



Problem of the Day 2014.Dec.09

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 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; a couple of stupid mistakes" (<http://wastewatertechnologytrainers.com/testimonials/>).

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 two 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**. I'm thinking *TPO Magazine* should be ashamed.

Add the words "math" and "pond" together and operators get even more angst!

The reason for this, I think, is that most operators have little or no experience with wastewater treatment ponds. The other thing about ponds that is a source of confusion is that some of the units associated with ponds are fairly unique to ponds. For example, area is expressed in **ac**, volume is expressed in **ac·ft**, hydraulic loading is expressed in **in/d**, organic loading is expressed in **lb BOD/d·ac**. Just keep the units straight, and enjoy finding the solution to all your pond problems!

Problem of the Day

A wastewater treatment system consists of two ponds, one 35 acres in area, the other 26 acres in area. Both are operated at a depth of 6 feet during the winter. The wastewater flow from the community served by the pond system is 2.38 MGD. What is the detention time in the pond system in days?

Discussion

Wastewater treatment plant operators often have to calculate how long it takes to fill a tank or a reservoir, how long it takes to empty a tank or a reservoir, or what the detention time is in a tank or a reservoir.

Whenever a question arises asking about time (T) and includes volume (V) and flow rate (Q), the equation will almost always be the same:

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

Repeat for emphasis, **this is the equation that will be used for every question asking about fill time, empty time or detention time.** All that is needed to do the calculation is the volume and flow rate and the units required in the answer. And sometimes questions will arise that ask to find volume given time and flow rate, or to find flow rate given time and volume. **Same equation slightly rearranged.**

As mentioned at the beginning of this post, there are many units that are fairly unique to ponds. Area is almost always given in acres. Often on certification math problems, flow is given in MGD. Many trainers instruct operators to convert flow in MGD to ac-ft/d. This just confuses the problem. What I like to call the “holy grail” conversion factor for ponds is:

$$\frac{3.069 \text{ ac-ft}}{\text{Mgal}} \quad \text{or} \quad \frac{\text{Mgal}}{3.069 \text{ ac-ft}}$$

I strongly recommend you memorize this. It makes many pond problems easy.

Also, to do this problem, we have to remember that volume (V in the equation above) is calculated for any body of water, even an ocean, by multiplying the surface area (A) times the depth (D):

$$V = A \times D$$

Solution

The question asks specifically for “... days ...” These units, **d**, are put between heavy vertical lines followed by the equals sign and the blank track. The equation for calculating detention time also is shown because it will be used to populate the railroad track.

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Information summary, specifically labeled:

- Plant flow = 2.38 Mgal/d
- Pond area = 35 ac + 26 ac = 61 ac
- Pond depth = 6 ft
- **Calculate: Detention time in d.**

$$\left| \quad d \quad \right| = \frac{V}{Q} = \underline{\hspace{10em}}$$

The railroad track is started by entering the volume of the pond system (surface area x depth) in the numerator divided by the flow. “Divided” means the flow is entered in the denominator.

d	$= \frac{V}{Q} =$	61 ac	6 ft	d	
					2.38 Mgal

Here is a truly helpful hint: if you are doing a pond problem and you have **ac** and **Mgal** on either side of the railroad track or either side of the equals sign, 9.9 times out of 10 you will use the holy grail pond conversion factor given above. Notice what happens when it's used in this example:

d	$= \frac{V}{Q} =$	61 ac	6 ft	d	Mgal
					2.38 Mgal

Done! All the units have canceled except those needed in the answer, **d**, shown in bold.

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The arithmetic gives the answer:

$$61 \times 6 \div 2.38 \div 3.069 = \mathbf{50\ d}$$

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

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 State Water Resources Control Board. We think our approach to doing math problems is so sound and can help so many operators, water and wastewater, WWTT is going to start doing math review classes for water treatment plant operators. If you know of anybody who is pursuing water treatment plant or distribution operator certification, or if you are, visit WWTT's courses webpage [here](#). The water classes aren't up as of this writing, but they will be soon!

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