Problem of the Day

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The so called Rational Method uses a very simple equation, Q = C x i x A to calculate the storm water flow rate, Q, from a drainage area, A, as a result of a storm of intensity, i, knowing the runoff coefficient, C. A wastewater treatment plant operator is calculating the stormwater flow, which drains to the plant influent, from a 15-acre area of the plant site. This area is part parking lot, part landscaping with an estimated runoff coefficient of 0.72. The 10-year storm is 5.5 inches of rain in 8 hours. Calculate the flow rate from the storm directed to the plant influent.

Introduction

More and more wastewater treatment plant operators, and certainly wastewater collection system operators, are having to deal with stormwater. While this is not a question you likely will ever be asked on a wastewater treatment plant operator certification exam, it is an interesting lesson in unit conversion. Today's Problem of the Day uses the this-is-going-to-make-your-life-so-much-easier conversion factor reviewed and used yesterday.

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

The problem statement gives the equation we need to use,

Q = CiA,

and then gives us the C, the i and the A, so it's just plug and chug followed by several unit conversions to get to the units needed.

Solution

The problem asks for the units in the answer to be Mgal/d. These units are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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

The solution bridge is started by multiplying C (0.72, no units) times i (5.5 in/8 hr) times A (15 ac).

Mgal / d	=	0.72	5.5 in / 8 hr	15 ac	

As mentioned yesterday, if you have any problem where ac and Mgal are either on opposite sides of the equals sign or on opposite sides of the solution bridge, you are probably going to use the conversion factor given above. To enter this conversion factor, where you see the units ac, go to the opposite side of the solution bridge and enter the conversion factor. Remember when "per" comes across your lips, you go to the other side of the solution bridge. We now have Mgal, needed in the numerator of the answer, on the solution bridge, as shown in bold.

Mgal / d	=	0.72	5.5 in / 8 hr	15 ~~ac~~	**Mgal** / 3.069 ~~ac~~ft	

The in (inches) in the numerator can't cancel the ft in the denominator until these units are canceled with the well known conversion factor 12 in/ft.

Mgal	=	0.72	5.5 ~~in~~	15 ~~ac~~	**Mgal**	~~ft~~	
d			8 hr		3.069 ~~ac~~ft	12 ~~in~~	

Now all we have to do is convert hr to d.

Mgal	=	0.72	5.5 ~~in~~	15 ~~ac~~	**Mgal**	~~ft~~	24 ~~hr~~
d			8 ~~hr~~		3.069 ~~ac~~ft	12 ~~in~~	**d**

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

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Mgal	=	0.72	5.5 ~~in~~	15 ~~ac~~	**Mgal**	~~ft~~	24 ~~hr~~
d			8 ~~hr~~		3.069 ~~ac~~ft	12 ~~in~~	**d**

0.72 x 5.5 x 15 x 24 ÷ 8 ÷ 3.069 ÷ 12 = **4.84 Mgal/d**.

Discussion

Depending on how much flow the plant usually treats, this could be a pretty significant flow rate. Over the eight hours of the storm, a total of 1.61 Mgal of additional influent would enter the plant. How much does it cost at your plant to treat 1 MGD of flow? Multiply that by 1.61 to see what it would cost to treat this additional influent.

Fun with math!

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.