



**WASTEWATER TECHNOLOGY
TRAINERS**

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

**Problem of the Day
2015.Jul.31**

Problem of the Day

The operator of a 58-acre wastewater stabilization pond increased the operating depth by raising the effluent telescoping weir. During the time the pond was filling to the new depth there was no discharge from the pond and the flow into the pond averaged 1.6 MGD. The depth of the pond was increased 18 inches. How many days does it take to fill the pond to the new level?

Introduction

As in the previous three Problems of the Day, this is a time-volume-flow problem and the equation for such problems is always the same:

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

where T is time, V is volume and Q is flow into or out of a tank, reservoir or, in this case, a pond. The one aspect in today's problems that was not in the others is that the volume of any tank, reservoir or pond is always calculated by multiplying surface area times depth. The equation then becomes:

$$T = \frac{A \times D_{\text{epth}}}{Q}$$

Solution

The list of "givens" expressed in the units used by WWTT:

1. Surface area, A = 58 ac
2. Depth increase, $D_{\text{epth}} = 18$ in
3. Influent flow, Q = 1.6 Mgal/d

The question specifically asks to find how many days it takes to fill the additional volume so the units d are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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	d		=	_____
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The second equation given above tells us how to start the solution bridge: A and D_{epth} ($A \times D_{\text{epth}} = V$) are entered in the numerator and Q is entered in the denominator. Don't worry about the inconsistency in the units, just enter the given information as is.

Area...

	d		=		58 ac		_____
--	---	--	---	--	-------	--	-------

times depth...

	d		=		58 ac		18 in		_____
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divided by flow...

	d		=	58 ac	18 in	d	
						1.6 Mgal	

After the equation for calculating fill time is used to populate the solution bridge, the math is done. What remains is converting units so the unwanted units cancel and we end up with the units needed in the answer. First, inches (in) are converted to feet (ft). Why? Because “ac·in” is not a unit commonly used but “ac·ft” is.

	d		=	58 ac	18 in	d	ft	
						1.6 Mgal	12 in	

Whenever you see ac and Mgal on opposite sides of the solution bridge, you are just about guaranteed to use what WWTT calls the holy grail of pond conversion factors.

	d		=	58 ac	18 in	d	ft	Mgal	
						1.6 Mgal	12 in	3.069 ac·ft	

Since all the unwanted units have now canceled and only the units needed in the answer remain (d, in bold), we know the solution bridge is complete. The arithmetic gives the answer.

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	d		=	58 ac	18 in	d	ft	Mgal	
						1.6 Mgal	12 in	3.069 ac·ft	

$$58 \times 18 \div 1.6 \div 12 \div 3.069 = \mathbf{17.7 \text{ d}}$$

Discussion

Similar problems show up on certification exams. Sometimes this “hint” is provided: “**Hint:** Calculate the hydraulic loading to the pond.” Although this will get you to the right answer, what a complete waste of time! Just know fill time and empty time and detention time all use the same equation and go from there using the solution bridge.

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.