Module 17:

The Activated Sludge Process - Part III

Answer Key

What other differences can you see between Complete Mix and Step Aeration?

Ans: One of the features that make Complete Mix Aeration different from Step Aeration is that mixed liquor is also removed from the tank at several locations. This, together with the orientation of the aerators, creates a series of back-mixing zones within the aeration tank that produce a uniform environment throughout the aeration tank.

What were the three reasons for modification?

Ans: Operational Benefits; Site Characteristics; Energy and Labor Requirements

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Exercise for Unit 1 - Modifications of the Conventional Activated Sludge Process

1. BOD measurements are used as a measure of the _organic_ strength of wastes in water.

2. The conventional activated sludge process uses a _plug_ - _flow_ reactor that is generally long and relatively narrow.

3. Potential benefits of modifying the conventional activated sludge system include:

   a. Increasing organic loading.
   b. Providing additional nutrients required for proper treatment.
   c. Accommodating flow rate or organic loading that varies seasonally.
   d. Achieving nutrient removal.
   e. All of the above.

4. The contact stabilization process assumes that BOD is first _adsorbed_ by the microorganisms and then BOD is _metabolized_ by the microorganisms for energy and growth.

5. In a contact stabilization activated sludge process, the maximum organic loading should be no more than _60 # BOD_ per 1,000 cubic feet/day.

6. The Kraus Process is applicable to treatment facilities receiving waste water that is low in carbohydrates.

   a. True b. False

7. The step - feed Aeration Process can be used to provide a more uniform distribution of oxygen demand throughout the aeration tank.

8. In general, the extended aeration (or oxidation ditch) process requires the longest minimum aeration time.

9. Oxidation ditches are configured in a ring with continuous flow around the ring that is induced by aerators.

10. The conventional activated sludge process is most suitable for low-strength, domestic wastes with minimal peak load considerations.

Exercise - Unit 1: Place the letter of the definition before the appropriate treatment process.

__C__ Conventional
__B___Complete-Mix
__E___Contact Stabilization
__A___Extended aeration/oxidation ditch
__F___Step-feed
__D__ Kraus

A. The principal benefits of this modification include reduced sludge handling and lower power requirements. Of the processes listed, this type of plant will perform the best in regards to achieving nitrification because of the long aeration and MCRT.

B. The benefits of this modification include greater hydraulic loading, a more stable microbial population, more efficient aeration, and tolerance of shock loads. These systems may be used for nitrification, however; they can be more sensitive to pH drops.

C. This process is most suitable for low-strength, domestic wastes with minimal peak loads. The system works well for nitrification. However, the process is susceptible to failure from shock loads.

D. This process is often used to treat wastewater that is nitrogen deficient, high in carbohydrates and has poor settling characteristics.

E. This process presumes that organic matter (BOD) destruction is a two-step process in which BOD is first adsorbed by the microorganisms then metabolized by the microorganisms for energy and growth. Hydraulic detention times are too short for significant nitrification to occur making the process unsuitable for nitrification. This modification performs well under high flow, wet weather conditions.

F. This process modification is used to provide a more uniform distribution of oxygen demand throughout the aeration tank. It is particularly beneficial when dealing with variable shock loads. It can be used to provide partial nitrification, however; detention times are too low for complete nitrification to occur.

Unit 2 - Inflow/Outflow Characteristics

How do influent and effluent flows occur in the conventional activated sludge process?

Ans: Both influent and effluent flows occur continuously in the conventional process.

Aeration Schedule

When does aeration occur in the conventional activated sludge process?

Ans: Aeration occurs continuously in the conventional process.

Organic Loading Schedule

When does organic loading occur in the conventional activated sludge process?

Ans: Organic loading is continuous in the conventional process.

Mixed Liquor Management

What happens to the return sludge in the conventional activated sludge process?

Ans: Conventional activated sludge systems receive return sludge from the secondary clarifier to make up for the sludge that was lost during the discharge of mixed liquor.

Clarification Efficiency

What makes clarification efficiency less than ideal in the conventional activated sludge process?

Ans: The clarifier is always receiving influent, which creates opportunities for short-circuiting and currents that disrupt the clarification process.

Why do you think it is important for SBR tanks to have such depth?

Ans: Sufficient depth is required to accommodate the variable depth requirements associated with a fill and draw operation.

Aeration and Mixing Equipment

Why are mechanical mixers favored in SBRs?

Ans: When doing nutrient removal, they can provide mixing energy without aerating.

Why would an air diffuser prohibit anoxic, or anaerobic, treatment cycles that are required for nutrient removal?

Ans: When operating, the diffuser's bubbles provide oxygen to the environment; anoxic and anaerobic treatment cycles require no free oxygen.

Why is the settling time longer when removing phosphorus (P)?

Ans: The extra settling time is needed to create the anaerobic conditions for the biological phosphorus removal process.

Exercise for Unit 2 – The Sequencing Batch Reactor

1. The maximum operating depth of a typical SBR system ranges from 12 to 20 feet.

2. SBR systems can in general use the same aeration and mixing equipment that is used for conventional activated sludge systems.
   a. True b. False

3. PLC means Programmable Logic Controller. A PLC controls the mechanical equipment and the timing of the different stages.

3. List the five stages of operation in a SBR and briefly explain what happens in each stage.

   a. fill - (biological treatment) Influent raw wastewater entering the reactor during this mode, there may also be periods of mixing without aeration (anoxic) and mixing with aeration (aerobic). cBOD removal, nitrification and denitrification may be taking place during this mode. Typically, you would want raw wastewater (carbon source) for anoxic denitrification periods. No wastewater is being discharged in this mode. The amount of time spent in this mode could be dependent on flow, storm flow could significantly limit the amount of time.

b. react - (biological treatment) During this mode, there is typically no raw wastewater entering the SBR (this could be different in storm mode). Periods of aerobic and anoxic treatment may occur to provide for cBOD removal, nitrification and denitrification. No wastewater is being discharged in this mode. This is a time for reaction, providing time for the microorganisms contained in the SBR to consume and convert the pollutants in the wastewater.

c. settle - (physical treatment) During this mode there is typically no wastewater entering or exiting the SBR. There is no mixing or aeration, it is a quiescent period that provides for settling of the mixed liquor. In this mode the SBR is essentially a clarifier.

d. decant - (physical treatment) In the decanting mode, the treated wastewater is decanted from the reactor and sent on for disinfection. It is typically in this mode that sludge is also wasted from the system.

e. idle - (endogenous phase) As the name suggests, this is a mode where the process is at an idle. There is no wastewater entering or exiting the system. There may be some mixing and aeration. The biomass is at endogenous respiration. Some reactors may not have an idle mode or the idle mode may not be used during wet weather.