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Test Your Knowledge of Wastewater Treatment Topics

- Which is a higher life form in the activated sludge process: a free swimming ciliate, a stalked ciliate, or a rotifer?
 - Free swimming ciliate
 - Stalked ciliate
 - Rotifer
 - They are all the same.
- Given the following data, what is the solids loading rate on the secondary clarifiers?
 - Plant influent flow is 5.5 mgd
 - The return activated sludge (RAS) rate is 50 percent of Q
 - There is one 100-ft diameter secondary clarifier
 - The aeration mixed liquor suspended solids (MLSS) is 2,200 mg/L
 - 19.3 lbs/day/ft²
 - 8.6 lbs/day/ft²
 - 18.9 lbs/day/ft²
 - 15.5 lbs/day/ft²
- What is the best definition of a shock load?
 - An unexpected bump.
 - A strong influent waste strength.
 - A high concentration of total suspended solids (TSS).
 - A heavy truck load entering the plant.
- Which condition may produce the best denitrification efficiency in an aeration tank?
 - High air supply
 - High aeration dissolved oxygen (DO)
 - Low aeration DO
 - Low RAS rate
- Which zone of a biological nutrient removal (BNR) plant produces a release of phosphorus and is responsible for conditioning the phosphorus for later uptake in the downstream zones?
 - Anoxic
 - Fermentation
 - Aerobic
 - Reaeration
- Which group of bacteria is responsible for conversion of inorganic ammonia in wastewater?
 - Carbon eaters
 - Methanogens
 - Autotrophic
 - Heterotrophic
- What is the advanced stage of activated sludge called when bacteria oxidize their own cell mass?
 - Log growth
 - Declining growth
 - Cathodic protection
 - Endogenous respiration
- Which group of bacteria can be facultative and are responsible for carbonaceous biochemical oxygen demand (CBOD₅) removal and denitrification in the activated sludge process?
 - Heterotrophic
 - Nitrosomonas
 - Autotrophic
 - Fermenters
- How much alkalinity is required to convert 1.0 lb of ammonia-nitrogen during the nitrification process?
 - 7.2 lbs
 - 8.34 lbs
 - 7.48 lbs
 - 4.6 lbs
- Which adjustment will create an increased contact time in the aeration tank?
 - Lower the weir.
 - Increase the air supply rate.
 - Decrease the WAS rate.
 - Decrease the RAS rate.

Answers on page 78

SEND US YOUR QUESTIONS

Readers are welcome to submit questions or exercises on water or wastewater treatment plant operations for publication in Certification Boulevard. Send your question (with the answer) or your exercise (with the solution) by email to roy.pelletier@cityoforlando.net, or by mail to:

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Certification Boulevard Answer Key

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1. **C) Rotifer**

Beginning with the lowest life form, the microorganism indicators are amoebas, small flagellates, large flagellates, free swimming ciliates, stalk ciliates, rotifers, nematodes (worms) and water bears. So, of the three indicators listed in the question, the rotifer is the highest life form in the activated sludge process.

2. **A) 19.3 lbs/day/ft²**

Formula

Total lbs per day entering the secondary clarifier
÷ Total clarifier surface area in ft²

Total lbs per day entering the secondary clarifier
= (5.5 mgd + 2.75 mgd) x 2,200 mg/L x 8.34
lbs/gal
= 151,371 lbs per day

Clarifier surface area = 3.14 x (50 ft x 50 ft)
= 7,850 ft²

= 151,371 lbs per day ÷ 7,850 ft²
= 19.28 lbs per day per ft²

3. **B) A strong influent waste strength.**

The term "loading" refers to the demand for oxygen placed on the activated sludge process from the flow being treated. A shock load is a high demand for oxygen (from CBOD₅, COD or nitrogen) placed on the activated sludge process in a short period of time.

4. **C) Low aeration DO**

Because denitrification is an anoxic reaction, low dissolved oxygen levels in the aeration tank will typically result in the best denitrification efficiency.

5. **B) Fermentation**

The fermentation zone of a Bardenpho process receives raw wastewater (usually after

preliminary treatment) and return activated sludge (from secondary clarifiers). The MLSS is mixed and not aerated in the fermentation zone for a time period of about 1 to 3 hours. This zone, absent of all sources of oxygen, basically activates a group of phosphorus accumulating organisms (PAO), which trade phosphorus for CBOD₅. These bugs release phosphorus from their cells and "grab onto" food for later decomposition. A successful fermentation zone will have phosphorus levels in the outlet about two to four times higher than the inlet to the tank.

6. **C) Autotrophic**

There are two main groups of autotrophic bacteria that are responsible for the conversion of inorganic ammonia to nitrate. The first group, called nitrosomonas (known as ammonia-oxidizing bacteria), convert ammonia to nitrite. The second group, called nitrobacter (known as nitrite-oxidizing bacteria), convert nitrite to nitrate. The process of nitrification does not necessarily remove nitrogen from the wastewater; it only converts it to a more stable form.

7. **D) Endogenous respiration**

Endogenous respiration takes place when the sludge is very old and food availability is very low (low F/M ratio, high SRT). This condition encourages active bacteria still hungry to "cannibalize" other bacteria to find and assimilate their uneaten food (carbon) value. Endogenous respiration is known as "survival of the fittest," and is on the far right side of the growth curve.

8. **A) Heterotrophic**

Facultative heterotrophic bacteria are responsible for the conversion of nitrate (NO₃) to free nitrogen gas (N₂) in the absence of dissolved oxygen. This activity, called denitrification, consumes some CBOD₅ in the process.

9. **A) 7.2 lbs**

Nitrification consumes alkalinity at the rate of about 7.2 lbs of alkalinity for each lb of ammonia oxidized. Because this action causes the mixed liquor pH to drop, biological denitrification is desirable, which replenishes the alkalinity at a rate of about 3.6 lbs of alkalinity for each lb of nitrate that is consumed as a source of oxygen. The action of denitrification helps to stabilize the MLSS pH in a range acceptable to the nitrifying bacteria.

10. **D) Decrease the RAS rate.**

The total flow entering an aeration tank is Q plus QR (influent flow plus RAS flow). As the RAS flow is decreased, the contact time through the aeration tank zones is increased, due to a reduction of the total flow entering the aeration tank.

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Columnist note: Hubert H. Barnes, P.E., maintenance superintendent for the City of Hollywood Wastewater Treatment Plant, submitted the following comment concerning question 8 in this column in the November 2013 issue of the *Journal*. The question and answer were related to cavitation of a high-service water pump.

It is insufficient to say that "This drop in pressure causes gas pockets to form in the water, which then collapse" without explanation that the "gas" is actually water vapors, and that they collapse as the pump imparts pressure energy to overcome the vapor pressure of the fluid. We are talking about a high-service pump, and therefore take it that there are no volatile gases trapped in the water. The answer also stated that "This can occur when a pump is trying to deliver more water than it was designed for." *Pumps do not try to do anything*; they simply react to the suction and discharge conditions.

Thank you, Hubert, for your comments and for reading Certification Boulevard. Your response may help other readers who may have been confused about the explanation to that question.

Roy