Problem of the Day

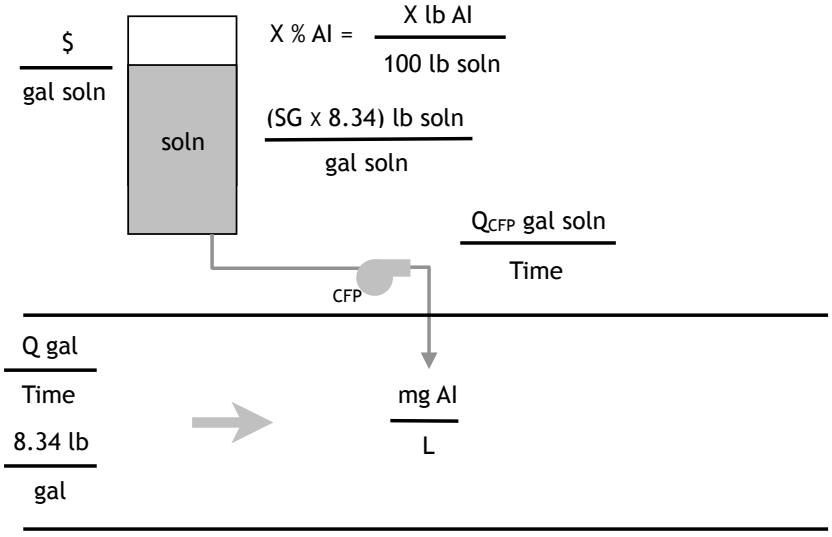
2015.Jul.18

Problem of the Day

High test hypochlorite, HTH, is being used to super-chlorinate a recycle water holding tank. The HTH is 70% available chlorine. The tank is 65 feet in diameter and holds 16 feet of water. How many pounds of HTH must be added to dose the tank at 45 mg/L chlorine?

Introduction

As in yesterday's Problem of the Day, the first step in approaching today's problem is to recognize this as a chemical dosing problem. WWTT uses the same basic graphic, repeated below, for all chemical dosing problems.



Generic graphic for setting up chemical dosing problems (AI = active ingredient, SG = specific gravity, CFP = chemical feed pump, Q_{CFP} = flow rate of chemical feed pump, and Q = process flow).

In today's problem, HTH, a solid, is being added to a volume not a flow. If I were drawing this on the whiteboard, instead of the open-ended pipe shown in the graphic, I'd put "ends" on the pipe so it would look like a tank rather than a pipe. Also, since HTH is a solid, there is no density to report.

Solution

It is helpful to list the "givens" in the problem in the same order used in all chemical dosing problems expressed very specifically (the WWTT way!). Note: the active ingredient in this problem is chlorine (Cl_2)

1. Concentration of active ingredient in HTH = 70% Cl_2 = 70 lb Cl_2/100 lb HTH
2. Density of HTH: no density needed since HTH is a solid
3. HTH feed rate = **unknown**
4. Volume to which HTH is fed: to be determined
5. Density of water = 8.34 lb/gal
6. Dose = 45 mg Cl_2/L

The question asks for pounds of HTH so the units lb HTH are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

Problem of the Day: High test hypochlorite, HTH, is being used to super-chlorinate a recycle water holding tank. The HTH is 70% available chlorine. The tank is 65 feet in diameter and holds 16 feet of water. How many pounds of HTH must be added to dose the tank at 45 mg/L chlorine?

$$\left| \text{lb HTH} \right| = \_\_\_\_\_$$

The solution bridge is started by entering item No. 1 in the list, so that the units lb HTH are in the numerator as needed in the answer (shown in **bold**). In the list given above, this is the only piece of

information given with the units lb HTH.

lb HTH	=	100 **lb HTH**	
		70 lb Cl_2	

There is no other item in the list with the units lb Cl_2, but there is the next best thing, mg Cl_2 (item No. 6). This is entered so the units Cl_2 cancel, denominator and numerator.

lb HTH	=	100 **lb HTH**	45 mg ~~Cl_2~~	
		70 lb ~~Cl_2~~	L	

The next entry cancels mg and L.

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	
		70 lb ~~Cl_2~~	~~L~~	M·~~mg~~	

The M in the conversion factor just entered reminds us that an Mgal is needed (this portion of the solution bridge is a pounds calculation). Since we don't have an Mgal in the information given, we enter the conversion factor Mgal/10^6 gal.

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	~~M~~gal	
		70 lb ~~Cl_2~~	~~L~~	~~M·mg~~	10^6 gal	

There are no other gal in the information given, but we know we can calculate the volume of the tank in ft^3, so another conversion factor is entered.

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	~~M~~gal	7.48 ~~gal~~	
		70 lb ~~Cl_2~~	~~L~~	~~M·mg~~	10^6 ~~gal~~	ft^3	

The volume of the cylindrical tank is entered next and units canceled as appropriate.

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	~~M~~gal	7.48 ~~gal~~	0.785	65 ~~ft~~	65 ~~ft~~	16 ~~ft~~	
		70 lb ~~Cl_2~~	~~L~~	~~M·mg~~	10^6 ~~gal~~	~~ft^3~~					

Finally, the density of water is entered to cancel lb and gal.

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	~~Mgal~~	7.48 ~~gal~~	0.785	65 ~~ft~~	65 ~~ft~~	16 ~~ft~~	8.34 ~~lb~~
		70 ~~lb~~ ~~Cl_2~~	~~L~~	~~M·mg~~	10^6 ~~gal~~	~~ft^3~~					~~gal~~

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.

Problem of the Day: High test hypochlorite, HTH, is being used to super-chlorinate a recycle water holding tank. The HTH is 70% available chlorine. The tank is 65 feet in diameter and holds 16 feet of water. How many pounds of HTH must be added to dose the tank at 45 mg/L chlorine?

lb HTH	=	100 **lb HTH**	45 ~~mg~~ ~~Cl_2~~	~~L~~	~~Mgal~~	7.48 ~~gal~~	0.785	65 ~~ft~~	65 ~~ft~~	16 ~~ft~~	8.34 ~~lb~~
		70 ~~lb~~ ~~Cl_2~~	~~L~~	~~M·mg~~	10^6 ~~gal~~	~~ft^3~~					~~gal~~

100 x 45 x 7.48 x 0.785 x 65 x 65 x 16 x 8.34 ÷ 70 ÷ 1,000,000 = **<u>213 lb HTH</u>**.

Discussion

Again, no need to memorize any equations or piecharts because the units tell us how to solve the problem!

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.