Problem of the Day

2015.Dec.1

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The COD concentration in the raw sewage to the Springfield Resource Recovery Facility averaged 524 mg/L last month. During the same time, the flow to the facility averaged 65.6 MGD. On average, how many pounds of COD did the facility treat each day during the past month?

Introduction

I have been away from Problem of the Day since mid-August 2015. I was so far behind then and there was so much going on, I decided to take a little "vacation." Since then, the wastewater operator certification exams in California have been given (October 10, 2015). We have heard back from many operators who took their exams. So far, so good except for a few who all seemed to have missed the passing score by very few points. One operator taking the Grade II exam missed the passing score by three points! The Grade I and Grade II wastewater certification exams given by the California State Water Quality Control Board's Office of Operator Certification (http://www.swrcb.ca.gov/water_issues/programs/operator_certification/operator_certification.shtml) are true/false and multiple choice. The 10 math problems given on the two exams are multiple choice. If an examinee shows his/her math solutions, **neatly and legibly**, it is possible to receive partial credit for an incorrect answer. The operator I just referenced did not show his work for all his math solutions. I don't know if he may have scored the three points needed to pass had he shown his work for all the math solutions, but since he scored 31 points on the math section out of a possible 40 points (4 points each), he did receive at least some partial credit on the solutions he did show. There is an important lesson here: show your work, neatly and legibly. You never know.

About the time I took a vacation from Problem of the Day, I had begun approaching pounds and pounds-per-day problems a little bit differently. The Problem of the Day for 2015.Aug.17 (http://wastewatertechnologytrainers.com/wp-content/uploads/2015/09/2015.Aug_.17.pdf), in fact, was when I introduced this "new way."

Today's Problem of the Day, obviously, is a very straightforward pounds-per-day calculation. As I said on August 17, 2015, 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. Resolving that difference is what prompted me to try it a new way.

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 (1 g/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 between the two!

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 in my new way. 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. The expressions I have used (for example "raw sewage (RS)" are not unique. As you get used to doing problems like this, you can use whatever expressions make the most sense to you.

1. Raw sewage (RS) influent flow = 65.6 Mgal RS/d
2. Influent COD concentration = 524 mg/L = 524 ppM = 524 lb COD/M lb RS
3. Density of RS = 8.34 lb RS/gal RS (assumed since not given)

Today's problem asks to calculate lb COD/d treated at the facility. These units, then, are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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

The only place the units lb COD appear in the list given above 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.

$$\left|\frac{\textbf{lb COD}}{\text{d}}\right| = \left|\frac{524\ \textbf{lb COD}}{\text{M lb RS}}\right| \frac{\qquad\qquad\qquad\qquad}{}$$

I have been convinced by several students in recent classes to get all the units on the solution bridge needed in the answer before starting to cancel units. To this end, I look in the list above for the units d. The only place they appear is in the denominator of No. 1. This, then, is entered to get the units needed in the denominator of the answer as shown in bold. Note the Ms cancel in the denominator and numerator.

$$\left|\frac{\textbf{lb COD}}{\textbf{d}}\right| = \left|\frac{524\ \textbf{lb COD}}{\cancel{\text{M}}\ \text{lb RS}}\right| \left|\frac{65.6\ \cancel{\text{M}}\ \text{gal RS}}{\textbf{d}}\right| \frac{8.34\ \text{lb RS}}{\text{gal RS}}$$

The solution bridge now contains all the units needed in the answer. The next step is to cancel unwanted units. The density of the raw sewage (No. 3) is entered so the units lb RS and gal RS cancel in the numerator and denominator.

$$\left|\frac{\textbf{lb COD}}{\textbf{d}}\right| = \left|\frac{524\ \textbf{lb COD}}{\cancel{\text{M}}\ \cancel{\text{lb RS}}}\right| \left|\frac{65.6\ \cancel{\text{M}}\ \cancel{\text{gal RS}}}{\textbf{d}}\right| \frac{8.34\ \cancel{\text{lb RS}}}{\cancel{\text{gal RS}}}$$

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

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$$\left|\frac{\textbf{lb COD}}{\textbf{d}}\right| = \left|\frac{524\ \textbf{lb COD}}{\cancel{\text{M}}\ \cancel{\text{lb RS}}}\right| \left|\frac{65.6\ \cancel{\text{M}}\ \cancel{\text{gal RS}}}{\textbf{d}}\right| \frac{8.34\ \cancel{\text{lb RS}}}{\cancel{\text{gal RS}}}$$

524 x 65.6 x 8.34 = **<u>287,000 lb COD/d</u>** (rounded).

Discussion

I'm liking the "lb/M lb." What do you think?

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.