Problem of the Day

2014.Oct.1

Discussion

Calculating the pounds of mixed liquor volatile suspended solids (MLVSS) under aeration is required to calculate the food-to-microorganism (F/M) ratio. Most state certification exams require operators to be able to calculate the F/M ratio and to use it to determine how many pounds of biomass, or "microorganisms," are needed in the aeration basin for the amount of BOD, or "food," per day that is entering the aeration basin. The utility of the F/M ratio for controlling the activated sludge process will be discussed further in a future Problem of the Day. **Suffice it to say here, and this is contrary to what readers will hear from almost everybody except WWTT, neither operators nor engineers control the amount of biomass in an activated sludge system, the microbes do**. If you understand this concept, you understand the activated sludge process.

Problem

Today's problem is a precursor to other F/M ratio calculations.

Problem of the Day: An aeration basin is 125 ft long, 35 ft wide and 18 ft deep. The MLVSS concentration is 1,880 mg/L (1,880 mg MLVSS/L). How many pounds of MLVSS are in this aeration basin?

Solution

This is another pounds calculation. Pounds, not pounds per day. As discussed in the 2014.Sept.21 Problem of the Day, understand that when calculating "pounds," volume is used, and when calculating "pounds/day," flow is used. If concentration is given in units of "mg/L" or "ppM," which are equivalent, **the calculation for pounds (or pounds/day) will always be Concentration x Volume (or Flow) x 8.34**. The aspiring wastewater treatment plant operator must know the pounds and pounds-per-day calculations because it is necessary to calculate pounds and pounds per day in many wastewater math problems. Keep in mind, though, that it is **imperative** that these calculations be made using unit cancelation as has been demonstrated in previous Problems of the Day. Keep in mind, too, that **volume or flow must be in units of Mgal or Mgal/Time** (note, it is not necessary to always express flow in units of Mgal/day). Including the conversion factor M·mg/L will remind the student of the need for Mgal so the Ms cancel!

The first step, as always, is to identify the units wanted in the answer—in this case, lb MLVSS—which is entered between heavy vertical lines followed by an equals sign and the blank track.

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$$\left| \text{lb MLVSS} \right| = \frac{\quad}{\quad}$$

WWTT always starts pounds and pounds-per-day railroad tracks with the given concentration. In this problem, doing so gets the units "MLVSS," needed in the answer, entered into the railroad track.

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$$\left| \text{lb } \mathbf{MLVSS} \right| = \frac{\left| 1{,}880 \text{ mg } \mathbf{MLVSS} \right|}{\left| \text{L} \right|} \quad \left| \quad \right|$$

Whenever the units, "mg/L," are entered into the railroad track (unless solving for mg/L), the conversion factor "L/M·mg" is entered to cancel out mg and L.

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The "M" in the denominator is a reminder that an "Mgal" is needed in the numerator. In this problem the volume of the aeration basin has to be calculated in ft^3, converted to gal, and then converted to Mgal. To cancel the Ms, the Mgal-to-gal conversion is entered next in the railroad track.

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$$\text{lb } \textbf{MLVSS} = \frac{1{,}880\ \cancel{\text{mg}}\ \textbf{MLVSS} \;\big|\; \cancel{\text{L}} \;\big|\; \cancel{\text{M}}\text{gal}}{\cancel{\text{L}} \;\big|\; \cancel{\text{M}}\cdot\cancel{\text{mg}} \;\big|\; 10^6\ \text{gal}}$$

The entry, "10^6," is shorthand (scientific notation) for "1,000,000." This conversion factor, 10^6 gal/Mgal (inverted in this railroad track, Mgal/10^6 gal), basically says "there's 1,000,000 gal in an Mgal." Using this conversion factor will eliminate the need in an exam to figure out if the problem requires multiplication or division by 1,000,000. Keep in mind that "10^6" means a "1" (**not** a "10") followed by six zeros.

Also note in the railroad track above, that the units, gal, in the numerator and denominator are not canceled. This is to remind us that we have to find the volume of the aeration basin, which is length times width times depth.

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No units are canceled here, but the ft x ft x ft (ft^3), calls for the conversion factor, 7.48 gal/ft^3), which cancels several units.

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As can be seen, there is still a gal that needs to be canceled and lb are needed in the railroad track because this unit is needed in the answer. The last step is to enter the density of water into the railroad track.

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All the units have canceled except those needed in the answer, lb MLVSS, so the math is done. The arithmetic completes the problem:

1,880 x 125 x 35 x 18 x 7.48 x 8.34 ÷ 1,000,000 = <u>9,236 lb MLVSS</u>.

How cool is that?