The Napa "Great Shake" WARM-UP

Calculating hydraulic detention time and organic loading are two important factors treatment plant operators have to understand in order to operate a wastewater treatment plant.

Hydraulic detention time (HDT) also known as hydraulic retention time (HRT) is a measure of the average length of time that a compound (in this case wastewater) remains in a treatment tank or unit. Simply stated if you started to fill a tank with wastewater the detention time is the average amount of a time that a drop of that water will remain in the treatment tank before the tank fills and that drop of water flows out of it. This is important because as wastewater passes through a treatment tank it must stay in the tank for the necessary period of time in order to be adequately treated. For example, in most aeration treatment systems, 4 to 8 hours of detention time is necessary in order for the microorganisms in the aeration system to absorb, adsorb and remove the contaminants (bacteria food) in the wastewater.

Like humans, animals and other organisms, the microorganisms used to treat wastewater need the right amount of food in order to survive and thrive. Organic loading in wastewater is measured as BOD (Biochemical Oxygen Demand) which is a test run in a lab which measures the concentration or strength of the organic loading of a volume of wastewater. Think of the BOD or organic load as wastewater contamination which serves as bacteria food that the microorganisms in the treatment system consume and remove from the wastewater. Treatment plant operators must understand the relationship between the contaminant (organic load) in the wastewater relative to the amount of microorganisms in the treatment system that are available to remove that organic load. Therefore, operators must calculate the pounds of organic load contained in a volume of wastewater then calculate the pounds of microorganisms that are in the treatment system which is available to consume and remove the organic load. The operator then compares the pounds of organic loading to the pounds of microorganisms. This comparison is referred to as the Food to Microorganism (F/M) ratio. Most treatment plants operate at an F/M ratio of 0.2 to 0.5. This means for every 2 to 5 pounds of organic load in a volume of wastewater the treatment system must contain 10 pounds of microorganisms in order to stabilize and remove that organic load.

1. **Hydraulic Detention Time**

A. Calculate the Hydraulic Detention Time in a treatment tank given the following:

Flow to a rectangular aeration basin is 3.0 million gallons per day. The clarifier is 100 ft in length, 50 ft wide, and 15 ft deep. Calculate the aeration basin's hydraulic detention time.

$$\text{Volume of Rectangular or circular tank of uniform depth, } \{ft^3\} = \text{area, } \{ft\}^2 \text{ x depth, } \{ft\}$$

$$\text{Detention time, } \{hr\} = \left[\frac{\text{tank volume, } \{ft^3\} \text{ X } 7.5 \left\{\frac{\text{gallons}}{ft^3}\right\} \text{ X } 24\left\{\frac{\text{hrs}}{\text{day}}\right\}}{Q, \ \{\text{gallons/day}\}}\right]$$

B. Is this an adequate amount of treatment time?

2. **Organic Loading**

   a. Convert a concentration of wastewater contaminants to pounds.
      i. A wastewater flow rate is 6 MGD (million gallons/day) has an organic loading concentration of 250 mg/l BOD (Biochemical Oxygen Demand).

$$\underline{\text{BOD or SS}},\ \{\text{lbs/day}\} = 8.34\ \{\text{lbs}\cdot\text{L/MG}\cdot\text{mg}\} \times Q,\{\text{MGD}\} \times \text{conc},\{\text{mg/L}\}$$

   b. Determine microorganism population in pounds.
      i. A wastewater treatment tank has a volume of 3.0 (MG) million gallons and has a solids concentration of 2500 mg/l (parts per million) which is 81% volatile (microorganisms).

Bacteria under Aeration (lbs) = 8.34 (lbs*L/MG*mg) x Vol,(MG) x Conc. (mg/l) x Volatile %

   c. Comparing pounds of wastewater contamination (bacteria food) to pounds of bacteria in the treatment system what is the Food to Microorganism Ratio?

$$F/M = \frac{\text{CBOD applied}}{\text{Organic solids under aeration}}$$