Problem of the Day

2015.Aug.17

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A wastewater treatment plant receives an average flow of 1.65 MGD. The influent TSS concentration averages 312 mg/L. How many pounds of TSS per day are received at the plant?

Introduction

This, obviously, is a very straightforward pounds-per-day calculation. I am behind on Problems of the Day so I'm actually writing the 2015.Aug.17 Problem of the Day on September 25, 2015, the day after WasteWater Technology Trainers finished the summer certification review season with a Grades I and II Operator Certification and Math Review class in Oceanside, California sponsored by the City of Oceanside.

I've always had this niggling in the back of my head that I approach pounds and pounds-per-day calculations a little differently whether the concentration for whatever pollutant of interest is given in mg/L or percent (%). I have always been very consistent in my approach to both, but they are just a little bit different and that difference has always bothered me a little.

Today I woke up thinking about that difference. So I'm going to try something new in today's Problem of the Day.

In the water and wastewater treatment business, a mg/L is equivalent to a part per million parts, or ppM. This is because the density of water is equal to 1 gram per milliliter (1g/mL) in metric units. This leads to the fact that 1 L of water weighs 1,000,000 mg, so 1 mg in a L of water is 1 ppM. Even though most operators are told very early on in their careers that a mg/L is equivalent to a ppM, there are a lot of folks that get this wrong on certification exams.

In contrast to a mg/L, percent (%) is equivalent to a part per hundred parts, or ppH. There is a big difference between a ppH and a ppM best appreciated by example: What would you rather have, a hundred dollars or a million dollars? Big, big difference!

In our classes I've always told folks that if concentration is given in mg/L, you will use the pounds or pounds-per-day calculation. If concentration is given in %, I teach people to label things in a very specific way to let the units "do the math for you." The solution given below to today's Problem of the Day is presented a little differently. Let me what you think.

Solution

The following information is given in the problem statement or assumed. Note the manner in which I have modified the way I express mg/L and others.

1. Plant flow = 1.65 Mgal H_2O/d (because raw sewage is 99.9% pure water as discussed in class!)
2. TSS concentration = 312 mg/L = 312 ppM = 312 lb TSS/M lb H_2O
3. Density of water = 8.34 lb H_2O/gal H_2O

Today's problem asks to calculate pounds of TSS per day in the influent. These units, lb TSS/d, then, are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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$$\left|\frac{\text{lb TSS}}{\text{d}}\right| = \frac{\qquad\qquad\qquad\qquad\qquad\qquad}{}$$

The only place the units lb TSS appear in the list is in the numerator of No. 2. This, then, is entered to start the solution bridge to get the units needed in the numerator of the answer as shown in bold.

$$\left|\frac{\textbf{lb TSS}}{\text{d}}\right| = \left|\frac{312\ \textbf{lb TSS}}{\text{M lb } H_2O}\right| \frac{\qquad\qquad\qquad\qquad\qquad\qquad}{}$$

The only place the units d appear in the list is in the denominator of No. 1. This, then, is entered next to get the units needed in the denominator of the answer as shown in bold. Notice, too, that the Ms cancel denominator and numerator.

$$\frac{\textbf{lb TSS}}{\textbf{d}} = \frac{312\ \textbf{lb TSS}}{\cancel{\text{M}}\ \text{lb } H_2O} \quad \frac{1.65\ \cancel{\text{M}}\text{gal } H_2O}{\textbf{d}}$$

We have all the units on the solution bridge needed in the answer, lb TSS/d (shown in bold), so now the "solution" is to cancel unwanted units. Entering the density of water (No. 3 in the list) so lb H_2O cancel also cancels gal H_2O.

$$\frac{\textbf{lb TSS}}{\textbf{d}} = \frac{312\ \textbf{lb TSS}}{\cancel{\text{M}}\ \cancel{\text{lb } H_2O}} \quad \frac{1.65\ \cancel{\text{Mgal } H_2O}}{\textbf{d}} \quad \frac{8.34\ \cancel{\text{lb } H_2O}}{\cancel{\text{gal } H_2O}}$$

Since all the units have now canceled except those needed in the answer, **lb TSS/d**, we know the solution bridge is complete. The arithmetic gives the answer.

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$$\frac{\textbf{lb TSS}}{\textbf{d}} = \frac{312\ \textbf{lb TSS}}{\cancel{\text{M}}\ \cancel{\text{lb } H_2O}} \quad \frac{1.65\ \cancel{\text{Mgal } H_2O}}{\textbf{d}} \quad \frac{8.34\ \cancel{\text{lb } H_2O}}{\cancel{\text{gal } H_2O}}$$

312 x 1.65 x 8.34 = **4,293 lb TSS/d**.

Discussion

Again, this is no more than the pounds-per-day calculation, but it is shortened by one step from how I have been "solution bridging" this kind of calculation. Note by representing the mg/L concentration as ppM and expressing it in terms of "lb per M lb," I don't have to use the conversion factor L/M·mg. Note, too, that my general strategy has become, based on the recommendation of one of WWTT's students, that we get all units needed in the answer on the solution bridge before we start canceling unwanted units. I'm liking this strategy. How about you?

In tomorrow's Problem of the Day I work a problem that was the kind of problem that caused me the greatest angst in terms of different tacts I have taken to solving for pounds per day depending if the concentration of pollutant was given in mg/L or percent.

Happy calculating! Let us know, by leaving a comment, if you want us to do a specific problem, if you see a mistake, or if you have a question on any of the Problems of the Day you are looking at.