



**WASTEWATER TECHNOLOGY
T R A I N E R S**

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

**Problem of the Day
2015.Dec.13**

Problem of the Day

It takes 46 days for the level in an 85-acre pond to be raised 3 feet when it begins to discharge. Assuming the flow into the pond was constant and ignoring evaporation and precipitation, calculate the flow, in Mgal/d, into the pond over this time period.

Introduction

Most operators taking certification exams abhor “pond problems,” but we really make them way harder than they need to be. In most pond problems, influent flow is given in Mgal/d (MGD) and the area of the pond is given in acres or can be easily converted to acres with the well known conversion factor:

$$\frac{43,560 \text{ ft}^2}{\text{ac}} \quad \text{or} \quad \frac{\text{ac}}{43,560 \text{ ft}^2}$$

If ac and Mgal are both in a pond problem either on opposite sides of the equals sign (=) or on opposite sides of the railroad track, the holy grail conversion factor of pond problems is:

$$\frac{3.069 \text{ acft}}{\text{Mgal}} \quad \text{or} \quad \frac{\text{Mgal}}{3.069 \text{ acft}}$$

With this conversion factor, pond problems “calculate themselves.” Memorize it.

Solution

Understanding the relationship between time, volume and flow is important for all water and wastewater treatment plant operators. 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 and includes a volume (V) and flow rate (Q), the equation will be the same:

$$\text{Time} = \frac{V}{Q}$$

Again, 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.

Our situation here is somewhat different: we know how long it takes to fill the pond 3 feet (85 days), and we can calculate volume ($V = A \times \text{depth}$). In this case, we have to calculate the flow rate.

The equation above can be rearranged to solve for Q, a simple algebraic manipulation:

$$Q = \frac{V}{\text{Time}}$$

This equation is what can be used to populate the solution bridge, which is started by identifying the units needed in the answer, Mgal/d, which are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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$$\left| \frac{\text{Mgal}}{\text{d}} \right| = \underline{\hspace{10em}}$$

It takes 46 days to fill the pond by 3 feet. We need the units d in the denominator of the answer, so the 46 d is entered in the denominator of the solution bridge to get the units needed as shown in bold.

Mgal	=		
d		46 d	

We now need Mgal in the numerator but we don't have these units, so we enter the conversion factor of all pond conversion factors.

Mgal	=		Mgal
d		46 d	3.069 ac-ft

We have all the units on the solution bridge that we need in the answer so now we cancel units. First the area of the pond is entered in the numerator to cancel ac.

Mgal	=		Mgal	85 ac	
d		46 d	3.069 ac-ft		

Now the depth (3 ft) is entered in the numerator to cancel ft.

Mgal	=		Mgal	85 ac	3 ft
d		46 d	3.069 ac-ft		

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

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Mgal	=		Mgal	85 ac	3 ft
d		46 d	3.069 ac-ft		

$$85 \times 3 \div 46 \div 3.069 = \underline{1.81 \text{ Mgal/d}}$$

Discussion

Notice in the final solution bridge that 85 ac × 3 ft is the volume, V, of interest. The volume of any channel, tank, reservoir, pond, even an ocean, is equal to the surface area times the depth. Note, too, that 46 days in the denominator is time, Time. In order to calculate flow, Q, we divided V by Time, the exact equation given above. The difference is we let the units tell us what to do but, either way (unit approach or equation approach), if we get the same answer, we're doing the same thing.

Pond problems are fun!

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.