Problem of the Day

2014.Nov.30

Introduction

Every operator should know how to calculate pounds and pounds per day given concentration (in mg/L or ppM) and volume and flow, respectively. The conversion factor that makes the units "work" in the pounds and pounds-per-day calculation is my favorite:

$$\frac{M \cdot mg}{L} \quad \text{or} \quad \frac{L}{M \cdot mg}$$

WWTT recommends that whenever concentration is given in ppM (parts per million parts), it should be expressed as mg/L because in the water and wastewater business, mg/L is equal to ppM. But notice the M in the conversion factor above. This M has to be canceled by the M in Mgal so every pounds and pounds-per-day calculation is going to need an Mgal in the railroad track. Today's Problem of the Day demonstrates.

Problem of the Day

Calculate the pounds of MLSS in two aeration basins each 175 feet long, 35 feet wide, with 20 feet water depth. The MLSS concentration measured on a grab sample earlier today was 1,825 mg/L.

Discussion

I can't tell you how often we calculate pounds and pounds per day in the wastewater treatment business. We do these calculations over and over and over again. Doing them should be second nature to all operators. No matter how comfortable you are doing these calculations, WWTT recommends you always carry the units all the way through so you don't forget anything. Today's problem is a good example of "a lot going on." Remember: units are your friend and they will tell how how to do a problem in almost all instances.

Solution

We are obviously solving for pounds of MLSS in this problem, so we start with the units we want in the answer between heavy vertical lines followed by the equals sign and the blank track.

Problem of the Day: Calculate the pounds of MLSS in two aeration basins each 175 feet long, 35 feet wide, with 20 feet water depth. The MLSS concentration measured on a grab sample earlier today was 1,825 mg/L.

Information summary, specifically labeled:

- Number of aeration basins = 2 AB
- Aeration basin length = 175 ft
- Aeration basin width = 35 ft
- Aeration basin water depth = 20 ft
- MLSS concentration = 1,825 mg MLSS/L
- **Calculate: pounds of MLSS in the two aeration basins**.

$$|\text{lb MLSS}| = \_\_\_\_\_$$

The unit, **MLSS**, needed in the answer only shows up in the list of information given in the problem in one other place, 1,825 mg **MLSS**/L. Entering this starts the railroad track.

$$|\text{lb } \mathbf{MLSS}| = \frac{|1{,}825 \text{ mg } \mathbf{MLSS}|}{|\text{L}|}$$

Whenever mg/L are entered into the railroad track, WWTT recommends they be canceled with the conversion factor, **M•mg/L**, unless the problem is solving for mg/L.

$$|\text{lb } \mathbf{MLSS}| = \frac{|1{,}825 \ \cancel{\text{mg}} \ \mathbf{MLSS}| \ |\cancel{\text{L}}|}{|\cancel{\text{L}}| \ |\text{M}\cancel{\text{mg}}|}$$

The M that remains in the denominator is a reminder that an Mgal is needed in the numerator to cancel the Ms. But there is no Mgal in the information given in the problem. What do we do? We use the conversion factor, **Mgal/10^6 gal**, to enter the Mgal needed. Notice, too, that gal cancels in the numerator and denominator.

$$|\text{lb } \mathbf{MLSS}| = \frac{|1{,}825 \ \cancel{\text{mg}} \ \mathbf{MLSS}| \ |\cancel{\text{L}}| \ |\cancel{\text{Mgal}}|}{|\cancel{\text{L}}| \ |\cancel{\text{M}}\cancel{\text{mg}}| \ |10^6 \ \cancel{\text{gal}}|}$$

It looks like we're in trouble because we've canceled all the units in the railroad track except MLSS. But we still need **lb** in the answer so it has to be entered in the railroad track. We do this with the density of water. Notice that the unit, **lb**, has to go in the numerator.

lb MLSS	=	1,825 ~~mg~~ **MLSS**	~~L~~	~~Mgal~~	8.34 **lb**	
		~~L~~	~~M mg~~	10^6 ~~gal~~	gal	

Now we have the units needed in the answer, **lb MLSS**, but we've added, and need to cancel, **gal**. But there is no other information given in the problem that has **gal** in it. What do we do? We enter another conversion factor in order to cancel gal, **7.48 gal/ft³**.

lb MLSS	=	1,825 ~~mg~~ **MLSS**	~~L~~	~~Mgal~~	8.34 **lb**	7.48 ~~gal~~	
		~~L~~	~~M mg~~	10^6 ~~gal~~	~~gal~~	ft^3	

We now enter the volume of an aeration basin, length times width times depth, to cancel **ft³**, which is ft x ft x ft.

lb MLSS	=	1,825 ~~mg~~ **MLSS**	~~L~~	~~Mgal~~	8.34 **lb**	7.48 ~~gal~~	175 ~~ft~~	35 ~~ft~~	20 ~~ft~~	
		~~L~~	~~M mg~~	10^6 ~~gal~~	~~gal~~	~~ft^3~~	AB			

The volume we just entered is per aeration basin (**AB**). But how many aeration basins do we have? Two.

lb MLSS	=	1,825 ~~mg~~ **MLSS**	~~L~~	~~Mgal~~	8.34 **lb**	7.48 ~~gal~~	175 ~~ft~~	35 ~~ft~~	20 ~~ft~~	2 ~~AB~~
		~~L~~	~~M mg~~	10^6 ~~gal~~	~~gal~~	~~ft^3~~	~~AB~~			

Finally, the only units remaining in the railroad track are **lb MLSS** needed in the answer so the math is done. The arithmetic gives the answer:

1,825 x 8.34 x 7.48 x 175 x 35 x 20 x 2 ÷ 1,000,000 = **27,893 lb MLSS**.

Many of you in California may have heard that water treatment plant certification has been moved from the California Department of Health Services to the Office of Operator Certification in the Water Quality Control Board. We think our approach to doing math problems is so sound, WWTT is going to start doing math review for water treatment plant operators. If you know of anybody who is pursuing water treatment plant operator certification, or if you are, visit our courses webpage here. The water classes aren't up yet, but they will be soon!

Happy calculating. Let us know, by leaving a comment, if you want us to do a specific problem.