

Onsite Domestic Wastewater Treatment, Dispersal and Reuse
Biosystems Engineering 532
Final Exam Fall 2008
Due by 4:00 p.m. Monday December 8, 2008
(either by email or hardcopy)

Name _____

Instructions: This exam is composed of multiple choice, true/false, and short answer questions. Show your calculations where appropriate and discussion answers should be concise but complete.

1. Liquid/solid separation is best characterized as:
 - a) Chemical Treatment
 - b) Physical Treatment
 - c) Biological Treatment
 - d) No Treatment

2. BOD₅ is a measure of:
 - a) Biological Oxygen Demand
 - b) Biology Oxygen Demand
 - c) Biochemical Oxygen Demand
 - d) Biomicrobics Oxygen Demand

3. COD and BOD₅ are measures of a wastewater's strength. What is the impact that a high BOD₅ or COD wastewater will have on a receiving waterbody?
 - a) Aerobic and facultative microorganisms use dissolved oxygen as an electron acceptor to breakdown dissolved organic compounds into CO₂ and H₂O – thus consuming dissolved oxygen out of the natural waterbody.
 - b) Anaerobic microorganisms use dissolved oxygen as an electron acceptor to breakdown dissolved organic compounds into CO₂ and H₂O – thus consuming dissolved oxygen out of the natural waterbody
 - c) The high BOD₅/COD wastewater is a direct toxin to the aquatic life and a discharge of this wastewater would result in a fish kill.

4. The microorganisms that digest domestic wastewater prefer a neutral pH. Thus the pH of the wastewater entering an aerobic treatment device should range between:
 - a) 1 to 4
 - b) 4 to 6
 - c) 6 to 8
 - d) 8 to 14

10. You are the service provider for a site with a three-bedroom home. The site has a 1000-gallon septic tank and the details are attached. Using your measuring device in the first compartment, you determine that the sludge layer is 8 inches thick, and the scum layer is 4 inches thick. Your threshold for pumping a tank is when solids occupy 30% of the tank's capacity. The tank was last pumped five years ago. You make a recommendation that the tank should be pumped out - but the homeowner is not happy about selling out the cash. Defend your decision to the homeowner.
11. A low-pressure pipe (LPP) system is to be designed for a rural commercial facility in Franklin County, Tennessee. The daily design flow from the establishment is 2,000 gallons per day. An extra high intensity soil survey found that the soil is a Cumberland Silt Loam.
- a) What is the minimum land area required to place the LPP drainfield. This calculation does not need to include the area of pump tank or septic tank.
- b) Assuming the minimum requirements that are specified in the Regulations to Govern Subsurface Sewage Disposal Systems, how many 5/32-inch diameter orifices are needed? Assume the use of 1-1/4-inch diameter Sch. 40 PVC pipe as laterals, the laterals are 80-feet long, orifices are 60 inches on center, and the operating pressure in the laterals is 1.30 psi.

11. (Continued)

- c) Using the number of emitters that you calculated in part b, determine the require pump flow if you divided the drainfield into four equal-flow zones.

12. Surface water runoff (stormwater) needs to be directed toward the wastewater treatment system in order to dilute the wastewater strength.

- a) Yes
- b) No

13. Every O&M job has a first “site visit.” During this initial visit, you find the following issues concerning an advanced treatment system that is already in the ground. Indicate what you would suggest to the property owner for each of the following issues.

- a) Very lush grass growth over three drip irrigation lines at the lower end of the zone, and normal grass growth (no different from the rest of the yard) over the remainder of the drip irrigation lines.

- b) You observe that the electrical conduit leading from the treatment device up to the control panel has been frequently lashed by a string trimmer (i.e., a weedeater).

13. (Continued)

c) You open the advanced treatment device and the space between the water surface and the top of the riser is full of foam.

d) You find that the lids on the risers did not have tamper-proof mechanical fasteners.

e) You find the downspouts from the gutters are directing stormwater away from the wastewater treatment and dispersal system.

14. A tank has the pump-off float located 12 inches below the pump-on float. Is this system:

a) a demand-based dose.

b) a time-based dose.

15. A rectangular tank has an internal width of 48 inches and internal length of 120 inches. The pump-off float is located 12 inches below the pump-on float. Each time the pump-on float is activated, how many gallons will be pumped from the tank.

16. Using your answer from number 15, determine the average pump flow rate if the pump requires 8 minutes for the pump to lower the water level down to the pump-off float.

17. A pump is used to pressurize an effluent drip irrigation system. A timer is used to activate the pump. The timer is set for 5 minutes of run time and 25 minutes of “off” time. Assuming the system receives sufficient effluent to prevent the “timer-off” float from dropping out, how many “events” should be indicated on the pump-counter after 24 hours of operation?

18. During a service visit, you need to observe the pump in action. The control panel has a toggle switch for the pump that is labeled “HAND-OFF-AUTO.” What position should the toggle switch be in before you close the control panel and leave the site?

19. Upon raising the lid, aerobic treatment devices commonly have a strong sulfur (hydrogen sulfide) smell that would be considered normal.
 - a) Yes
 - b) No

20. How does an aerobic treatment device reduce pathogens?

21. A recirculating media filter is dosed 12 times per day – each dose is 300 gallons. Each day the effluent drip irrigation field receives 600 gallons. Calculate the recirculation ratio of this system.

22. You inspect an aerobic treatment device and find that the pH is 3. Is this likely a problem caused by the treatment system or a problem caused by the homeowner?

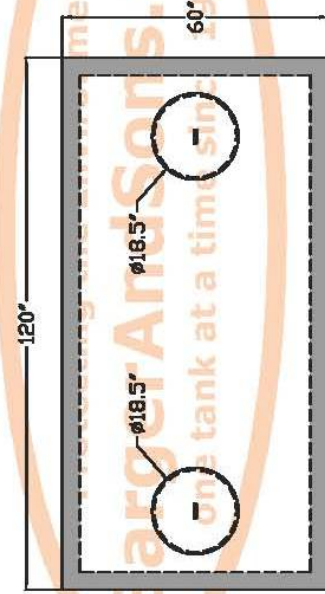
23. How does the relative risk to human and environmental health relate to the frequency of O&M visits?

24. You are inspecting a suspended-growth treatment unit (often called an ATU). Air is being pumped into the unit. You observe air bubbles rising in the clarifier. Why is this a problem?

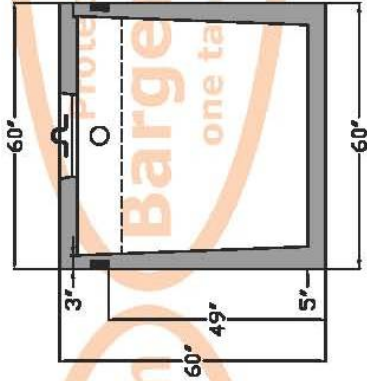
25. Which phrase best describes the function of a suspended-growth aerobic treatment device. (bugs are beneficial microorganisms)
- a) A happy home for happy bugs
 - b) food is brought to the bugs
 - c) the bugs are attached to their food
 - d) the food is mixed with the bugs
26. Residential aerobic treatment devices operate in this mode.
- a) Endogenous respiration
 - b) Fermentation
 - c) Oxidation/Reduction
 - d) Autotrophic
27. The oxidation of organic carbon is exothermic. This natural reaction should produce sufficient heat to maintain the water temperature within a below-ground ATU at 80°F.
- a) True
 - b) False
28. A blower is supply air to an ATU. Odors from the ATU are very strong. The blower seems to be working but on further inspection you determine that the motor is pulling more amps than indicated on the faceplate. What should you look for?
- a) Hydraulic overloading from the wastewater source
 - b) A kink in the air tubing or clog in the air diffuser
 - c) Organic overloading from the wastewater source
 - d) A dirty air filter serving the blower
 - e) Both a and c
 - f) Both b and d
29. A packed-bed media filter uses a blower to aerate septic tank effluent
- a) True
 - b) False
30. Open cell foam, non-woven textile sheets, inert highly porous aggregates, and peat are all examples of:
- a) Attached-growth treatment media
 - b) fixed-film treatment media
 - c) Both a and b
 - d) None of the above
31. The conversion of soluble nitrate into gaseous nitrogen is:
- a) Nitrification
 - b) Denitrification
 - c) Ammonification
 - d) Putrefaction

32. A single-zone effluent drip irrigation system has 500 pressure-compensated emitters. Each emitter is rated for 0.62 gallon per hour. You observed the system operate for 10 minutes. How many gallons of effluent should have pumped from the pump tank during the 10 minutes?
33. The system described in problem number 32 does not have a flow meter. The interior of the pump tank is 48 inches wide and 48 inches long. Based on your answer from problem number 32, how inches should the water level have dropped during the 10 minutes?
34. You measured the flow and pressure produced by the pump for the effluent drip irrigation system. Based on the original design information, you determine that the pressure is too low and flow is too high. What do you determine from this information?

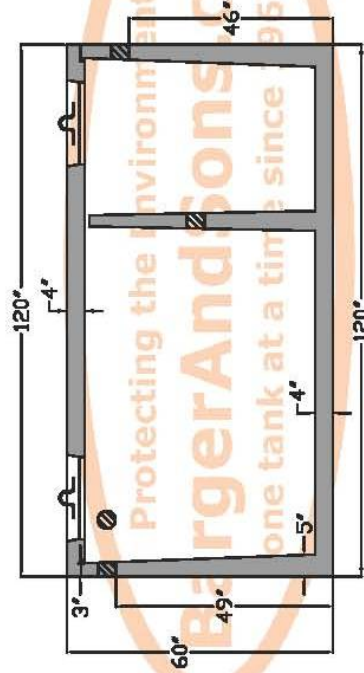
Top View



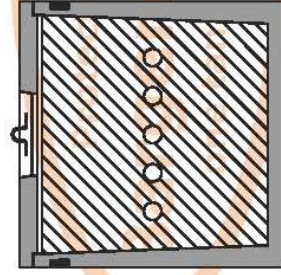
End View



Side View



Baffle View



Specifications

Concrete: 5,000 psi minimum strength (28 day)

Reinforcing: Primary reinforcement will be top, side, and bottom #3 and/or #4 rebar (Grade 60)

Risers: All risers, if required, will be watertight and at least 8" in diameter.

Sealant: Sealant used in the seam of the tank will meet or exceed ASTM C990.

Pipe Penetrations: Inlet and outlets are fitted with seals that meet or exceed all ASTM C923 specifications.

Partition Wall: The partition wall, if present, is poured monolithically.

Installation: The tank hole is not to be more than one foot longer and wider than the tank. There shall be a minimum of 6" of 3/4" stone bedding in soil terrain and a 12" stone bedding in rock terrain. Do not install across path of vehicles or heavy equipment. This tank is designed for one hundred fifty pounds per square foot (1.50 lb/ft²) uniform loading on the top of the tank with a maximum backfill cover of 36" and a minimum of 6".

Tank Warranty: The C. R. Barger & Sons, Inc. septic tank when installed in accordance with manufacturer's instructions is warranted against defective materials and/or workmanship for 1 year from the date of delivery to the project site. Should a defect appear within the warranty period, C. R. Barger & Sons, Inc. will supply a new septic tank in replacement thereof. C. R. Barger & Sons, Inc. liability is limited to the value of the septic tank itself and specifically excludes the cost of installation and/or removal and consequential damages. Failure to comply with C. R. Barger & Sons, Inc. installation procedures and general notes will void warranty.

Manufactured by:
C. R. Barger & Sons, Inc.
 238 Mays Valley Road
 Harmon Tn 37748
 Phone 865.882.5860 Fax 865.882.6394
 www.bargerandsons.com

General Notes:
 All vertical measurements are accurate within ± 1 inch on the tank. The lids can be moved and resized if necessary. Written specifications are available upon request.

Tank Type: **Septic Tank 1000 Gallon Top Seam**
 Date: **3.262006**
 Drawn By: **Eric Barger**

Approx. Weight: **11,000 lbs.**

Description: **Top Seam**