b. Low pressure (wedge)
c. High pressure
d. Twilight
12. Lowering the vat depth of a vacuum filter is most likely to produce _____ cake produce
a. Wetter
b. Thicker
c. Stronger
d. Dryer
13. You have observed water spraying out of the vacuum filter's silencer (or snubber; exhaust pipe Which of the following conditions is the most likely cause of the problem?
a. Filtrate pump not functioning properly
b. Vacuum too high
c. Vacuum too low
d. Worn check valves in vacuum system
14. An air flotation thickener will produce a thin float if
a. Flight speed too high and skimmer wiper not adjusted properly
b. Excessive air/solids ratio and polymer dosages too low
c. High dissolved oxygen and flight speed too low
d. Polymer dosages too high and unit overloaded.
15. Gravity-thickened primary sludge will contain solids within which of the following concentration ranges?
a. 1,000 - 8,000 mg/l
b. 10,000 – 40,000 mg/l
c. 40,000 - 80,000 mg/l
d. 100,000 - 400,000 mg/l
e. none of the above
16. The float blanket in a DAF unit appears well flocculated and concentrated. Too low a flight speed would likely result in:

a. Using excessive amounts of air.
b. Float solids that are too thick.
c. Too low an air-to-solids ratio.
d. Poor thickener underflow quality.
e. De-flocculation of float solids.
17. The least critical operational control of a dissolved air flotation thickener in producing an adequately thickened sludge is the:
a. Flight speed.
b. Air to solids ratio.
c. Polymer dosage.
d. Recycle ratio.
e. Pre-thickened WAS concentration.
18. The operational control of a dissolved air flotation thickener most critical for producing an adequately thickened float solids is the:
a. Fight speed.
b. Air to solids ratio.
c. Polymer dosage.
d. Recycle ratio.
e. Concentration of WAS being thickened.
19. To increase solids recovery on a dual belt, belt press, the operator should:
a. Increase the differential belt speed.
b. Increase belt speed.
c. Increase sludge feed rate.
d. Decrease sludge feed rate.
e. Increase polymer feed.
20. Too high a flight speed in a DAF will likely result in:
a. Using excessive amounts of air.
b. Excessive underflow volume.
c. Thin float solids.
d. Too high an air to solids ratio.
e. Too low an air to solids ratio.
21. What can be a problem with a belt filter press?
a. Washing out
b. Polymer overdosing
c. Blinding
d. All of the above
22. What can be used to evaluate the efficiency of a belt filter press?
a. Vacuum required in inches of mercury
b.
c. Sludge feed rate in gpd
d. Filter yield in lbs/hr/sq ft
e. Gph of filtrate removal.
23. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
d. Reduce costs of biosolids hauling
24. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.

e. All of the above are thickeners, not dewatering devices.
25. Which one of the following statements is TRUE in regard to DAF thickeners?
a. The air to solids ratio in a DAF unit is typically 0.03 to 0.05.
b. The speed of the so-called "flights" has very little effect on the concentration of the float solids.
c. Adjustments in the air to solids ratio in a DAF unit will affect the float solids but not the unit's effluent suspended solids.
d. Anionic polymers are typically used to condition the WAS feed to a DAF unit.
26. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.
27. Which one of the following statements is TRUE in regard to the operation of a belt filter press:
a. Unlike a gravity belt, cationic polymers need not be used to condition the feed sludge to this unit.
b. When dewatering a mixture of WAS and primary sludge, which has been anaerobically digested, the operator can expect to produce a sludge cake with 22
c. The best belt speed for this unit is the slowest speed the belt can be operated at, without causing "washout."
d. Colloidal solids are likely to cause plugging of belt pores and thus cause "belt binding."
28. Which one the following statements is TRUE in regard to gravity thickeners?
a. Longer solids detention times are desired during summer operation of these units.
b. The sludge-volume-ratio (SVR) or sludge detention time is defined as the volume of the sludge blanket divided by the daily volume of sludge withdrawn from the thickener.
c. SVRs should be in range of 5 to 10 hours.
d. A likely cause of a gravity thickener producing a poor quality effluent is too low of a sludge blanket.*

DigesterMC

1. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
2. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
3. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
4. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.

5. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
6. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
7. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.
8. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
9. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93 Deg. F to 98 Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
10. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.
11. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.

d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.
12. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
13. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
14. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
15. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.
16. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.
17. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.
18. Identify the incorrect statement regarding operation of an anaerobic digester.
a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

19. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.
20. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
21. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.
22. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.
23. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia
24. A gas meter in the gas line from the digester is most helpful in:
a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.
25. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93Deg. F to 98Deg. F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.
26. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00Deg. F
27. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers

b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1
28. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above
29. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
30. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
31. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
32. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
33. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above
34. In an on-line treatment facility having three aerobic digesters in series, which of the following statements would be false?
a. it is not necessary to aerate all three digesters
b. draw off supernatant from tanks #2 and #3 only
c. a dissolved oxygen level will be easier to maintain in tank #3 than in tank #1
d. sludge pumped to digester #3 must be thicker than sludge pumped to digester #2, and #2 thicker than 1
35. The volatile acid/alkalinity relationship of an anaerobic digester is an indication of the buffer capacity of the digester contents. When the ratio starts to increase, it indicates:
a. excellent digester operation
b. decreases in alkalinity
c. better methane production

d. a decrease in volatile acids
e. an increase in pH
36. For domestic wastewater, gas production in a well operated anaerobic digester should be in the vicinity of:
a. 1 cu. ft. of gas per day per pound of volatile matter destroyed
b. 10 BTU per pound of dry solids at 70% volatile
c. one cubic foot of gas per capita per day
d. 50 BTU per cubic foot
e. all of the above
37. What is the purpose of heating and mixing a primary anaerobic digester?
a. To eliminate all oxygen present
b. To increase the digestion rate
c. To keep methane gas in suspension
d. To prevent settling of grit to the bottom of the digester
38. Given the following data, what is the most likely cause of the anaerobic digester problem? DATA: Raw sludge pump on Digester gas pressure high Gas pressure relief valve open
a. Vacuum relief valve stuck open
b. Too much raw sludge feed
c. Supernatant line pugged
d. Digester cover seal broken
39. The pH in an aerobic digester may decrease due to
a. The aerobic destruction of alkalinity
b. Production of CO2 and nitrate ions
c. Oxidation of H2S to sulfuric acid
d. An increase in volatile acids
40. The proper way to start up an anaerobic digester is to fill it
a. Halfway with seed sludge, then add raw sludge slowly
b. Up first with raw sludge and wastewater
c. Up with waste activated sludge
d. With seed sludge, add lime to pH 10 and mix
41. How would you determine if a gas mixing system is plugged or otherwise malfunctioning in your anaerobic digester?
a. By measuring the blower discharge pressure
b. By measuring the temperature throughout the digester
c. By observing amount of gas production
d. By visual observation through the inspection port
42. Part of the digester gas that can be used as a fuel?
a. Propane
b. Methane
c. Ethane
d. Carbon dioxide
43. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
e. anaerobic digester with temperatures over l00Deg. F
44. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1

45. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above
46. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)
47. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
e. all of the above
48. When defining BTU (British Thermal Unit), which of the following would apply?
a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above
49. The primary purpose of a secondary digester is to:
a. increase gas production
b. stabilize volatile solids
c. provide additional storage for detritus
d. allow for solids separation
e. none of the above
50. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above

DigestionMathMC1a

1. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft
2. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%
b. 40%
c. 57%
d. 71%

3. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
b. 24
c. 36
d. 48
4. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
e. 4,170 lbs/day
5. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day
last
1. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
b. False
**********SolidsTreatmentTF**
Answers:
1. b.
2. a.
3. b.
4. a.
5. b.
6. b.
7. a.
9. b.
10. b.
11. b.
12. b.
13. b.
14. a.
15. b.
16. b.
17. a.
18. b.
19. b.
20. b.
21. a.
22. a.
23. b.
24. b.
25. a.

26. a.
27. b.
28. b.
29. b.
30. b.
31. a.
32. b.
33. b.
34. a.
35. b.
36. b.
37. b.
38. a.
39. a.
40. b.
41. b.
42. a.
43. a.
44. b.
45. b.
46. b.
47. b.
48. a.
49. b.
50. a.
51. b.
52. b.
53. b.
54. b.
55. b.
56. a.
57. b.
58. b.
59. a.
60. b.
61. b.
62. b.
63. b.
64. b.

BiosolidsTF05192018

Answers: 1. b.
2. b.

Digestion5

Answers:
1. b.
2. a.
3. b.
4. a.
5. b.
6. b.
8. b.
9. b.
10. b.

11. a.
12. b.
13. b.
14. a.
15. b.
16. b.
17. b.
18. a.
19. a.
20. b.
21. b.
22. a.
23. a.
24. b.
25. b.
26. b.
27. b.
28. a.
29. b.
30. a.
31. b.
32. b.
33. b.
34. a.
35. b.
36. b.
37. b.
38. b.
39. b.
40. a.
41. a.
42. b.
43. b.

digestionTF

Answers:

1. b.
2. b.
3. b.
4. a.
5. b.
6. b.
7. b.
8. b.
9. a.
10. b.
11. b.
12. a.
13. a.
14. b.
15. b.
16. a.
17. a.
18. b.

DigestionTF1a
Answers: 1. b.
2. a.
3. b.
4. b.
5. a.
6. b.
7. b.
8. b.
9. a.
10. a.
11. b.
12. b.
13. a.
14. a.
15. b.
16. b.
17. b.

Biosolids0a0
Answers:
1. b.
2. a.
3. b.

SolidsTreatment5a
Answers: 1. b.
2. b.
3. b.
4. b.
5. b.
6. a.
7. b.

Digestion
Answers:
2. a. 24554.0
3. a. 7131.0
4. a. 61.4
5. c.
6. c.
7. a.
8. c.
9. c.
10. c.
11. b.
12. c.
13. a.
14. b.
15. e.
16. d.
17. e.
18. c.
19. b.
20. d.
21. e.

22. a.
23. d.
24. b.
25. a.
26. b.
27. c.
28. b.
29. a.
30. c.
31. a.
32. d.
33. b.
34. c.
35. b.
36. b.
37. a.
38. b.
39. d.
40. b.
41. c.
42. d.
43. d.
44. b.
45. b.
46. a.
47. b.
48. b.
49. a.
50. b.
51. b.
52. b.
53. a.
54. a.
55. b.
56. b.
57. a.
58. a.
59. b.
60. b.
61. b.
62. c.
63. a.
64. c.
65. c.
66. c.
67. c.

DigestionMathMC08122018

Answers: 1. c.
2. a.
3. b.
4. e.
5. d.

SolidsThickeningMathMC08122018

Answers: 1. b.

DigestionMC08122018

Answers: 1. e.
2. c.
3. b.
4. d.
5. e.
6. a.
7. d.
8. b.
9. a.
10. b.
11. c.
12. b.
13. a.
14. c.
15. a.
16. d.
17. b.

Biosolids

Answers:
1. d.

Digestion Question Bank

Answers:
1. a. 24554.0
2. a. 7131.0 3. a. 61.4
4. c.
5. c.
6. a.
7. c.
8. c.
9. c.
10. b.
13. a. 24554.0
14. a. 7131.0
15. a. 61.4
16.
17. c.
18. a.
19. c.
20. b.
21. a.
22. d.
23. a.
24. b.
25. e.
26. d.
27. a.
28. c.
29. a.
30. c.
31. c.
32. a.

33. b.
34. e.
35. d.
36. c.
37. c.
38. a.
39. c.
40. b.
41. c.
42. c.
43. c.
44. b.
45. b.
46. a.
47. b.
48. d.
49. b.
50. c.
51. d.
52. d.
53. b.
54. c.
55. b.
56. b.
57. a.
58. b.
59. d.
60. d.
61. d.
62. b.
63. d.
64. e.
65. e.
66. c.
67. b.
68. d.
69. e.
70. a.
71. d.
72. b.
73. a.
74. b.
75. c.
76. b.
77. a.
78. c.
79. a.
80. d.
81. b.
82. e.
83. c.
84. b.
85. d.

86. e.
87. a.
88. d.
89. b.
90. d.
91. d.
92. e.
93. d.
94. b.
95. b.
96. b.
97. c.
98. c.
99. a.
100. c.
101. b.
102. b.
103. a.
104. b.
105. d.
106. b.
107. c.
108. d.
109. d.
110. b.
111. d.
112. d.
113. d.
114. d.
115. b.
116. b.
117. a.
118. a.
119. b.
120. b.
121. c.
122. c.
123. c.
124. c.
125. b.
126. e.
127. b.
128. b.
129. d.
130. a.
131. b.
132. d.
133. d.
134. c.
135. c.
136. b.
137. b.
138. b.

139. f.
140. b.
141. a.
142. b.
143. a.
144. b.
145. b.
146. a.
148. b.
149. b.
150. b.
151. b.
152. b.
153. a.
154. b.
155. b.
156. a.
157. b.
158. b.
159. b.
160. a.
161. a.
162. b.
163. b.
164. a.
165. a.
166. b.
167. b.
168. b.
169. b.
170. a.
171. b.
172. b.
173. a.
174. b.
175. b.
176. b.
177. a.
178. a.
179. b.
180. b.
181. a.
182. a.
183. b.
184. b.
185. b.
186. b.
187. a.
188. b.
189. a.
190. b.
191. a.
192. b.

193. a.
194. b.
195. b.
196. b.
197. b.
198. a.
199. b.
200. a.
201. b.
202. b.
203. a.
204. b.
205. b.
206. b.
207. b.
208. b.
209. a.
210. a.
211. b.
212. b.

Dewatering

Answers:
1. a.

SolidsMC

Answers:
1. d.
2. a.
3. c.
4. c.
5. a.
6. a.
7. b.
8. a.
9. d.
10. d.
11. d.
12. d.
13. b.
14. b.
15. e.
16. d.
17. d.
18. b.
19. d.
20. c.
21. d.
22. d.
23. d.
24. a.
25. a.
26. a.
27. c.
28. d.

DigesterMC

Answers:

1. b.
2. c.
3. c.
4. c.
5. b.
6. b.
7. a.
8. b.
9. d.
10. b.
11. c.
12. d.
13. d.
14. b.
15. c.
16. b.
17. b.
18. a.
19. b.
20. d.
21. d.
22. d.
23. b.
24. d.
25. e.
26. e.
27. c.
28. b.
29. d.
30. e.
31. a.
32. d.
33. b.
34. a.
35. b.
36. c.
37. b.
38. a.
39. c.
40. a.
41. d.
42. b.
43. e.
44. c.
45. b.
46. d.
47. e.
48. a.
49. d.
50. b.

DigestionMathMC1a

Answers:
1. c.
2. a.
3. b.
4. e.
5. d.

last

1. b.

1. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
   *a. 52.3%
   b. 64%
   c. 16.5%
   d. 42%

   Solution:

   The VS reduction of the digester is provided by the Van Kleeck equation

   $$Digester\ VS\ reduction(\%) = \frac{VS_{in} - VS_{out}}{VS_{in} - VS_{in} * VS_{out}} * 100$$

   $$Digester\ VS\ reduction(\%) = \frac{0.737 - 0.572}{0.737 - 0.737 * 0.572} * 100 = \boxed{52.3\%}$$

2. 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? [Ans: 32,841 gal]

3. 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? [Ans: 2,241 mg/l alkalinity]

4. 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? [0.057 lbs VS/ft3-day]

5. 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? [3,850 gallons]

6. 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? [5,643 galllons]

7. 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? [Ans. 11,676 cu. ft/day]

8. 10,000 gallons/day of sludge is pumped to an anaerobic digester/day at 4% solids (70% VS). If 50% of the VS is destroyed, how many lbs of VS is destroyed per day?
   Solution:
   $$\frac{10,000\ Gal}{day} * \frac{8.34\ lbs\ sludge}{Gal} \frac{0.04 * 0.7\ lbs\ VS\ feed}{lb\ sludge} * \frac{0.5\ lbs\ VS\ destroyed}{lbs\ VS\ feed} = \boxed{\frac{1,168 lbs\ VS\ destroyed}{day}}$$

9. 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. What is the combined solids concentration? [Ans. 2.28%] If the primary sludge is 68% VS and the secondary sludge is 63% VS, how many pounds of VS are in the combined sludge? [Ans. 5400.3 lbs VS]

10. 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?[Ans. 24,980 gallons]

11. How many pounds of solids are pumped to a digester each day if the digester receives 10,000 gpd of sludge at 5% solids concentration?
Solution:
$$\frac{lbs\ \ TS}{day} = \frac{10,000 gal\ \ sludge}{day} * \frac{(8.34 * 0.05 lbs TS)}{gal\ \ sludge} = 4,170 \frac{lbs\ \ TS}{day}$$

12. Calculate the % VS reduction in a digester given the volatile solids content of the influent sludge to the digester is 70% and the volatile solids content of the sludge leaving the digester is 52.5%
Solution: $Digester\ \ VS\ \ reduction(\%) = \frac{0.7 - 0.525}{0.7 - 0.7 * 0.525} * 100 = \boxed{53\%}$
85. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
c. 63%
d. 89%

Solution:

$$Digester\ \ VS\ \ reduction(\%) = \frac{0.8 - 0.6}{0.8 - 0.8 * 0.6} * 100 = \boxed{63\%}$$

13. Calculate the VS loading to the digester in lbs/day if 10,000 gallons of sludge containing 5% TS with and average VS content of 78%
Solution:
Digester VS loading (lbs/day)
$$= \frac{10,000\ \ gallons\ \ sludge}{day} * \frac{8.34 lbs\ \ sludge}{gal} * \frac{0.05 * 0.78 lbs VS}{lb\ \ sludge} = \boxed{3,253 lbs\ \ sludge\ \ per\ \ day}$$

14. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day

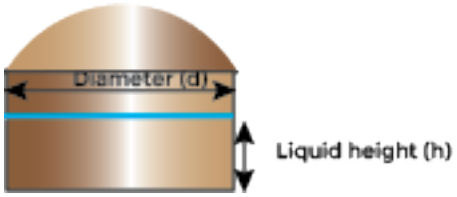
Solution:

Digester VS loading (lbs/day)
$$= \frac{25 * 1,440\ \ gallons\ \ sludge}{day} * \frac{8.34 lbs\ \ sludge}{gal} * \frac{0.05 * 0.73 lbs VS}{lb\ \ sludge} = \boxed{10,960\ \ lbs\ \ sludge\ \ per\ \ day}$$

15. 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?

Solution:

$$Digester\ \ volatile\ \ solids\ \ loading\ \ rate = \frac{Digester\ \ Loading \frac{lbs\ \ VS}{day}}{Digester\ \ volume(V) ft^3}$$

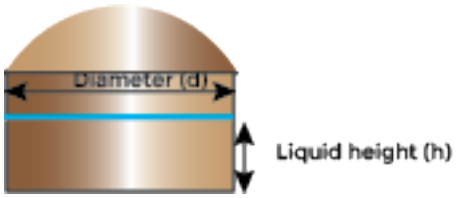


$$= \frac{5000 \frac{gal\ \ sludge}{day} * (8.34 * 0.06 * 0.66) \frac{lbsVS}{gal\ \ sludge}}{(\frac{\pi}{4} * 37^2 * 27) ft^3} = \boxed{0.057 \frac{lbs\ \ VS}{day - ft^3}}$$

16. The sludge feed to a digester is 12,000 ft^3/day. The sludge contains 4.5% total solids with 70% volatile solids. What is the digester loading in lbs VSS/day per ft^3 if the digester diameter is 100 ft and a working sludge level of 20 ft.

Solution:

$$Digester\ \ volatile\ \ solids\ \ loading\ \ Rate = \frac{Digester\ \ loading \frac{lbs\ \ VS}{day}}{Digester\ \ volume(V) ft^3}$$



$$= \frac{12,000 \frac{ft^3\ \ sludge}{day} * 7.48 \frac{gal}{ft^3} * (8.34 * 0.045 * 0.70) \frac{lbsVS}{gal\ \ sludge}}{(\frac{\pi}{4} * 100^2 * 20) ft^3} = \boxed{0.15 \frac{lbs\ \ VS}{day - ft^3}}$$

17. How much gas is produced in the above digester in ft^3/day if the digested sludge contains 2.5% total solids of which 59% is volatile solids and the gas production rate is 14 ft^3/lb VS destroyed?

Solution:

$$Digester\ \ VS\ \ reduction(\%) = \frac{0.70 - .59}{0.70 - 0.70 * 0.59} * 100 = 38.3\%$$

$$\frac{lbs\ \ VS\ \ reduction}{day} = \frac{3153 lbs\ \ VS\ \ feed * 0.383\ \ VS\ \ reduction}{day} = 1,208 \frac{lbs\ \ VS\ \ reduction}{day}$$

$$\frac{ft^3 gas\ \ produced}{day} = 1208 \frac{lbs\ \ VS\ \ reduced}{day} * \frac{14 ft^3\ \ gas\ \ produced}{lb\ \ VS\ \ reduced} = 16,912 \frac{ft^3\ \ digester\ \ gas\ \ produced}{day}$$

18. The sludge feed to a digester is 80,000 gal/day. The sludge contains 4.5% total solids with 75% volatile solids. If 50% of VS are reduced in the digester:

(a) Find lbs VS destroyed per 1000 gal of digester capacity per day if the digester radius is 55 ft with an operating sludge level of 25 ft.(5 points)

Solution:

Digester Volume: $(\pi * 55^2 * 25)ft^3 * 7.48\frac{gal}{ft^3} = 1,776,220 gallons = 1,776.2 \ (1000 \ gallons)$

$$\frac{lbs \ VS \ reduction}{day} = \frac{80,000gal * 8.34\frac{lbs}{gal} * (0.045 * 0.75)\frac{lbsVS}{lb} * 0.5\frac{lbs \ VS \ reduction}{lb \ VS}}{day}$$

$$= 11,259\frac{lbs \ VS \ reduction}{day}$$

$$\frac{lbs \ VS \ reduction}{1000 \ digester \ capacity} = \frac{11,259\frac{lbs \ VS \ reduction}{day}}{1,776.2 \ (1000 \ gallons)} = \boxed{6.3\frac{lbs \ VS \ reduction}{1000 gallons \ digester \ volume}}$$

(b) What is the digester gas production in Btu/day? Assume 14 cu. ft digester gas per lb of VS destroyed and a 650 Btu/cu. ft heating value for the digester gas produced (5 points)

Solution:

$$\frac{ft^3 gas \ produced}{day} = 11,259\frac{lbs \ VS \ reduced}{day} * \frac{14ft^3 \ gas \ produced}{lb \ VS \ reduced} = 157,626\frac{ft^3 \ digester \ gas \ produced}{day}$$

$$\frac{BTU \ produced}{day} = 157,626\frac{ft^3 \ gas \ produced}{day} * \frac{650BTU \ gas \ produced}{ft^3 gas} = \boxed{102,456,900\frac{BTU \ produced}{day}}$$

19. 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. What is the combined solids concentration? If the primary sludge is 68% VS and the secondary sludge is 63% VS, what is the VS concentration (%) in the combined sludge?

Solution:

Combined solids concentration: $C_1 * V_1 + C_2 * V_2 = C_3 * V_3$

$$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{4.1 * 15,000 + 1.3 * 28,000}{15,000 + 28,000} = \boxed{2.28\%}$$

Lbs of VS in combined sludge: $C_{VS1} * V_1 + C_{VS2} * V_2 = C_{VS3} * V_3$

$$\implies C_{VS3} = \frac{C_{VS1} * V_1 + C_{VS2} * V_2}{V3} = \frac{C_{VS1} * V_1 + C_{VS1} * V_2}{V_1 + V_2}$$

$$\implies C_{VS3} = \frac{4.1 * 15,000 * 0.68 + 1.3 * 28,000 * 0.63}{15,000 + 28,000} = \boxed{1.50\%}$$

20. 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?

Solution:

Volatile acid:Alkalinity=$0.087 = \frac{195}{x} \implies x = \frac{195}{0.087} = \boxed{2,241\frac{mg}{l}}$

21. 10,000 gallons of sludge is pumped to an anaerobic digester/day at 4% solids (70% VS). 50% of the VS are destroyed, creating 15 ft^3 of gas per lbs. of VS destroyed. How much gas is produced each day?

$$\frac{lbs\ VS\ reduction}{day} = \frac{10,000gal * 8.34\frac{lbs}{gal} * (0.04 * 0.7)\frac{lbsVS}{lb} * \frac{0.5lbs\ VS\ reduction}{lb\ VS}}{day} = 1,168\frac{lbs\ VS\ reduction}{day}$$

$$\frac{ft^3 gas\ produced}{day} = 1,168\frac{lbs\ VS\ reduced}{day} * \frac{15ft^3\ gas\ produced}{lb\ VS\ reduced} = 17,520\frac{ft^3\ digester\ gas\ produced}{day}$$

22. Given a sludge flow of 5,500 gpd with 6.5% solids containing 72% VS to a digester with a VS destruction of 48% If the digester is digester is 40 ft. diameter with a sludge level of 25 ft, find lbs. VS destroyed per 1000 gal of digester capacity per day. What is the digester gas production in Btu/day if the % VS reduction in the digester is 58% and the digester raw sludge feed is 6000 cu. Ft/day containing 4.5% total solids with a 64% VS content? Assume 13.5 cu. ft digester gas per lb of VS destroyed and a 650 Btu/cu. ft heating value for the digester gas produced

Digester Volume: $(\frac{\pi}{4} * 40^2 * 25)ft^3 * 7.48\frac{gal}{ft^3} = 940,086gallons = 940\ (1000\ gallons)$

$$\frac{lbs\ VS\ reduction}{day} = \frac{5,500gal * 8.34\frac{lbs}{gal} * (0.065 * 0.72)\frac{lbsVS}{lb} * \frac{0.48lbs\ VS\ reduction}{lb\ VS}}{day} = 1,030\frac{lbs\ VS\ reduction}{day}$$

$$\frac{lbs\ VS\ reduction}{1000\ digester\ capacity} = \frac{1,030\frac{lbs\ VS\ reduction}{day}}{940\ (1000\ gallons)} = 1.1\frac{lbs\ VS\ reduction}{1000gallons\ digester\ volume}$$

$$\frac{ft^3 gas\ produced}{day} = 1,030\frac{lbs\ VS\ reduced}{day} * \frac{13.5ft^3\ gas\ produced}{lb\ VS\ reduced} = 13,905\frac{ft^3\ digester\ gas\ produced}{day}$$

$$\frac{BTU\ produced}{day} = 13,905\frac{ft^3\ gas\ produced}{day} * \frac{650BTU\ gas\ produced}{ft^3 gas} = 9,038,250\frac{BTU\ produced}{day}$$

23. Two sludges are blended together as follows: 60,000 gal per day. primary sludge at 4.5% solids and 28,000 gal secondary sludge at 5% solids.

(a) What is the combined solids concentration? (3 points)

$$\frac{60,000 * 4.5 + 28,000 * 5}{88,000} = \boxed{4.66\%}$$

(b) How many lbs of solids (per day) are in the combined sludge (3 points)

$$88,000gal * 8.34 * 0.0466 = \boxed{34,200lbs}$$

(c) If the primary sludge is 68% VS and the secondary sludge is 83% VS, how many pounds of VS are in the combined sludge? (3 points)

$$60,000gal * \frac{8.34 * 0.045 * 0.68lbs\ VS}{gal} + 28,000gal * \frac{8.34 * 0.05 * 0.83lbs\ VS}{gal} = \boxed{25,003lbs\ VS}$$

(d) What is the digester feed VS%? (3 points)

$$\frac{25,003 lbs\ VS}{34,200 lbs TS} = \boxed{73.1\%}$$

(e) If the digester is 120' diameter with a liquid height of 20', what is the VS loading in lbs VS/ft3-day (3 points)

$$\frac{25,003 lbs\ VS}{0.785 * 120^2 * 20} = \boxed{\frac{0.11 lbs\ VS}{day - ft^3}}$$

(f) If the digested sludge has 52% VS, calculate the digester VS reduction percent (3 points)

$$Digester\ VS\ reduction(\%) = \frac{0.731 - .52}{0.731 - 0.731 * 0.52} * 100 = \boxed{60.1\%}$$

(g) What is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed (3 points)

$$25{,}003 * 0.601 \frac{lbs\ VS destroyed}{} * \frac{14 ft^3\ gas\ produced}{lb\ VS\ destroyed} = \boxed{210,375 ft^3 gas}$$

(h) How many belt presses are needed to keep up with the digested sludge flow if the belt presses can be operated at a maximum flow of 50 GPM (3 points)

$$88{,}000 \frac{gal\ sludge}{day} * \frac{day}{1440 min} = 61 GPM$$

@50 GPM per press - $\boxed{2\ BFP\ required}$

(i) If the digested sludge feed to the belt filter presses is 2.6% and assuming the belt press feed solids capture is 90%. How many lbs of solids (dry) are produced by the BFP (4 points)

$$88,000 \frac{gal}{day} * 8.34 * 0.026 \frac{lbs\ solids\ feed}{day} * 0.9 \frac{lbs\ solids\ captured}{lbs\ solids\ feed} = \boxed{17,174 lbs\ solids\ per\ day}$$

(j) If the BFP produces a 20% cake, how many wet tons cake produced per day (4 points)

$$\frac{17,174lbs\ \ solids\ \ produced}{day} * \frac{100lbs\ \ cake}{20lbs\ \ solids\ \ produced} * \frac{tons}{2,000lbs} = \boxed{\frac{42.9tons}{day}}$$

(k) If the cake density is 68 lbs/cu. ft, how much time will it take to fill a 30 cu. yd bin (3 points)

(Ans. 15.4 hours) $\frac{(42.9 * 2000)lbs\ \ cake}{day} * \frac{day}{1440min} = \frac{59.583}{lbs\ \ cake} min$

$\frac{59.583}{lbs\ \ cake} min * \frac{ft^3}{68lbs\ \ cake} = \frac{0.876ft^3}{min}$

$30yd^3 * \frac{27ft^3}{yd^3} * \frac{min}{0.876ft^3} * \frac{hrs}{60min} = \boxed{15.4hrs}$

(l) What will be the cost of hauling dewatered cake per day @ $65 per ton cake (2 points)

$42.9\frac{tons}{day} * \frac{\$65}{ton} = \boxed{\frac{\$2,789}{day}}$

24. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%

25. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester

26. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%

27. Calculate the organic loading rate to two 320,000 gallon anaerobic digesters given: Primary sludge feed rate of 25,000 gallons with 6.2% TS containing 73% solids and SG of 1.03. Secondary sludge feed rate of 30,500 gallons with 3.8% TS containing 77% solids (7 points) (Answer: 0.2lbs VS/day-ft3)

Solving Dewatering Problems

1. **Calculation of solids recovery**
   (a) Calculate amount of solids fed to the dewatering unit
   (b) Calculate the amount of solids produced as part of the dewatered cake
   (c) The ratio of the solids in dewatered cake to that in the feed times 100 will give you the solids recovery (solids recovery rate)

2. **Calculation of dewatered cake volume**
   (a) First calculate the amount of cake solids produced in terms of weight per time.
   (b) From the weight of the cake produced calculate the volume - from the cake density which is normally given

3. **Calculation of solids hauling costs or savings associated with change in cake solids content**

(a) First calculate the amount of dry solids produced as part of the original wet cake solids percent
(b) Using the value of the dry solids calculate the wet cake weight with the new cake solids percentage

4. **General formula for calculating net savings associated with change in cake solids content**
Savings $= \frac{(New\ \ solids\ \ \% - Old\ \ Solids\ \ \%)}{New\ \ solids\ \ \%} * Old\ \ Cost$
So if the cake dryness goes up from 20% to 26% and currently a utility is spending $ 1,000,000 per year for biosolids hauling and disposal, their net savings will be: (26%-%20)/26*$ 1,000,000 = $ 230,769

1. Calculate the organic loading rate to two 320,000 gallon anaerobic digesters given:
Primary sludge feed rate of 25,000 gallons with 3.8% TS containing 73% solids and SG of 1.03.
Secondary sludge feed rate of 30,500 gallons with 3.8% TS containing 77% solids
(Answer: 0.2 $\frac{lbs\ \ VS}{day - ft^3}$)

2. 325 GPM of WAS with 7,000 mg/l TSS is thickened in a DAFT. Assuming an air:solids ratio of 0.05 lb of air for each lb of feed solids, The SCFM (standard cubic feed per minute) air required to thicken the WAS given 1 SCFM = 0.075 lb is:
(Answer: 12.6 $SCFM$)
Solution:
Correct Answer:

$$0.05 = \frac{lb\ \ air}{lb\ \ solids} = \frac{\frac{0.075\ \ lbs\ \ air}{SCF} * x\ \ SCFM}{(\frac{325}{1,000,000} MG\ \ per\ \ min * 7000 * 8.34)\ \ lbs\ \ solids}$$

$$\implies x\ \ SCFM = \frac{0.05 * 325 * 7000 * 8.34}{0.075 * 1,000,000} = \boxed{12.6\ \ SCFM} - Correct\ \ answer$$

Incorrect Answer #1:
12,600SCFM

Incorrect Answer #2:
0.126SCFM

Incorrect Answer #3:
1.26SCFM

3. 30,000 gpd of 4.5% sludge is dewatered in a centrifuge yielding 24.5 yd^3/day of 25% cake with a density of 65 lb per ft^3. Calculate the percentage solids recovery.
(Answer: 95.5%)

4. Estimate the amount of heat value of the gas produced from an anaerobic digester in $\frac{BTU}{day}$ given the following:

Raw sludge pumping schedule	12 min/hr
Sludge pumping rate	68 GPM
Raw sludge %TS	5.2%
Raw sludge %VS	72.5%
Gas production	$\frac{12 ft^3}{lb\ VS\ destroyed\ -\ day}$
Percent CO_2	34%
Other gases	1%
Pure methane net heat value	932 $\frac{BTU}{ft^3}$

(Answer: 23,146,220 $\frac{BTU}{day}$)

5. 12,000 ft^3 of anaerobically digested sludge containing 2.8% TS is dewatered in a centrifuge. The centrifuge yields 37 yd^3 of 26% of dewatered cake with a density of 73 lb/ft^3. Calculate the solids capture rate.
   Solution:
   $$lbs\ TS\ feed\ to\ centrifuge = 12,000 ft^3\ \ sludge * 7.48 \frac{gal}{ft^3} * \frac{(8.34 * 0.028 lbs\ TS)}{gal\ \ sludge} = 20,960 lbs\ TS$$
   $$lbs\ TS\ feed\ from\ centrifuge = 37 yd^3\ \ sludge * 27 \frac{ft^3}{yd^3} * \frac{(73 lbs * 0.26\ TS)}{ft^3\ \ sludge} = 18,961 lbs\ TS$$
   $$solids\ capture\ rate = \frac{18,961 lbs\ solids\ produced\ by\ centrifuge}{20,960 lbs\ solids\ fed\ from\ digester} * 100 = \boxed{90.4\% solids\ capture}$$

6. At a 60 GPM of 2.8% feed a belt press which has a 90% solids capture rate produces a 20% cake at 68 lbs/ft^3. How long would it take to fill a 3 yd^3 bin

   Solution:
   Approach:

   - First calculate the amount of cake solids produced in terms of weight per time.
   - From the weight of the cake produced calculate the volume time, and finally
   - using the calculated value of the volume of the cake produced per time, calculate the time required to fill the bin

   $$\frac{cake\ TS\ produced - lbs}{min} = \frac{60 gallons\ \ sludge}{min} * \frac{8.34 lbs\ \ sludge\ \ feed}{galllon} * \frac{0.028 lbs\ TS}{lb\ \ sludge} * 0.9$$
   $$= \frac{12.61 lbs\ TS}{min}$$
   $$\frac{ft^3\ \ cake\ \ produced}{min} = \frac{12.61 lbs\ TS}{min} * \frac{100 lbs\ \ cake}{20 lbs\ TS} * \frac{ft^3\ \ cake}{68 lbs\ \ cake} = \frac{0.927 ft^3 cake}{min}$$
   $$\frac{ft^3\ \ cake\ \ produced}{min} = \frac{12.61 lbs\ TS}{min} * \frac{100 lbs\ \ cake}{20 lbs\ TS} * \frac{ft^3\ \ cake}{68 lbs\ \ cake} = \frac{0.927 ft^3 cake}{min}$$
   $$Time\ required\ to\ fill\ the\ bin = \frac{min}{0.927 ft^3} * 3 yd^3 * \frac{27 ft^3}{yd^3} = \boxed{75 min}$$

7. Calculate the annual cost savings for an improvement of cake solids from 20% to 21% if 400 wet tons (@ 20% cake) are produced each day and the average cake hauling and disposal cost is $65 per wet ton.

$$Total\ (dry)\ solids\ produced\ per\ day = \frac{400\ wet\ tons}{day} * \frac{20 tons\ solids}{100 wet\ tons} = 80 tons\ solids$$

$$Tons\ wet\ cake\ @21\%\ solids = \frac{80\ tons\ solids}{day} * \frac{100 wet\ tons}{21 tons\ solids}$$

$$= \frac{380 tons\ wet\ solids}{day}$$

$$Net\ savings\ (\$/yr) = (400-380)\frac{wet\ tons}{day} * 365 * \frac{days}{yr} * \frac{\$65}{wet\ ton} = \boxed{\$474,500\ per\ year}$$

NOTE: General formula for future reference: So if the cake dryness goes up from 20% to 26% and currently a utility is spending $1,000,000 per year for biosolids hauling and disposal, their net savings will be: (26-20)/26*1,000,000 = $230,769. Conversely say if the dewatering cake solids drops to 18%, the net impact will be: (18-20)/18*1,000,000 = $-111,111 (loss or extra cost).

8. Two sludges are blended together as follows: 60,000 gal per day. primary sludge at 4.5% solids and 28,000 gal secondary sludge at 5% solids.

   (a) What is the combined solids concentration? (3 points)
   $$\frac{60,000 * 4.5 + 28,000 * 5}{88,000} = \boxed{4.66\%}$$

   (b) How many lbs of solids (per day) are in the combined sludge (3 points)
   $$88,000 gal * 8.34 * 0.0466 = \boxed{34,200 lbs}$$

   (c) If the primary sludge is 68% VS and the secondary sludge is 83% VS, how many pounds of VS are in the combined sludge? (3 points)
   $$60,000 gal * \frac{8.34 * 0.045 * 0.68 lbs\ VS}{gal} + 28,000 gal * \frac{8.34 * 0.05 * 0.83 lbs\ VS}{gal} = \boxed{25,003 lbs\ VS}$$

   (d) What is the digester feed VS%? (3 points)
   $$\frac{25,003 lbs\ VS}{34,200 lbs TS} = \boxed{73.1\%}$$

   (e) If the digester is 120' diameter with a liquid height of 20', what is the VS loading in lbs VS/ft3-day (3 points)
   $$\frac{25,003 lbs\ VS}{0.785 * 120^2 * 20} = \boxed{\frac{0.11 lbs\ VS}{day - ft^3}}$$

   (f) If the digested sludge has 52% VS, calculate the digester VS reduction percent (3 points)
   $$Digester\ VS\ reduction(\%) = \frac{0.731 - .52}{0.731 - 0.731 * 0.52} * 100 = \boxed{60.1\%}$$

(g) What is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed (3 points)

$$25{,}003*0.601\frac{lbs\ \ VS destroyed}{}*\frac{14ft^3\ \ gas\ \ produced}{lb\ \ VS\ \ destroyed}=\boxed{210,375ft^3 gas}$$

(h) How many belt presses are needed to keep up with the digested sludge flow if the belt presses can be operated at a maximum flow of 50 GPM (3 points)

$$88{,}000\frac{gal\ \ sludge}{day}*\frac{day}{1440min}=61GPM$$

@50 GPM per press - $\boxed{2\ \ BFP\ \ required}$

(i) If the digested sludge feed to the belt filter presses is 2.6% and assuming the belt press feed solids capture is 90%. How many lbs of solids (dry) are produced by the BFP (4 points)

$$88{,}000\frac{gal}{day}*8.34*0.026\frac{lbs\ \ solids\ \ feed}{day}*0.9\frac{lbs\ \ solids\ \ captured}{lbs\ \ solids\ \ feed}=\boxed{17,174lbs\ \ solids\ \ per\ \ day}$$

(j) If the BFP produces a 20% cake, how many wet tons cake produced per day (4 points)

$$\frac{17,174lbs\ \ solids\ \ produced}{day}*\frac{100lbs\ \ cake}{20lbs\ \ solids\ \ produced}*\frac{tons}{2,000lbs}=\boxed{\frac{42.9tons}{day}}$$

(k) If the cake density is 68 lbs/cu. ft, how much time will it take to fill a 30 cu. yd bin (3 points)

(Ans. 15.4 hours) $\frac{(42.9*2000)lbs\ \ cake}{day}*\frac{day}{1440min}=\frac{59.583}{lbs\ \ cake}min$

$$\frac{59.583}{lbs\ \ cake}min*\frac{ft^3}{68lbs\ \ cake}=\frac{0.876ft^3}{min}$$

$$30yd^3*\frac{27ft^3}{yd^3}*\frac{min}{0.876ft^3}*\frac{hrs}{60min}=\boxed{15.4hrs}$$

(l) What will be the cost of hauling dewatered cake per day @ \$65 per ton cake (2 points)

$$42.9\frac{tons}{day}*\frac{\$65}{ton}=\boxed{\frac{\$2,789}{day}}$$

9. 12,000 ft^3 of anaerobically digested sludge containing 2.8% TS is dewatered in a centrifuge. The centrifuge yields 37 yd^3 of 26% of dewatered cake with a density of 73 lb/ft^3. Calculate the solids capture rate.

Solution:

$$lbs\ \ TS\ \ feed\ \ to\ \ centrifuge=12,000ft^3\ \ sludge*7.48\frac{gal}{ft^3}*\frac{(8.34*0.028lbs\ \ TS)}{gal\ \ sludge}=20,976lbs\ \ TS$$

$$lbs\ \ TS\ \ feed\ \ from\ \ centrifuge=37yd^3\ \ sludge*27\frac{ft^3}{yd^3}*\frac{(73lbs*0.26\ \ TS)}{ft^3\ \ sludge}=18,961lbs\ \ TS$$

$$solids\ \ capture\ \ rate=\frac{18,961lbs\ \ solids\ \ produced\ \ by\ \ centrifuge}{20,976lbs\ \ solids\ \ fed\ \ from\ \ digester}*100=\boxed{90.4\%solids\ \ capture}$$

10. At a 60 GPM of 2.8% feed a belt press which has a 90% solids capture rate produces a 20% cake at 68 lbs/ft^3. How long would it take to fill a 3 yd^3 bin

Solution:

Approach:

- First calculate the amount of cake solids produced in terms of weight per time.
- From the weight of the cake produced calculate the volume time, and finally

- using the calculated value of the volume of the cake produced per time, calculate the time required to fill the bin

$$\frac{cake\ \ TS\ \ produced - lbs}{min} = \frac{60 gallons\ \ sludge}{min} * \frac{8.34 lbs\ \ sludge\ \ feed}{galllon} * \frac{0.028 lbs\ \ TS}{lb\ \ sludge} * 0.9$$

$$= \frac{12.61 lbs\ \ TS}{min}$$

$$\frac{ft^3\ \ cake\ \ produced}{min} = \frac{12.61 lbs\ \ TS}{min} * \frac{100 lbs\ \ cake}{20 lbs\ \ TS} * \frac{ft^3\ \ cake}{68 lbs\ \ cake} = \frac{0.927 ft^3 cake}{min}$$

$$\frac{ft^3\ \ cake\ \ produced}{min} = \frac{12.61 lbs\ \ TS}{min} * \frac{100 lbs\ \ cake}{20 lbs\ \ TS} * \frac{ft^3\ \ cake}{68 lbs\ \ cake} = \frac{0.927 ft^3 cake}{min}$$

$$Time\ \ required\ \ to\ \ fill\ \ the\ \ bin = \frac{min}{0.927 ft^3} * 3 yd^3 * \frac{27 ft^3}{yd^3} = \boxed{75 min}$$

11. Calculate the annual cost savings for an improvement of cake solids from 20% to 21% if 400 wet tons (@ 20% cake) are produced each day and the average cake hauling and disposal cost is $65 per wet ton.
Solution:

$$Total\ (dry)\ solids\ produced\ per\ day = \frac{400\ wet\ tons}{day} * \frac{20\ tons\ solids}{100\ wet\ tons} = 80\ tons\ solids$$

$$Tons\ wet\ cake\ @21\%\ solids = \frac{80\ tons\ solids}{day} * \frac{100\ wet\ tons}{21\ tons\ solids}$$

$$= \frac{380\ tons\ wet\ solids}{day}$$

$$Net\ savings\ (\$/yr) = (400-380)\frac{wet\ tons}{day} * 365 * \frac{days}{yr} * \frac{\$65}{wet\ ton} = \boxed{\$474,500\ per\ year}$$

NOTE: General formula for future reference: So if the cake dryness goes up from 20% to 26% and currently a utility is spending $1,000,000 per year for biosolids hauling and disposal, their net savings will be: $\frac{(26-20)}{20} * \$1,000,000 = \$300,000$

12. A belt press is used for dewatering 70 GPM digested sludge containing 3% TS, seven hours per day. At the end of the day it produces 24 yd^3 of 16% TS biosolids @ 65 lbs/ft^3 density. What is the percent belt press solids recovery?
Solution:
lbs solids feed to belt press: $\frac{70\ gal}{min} * \frac{8.34\ lbs}{gal} * \frac{0.03\ lbs\ solids}{lb\ feed\ sludge} * \frac{7*60\ min}{day} = \frac{7,356\ lbs\ solids}{day}$

lbs solids in belt press cake: $\frac{24\ yd^3\ cake}{day} * \frac{27\ ft^3}{yd^3} * \frac{65\ lbs\ cake}{ft^3} * \frac{0.16\ lbs\ solids}{lb\ cake} = \frac{6,739\ lbs\ solids}{day}$

belt press solids recovery: $\frac{6,739}{7,356} = \boxed{0.92\ or\ 92\%}$

13. Calculate the air required (SCFM) to meet a 0.04 lb air:lb feed solids ratio for a 100 GPM WAS flow with a solids content of 6500mg/l? Assume 0.08 lbs air/SCF air.
Solution:

$$0.04 = \frac{lb\ air}{lb\ solids} = \frac{\frac{0.08\ lbs\ air}{SCF} * x\ SCF\ per\ minute}{(\frac{100}{1,000,000} MG\ per\ min * 6500 mg/l * 8.34)\ lbs\ solids}$$

$$\implies 0.04 = 0.0148\ *\ x\ SCF\ per\ minute \implies x\ SCF\ per\ minute = \frac{0.04}{0.0148} = \boxed{2.7\ SCFM}$$

14. A treatment plant receives an influent flow of 30 MGD with a TSS concentration of 280 mg/l. The primary treatment removes 55% TS and the primary sludge is pumped to a 40 ft diameter gravity thickener. Calculate the average solids loading to the thickener in lbs TSS/day-ft^2
Solids loading to gravity thickener$= \frac{(30\ MGD\ *\ 280*0.55\ mg/l\ *8.34) lbs\ TSS\ per\ day}{0.785*40^2\ ft^2} =$

$\boxed{30.7\ lbsTSS/day - ft^2}$

15. Two, 110' diameter digesters with a cone depth of 15 ft and operating at a cylindrical liquid level of 28 ft is fed with a blend of primary and secondary sludge. The 85,000 gal/day primary sludge feed contains 5% solids with a 65% VS content. The secondary sludge flow is 33,000 gallons per day with a 5.5% solids and 86% VS content.

(a) What is the combined solids concentration?
Combined solids concentration:
$C_1 * V_1 + C_2 * V_2 = C_3 * V_3$
$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{5 * 85,000 + 5.5 * 33,000}{88,000 + 33,000} = \boxed{5.14\%\ TS\ content}$

(b) What is the digester VS loading rate ($lbs\ VS/ft^3$)
Digester VS loading $= \frac{lbs\ VS}{Digester\ volume}$

$$\implies \frac{8.34 * (Pri.\ Sldg\ gal/day * Pri.Sldg\ TS * \%VS + \ Sec.\ sludge\ gal/day * Sec.\ sludgeTS * \%VS)}{2 * \left[\frac{3.14 * D^2 * h_1}{12} + 0.785 * D^2 * h\right]}$$

$$\implies \frac{8.34 * (88,000\ gal/day * 0.05 * 0.65\ +\ 33,000\ gal/day * 0.055 * 0.86)}{2 * \left[\frac{(3.14 * 110^2 * 15}{12} + 0.785 * 110^2 * 28\right]} = \boxed{0.059 \frac{lbs\ VS}{ft^3}}$$

(c) If the digested sludge has 52% VS, calculate the digester VS reduction percent

Calculate VS% in: $= \frac{lbs\ VS}{lbs\ TS} * 100$

$$\implies \frac{8.34 * (Pri.\ Sldg\ gal/day * Pri.Sldg\ TS * \%VS + \ Sec.\ sludge\ gal/day * Sec.\ sludgeTS * \%VS)}{8.34 * (Pri.\ Sldg\ gal/day * Pri.Sldg\ TS + \ Sec.\ sludge\ gal/day * Sec.\ sludgeTS *)}$$

$$\implies \frac{8.34 * (88,000\ gal/day * 0.05 * 0.65\ +\ 33,000\ gal/day * 0.055 * 0.86)}{8.34 * (88,000\ gal/day * 0.05\ +\ 33,000\ gal/day * 0.055)} * 100$$

$= \frac{36,870 lbs\ VS}{51,833\ lbs\ TS} * 100 = \boxed{71.1\% VS_{in}}$
$Digester\ VS\ reduction(\%) = \frac{0.71 - .52}{0.71 - 0.71 * 0.52} * 100 = \boxed{55.8\%\ VS\ reduction}$

(d) What is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed
$36,870\ lbs\ VS_{in} * 0.558 lbs\ VS\ destroyed * \frac{14 ft^3\ gas\ produced}{lb\ VS\ destroyed} = \boxed{288,028\ ft^3\ gas\ produced}$

(e)

(f) How many belt presses are needed to keep up with the digested sludge flow if the belt presses can be operated at a maximum flow of 50 GPM
$121{,}000 \frac{gal\ sludge}{day} * \frac{day}{1440 min} = 84 GPM$
@50 GPM per press - $\boxed{2\ BFP\ required}$

(g) If the digested sludge feed to the belt filter presses is 2.6% and assuming the belt press feed solids capture is 90%. How many lbs of solids (dry) are produced by the BFP
$121,000 \frac{gal}{day} * 8.34 * 0.026 \frac{lbs\ solids\ feed}{day} * 0.9 \frac{lbs\ solids\ captured}{lbs\ solids\ feed} = \boxed{23,028 lbs\ solids\ per\ day}$

(h) If the belt press produces a 20% cake at 68 lbs/ft^3. How long would it take to fill a 3 yd^3 bin?

$$lbs\ \ cake: 23,028\ \frac{lbs\ \ solids}{day} * \frac{lb\ \ cake}{0.2\ \ lb\ \ solids} = 115,140\ \frac{lbs\ \ cake}{day}$$

Volume of cake produced: $115,140\ \frac{lbs\ \ cake}{day} * \frac{ft^3}{68\ \ lbs\ \ cake} * \frac{yd^3}{27\ \ ft^3} * \frac{day}{24\ \ hrs} = 2.61\ \frac{yd^3\ \ cake}{hr}$

(i) Time to fill the 3 cu. yd bin: $3\ \ yd^3 * \frac{hr}{2.61 yd^3\ \ cake} = \boxed{1.15\ \ hrs}$

eak

16. Two sludges are blended together as follows: 60,000 gal. primary sludge at 4.5% solids and 28,000 gal. secondary sludge at 5% solids.

(a) What is the combined solids concentration?

(b) If the primary sludge is 68% VS and the secondary sludge is 83% VS, how many pounds of VS are in the combined sludge?

(c) If the digester is 120' diameter cylinder with a liquid height of 20', what is the VS loading in lbs VS/ft^3-day?

(d) If the digester VS reduction is 60%, what is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed?

(e) How many belt presses are needed to keep up with the digested sludge flow if the belt presses are operated at a maximum flow of 50 GPM ?

(f) Knowing the digester VS reduction and the TS feed, calculate the solids (TS) concentration coming out of the digesters

(g) Assuming the belt press solids capture is 90%; if it produces a 20% cake which is 68 lbs/ft^3, in how many hours will it take to fill a 3 yd^3 bin with the cake?

Solution:

(a) What is the combined solids concentration?
Combined solids concentration: $C_1 * V_1 + C_2 * V_2 = C_3 * V_3$

$$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{4.5 * 60,000 + 5 * 28,000}{60,000 + 28,000} = \boxed{4.66\%}$$

lbs TS from primary sludge: $(4.5 * 10,000)\frac{mg}{l} TS * \frac{60,000}{1,000,000} MGD * 8.34 = 22,518\ \ lbs\ \ TS$

lbs TS from secondary sludge: $(5 * 10,000)\frac{mg}{l} TS * \frac{28,000}{1,000,000} MGD * 8.34 = 11,676\ \ lbs\ \ TS$

Total TS = 22,518+11,676=34,194 lbs TS

$$TS\ \ conc.(mg/l) = \frac{34,194\ \ lbs\ \ TS}{8.34 * \frac{88,000}{1,000,000} MGD} = \boxed{46,591\frac{mg}{l}\ \ or\ \ 4.66\%}$$

(b) If the primary sludge is 68% VS and the secondary sludge is 83% VS, how many pounds of VS are in the combined sludge?
lbs of VS in combined sludge: $C_{VS1} * V_1 + C_{VS2} * V_2 = C_{VS3} * V_3$

$$\implies C_{VS3} = \frac{C_{VS1} * V_1 + C_{VS2} * V_2}{V3} = \frac{C_{VS1} * V_1 + C_{VS1} * V_2}{V_1 + V_2}$$

$$\implies C_{VS3} = \frac{4.5 * 60,000 * 0.68 + 5 * 28,000 * 0.83}{60,000 + 28,000} = 3.406\%$$

$$lbs\ \ VS = 3.41 * 10,000 mg/l * \frac{88,000}{1,000,000} * 8.34 = \boxed{25,027\ \ lbs\ \ VS}$$

lbs VS from primary sludge: $(4.5*0.68*10,000)\frac{mg}{l}VS*\frac{60,000}{1,000,000}MGD*8.34 = 15,312\ lbs\ VS$

lbs VS from secondary sludge: $(5*0.83*10,000)\frac{mg}{l}VS*\frac{28,000}{1,000,000}MGD*8.34 = 9,691\ lbs\ VS$

Total VS = 15,312+9,691=$\boxed{25,003\ lbs\ VS}$

(c) If the digester is 120' diameter cylinder with a liquid height of 20', what is the VS loading in lbs VS/ft^3-day?

$$VS\ loading = \frac{lbs\ VS\ per-day}{Digester\ volume\ (ft^3)} = \frac{25,003\ lbs\ VS\ per-day}{0.785*120^2*20\ ft^3} = \boxed{\frac{0.11\ lbs\ VS}{day-ft^3}}$$

(d) If the digester VS reduction is 60%, what is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed?

$Digester\ gas\ production = lbs\ VS\ reduced * gas\ production\ rate(ft^3/lb\ lbs\ VS\ reduced$

$$\implies 25,003*0.6\ lbs\ VSreduced*\frac{14\ ft^3\ gas}{lb\ VS\ destroyed} = \boxed{210,025\ ft^3\ gas\ per-day}$$

(e) How many belt presses are needed to keep up with the digested sludge flow if the belt presses are operated at a maximum flow of 50 GPM?

Flow to the belt press=Flow to the digesters as digesters are fixed volume tanks

$\implies$ flow in to the digester = flow out of the digesters - which will be the flow to the belt press

$\implies$ flow to the belt press = 88,000 gal $\implies 88,000\frac{gal}{day}*\frac{day}{1440\ min} = 61\frac{gal}{min}$

$\implies$ @50 GPM $belt\ press\ flow\ capacity\ need$ $\boxed{2\ belt\ presses}$

(f) Knowing the digester VS reduction and the TS feed, calculate the solids (TS) concentration coming out of the digesters
Approach: Calculate the lbs of VS destroyed in the digester and subtract that out of the lbs TS feed to the digester. This will be the mass of solids leaving the digester. The mass of solids divided by the volume of the feed (also the out) would be the TS concentration

$$\Longrightarrow \frac{34,194\ lbs\ TS\ \ feed - 25,003 * 0.6\ lbs\ VS\ reduced}{88,000\ gal * 8.34\ \frac{lbs}{gal} * \frac{10^6 lbs}{1,000,000 lbs}}$$

$$= 20,441 \frac{lbs\ solids}{10^6\ lbs}\ or\ 26,150\ ppm\ or\ \boxed{2.61\%}$$

(g) Assuming the belt press solids capture is 90%; if it produces a 20% cake which is 68 lbs/ft^3, in how many hours will it take to fill a 3 yd^3 bin with the cake?
Approach

i. Calculate the lbs of solids feed to the belt press.
ii. Based on the 90% capture rate, calculate the lbs of solids leaving the belt press.
iii. Knowing the cake is 20% solids, calculate the lbs of cake produced.
iv. Knowing the density of the cake (68 lbs/ft^3), calculate the volume of the cake produced.
v. Knowing the cake volume produced, calculate the time it will take to fill the 3 cu. yd bin

Calculations:

i. $(34,194\ lbs\ TS\ \ feed - 25,003 * 0.6\ lbs\ VS\ reduced)\ solids\ feed\ belt\ press$
$= 19,192\ lbs\ TS\ solids\ feed$
ii. solids leaving belt press: 19,192*0.9=17,273 lbs
iii. $lbs\ cake: 17,273\ \frac{lbs\ solids}{day} * \frac{lb\ cake}{0.2\ lb\ solids} = 86,365\ \frac{lbs\ cake}{day}$
iv. Volume of cake produced: $86,365\ \frac{lbs\ cake}{day} * \frac{ft^3}{68\ lbs\ cake} * \frac{yd^3}{27\ ft^3} * \frac{day}{24\ hrs} = 1.96\ \frac{yd^3\ cake}{hr}$
v. Time to fill the 3 cu. yd bin: $3\ yd^3 * 1.96\ \frac{hr}{yd^3\ cake} = \boxed{1.53\ hrs}$

Question 1: A sludge thickened from 1% to 4% solids will be reduced in volume by how much?
Solution: Assume 1 lbs of solids are in the sludge.
Sludge weight for 1% solids = 100 lbs because, 1% $\Longrightarrow \frac{100\ lbs\ sludge}{1\ lb\ solids}$
Sludge weight for 4% solids = 25 lbs because, 4% $\Longrightarrow \frac{100\ lbs\ sludge}{4\ lb\ solids}\ or\ \frac{25\ lbs\ sludge}{1\ lb\ solids}$
Thus, sludge weight and volume of the 4% sludge will be 25% of the original 1% sludge

Alternatively, $C_{1(1\%)} * V_{1(1\%)} = C_{2(4\%)} * V_{2(4\%)} \Longrightarrow 0.01V_{1(1\%)} = 0.04V_{2(4\%)} \Longrightarrow V_{2(4\%)} = 0.25V_{1(1\%)}$
Thus, volume of the 4% sludge will be 25% of the original 1% sludge.

17. If a belt filter press is used 14 hrs per day to dewater 90 GPM digester sludge feed with 2.7% solids, the daily lbs solids feed is:
Solution:
lbs solids feed to belt press:

$$90 \frac{gal}{min} * 8.34 \frac{lbs}{gal} * 0.027 \frac{lbs\ solids}{lb\ feed\ sludge} * (14 * 60) \frac{min}{day} = \boxed{17,024 \frac{lbs\ solids}{day}}$$

18. A belt filter press is used 10 hrs per day to dewater 80 GPM digester sludge feed with 2.5% solids. The belt press produces 22% biosolids (bulk density - 70 lbs/ft^3) which is loaded into trucks for off-site disposal. Five truckloads of biosolids are produced every three days with each truckload averaging 13.3 yd^3 of material.

    (a) Calculate the lbs of solids feed to the belt press (5 points)

    (b) Calculate lbs cake hauled by the trucks over the three days (5 points)

    (c) Calculate the lbs solids in the cake hauled (given the solids % of biosolids) (5 points)

    (d) Calculate percent solids recovery (lbs solids produced per lbs feed solids) (5 points)

    Solution:

    (a) lbs solids feed to belt press:

    $$80\frac{gal}{min} * 8.34\frac{lbs}{gal} * 0.025\frac{lbs\ \ solids}{lb\ \ feed\ \ sludge} * (10 * 60)\frac{min}{day} = \boxed{10,008\frac{lbs\ \ solids}{day}}$$

    (b) lbs cake hauled by truck over three days:

    $$13.3\frac{yd^3\ \ sludge}{truck} * 5\frac{trucks}{three\ \ days} * 27\frac{ft^3}{yd^3} * 70\frac{lbs\ \ cake}{ft^3\ \ sludge} = \boxed{125,685\frac{lbs\ \ cake}{three\ \ days}}$$

    (c) lbs solids in the cake hauled:

    $$125,685\frac{lbs\ \ cake}{three\ \ days} * 0.22\frac{lbs\ \ solids}{lbs\ \ cake} = \boxed{27,651\frac{lbs\ \ solids}{three\ \ days}}$$

    (d) Percent solids recovery:

    $$= \frac{lbs\ \ solids\ \ in\ \ cake}{lbs\ \ solids\ \ fed\ \ to\ \ belt\ \ press} = \frac{27,651\frac{lbs\ \ solids}{three\ \ days}}{10,008 * 3\frac{lbs\ \ solids}{three\ \ days}} = \boxed{0.92\ \ or\ \ 92\%}$$

19. Lab data from your 100,000 gallon primary anaerobic digester, which receives primary sludge only, is shown below. Using this data :

    (a) Calculate the average volatile solids reduction. Compare your calculated value to generally accepted ranges for a healthy anaerobic digester. Comment.

    (b) Compare the other data to expected ranges.

    (c) Is this digester experiencing an operational problem ? If so, what is the problem. Name three steps that may be taken to mitigate the problem.

    (d) Should slake lime be added ? Why or why not ?

Data							
Date	pH	Alkalinity (mg/l)	Volatile acids (mg/l)	CO_2	Raw Sludge (TS%)	Raw Sludge (VS%)	Digested Sludge (VS%)
9/02	7.10	3,200	280	35.5	5.4	65.5	56
9/09	7.00	3,020	320	36.0	5.0	66.7	53.8
9/16	6.90	2,800	400	37.7	4.9	65.9	54.2
9/17	6.85	2,720	450	38.2			

20. Two sludges are blended together as follows: 8,000 cu. ft primary sludge at 4.90% solids and 23,000 gal. secondary sludge at 5.20% solids. What is the combined solids concentration?
    Solution:
    Correct Answer:
    $C_1 * V_1 + C_2 * V_2 = C_3 * V_3$

$$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{4.9 * 8,000 ft^3 * \frac{7.48 gal}{ft^3} + 5.2 * 23,000}{8000 * 7.48 + 23,000} =$$

$\boxed{4.98\%}$ – *Correct Answer*

Incorrect Answer #1

$C_1 * V_1 + C_2 * V_2 = C_3 * V_3$

$$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{4.9 * 8,000 ft^3 + 5.2 * 23,000}{8000 + 23,000} = \boxed{5.12\%} -$$

Incorrect Answer#1

Incorrect Answer #2
6.23%

Incorrect Answer #3
3.84%

21. You have two 110 foot diameter primary clarifiers. The raw wastewater flow of 1.5 MGD is divided equally between the these two basins. Raw settled primary sludge is pumped continuously from both clarifiers for thickening in a single 40 foot diameter gravity thickener. The average suspended solids are 210 mg/L for the raw influent flow and 85 mg/L for the primary effluent. Calculate the average solids loading on the thickener in pounds/ft^2/day Ans. 1.25lbs/ft^2/day

22. A belt filter press is used 10 hrs per day to dewater 80 GPM digester sludge feed with 2.5% solids.

23. A belt filter press is used 10 hrs per day to dewater 80 GPM digester sludge feed with 2.5% solids. The belt press produces 22% biosolids (bulk density - 70lbs/cu. ft) which is loaded into trucks for offsite disposal. Five truckloads of biosolids are produced every three days with each truckload averaging 13.3 cu. yd of material.

    (a) Calculate the lbs of solids feed to the belt press (5 points)

    (b) Calculate lbs cake hauled by the trucks over the three days (5 points)

    (c) Calculate the lbs solids in the cake hauled (given the solids % of biosolids) (5 points)

    (d) Calculate percent solids recovery (lbs solids produced per lbs feed solids) (5 points)

    (e) Two sludges are blended together as follows: 8,000 cu. ft primary sludge at 4.90% solids and 23,000 gal. secondary sludge at 5.20% solids. What is the combined solids concentration?
    a. 3.84
    b. 6.23
    c. 5.12
    *d. 4.98

24. 325 GPM of WAS with 7,000 mg/l TSS is thickened in a DAFT. Assuming an air:solids ratio of 0.05 lb of air for each lb of feed solids, The SCFM (standard cubic feed per minute) air required to thicken the WAS given 1 SCFM = 0.075 lb is:
    *a. 12.6 SCFM
    b. 0.126 SCFM
    c. 12,600 SCFM
    d. 1.26 SCFM

25. When you spread sludge on agricultural land, the annual application rate of cadmium in the sludge should be less than 2 lbs/acre/year If your sludge contains 30 mg cadmium per kilogram of solids and your plant produces 950,000 lbs per year of dry solids, how many acres do you need?
    a. 3 acres

*b. 14 acres
c. 19 acres
d. 27 acres

26. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64%
c. 16.5%
d. 42%

Solution:

The VS reduction of the digester is provided by the Van Kleeck equation

$$Digester\ VS\ reduction(\%) = \frac{VS_{in} - VS_{out}}{VS_{in} - VS_{in} * VS_{out}} * 100$$

$$Digester\ VS\ reduction(\%) = \frac{0.737 - 0.572}{0.737 - 0.737 * 0.572} * 100 = \boxed{52.3\%}$$

27. 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? [Ans: 32,841 gal]

28. 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? [Ans: 2,241 mg/l alkalinity]

29. 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? [0.057 lbs VS/ft3-day]

30. 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? [3,850 gallons]

31. 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? [5,643 galllons]

32. 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? [Ans. 11,676 cu. ft/day]

33. 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. What is the combined solids concentration? [Ans. 2.28%] If the primary sludge is 68% VS and the secondary sludge is 63% VS, how many pounds of VS are in the combined sludge? [Ans. 5400.3 lbs VS]

34. 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?[Ans. 24,980 gallons]

35. How many pounds of solids are pumped to a digester each day if the digester receives 10,000 gpd of sludge at 5% solids concentration?
Solution:

$$\frac{lbs\ \ TS}{day} = \frac{10,000 gal\ \ sludge}{day} * \frac{(8.34 * 0.05 lbs TS)}{gal\ \ sludge} = 4,170 \frac{lbs\ \ TS}{day}$$

36. Calculate the % VS reduction in a digester given the volatile solids content of the influent sludge to the digester is 70% and the volatile solids content of the sludge leaving the digester is 52.5%

Solution: $Digester\ \ VS\ \ reduction(\%) = \frac{0.7 - 0.525}{0.7 - 0.7 * 0.525} * 100 = \boxed{53\%}$

85. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:

a. 20%
b. 25%
c. 63%
d. 89%

Solution:

$$Digester\ \ VS\ \ reduction(\%) = \frac{0.8 - 0.6}{0.8 - 0.8 * 0.6} * 100 = \boxed{63\%}$$

37. Calculate the VS loading to the digester in lbs/day if 10,000 gallons of sludge containing 5% TS with and average VS content of 78%

Solution:

Digester VS loading (lbs/day)

$$= \frac{10,000\ \ gallons\ \ sludge}{day} * \frac{8.34 lbs\ \ sludge}{gal} * \frac{0.05 * 0.78 lbs VS}{lb\ \ sludge} = \boxed{3,253 lbs\ \ sludge\ \ per\ \ day}$$

38. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?

a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
d. 10,960 lbs/day
e. 15,010 lbs/day

Solution:

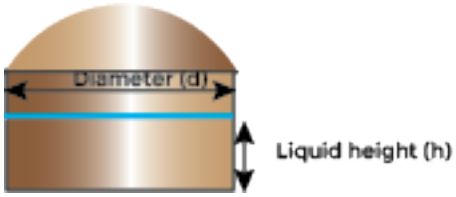
Digester VS loading (lbs/day)

$$= \frac{25 * 1,440\ \ gallons\ \ sludge}{day} * \frac{8.34 lbs\ \ sludge}{gal} * \frac{0.05 * 0.73 lbs VS}{lb\ \ sludge} = \boxed{10,960\ \ lbs\ \ sludge\ \ per\ \ day}$$

39. 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?

Solution:

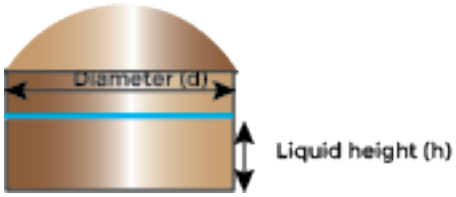
$$Digester\ \ volatile\ \ solids\ \ loading\ \ rate = \frac{Digester\ \ Loading \frac{lbs\ \ VS}{day}}{Digester\ \ volume(V) ft^3}$$



$$= \frac{5000\frac{gal\ \ sludge}{day} * (8.34 * 0.06 * 0.66)\frac{lbsVS}{gal\ \ sludge}}{(\frac{\pi}{4} * 37^2 * 27)ft^3} = \boxed{0.057\frac{lbs\ \ VS}{day - ft^3}}$$

40. The sludge feed to a digester is 12,000 ft^3/day. The sludge contains 4.5% total solids with 70% volatile solids. What is the digester loading in lbs VSS/day per ft^3 if the digester diameter is 100 ft and a working sludge level of 20 ft.
Solution:

$$Digester\ \ volatile\ \ solids\ \ loading\ \ Rate = \frac{Digester\ \ loading\frac{lbs\ \ VS}{day}}{Digester\ \ volume(V)ft^3}$$



$$= \frac{12,000\frac{ft^3\ \ sludge}{day} * 7.48\frac{gal}{ft^3} * (8.34 * 0.045 * 0.70)\frac{lbsVS}{gal\ \ sludge}}{(\frac{\pi}{4} * 100^2 * 20)ft^3} = \boxed{0.15\frac{lbs\ \ VS}{day - ft^3}}$$

41. How much gas is produced in the above digester in ft^3/day if the digested sludge contains 2.5% total solids of which 59% is volatile solids and the gas production rate is 14 ft^3/lb VS destroyed?
Solution:

$$Digester\ \ VS\ \ reduction(\%) = \frac{0.70 - .59}{0.70 - 0.70 * 0.59} * 100 = 38.3\%$$

$$\frac{lbs\ \ VS\ \ reduction}{day} = \frac{3153lbs\ \ VS\ \ feed * 0.383\ \ VS\ \ reduction}{day} = 1,208\frac{lbs\ \ VS\ \ reduction}{day}$$

$$\frac{ft^3 gas\ \ produced}{day} = 1208\frac{lbs\ \ VS\ \ reduced}{day} * \frac{14ft^3\ \ gas\ \ produced}{lb\ \ VS\ \ reduced} = 16,912\frac{ft^3\ \ digester\ \ gas\ \ produced}{day}$$

42. The sludge feed to a digester is 80,000 gal/day. The sludge contains 4.5% total solids with 75% volatile solids. If 50% of VS are reduced in the digester:

    (a) Find lbs VS destroyed per 1000 gal of digester capacity per day if the digester radius is 55 ft with an operating sludge level of 25 ft.(5 points)

    Solution:
    Digester Volume: $(\pi * 55^2 * 25)ft^3 * 7.48\frac{gal}{ft^3} = 1,776,220 gallons = 1,776.2\ \ (1000\ \ gallons)$

$$\frac{lbs\ VS\ reduction}{day} = \frac{80,000gal * 8.34\frac{lbs}{gal} * (0.045 * 0.75)\frac{lbsVS}{lb} * 0.5\frac{lbs\ VS\ reduction}{lb\ VS}}{day}$$

$$= 11,259\frac{lbs\ VS\ reduction}{day}$$

$$\frac{lbs\ VS\ reduction}{1000\ digester\ capacity} = \frac{11,259\frac{lbs\ VS\ reduction}{day}}{1,776.2\ (1000\ gallons)} = \boxed{6.3\frac{lbs\ VS\ reduction}{1000gallons\ digester\ volume}}$$

(b) What is the digester gas production in Btu/day? Assume 14 cu. ft digester gas per lb of VS destroyed and a 650 Btu/cu. ft heating value for the digester gas produced (5 points)

Solution:

$$\frac{ft^3 gas\ produced}{day} = 11,259\frac{lbs\ VS\ reduced}{day} * \frac{14ft^3\ gas\ produced}{lb\ VS\ reduced} = 157,626\frac{ft^3\ digester\ gas\ produced}{day}$$

$$\frac{BTU\ produced}{day} = 157,626\frac{ft^3\ gas\ produced}{day} * \frac{650BTU\ gas\ produced}{ft^3 gas} = \boxed{102,456,900\frac{BTU\ produced}{day}}$$

43. 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. What is the combined solids concentration? If the primary sludge is 68% VS and the secondary sludge is 63% VS, what is the VS concentration (%) in the combined sludge?

Solution:

Combined solids concentration: $C_1 * V_1 + C_2 * V_2 = C_3 * V_3$

$$\implies C_3 = \frac{C_1 * V_1 + C_2 * V_2}{V3} = \frac{C_1 * V_1 + C_2 * V_2}{V_1 + V_2} = \frac{4.1 * 15,000 + 1.3 * 28,000}{15,000 + 28,000} = \boxed{2.28\%}$$

Lbs of VS in combined sludge: $C_{VS1} * V_1 + C_{VS2} * V_2 = C_{VS3} * V_3$

$$\implies C_{VS3} = \frac{C_{VS1} * V_1 + C_{VS2} * V_2}{V3} = \frac{C_{VS1} * V_1 + C_{VS1} * V_2}{V_1 + V_2}$$

$$\implies C_{VS3} = \frac{4.1 * 15,000 * 0.68 + 1.3 * 28,000 * 0.63}{15,000 + 28,000} = \boxed{1.50\%}$$

44. 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?

Solution:

Volatile acid:Alkalinity=$0.087 = \frac{195}{x} \implies x = \frac{195}{0.087} = \boxed{2,241\frac{mg}{l}}$

45. 10,000 gallons of sludge is pumped to an anaerobic digester/day at 4% solids (70% VS). 50% of the VS are destroyed, creating 15 ft^3 of gas per lbs. of VS destroyed. How much gas is produced each day?

$$\frac{lbs\ VS\ reduction}{day} = \frac{10,000gal * 8.34\frac{lbs}{gal} * (0.04 * 0.7)\frac{lbsVS}{lb} * \frac{0.5lbs\ VS\ reduction}{lb\ VS}}{day} = 1,168\frac{lbs\ VS\ reduction}{day}$$

$$\frac{ft^3 gas\ produced}{day} = 1,168\frac{lbs\ VS\ reduced}{day} * \frac{15ft^3\ gas\ produced}{lb\ VS\ reduced} = 17,520\frac{ft^3\ digester\ gas\ produced}{day}$$

46. Given a sludge flow of 5,500 gpd with 6.5% solids containing 72% VS to a digester with a VS destruction of 48% If the digester is digester is 40 ft. diameter with a sludge level of 25 ft, find lbs. VS destroyed per 1000 gal of digester capacity per day. What is the digester gas production in Btu/day if the % VS reduction in the digester is 58% and the digester raw sludge feed is 6000 cu. Ft/day containing 4.5% total solids with a 64% VS content? Assume 13.5 cu. ft digester gas per lb of VS destroyed and a 650 Btu/cu. ft heating value for the digester gas produced

Digester Volume: $(\frac{\pi}{4} * 40^2 * 25)ft^3 * 7.48\frac{gal}{ft^3} = 940,086gallons = 940\ (1000\ gallons)$

$$\frac{lbs\ VS\ reduction}{day} = \frac{5,500gal * 8.34\frac{lbs}{gal} * (0.065 * 0.72)\frac{lbsVS}{lb} * \frac{0.48lbs\ VS\ reduction}{lb\ VS}}{day} = 1,030\frac{lbs\ VS\ reduction}{day}$$

$$\frac{lbs\ VS\ reduction}{1000\ digester\ capacity} = \frac{1,030\frac{lbs\ VS\ reduction}{day}}{940\ (1000\ gallons)} = 1.1\frac{lbs\ VS\ reduction}{1000gallons\ digester\ volume}$$

$$\frac{ft^3 gas\ produced}{day} = 1,030\frac{lbs\ VS\ reduced}{day} * \frac{13.5ft^3\ gas\ produced}{lb\ VS\ reduced} = 13,905\frac{ft^3\ digester\ gas\ produced}{day}$$

$$\frac{BTU\ produced}{day} = 13,905\frac{ft^3\ gas\ produced}{day} * \frac{650BTU\ gas\ produced}{ft^3 gas} = 9,038,250\frac{BTU\ produced}{day}$$

47. Two sludges are blended together as follows: 60,000 gal per day. primary sludge at 4.5% solids and 28,000 gal secondary sludge at 5% solids.

(a) What is the combined solids concentration? (3 points)

$$\frac{60,000 * 4.5 + 28,000 * 5}{88,000} = \boxed{4.66\%}$$

(b) How many lbs of solids (per day) are in the combined sludge (3 points)

$$88,000gal * 8.34 * 0.0466 = \boxed{34,200lbs}$$

(c) If the primary sludge is 68% VS and the secondary sludge is 83% VS, how many pounds of VS are in the combined sludge? (3 points)

$$60,000gal * \frac{8.34 * 0.045 * 0.68lbs\ VS}{gal} + 28,000gal * \frac{8.34 * 0.05 * 0.83lbs\ VS}{gal} = \boxed{25,003lbs\ VS}$$

(d) What is the digester feed VS%? (3 points)
$\frac{25,003 lbs\ VS}{34,200 lbs TS} = \boxed{73.1\%}$

(e) If the digester is 120' diameter with a liquid height of 20', what is the VS loading in lbs VS/ft3-day (3 points)
$\frac{25,003 lbs\ VS}{0.785 * 120^2 * 20} = \boxed{\frac{0.11 lbs\ VS}{day - ft^3}}$

(f) If the digested sludge has 52% VS, calculate the digester VS reduction percent (3 points)
$Digester\ VS\ reduction(\%) = \frac{0.731 - .52}{0.731 - 0.731 * 0.52} * 100 = \boxed{60.1\%}$

(g) What is the gas production (ft^3/day) if the digester produces 14 ft^3 gas/lb VS destroyed (3 points)
25,003*0.601$\frac{lbs\ VS destroyed}{} * \frac{14 ft^3\ gas\ produced}{lb\ VS\ destroyed} = \boxed{210,375 ft^3 gas}$

(h) How many belt presses are needed to keep up with the digested sludge flow if the belt presses can be operated at a maximum flow of 50 GPM (3 points)
88,000$\frac{gal\ sludge}{day} * \frac{day}{1440 min} = 61 GPM$
@50 GPM per press - $\boxed{2\ BFP\ required}$

(i) If the digested sludge feed to the belt filter presses is 2.6% and assuming the belt press feed solids capture is 90%. How many lbs of solids (dry) are produced by the BFP (4 points)
$88,000\frac{gal}{day} * 8.34 * 0.026\frac{lbs\ solids\ feed}{day} * 0.9\frac{lbs\ solids\ captured}{lbs\ solids\ feed} = \boxed{17,174 lbs\ solids\ per\ day}$

(j) If the BFP produces a 20% cake, how many wet tons cake produced per day (4 points)

$$\frac{17,174 lbs\ \ solids\ \ produced}{day} * \frac{100 lbs\ \ cake}{20 lbs\ \ solids\ \ produced} * \frac{tons}{2,000 lbs} = \boxed{\frac{42.9 tons}{day}}$$

(k) If the cake density is 68 lbs/cu. ft, how much time will it take to fill a 30 cu. yd bin (3 points)

(Ans. 15.4 hours) $\frac{(42.9 * 2000) lbs\ \ cake}{day} * \frac{day}{1440 min} = \frac{59.583}{lbs\ \ cake} min$

$\frac{59.583}{lbs\ \ cake} min * \frac{ft^3}{68 lbs\ \ cake} = \frac{0.876 ft^3}{min}$

$30 yd^3 * \frac{27 ft^3}{yd^3} * \frac{min}{0.876 ft^3} * \frac{hrs}{60 min} = \boxed{15.4 hrs}$

(l) What will be the cost of hauling dewatered cake per day @ $65 per ton cake (2 points)

$42.9 \frac{tons}{day} * \frac{\$65}{ton} = \boxed{\frac{\$2,789}{day}}$

48. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%

49. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester

Solution:

$$\frac{25,000\ \ Gal}{day} * \frac{8.34\ \ lbs\ \ sludge}{Gal} * \frac{(0.045 * 0.76)\ \ lbs\ \ VS\ \ feed}{lb\ \ sludge} = \boxed{\frac{7,131\ \ lbs\ \ VS}{day}}$$

50. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%

51. Calculate the organic loading rate to two 320,000 gallon anaerobic digesters given: Primary sludge feed rate of 25,000 gallons with 6.2% TS containing 73% solids and SG of 1.03. Secondary sludge feed rate of 30,500 gallons with 3.8% TS containing 77% solids (7 points) (Answer: 0.2lbs VS/day-ft3)

52. 10,000 gallons/day of sludge is pumped to an anaerobic digester/day at 4% solids (70% VS). If 50% of the VS is destroyed, how many lbs of VS is destroyed per day?

Solution:

$$\frac{10,000\ \ Gal}{day} * \frac{8.34\ \ lbs\ \ sludge}{Gal} \frac{0.04 * 0.7\ \ lbs\ \ VS\ \ feed}{lb\ \ sludge} * \frac{0.5\ \ lbs\ \ VS\ \ destroyed}{lbs\ \ VS\ \ feed} = \boxed{\frac{1,168 lbs\ \ VS\ \ destroyed}{day}}$$

53. A DAF thickener has effluent solids of 55 mg/L and float solids of 2.0%. Solids loading and polymer dosing is in the normal range. This data likely indicates:
a. This unit is operating normally
b. Too low air to solids ratio
c. Float blanket too thick
*d. Flight speed too fast
e. Flight speed too slow

54. An air flotation thickener will produce a thin float if:
    *a. Flight speed too high and skimmer wiper not adjusted properly
    b. Excessive air/solids ratio and polymer dosages too low
    c. High dissolved oxygen and flight speed too low
    d. Polymer dosages too high and unit overloaded

55. An increase in the pool depth of a scroll-type centrifuge:
    a. would not affect the moisture content of the cake.
    b. would produce a drier cake
    *c. would produce a wetter cake, but produce a greater solids recovery.
    d. would not affect either solids recovery, nor cake moisture content.
    e. would require an increase in the cationic polymer dosage.

56. A sludge thickened from 1% to 4% solids will be reduced in volume by how much?
    a. no more than 4% of original volume
    b. approximately 17% of original volume
    c. approximately 25% of original volume
    d. more information is needed

57. Gravity thickeners, compared to DAFs, are best suited to:
    *a. Thickening primary sludge.
    b. Thickening waste activated sludge.
    c. Controlling sulfide odors.
    d. Removing filamentous bacteria.
    e. Provide highest concentration sludge.

58. Gravity thickeners, compared to DAFTs, are best suited to:
    *a. Thickening primary sludge
    b. Thickening waste activated sludge
    c. Controlling sulfide odors
    d. Removing filamentous bacteria
    e. Provide highest concentration sludge

59. Identify the incorrect statement regarding gravity thickeners.
    a. Gravity thickeners are similar in design to primary clarifiers.
    *b. The sludge blanket depth and the rate of sludge withdrawal are used to calculate the sludge detention time.
    c. The purpose of pickets in a sludge thickener is to gently stir settling sludge particles to release gases that may prevent the sludge particles from compacting.
    d. Mixtures of primary and waste activated sludge are never thickened in a gravity thickener due to the possibilility of de-nitrification.
    e. Solids loading (pounds per day per square foot) is an important guideline for a gravity thickener.

60. On a routine check of a DAF unit the operator finds suspended solids of 450 mg/L in the effluent. The float blanket appears well flocculated and concentrated. The operator should:
    *a. Increase the flight speed.
    b. Do nothing, the unit is operating normally.
    c. Reduce the air to solids ratio.
    d. Increase the air to solids ratio.
    e. Check unit operating pressure.

61. On a routine check of a DAFT unit the operator finds suspended solids of 450 mg/L in the effluent. The float blanket appears well flocculated and concentrated. The operator should:
    a. increase the flight speed
    b. do nothing, the unit is operating normally

c. reduce the air to solids ratio
*d. increase the air to solids ratio
e. check unit operating pressure

62. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
*d. Reduce costs of biosolids hauling

63. What zone is not involved in a belt filter press?
a. Gravity
b. Low pressure (wedge)
c. High pressure
*d. Twilight

64. The float blanket in a DAF unit appears well flocculated and concentrated. Too low a flight speed would likely result in:
a. Using excessive amounts of air.
b. Float solids that are too thick.
c. Too low an air-to-solids ratio.
*d. Poor thickener underflow quality.
e. De-flocculation of float solids.

65. The least critical operational control of a dissolved air flotation thickener in producing an adequately thickened sludge is the:
a. Flight speed.
b. Air to solids ratio.
c. Polymer dosage.
*d. Recycle ratio.
e. Pre-thickened WAS concentration.

66. The operational control of a dissolved air flotation thickener most critical for producing an adequately thickened float solids is the:
a. Fight speed.
*b. Air to solids ratio.
c. Polymer dosage.
d. Recycle ratio.
e. Concentration of WAS being thickened.

67. To increase solids recovery on a dual belt, belt press, the operator should:
a. Increase the differential belt speed.
b. Increase belt speed.
c. Increase sludge feed rate.
*d. Decrease sludge feed rate.
e. Increase polymer feed.

68. Too high a flight speed in a DAF will likely result in:
a. Using excessive amounts of air.
b. Excessive underflow volume.
*c. Thin float solids.
d. Too high an air to solids ratio.
e. Too low an air to solids ratio.

69. What can be a problem with a belt filter press?
a. Washing out

b. Polymer overdosing
c. Blinding
*d. All of the above

70. What can be used to evaluate the efficiency of a belt filter press?
a. Vacuum required in inches of mercury
b. % volatile solids in cake
c. Sludge feed rate in gpd
*d. Filter yield in lbs/hr/sq ft
e. Gph of filtrate removal.

71. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
*d. Reduce costs of biosolids hauling

72. Which one of the following statements is TRUE in regard to DAF thickeners?
*a. The air to solids ratio in a DAF unit is typically 0.03 to 0.05.
b. The speed of the so-called "flights" has very little effect on the concentration of the float solids.
c. Adjustments in the air to solids ratio in a DAF unit will affect the float solids but not the unit's effluent suspended solids.
d. Anionic polymers are typically used to condition the WAS feed to a DAF unit.

73. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
*a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.

74. Which one the following statements is TRUE in regard to gravity thickeners?
a. Longer solids detention times are desired during summer operation of these units.
b. The sludge-volume-ratio (SVR) or sludge detention time is defined as the volume of the sludge blanket divided by the daily volume of sludge withdrawn from the thickener.
c. SVRs should be in range of 5 to 10 hours.
d. A likely cause of a gravity thickener producing a poor quality effluent is too low of a sludge blanket.

75. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
*b. False

76. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

77. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

78. Gravity thickener is commonly used for sludge dewatering
a. True
*b. False

79. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

80. Which one of the following statements is TRUE in regard to the operation of a belt filter press:
a. Unlike a gravity belt, cationic polymers need not be used to condition the feed sludge to this unit.
b. When dewatering a mixture of WAS and primary sludge, which has been anaerobically digested, the operator can expect to produce a sludge cake with 22% TS to 25%.
*c. The best belt speed for this unit is the slowest speed the belt can be operated at, without causing "washout."
d. Colloidal solids are likely to cause plugging of belt pores and thus cause "belt binding."

81. In your own words, what does sludge stabilization accomplish. (4 points)
What are the different methods utilized for sludge stabilization (4 points)
Correct Answer(s):

82. Explain the benefits of sludge thickening
Correct Answer(s):

83. Define sludge volume ratio and what is the significance of this term in gravity thickening
Correct Answer(s):

84. in your opinion what are the key operational parameters of the DAFT and why are they key
Correct Answer(s):

85. What is the key difference between sludge thickening and sludge dewatering
Correct Answer(s):

86. In your own words, what does sludge stabilization accomplish. (4 points)
What are the different methods utilized for sludge stabilization (4 points)
Correct Answer(s):

87. Why is solids stabilization critical
Correct Answer(s):

88. List four reasons for treating wastewater solids
Correct Answer(s):

89. Explain the significance of pond depth in centrifuge operation
Correct Answer(s):

90. Explain the benefits of sludge thickening
Correct Answer(s):

91. Define sludge volume ratio and what is the significance of this term in gravity thickening
Correct Answer(s):

92. in your opinion what are the key operational parameters of the DAFT and why are they key
Correct Answer(s):

93. What is the key difference between sludge thickening and sludge dewatering
Correct Answer(s):

94. In your own words, what does sludge stabilization accomplish. (4 points)
What are the different methods utilized for sludge stabilization (4 points)
Correct Answer(s):

95. Why is solids stabilization critical
Correct Answer(s):

96. List four reasons for treating wastewater solids
Correct Answer(s):

97. Explain the significance of pond depth in centrifuge operation
Correct Answer(s):

98. 325 GPM of WAS with 7,000 mg/l TSS is thickened in a DAFT. Assuming an air:solids ratio of 0.05 lb of air for each lb of feed solids, The SCFM (standard cubic feed per minute) air required to thicken the WAS given 1 SCFM = 0.075 lb is:
*a. 12.6 SCFM
b. 0.126 SCFM
c. 12,600 SCFM
d. 1.26 SCFM

99. 325 GPM of WAS with 7,000 mg/l TSS is thickened in a DAFT. Assuming an air:solids ratio of 0.05 lb of air for each lb of feed solids, The SCFM (standard cubic feed per minute) air required to thicken the WAS given 1 SCFM = 0.075 lb is:
*a. 12.6 SCFM
b. 0.126 SCFM
c. 12,600 SCFM
d. 1.26 SCFM

100. When you spread sludge on agricultural land, the annual application rate of cadmium in the sludge should be less than 2 lbs/acre/year If your sludge contains 30 mg cadmium per kilogram of solids and your plant produces 950,000 lbs per year of dry solids, how many acres do you need?
a. 3 acres
*b. 14 acres
c. 19 acres
d. 27 acres

101. A DAF thickener has effluent solids of 55 mg/L and float solids of 2.0%. Solids loading and polymer dosing is in the normal range. This data likely indicates:
a. This unit is operating normally
b. Too low air to solids ratio
c. Float blanket too thick
*d. Flight speed too fast
e. Flight speed too slow

102. An air flotation thickener will produce a thin float if:
*a. Flight speed too high and skimmer wiper not adjusted properly
b. Excessive air/solids ratio and polymer dosages too low
c. High dissolved oxygen and flight speed too low
d. Polymer dosages too high and unit overloaded

103. An increase in the pool depth of a scroll-type centrifuge:
a. would not affect the moisture content of the cake.
b. would produce a drier cake
*c. would produce a wetter cake, but produce a greater solids recovery.
d. would not affect either solids recovery, nor cake moisture content.
e. would require an increase in the cationic polymer dosage.

104. A sludge thickened from 1% to 4% solids will be reduced in volume by how much?
a. no more than 4% of original volume
b. approximately 17% of original volume
c. approximately 25% of original volume
d. more information is needed

105. Gravity thickeners, compared to DAFs, are best suited to:
*a. Thickening primary sludge.
b. Thickening waste activated sludge.
c. Controlling sulfide odors.
d. Removing filamentous bacteria.
e. Provide highest concentration sludge.

106. Gravity thickeners, compared to DAFTs, are best suited to:
*a. Thickening primary sludge
b. Thickening waste activated sludge
c. Controlling sulfide odors
d. Removing filamentous bacteria
e. Provide highest concentration sludge

107. Identify the incorrect statement regarding gravity thickeners.
a. Gravity thickeners are similar in design to primary clarifiers.
*b. The sludge blanket depth and the rate of sludge withdrawal are used to calculate the sludge detention time.
c. The purpose of pickets in a sludge thickener is to gently stir settling sludge particles to release gases that may prevent the sludge particles from compacting.
d. Mixtures of primary and waste activated sludge are never thickened in a gravity thickener due to the possibilility of de-nitrification.
e. Solids loading (pounds per day per square foot) is an important guideline for a gravity thickener.

108. On a routine check of a DAFT unit the operator finds suspended solids of 450 mg/L in the effluent. The float blanket appears well flocculated and concentrated. The operator should:
a. increase the flight speed
b. do nothing, the unit is operating normally
c. reduce the air to solids ratio
*d. increase the air to solids ratio
e. check unit operating pressure

109. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
*d. Reduce costs of biosolids hauling

110. What zone is not involved in a belt filter press?
a. Gravity
b. Low pressure (wedge)
c. High pressure
*d. Twilight

111. Lowering the vat depth of a vacuum filter is most likely to produce _____ cake produce
a. Wetter
b. Thicker
c. Stronger
*d. Dryer

112. You have observed water spraying out of the vacuum filter's silencer (or snubber; exhaust pipe Which of the following conditions is the most likely cause of the problem?
a. Filtrate pump not functioning properly
*b. Vacuum too high
c. Vacuum too low
d. Worn check valves in vacuum system

113. An air flotation thickener will produce a thin float if
    a. Flight speed too high and skimmer wiper not adjusted properly
    *b. Excessive air/solids ratio and polymer dosages too low
    c. High dissolved oxygen and flight speed too low
    d. Polymer dosages too high and unit overloaded.

114. Gravity-thickened primary sludge will contain solids within which of the following concentration ranges?
    a. 1,000 - 8,000 mg/l
    b. 10,000 – 40,000 mg/l
    c. 40,000 - 80,000 mg/l
    d. 100,000 - 400,000 mg/l
    *e. none of the above

115. The float blanket in a DAF unit appears well flocculated and concentrated. Too low a flight speed would likely result in:
    a. Using excessive amounts of air.
    b. Float solids that are too thick.
    c. Too low an air-to-solids ratio.
    *d. Poor thickener underflow quality.
    e. De-flocculation of float solids.

116. The least critical operational control of a dissolved air flotation thickener in producing an adequately thickened sludge is the:
    a. Flight speed.
    b. Air to solids ratio.
    c. Polymer dosage.
    *d. Recycle ratio.
    e. Pre-thickened WAS concentration.

117. The operational control of a dissolved air flotation thickener most critical for producing an adequately thickened float solids is the:
    a. Fight speed.
    *b. Air to solids ratio.
    c. Polymer dosage.
    d. Recycle ratio.
    e. Concentration of WAS being thickened.

118. To increase solids recovery on a dual belt, belt press, the operator should:
    a. Increase the differential belt speed.
    b. Increase belt speed.
    c. Increase sludge feed rate.
    *d. Decrease sludge feed rate.
    e. Increase polymer feed.

119. What can be a problem with a belt filter press?
    a. Washing out
    b. Polymer overdosing
    c. Blinding
    *d. All of the above

120. What can be used to evaluate the efficiency of a belt filter press?
    a. Vacuum required in inches of mercury
    b. % volatile solids in cake
    c. Sludge feed rate in gpd

*d. Filter yield in lbs/hr/sq ft
e. Gph of filtrate removal.

121. Which of the following is not the main reason for thickening sludge
a. Improved digester performance due to a lower volume of sludge
b. Cost savings in the construction of new digestion facilities
c. Reduction in anaerobic digestion heating requirements since less water has to be heated
*d. Reduce costs of biosolids hauling

122. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
*a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.

123. Which one of the following statements is TRUE in regard to DAF thickeners?
*a. The air to solids ratio in a DAF unit is typically 0.03 to 0.05.
b. The speed of the so-called "flights" has very little effect on the concentration of the float solids.
c. Adjustments in the air to solids ratio in a DAF unit will affect the float solids but not the unit's effluent suspended solids.
d. Anionic polymers are typically used to condition the WAS feed to a DAF unit.

124. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
*a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.

125. Which one of the following statements is TRUE in regard to the operation of a belt filter press:
a. Unlike a gravity belt, cationic polymers need not be used to condition the feed sludge to this unit.
b. When dewatering a mixture of WAS and primary sludge, which has been anaerobically digested, the operator can expect to produce a sludge cake with 22% TS to 25%.
*c. The best belt speed for this unit is the slowest speed the belt can be operated at, without causing "washout."
d. Colloidal solids are likely to cause plugging of belt pores and thus cause "belt binding."

126. Which one the following statements is TRUE in regard to gravity thickeners?
a. Longer solids detention times are desired during summer operation of these units.
b. The sludge-volume-ratio (SVR) or sludge detention time is defined as the volume of the sludge blanket divided by the daily volume of sludge withdrawn from the thickener.
c. SVRs should be in range of 5 to 10 hours.
d. A likely cause of a gravity thickener producing a poor quality effluent is too low of a sludge blanket.

127. Match the sludge treatment methods

128. In a gravity thickener the depth of the sludge is kept minimal (<six inches) to avoid solids going over the effluent weir
a. True
*b. False

129. In a decanter centrifuge, greater pond depth would produce drier cake
a. True
*b. False

130. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

131. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

132. Gravity thickener is commonly used for sludge dewatering
a. True
*b. False

133. Grit and screenings from the preliminary treatment are also considered as biosolids
*a. True
b. False

134. In a decanter centrifuge, greater pond depth would produce drier cake
a. True
*b. False

135. Sludge thickening is primarily conducted to reduce costs associated with biosolids hauling
a. True
*b. False

136. Two sludges are blended together as follows: 8,000 cu. ft primary sludge at 4.90% solids and 23,000 gal. secondary sludge at 5.20% solids. What is the combined solids concentration?
a. 3.84
b. 6.23
c. 5.12
*d. 4.98

137. Two sludges are blended together as follows: 8,000 cu. ft primary sludge at 4.90% solids and 23,000 gal. secondary sludge at 5.20% solids. What is the combined solids concentration?
a. 3.84
b. 6.23
c. 5.12
*d. 4.98

138. Which one of the following statements is TRUE in regard to the operation of a belt filter press:
a. Unlike a gravity belt, cationic polymers need not be used to condition the feed sludge to this unit.
b. When dewatering a mixture of WAS and primary sludge, which has been anaerobically digested, the operator can expect to produce a sludge cake with 22% TS to 25%.
*c. The best belt speed for this unit is the slowest speed the belt can be operated at, without causing "washout."
d. Colloidal solids are likely to cause plugging of belt pores and thus cause "belt binding."

139. A primary clarifier receives an average flow of 12 MGD containing 280mg/L of TSS. The typical primary removal efficiency is 75% and produces a 3.5% sludge and the sludge pump is rated to pump 70 cu.ft/min.
1. How many pounds of TSS is removed in the clarifier? 5 points
2. How many cu.ft of sludge at the given 3.5% sludge needs to be pumped per day to remove the solids? 5 points

3. How many minutes would the sludge pump need to be operational each day to pump the required amount of sludge (calculated from 2 above)? 3 points
4. For how many minutes each hour the sludge pump should be programmed to operate (Given the number of minutes the pump need to operate per day calculated from 3 above) ? 2 points
Correct Answer(s):

140. Given the following information, how many gallons of primary sludge containing 5 % solids must be pumped daily?
Flow: 3 mgd
Primary influent TSS: 200 mg/l
Primary effluent TSS: 100mg/l
Correct Answer(s): a. 6000.0 b. 0.0 c. 0.0 d. 0.0

141. A sludge pump is set to pump 5 minutes each hour. It pumps at the rate of 35 gpm. How many cubic feet of sludge is pumped each day?
Correct Answer(s): a. 561.0 b. 0.0 c. 0.0 d. 0.0

142. How long will it take (hrs) to fill a 2 ac-ft pond if the pumping rate is 400 GPM
Correct Answer(s): a. 27.0 b. 0.0 c. 0.0 d. 0.0

143. Given the tank is 10ft wide, 12 ft long and 18 ft deep tank including 2 ft of freeboard when filled to capacity. How much time (minutes) will be required to pump down this tank to a depth of 2 ft when the tank is at maximum capacity using a 600 GPM pump
Correct Answer(s): a. 21.0 b. 0.0 c. 0.0 d. 0.0

144. A sludge pump is set to pump 5 minutes each hour. It pumps at the rate of 35 gpm. How many gallons of sludge are pumped each day?
a. 120 gpd
b. 175 gpd
c. 840 gpd
*d. 4200 gpd

145. Calculate the waste sludge pumping rate if you want to waste 2,000 pounds per day of solids with a concentration of return sludge at 5000 mg/L.
a. 29 gpm.
*b. 33 gpm.
c. 35 gpm.
d. 37 gpm.

146. How many pounds og solids are pumped to a digester each day if the digester receives 10,000 gpd of sludge at 5% density
a. 417 lbs/day
b. 1,479 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
*e. 4,170 lbs/day

147. How many pounds og solids are pumped to a digester each day if the digester receives 10,000 gpd of sludge at 5% density
a. 417 lbs/day
b. 1,479 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
*e. 4,170 lbs/day

148. Primary sludge containing five (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
*d. 10,960 lbs/day
e. 15,010 lbs/day

149. In a 2.1 MGD wastewater treatment plant the influent suspended solids concentration to the primary clarifier is 240 mg/l. The primary sludge contains 3.2% TSS and the primary effluent has a suspended solids concentration of 125mg/l. How many gallons sludge should be pumped per day?
a. 63,000 gal/day
b. 32,000 gal/day
c. 8,200 gal/day
*d. 7,550 gal/day

150. A sludge pump is set to pump 5 minutes each hour. It pumps at the rate of 35 gpm. How many gallons of sludge are pumped each day

151. a. 120 gpd
b. 175 gpd
c. 840 gpd
*d. 4200 gpd

152. A sludge pump is set to pump 5 minutes each hour. It pumps at the rate of 35 gpm. How many gallons of sludge are pumped each day?
a. 120 gpd
b. 175 gpd
c. 840 gpd
*d. 4200 gpd

153. Which one of the following process units is usually classified as a sludge thickening device as opposed to a dewatering device:
*a. DAF unit.
b. Sludge drying bed.
c. Vacuum filter press.
d. Belt press.
e. All of the above are thickeners, not dewatering devices.

154. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
Correct Answer(s): a. 24554.0 b. 0.0 c. 0.0 d. 0.0

155. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
Correct Answer(s): a. 7131.0 b. 0.0 c. 0.0 d. 0.0

156. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
Correct Answer(s): a. 61.4 b. 0.0 c. 0.0 d. 0.0

157. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%

*c. 60%
d. 89%

158. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

159. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

160. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

161. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

162. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

163. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False

164. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.

165. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.

166. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
Correct Answer(s): a. 24554.0

167. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
Correct Answer(s): a. 7131.0

168. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
Correct Answer(s): a. 61.4

169. Calculate the organic loading rate to two 320,000 gallon anaerobic digesters given: Primary sludge feed rate of 25,000 gallons with 6.2% TS containing 73% solids and SG of 1.03. Secondary sludge feed rate of 30,500 gallons with 3.8% TS containing 77% solids (7 points) (Answer: 0.2lbs VS/day-ft3)
Correct Answer(s):

170. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
*c. 60%
d. 89%

171. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

172. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

173. Calculate the VS loading to the digester in lbs/day if 10,000 cu. ft of sludge containing 4.8% TS with and an average VS content of 82%
a. 42,756 lbs/day
*b. 24,554 lbs/day
c. 30,987 lbs/day
d. 3,256 lbs/day

174. Calculate the VS loading to the digester in lbs/day if 25,000 gallons of sludge containing 4.5% TS with and average VS content of 76% is fed to the digester
*a. 7,131 lbs/day
b. 17,432 lbs/day
c. 19,256 lbs/day
d. 26,244 lbs/day

175. Calculate the % VS reduction in a digester given the volatile solids content of the feed sludge to the digester is 76% and the volatile solids content of the sludge leaving the digester is 55%
a. 56%
b. 38%
c. 42%
*d. 61.4%

176. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
*a. 29%
b. 40%

c. 57%
d. 71%

177. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
*b. 24
c. 36
d. 48

178. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
*e. 4,170 lbs/day

179. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
*d. 10,960 lbs/day
e. 15,010 lbs/day

180. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

181. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
*c. 60%
d. 89%

182. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

183. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

184. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
*c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft

185. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
*a. 29%
b. 40%
c. 57%
d. 71%

186. You are operating a 1 MGD trickling filter plant with a single stage anaerobic digester You pump about 3,000 gpd of sludge to the fixed cover digester. The supernatant has a BOD of 950 mg/L The BOD loading coming from the supernatant in pounds per day is
a. 12
*b. 24
c. 36
d. 48

187. How many pounds of solids are pumped to a digester each day, if the digester receives 10,000 gpd of sludge at 5% density?
a. 417 lbs/day
b. 1,497 lbs/day
c. 2,337 lbs/day
d. 3,273 lbs/day
*e. 4,170 lbs/day

188. Primary sludge containing five percent (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?
a. 1,310 lbs/day
b. 1,800 lbs/day
c. 9,830 lbs/day
*d. 10,960 lbs/day
e. 15,010 lbs/day

189. If a digester loading is 0.05 lbs VSS/ft3/Day, how large must the digester be if it receives 1,000 lbs. of suspended solids per day with a volatile percentage of 75%?
a. 3,750 cu.ft
b. 10,000 cu.ft
*c. 15,000 cu.ft
d. 26,666 cu.ft
e. 37,500 cu.ft

190. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
*c. 60%
d. 89%

191. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

192. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

193. A gas meter in the gas line from the digester is most helpful in:
a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
*d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.

194. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

195. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
*e. Bicarbonate alkalinity in the range of 1500 to 1800.

196. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.

197. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

198. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide

c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

199. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

200. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.

201. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.

202. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

203. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
*c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.

204. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

205. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:

a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

206. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

207. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

208. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

209. When adding anhydrous ammonia to a sour primary anaerobic digester, the[redacted] is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

210. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.

211. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile

e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.

212. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

213. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

214. During anaerobic digestion, at what frequency should mixing be applied?
a. 12 hours per day.
b. 2 hours per shift.
c. 45 minutes per hour.
*d. Constantly.

215. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

216. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

217. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions

218. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

219. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.

c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

220. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

221. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

222. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

223. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

224. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

225. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:

a. 20%
b. 25%
*c. 63%
d. 89%

226. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
*c. 60%
d. 89%

227. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

228. In a two-stage anaerobic digestion system, what is the intended function of the secondary digester?
a. Acid formation.
*b. Primarily for gas production.
c. Separation of gas from supernatant.
d. Solids settling.

229. It is important to avoid adding an excess of hydrated lime to a sour anaerobic digester because this excess lime:
a. will add excess carbon dioxide to the digester gas.
b. may react violently with grease and oils.
c. may destroy desirable saprophytes.
d. adds hardness to the digester supernatant.
*e. may react as follows: Ca(OH)2 + CO2 àH20 + Ca(CO)3

230. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

231. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

232. One change can reduce the fuel consumption for digester heating, increase digester detention or displacement time and reduce the volume of anaerobic supernatant to be returned to the head works of a treatment plant. That one change would be:
a. Build a bigger digester
b. Install a counter-current hear exchanger
c. Pump primary sludge more frequently

*d. Install a sludge thickener
e. Double the insulation on the digester roof

233. Psychrophilic bacteria would be used in which kind of digester?
*a. Cold digester
b. Warm digester
c. Hot digester

234. Range for volatile acids to alkalinity ratio for a well operating anaerobic digester
a. >0.25
*b. <0.25
c. 2-4
d. >1

235. The earliest indication of biological upset or process trouble in heated anaerobic digester would usually be:
a. A significant decrease in pH.
b. An increase in the volatile solids percentage in digested sludge
c. An increase in alkalinity and a decrease in volatile acids
*d. An increase in volatile acids without a corresponding increase in alkalinity
e. An increase in volatile acids and alkalinity.

236. The progress of anaerobic sludge digestion can be determined by:
a. percent volatile matter in the sludge
b. frequent alkalinity and volatile acids determinations
c. the volume and composition of gases produced
*d. all of the above
e. a and b only

237. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%.
b. 40%.
*c. 57%.
d. 71%

238. What is the purpose of heating and mixing a primary anaerobic digester?
a. To prevent grit from settling
b. To eliminate all oxygen
*c. To increase the reaction rate
d. To keep methane in suspension

239. What should be done if your anaerobic digester starts to go sour?
a. Release methane and aerate digester
*b. Add lime or sodium bicarbonate and reduce raw sludge feed
c. Add lime and increase raw sludge feed
d. Add CO2 to reduce pH
e. Drain the tank

240. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

241. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

242. When feeding an aerobic digester, the operator can control within certain limits:
a. Amount of air available for stabilization
b. Solids concentration
c. Frequency of feeding
d. Organic concentration
e. b and d
*f. b and c

243. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

244. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.

245. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.

246. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
*c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.

247. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.

e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

248. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

249. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

250. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

251. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

252. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

253. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.

254. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.

255. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

256. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

257. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
*c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.

258. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

259. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

260. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.

d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

261. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

262. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

263. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.

264. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

265. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

266. A gas meter in the gas line from the digester is most helpful in:
a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
*d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.

267. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
*e. Bicarbonate alkalinity in the range of 1500 to 1800.

268. Thermophilic digestion would take place in:
    a. Imhoff tanks
    b. lagoons
    c. a sanitary sewer system
    d. unheated anaerobic digester
    *e. anaerobic digester with temperatures over l00°F

269. Acid-forming bacteria would be found predominantly in:
    a. aerated grit chambers
    b. aerobic digesters
    *c. anaerobic digesters
    d. chlorine contact chambers
    e. a flowing stream with a D.O of 5 mg/1

270. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
    a. 2 - 4 inches of water column
    *b. 6 - 9 inches of water column
    c. 4 inches of mercury column
    d. 8 inches of mercury column
    e. none of the above

271. Anaerobic digester gas is mainly:
    a. carbon dioxide (CO2) and water (H2O)
    b. chlorine (Cl2) and ammonia (NH3)
    c. ammonia (NH3) and hydrogen sulfide (H2S)
    *d. carbon dioxide (CO2) and methane (CH4)
    e. carbon dioxide (CO2) and carbon monoxide (CO)

272. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
    a. pH
    b. alkalinity
    c. volatile acids
    d. detention time
    *e. all of the above

273. When defining BTU (British Thermal Unit), which of the following would apply?
    *a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
    b. it is the metric system of measure
    c. it is an expression of measurement of water flow over a V-notch weir
    d. it is a thermal coupling used in fail-safe systems on electric motors
    e. none of the above

274. The primary purpose of a secondary digester is to:
    a. increase gas production
    b. stabilize volatile solids
    c. provide additional storage for detritus
    *d. allow for solids separation
    e. none of the above

275. One of the reasons that air should be excluded from anaerobic digesters is because:
    a. gas storage capacity is reduced
    *b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture

c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above

276. In an on-line treatment facility having three aerobic digesters in series, which of the following statements would be false?
*a. it is not necessary to aerate all three digesters
b. draw off supernatant from tanks #2 and #3 only
c. a dissolved oxygen level will be easier to maintain in tank #3 than in tank #1
d. sludge pumped to digester #3 must be thicker than sludge pumped to digester #2, and #2 thicker than 1

277. The volatile acid/alkalinity relationship of an anaerobic digester is an indication of the buffer capacity of the digester contents. When the ratio starts to increase, it indicates:
a. excellent digester operation
*b. decreases in alkalinity
c. better methane production
d. a decrease in volatile acids
e. an increase in pH

278. For domestic wastewater, gas production in a well operated anaerobic digester should be in the vicinity of:
a. 1 cu. ft. of gas per day per pound of volatile matter destroyed
b. 10 BTU per pound of dry solids at 70% volatile
*c. one cubic foot of gas per capita per day
d. 50 BTU per cubic foot
e. all of the above

279. What is the purpose of heating and mixing a primary anaerobic digester?
a. To eliminate all oxygen present
*b. To increase the digestion rate
c. To keep methane gas in suspension
d. To prevent settling of grit to the bottom of the digester

280. Given the following data, what is the most likely cause of the anaerobic digester problem? DATA: Raw sludge pump on Digester gas pressure high Gas pressure relief valve open
*a. Vacuum relief valve stuck open
b. Too much raw sludge feed
c. Supernatant line pugged
d. Digester cover seal broken

281. The pH in an aerobic digester may decrease due to
a. The aerobic destruction of alkalinity
b. Production of CO2 and nitrate ions
*c. Oxidation of H2S to sulfuric acid
d. An increase in volatile acids

282. The proper way to start up an anaerobic digester is to fill it
*a. Halfway with seed sludge, then add raw sludge slowly
b. Up first with raw sludge and wastewater
c. Up with waste activated sludge
d. With seed sludge, add lime to pH 10 and mix

283. How would you determine if a gas mixing system is plugged or otherwise malfunctioning in your anaerobic digester?
a. By measuring the blower discharge pressure

b. By measuring the temperature throughout the digester
c. By observing amount of gas production
*d. By visual observation through the inspection port

284. Part of the digester gas that can be used as a fuel?
a. Propane
*b. Methane
c. Ethane
d. Carbon dioxide

285. Thermophilic digestion would take place in:
a. Imhoff tanks
b. lagoons
c. a sanitary sewer system
d. unheated anaerobic digester
*e. anaerobic digester with temperatures over l00°F

286. Acid-forming bacteria would be found predominantly in:
a. aerated grit chambers
b. aerobic digesters
*c. anaerobic digesters
d. chlorine contact chambers
e. a flowing stream with a D.O of 5 mg/1

287. A pressure relief valve on a fixed roof anaerobic digester is normally set at:
a. 2 - 4 inches of water column
*b. 6 - 9 inches of water column
c. 4 inches of mercury column
d. 8 inches of mercury column
e. none of the above

288. Anaerobic digester gas is mainly:
a. carbon dioxide (CO2) and water (H2O)
b. chlorine (Cl2) and ammonia (NH3)
c. ammonia (NH3) and hydrogen sulfide (H2S)
*d. carbon dioxide (CO2) and methane (CH4)
e. carbon dioxide (CO2) and carbon monoxide (CO)

289. In order for methane formation to occur in an anaerobic digester, the proper environmental conditions must exist. Among these environmental factors are:
a. pH
b. alkalinity
c. volatile acids
d. detention time
*e. all of the above

290. When defining BTU (British Thermal Unit), which of the following would apply?
*a. it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
b. it is the metric system of measure
c. it is an expression of measurement of water flow over a V-notch weir
d. it is a thermal coupling used in fail-safe systems on electric motors
e. none of the above

291. The primary purpose of a secondary digester is to:
a. increase gas production

b. stabilize volatile solids
c. provide additional storage for detritus
*d. allow for solids separation
e. none of the above

292. one of the reasons that air should be excluded from anaerobic digesters is because:
a. gas storage capacity is reduced
*b. the entrance of air mixed with the gas produced in the digester could create an explosive mixture
c. air interferes with the action of the aerobic bacteria present
d. harmful or pathogenic bacteria may be brought in with the air
e. none of the above

293. A gas meter in the gas line from the digester is most helpful in:
a. Determining whether or not the pressure relief mechanism is functioning properly
b. Determining the quantity of gas that should be wasted
c. Preventing the gas from exploding
*d. Measuring the amount of gas produced per day
e. Determining how much gas it utilized by the autoclave.

294. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

295. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile solids per day per ft3 of digester capacity.
*e. Bicarbonate alkalinity in the range of 1500 to 1800.

296. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93˚F to 98˚F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.
f. Bicarbonate alkalinity in the range of 1500 to 1800.

297. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

298. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide

d. Methane and carbon monoxide
e. Methane and ammonia

299. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

300. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.

301. A true statement regarding the term "biosolids" is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for "a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled".
d. The term is used by the California Water Resources Control Board to include "all insoluble matter derived from living aquatic organisms.

302. Calculate the volatile solids reduction in an anaerobic digester given the following information: Raw sludge feed to digester: 73.7 % VS and digested sludge: 57.2 %VS
*a. 52.3%
b. 64
c. 16.5%
d. 42%

303. Which one of the following parameter ranges is most appropriate for a healthy anaerobic digester?
a. Volatile solid reduction in the range of 60 to 70%.
b. Digester gas production of 7 to 10 ft3 of gas produced per day per pound of volatile solids destroyed.
*c. Alkalinity in the range of 2500 to 3500 mg/L.
d. Hydrogen sulfide in range of 1% to 2% by volume.
e. Volatile acids in range of 500 to 750 mg/L.

304. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

305. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.

*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

306. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

307. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

308. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%.
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds (Lb) volatile Solids per day per ft3 of digester capacity.
e. Bicarbonate alkalinity in the range of 1500 to 1800.

309. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

310. A true statement regarding the term “biosolids” is:
a. The term is mandated for user by public law 92-500.
b. The term was developed by US EPA to define all biologically toxic precipitates.
*c. The term is recommended by WEF for “a primarily organic solids product, produced by wastewater treatment processes, that can be beneficially recycled”.
d. The term is used by the California Water Resources Control Board to include “all insoluble matter derived from living aquatic organisms.

311. All of the following are normal operating guidelines for a healthy anaerobic digester except for:
a. A mesophilic digester operating at 93°F to 98°F.
b. Methane gas in the range of approximately 62% to 70%
c. Carbon dioxide gas in the range of 30% to 38%.
*d. Organic loading to a high rate digester of 0.15 to 0.2 pounds Lb volatile
e. Solids per day per ft3 of digester capacity.

f. Bicarbonate alkalinity in the range of 1500 to 1800.

312. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

313. Anaerobic digester gas is composed mostly of:
a. Carbon dioxide and hydrogen sulfide
*b. Methane and carbon dioxide
c. Methane and hydrogen sulfide
d. Methane and carbon monoxide
e. Methane and ammonia

314. During anaerobic digestion, at what frequency should mixing be applied?
a. 12 hours per day.
b. 2 hours per shift.
c. 45 minutes per hour.
*d. Constantly.

315. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

316. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls.
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions.

317. Ferrous chloride solution is most often added to anaerobic digesters in order to:
a. Reduce corrosion in anaerobic digester walls
b. Increase the pH of the digesting sludge.
c. Add ferrous ion as an essential nutrient.
*d. Precipitate sulfide ions and thereby meet air pollution limits on sulfur emissions

318. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.
d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

319. Identify the incorrect statement regarding anaerobic digestion.
a. An anaerobic digester with pH of 7.05, an alkalinity of 2,900 mg/l and a volatile acid concentration of 250 mg/l is probably operating normally.
*b. Sodium bicarbonate may be used in place of lime to neutralize a sour anaerobic digester.
c. When adding lime to a sour anaerobic digester, it is important to add an excess of this chemical to act as a reservoir of alkalinity.

d. Ferrous sulfate may be added to an anaerobic digester to reduce hydrogen sulfide concentration where air quality is of concern.
e. Gas production from anaerobic digester may be expressed as cubic feet of gas produced per pound of volatile matter added per day.

320. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

321. Identify the incorrect statement regarding operation of an anaerobic digester.
*a. A healthy anaerobic digester would generally have volatile acids in the range of 50 mg/l to 300 mg/l.
b. The best strategy for pumping raw sludge to an anaerobic digester is to pump it once or twice a day so that the thickest possible raw sludge may be pumped.
c. An anaerobic digester operating at an alkalinity of 3200 mg/l should be able to tolerate a volatile acid concentration of 250 mg/l.
d. The change in pH is not a reliable indicator of the changing characteristics of the digesting sludge because the alkalinity in an anaerobic digester acts as a buffer.
e. The higher the volatile solid content of the primary sludge being fed to the digester, the higher is the expected volatile reduction.

322. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

323. Identify the true statement about anaerobic digesters:
a. Carbon dioxide and methane in digester gas should be 65% and 35%, respectively.
*b. Increasing carbon dioxide readings indicate possible organic overload.
c. Decreasing mixing will always improve recovery of a sour digester.
d. Increasing the frequency and decreasing the amount of sludge pumping will not improve digester performance.
e. Reducing the ratio of primary to waste activated sludge will improve gas production.

324. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

325. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%

b. 25%
*c. 63%
d. 89%

326. If an anaerobic digester receives sludge with VS of 76% and discharges digested sludge with a 56% VS. Its VS reduction is:
a. 36%
b. 48%
*c. 60%
d. 89%

327. If an anaerobic digester receives sludge with VS of 80% and discharges digested sludge with a 60% VS. Its VS reduction is:
a. 20%
b. 25%
*c. 63%
d. 89%

328. In a two-stage anaerobic digestion system, what is the intended function of the secondary digester?
a. Acid formation.
*b. Primarily for gas production.
c. Separation of gas from supernatant.
d. Solids settling.

329. It is important to avoid adding an excess of hydrated lime to a sour anaerobic digester because this excess lime:
a. will add excess carbon dioxide to the digester gas.
b. may react violently with grease and oils.
c. may destroy desirable saprophytes.
d. adds hardness to the digester supernatant.
*e. may react as follows: Ca(OH)2 + CO2 àH20 + Ca(CO)3

330. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

331. One action that may be taken to improve the health of an anaerobic digester that is going sour would be to:
a. Add small doses of lime daily to maintain the digester pH above 7.0.
*b. Add ferrous sulfate to reduce the concentration of hydrogen sulfide in the digester.
c. Add seed sludge from a healthy primary digester.
d. Pump raw sludge to this digester more frequently so that this sludge has a higher pH.
e. Increase the temperature of the digester to favor a population increase of the methane formers.

332. One change can reduce the fuel consumption for digester heating, increase digester detention or displacement time and reduce the volume of anaerobic supernatant to be returned to the head works of a treatment plant. That one change would be:
a. Build a bigger digester
b. Install a counter-current hear exchanger
c. Pump primary sludge more frequently
*d. Install a sludge thickener
e. Double the insulation on the digester roof

333. Psychrophilic bacteria would be used in which kind of digester?
*a. Cold digester
b. Warm digester
c. Hot digester

334. Range for volatile acids to alkalinity ratio for a well operating anaerobic digester
a. >0.25
*b. <0.25
c. 2-4
d. >1

335. The earliest indication of biological upset or process trouble in heated anaerobic digester would usually be:
a. A significant decrease in pH.
b. An increase in the volatile solids percentage in digested sludge
c. An increase in alkalinity and a decrease in volatile acids
*d. An increase in volatile acids without a corresponding increase in alkalinity
e. An increase in volatile acids and alkalinity.

336. The progress of anaerobic sludge digestion can be determined by:
a. percent volatile matter in the sludge
b. frequent alkalinity and volatile acids determinations
c. the volume and composition of gases produced
*d. all of the above
e. a and b only

337. What is the digester efficiency if the volatile solids concentration entering an anaerobic digester is 70% and the volatile solids concentration leaving the digester is 50%?
a. 29%.
b. 40%.
*c. 57%.
d. 71%

338. What is the purpose of heating and mixing a primary anaerobic digester?
a. To prevent grit from settling
b. To eliminate all oxygen
*c. To increase the reaction rate
d. To keep methane in suspension

339. What should be done if your anaerobic digester starts to go sour?
a. Release methane and aerate digester
*b. Add lime or sodium bicarbonate and reduce raw sludge feed
c. Add lime and increase raw sludge feed
d. Add CO2 to reduce pH
e. Drain the tank

340. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:
a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

341. When adding anhydrous ammonia to a sour primary anaerobic digester, the _____ is an important consideration because if it is too high, digester "poisoning" may result:

a. Concentration of hydrogen sulfide in digester gas.
*b. pH in digesting sludge.
c. Concentration of free copper ions in digesting sludge
d. Ferrous and ferric ion concentration in digesting sludge.
e. Dissolved sulfide concentration.

342. When feeding an aerobic digester, the operator can control within certain limits:
a. Amount of air available for stabilization
b. Solids concentration
c. Frequency of feeding
d. Organic concentration
e. b and d
*f. b and c

343. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
*b. False

344. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off' pressures.
*a. True
b. False

345. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
*b. False

346. A high rate anaerobic digester is always heated and mixed.
*a. True b.False

347. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
*b. False

348. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
*b. False

349. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame
*a. True
b. False

350. In an anaerobic digester, the [1] is destroyed producing [2]. The digester gas production is typically in the range of [3] cubic feet of digester gas per lb of volatile matter destroyed.

351. Gas production in an anaerobic digester results from the destruction of fixed solids
a. True
*b. False

352. A well operating digester will have a CO2 concentration of greater than 60%
a. True
*b. False

353. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False

354. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False

355. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
*b. False

356. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
*a. True
b. False

357. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
*b. False

358. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
*b. False

359. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
*a. True
b. False

360. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
*b. False

361. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
*b. False

362. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
*b. False

363. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
*a. True
b. False

364. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
*a. True
b. False

365. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
*b. False

366. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
*b. False

367. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
*a. True
b. False

368. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
*a. True
b. False

369. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
*b. False

370. Propeller mixers are located mainly on floating covers of anaerobic digesters rather than on fixed covers.
a. True
*b. False

371. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
*b. False

372. The range of volatile material in raw sludge may be as high as 60% - 80% while digested sludge normally will be below 20%.
a. True
*b. False

373. Foaming in digesters is often due to rapid acid digestion is caused by adding too much raw sludge during too short a time period.
*a. True
b. False

374. Aerobic digestion produces methane gas that provides energy for other operations.
a. True
*b. False

375. A good maintenance program should be established for all flame arresters to ensure they are all set at the recommended "pop-off" pressures.
a. True
*b. False

376. A flame arrester in the gas line between a waste gas burner and an anaerobic digester contains plates which should periodically be inspected and cleaned.
*a. True
b. False

377. The methane forming bacteria in an anaerobic digester reproduce more rapidly than the acid forming bacteria.
a. True
*b. False

378. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
*b. False

379. Supernatant liquor is withdrawn from the lowest possible level in an anaerobic digester.
a. True
*b. False

380. The pH of digested sludge in a healthy anaerobic digester will be near 7.0
*a. True
b. False

381. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
*a. True
b. False

382. A properly operated anaerobic, digester functions best within a pH range of 5.4 to 5.8.
a. True
*b. False

383. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
*b. False

384. In conventional secondary wastewater treatment processes, aerobic decomposition of solids will occur.
*a. True
b. False

385. Aerobic digesters are operated under the principle of extended aeration from the activated sludge process.
*a. True
b. False

386. After pumping raw sludge to a digester, it is necessary to seal both ends of the line to prevent back siphonage.
a. True
*b. False

387. A gallon of water weighs 8.34 pounds. A gallon of digested sludge, due to its high volatile content, will weigh much less.
a. True
*b. False

388. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
*b. False

389. "High rate" and Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
*a. True
b. False

390. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
*b. False

391. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
*a. True
b. False

392. A change in the-pH-of digesting sludge in anaerobic digester is the best early warning indicator of potential digester upset.
a. True
*b. False

393. A good maintenance program should be established for all flame arrestors to ensure they are all set at the recommended "pop-off' pressures.
*a. True
b. False

394. A healthy anaerobic digester should have a carbon dioxide concentration of more than 40%.
a. True
*b. False

395. A high rate anaerobic digester is always heated and mixed.
*a. True
b. False

396. Anaerobically digested sludge produces gas as a by-product. The gas produced is of little or no value.
a. True
*b. False

397. Digester gas containing 60% methane by volume will likely explode when exposed to a spark or flame.
a. True
*b. False

398. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False

399. Gas production in an anaerobic digester results from the destruction of fixed solids in the raw sludge.
a. True
*b. False

400. "High rate" and "Low rate" when used in referring to an anaerobic digester may refer to the rate of volatile solids loading.
*a. True
b. False

401. In computing anaerobic digester loadings, it is necessary to take into account the solids lost in the supernatant system.
a. True
*b. False

402. Increased concentrations of volatile acids and decreased alkalinity are the first measurable changes that take place when the process of anaerobic digestion is becoming upset.
*a. True
b. False

403. In a two-stage anaerobic digestion system, it is in the secondary tank where most of the volatile solids destruction occurs
a. True
*b. False

404. The lower explosive limit for methane is 40%
a. True
*b. False

405. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False

406. Sludge digestion is a process by which principally the inorganic matter in sludge is gasified and/or converted to a more stable form by the biological process.
a. True
*b. False

407. The determination of the pH on the anaerobic digester is one of the best early warning systems of digester upset.
a. True
*b. False

408. The gas produced as part of the anaerobic digestion is of little or no value
a. True
*b. False

409. The main function of a secondary digester in normal operation is to provide a storage space for seed sludge.
a. True
*b. False

410. The pH of digested sludge in a healthy anaerobic digester will be near 7.0.
*a. True
b. False

411. Volatile solids reduction is a measure of the effectiveness of an anaerobic digester.
*a. True
b. False

412. Volatile solids removal efficiency of a digester is most commonly monitored utilizing the BOD test
a. True
*b. False