WASTEWATER TECHNOLOGY
TRAINERS

Transforming today's operators into tomorrow's water quality professionals

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Problem of the Day

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Introduction

I understand that math gives many operators angst. Math gives many people angst. But as operations professionals, we can't dwell on the angst that math causes us because it is self defeating. Instead, we need to put that negative energy into understanding the problem at hand and practice, practice, practice.

Without being disrespectful, I would venture that the root cause of math anxiety for many of us can largely be explained by one or more poor math teachers in the beginning of our schooling. I don't have any statistics or scholarly papers to back up that assertion, but from my own experience as a trainer I have observed, over and over, this scenario: (1) a talented operator during introductions at the beginning of one of our certification review classes admits, "I can't do math; I have never been able to do math; I am going to fail," and (2) said operator passes his/her certification exam with "... no problem with the math; made only a couple of stupid mistakes" (http://wastewatertechnologytrainers.com/testimonials/). Success.

The solution to water and wastewater math problems for folks who struggle with math is to carry units through the problem. **Units show you how to do the problem**. In previous posts I discussed an article on the *TPO Magazine* website entitled, "5 Tips for Acing Wastewater Exam Math Questions" (http://www.tpomag.com/online_exclusives/2014/12/5_tips_for_acing_wastewater_exam_math_questions). There are multiple issues I have with the article, which, overall, I see as a disservice to the operations profession, but the most unforgiving is where the article express volume in MGD! **Gallons** is a unit of **volume** and **million gallons** is a unit of **volume**, but **MGD** is a unit of **flow**. While flow is volume per unit time, **volume and flow are not the same thing**. *TPO Magazine* should know better.

Primary clarification removes more organics for less money than any other process unit at a wastewater treatment plant. The process objective of primary clarification is the removal of settleable total suspended solids (TSS_{set}). Fortuitously, the BOD (or COD) associated with those solids also is removed and this is important. The reason it is important is because secondary treatment, where the remaining BOD is "removed" (I will explain "removed" in a subsequent post), is expensive, so the more BOD removed in the primary clarifiers, the better.

Problem of the Day

A primary clarifier has a detention time of 2 hours. The flow to the clarifier is 4.8 MGD. Calculate the volume of the primary clarifier in gallons.

Discussion

The equation for calculating detention time, fill time and empty time is always:

$$T = \frac{V}{Q}$$

where T is time (detention, fill or empty), V is volume, and Q is flow. Same equation over and over and over again. But in this problem we're calculating V given T and Q. We can easily solve this equation algebraically for V (since T and Q are known), but we're just going to let the units tell us what to do because the units will never let us down.

Solution

The question asks specifically to calculate volume in units of gallons. These units, **gal**, are put between heavy vertical lines followed by the equals sign and the blank track.

Problem of the Day: A primary clarifier has a detention time of 2 hours. The flow to the clarifier is 4.8 MGD. Calculate the volume of the primary clarifier in gallons.

Information summary, specifically labeled:

- Primary influent flow = 4.8 Mgal/d
- Detention time = 2 hr
- **Calculate: Primary clarifier volume in gal**.

$$|\text{gal}| = \_\_\_\_\_$$

The problem doesn't give much information. We don't have anything given with the units, **gal**, but we do have M**gal**/d, so that's how we start the railroad track.

$$|\text{gal}| = \frac{4.8\ \text{Mgal}}{\text{d}} \quad \_\_\_\_\_$$

We have to convert **Mgal** to **gal**. The conversion factor WWTT uses that basically says, "There's a million gallons in a million gallons," or **10^6 gal/Mgal**, seems kind of silly, but under the pressure of an exam, it will take the thinking out of "should I divide by 1,000,000 or multiply?" You won't make a mistake if you use it to cancel units as shown.

$$|\textbf{gal}| = \frac{4.8\ \cancel{\text{Mgal}}}{\text{d}} \quad \frac{10^6\ \textbf{gal}}{\cancel{\text{Mgal}}} \quad \_\_\_\_\_$$

We have the units we need in the answer in the railroad track, **gal**, but we need to cancel **d**. In the information from the problem, we know we have 2 **hr**. Hours, like days, is a unit of time, so we convert **d** to **hr** using the well-known conversion factor.

$$|\textbf{gal}| = \frac{4.8\ \cancel{\text{Mgal}}}{\cancel{\text{d}}} \quad \frac{10^6\ \textbf{gal}}{\cancel{\text{Mgal}}} \quad \frac{\cancel{\text{d}}}{24\ \text{hr}} \quad \_\_\_\_\_$$

Now we cancel hr with the detention time given in the problem.

$$\left| \textbf{gal} \right| = \frac{4.8\ \cancel{\text{Mgal}} \quad 10^6\ \textbf{gal} \quad \cancel{\text{d}} \quad 2\ \cancel{\text{hr}}}{\cancel{\text{d}} \quad \cancel{\text{Mgal}} \quad 24\ \cancel{\text{hr}}}$$

Because all the units have canceled in the railroad track except those needed in the answer, **gal**, we **know** the math is done.

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$$\left| \textbf{gal} \right| = \frac{4.8\ \cancel{\text{Mgal}} \quad 10^6\ \textbf{gal} \quad \cancel{\text{d}} \quad 2\ \cancel{\text{hr}}}{\cancel{\text{d}} \quad \cancel{\text{Mgal}} \quad 24\ \cancel{\text{hr}}}$$

The arithmetic gives the answer:

4.8 x 1,000,000 x 2 ÷ 24 = **400,000 gal**.

Math is not random. Use units and you will succeed.

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