Problem of the Day
2014.Oct.28

Discussion

As discussed in the 2014.Sept.22 Problem of the Day (http://wastewatertechnologytrainers.com/wp-content/uploads/2014/09/2014.Sep_.22-PoD.pdf), 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 and includes a volume (V) and flow rate (Q), the equation always 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, detention time or, as in today's problem, how long it takes to transfer a given volume. All that is needed to do the calculation is the volume, flow rate, and the units required in the answer.

Problem

Again, today's Problem of the Day is straight from a California Grade I practice exam that WWTT uses in its Grades I&II Operator Certification and Math Review Class (http://wastewatertechnologytrainers.com/)

Problem of the Day: If a sludge pump can pump 60 gpm, how long would it take this pump to transfer a total of 9,000 gallons of sludge?

a. 1 hour
b. 1 hour, 45 minutes
c. 2 hours, 10 minutes
d. 2 hours, 30 minutes
e. 9 hours, 40 minutes

Solution

There are only two pieces of information given, the pumping rate of the sludge pump and the volume of sludge to be transferred:

- Q = 60 gal sldg/min
- V = 9,000 gal sldg

The units given in each of the possible answers are mixed, showing both hours and minutes, except for letter a. All operators should know that there are 60 minutes in an hour. For this reason, the question is going to be solved in minutes, which we can then convert to hours and minutes. The unit, min, is entered between heavy vertical lines followed by an equals sign and the empty track as has been done before.

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

In order to get minutes, min, in the railroad track given the information given in the problem statement, the flow rate has to be entered into the denominator. In doing so, this is what you're saying as you're writing, "60 gallons of sludge **per** minute." Remember, whenever you say "per," you cross the railroad track and put whatever comes next on the opposite side as shown below. Minutes, min, are now in the numerator on both sides of the equal sign as shown in **bold**.

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$$|\textbf{min}| = \frac{\textbf{min}}{60 \text{ gal sldg}} \text{\_\_\_\_\_}$$

In order to cancel the units, gal sldg, the volume of sludge to be pumped is entered into the railroad track in the numerator, canceling gal sldg.

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$$|\textbf{min}| = \frac{\textbf{min}}{60 \text{ ~~gal sldg~~}} \frac{9{,}000 \text{ ~~gal sldg~~}}{}$$

Since all units have canceled except those needed in the answer, **min**, the math is done and the arithmetic completes the problem:

9,000 ÷ 60 = 150 min.

This isn't quite the answer since it is not one of the choices. Note that 150 minutes is 2 hours (120 minutes) with 30 minutes left over. Therefore, the answer is:

2 hours 30 minutes, letter d.

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c.
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e.

$$\textbf{min} = \frac{\textbf{min}}{60\ \cancel{\text{gal sldg}}} \times 9{,}000\ \cancel{\text{gal sldg}} = \textbf{150 min} = \textbf{2 hours 30 minutes}$$

It is very important to notice that we didn't even use the equation given at the beginning of this blog, but, in fact, the units told us exactly what to do: divide volume by flow rate. **That's the units talking to you!**