Problem of the Day

2014.Nov.10

Discussion

The Water Environment Federation is the trade organization for water professionals, including wastewater treatment operations professionals (http://wefcom.wef.org/home). Individual states, or groups of states, sponsor local chapters. On October 29, 2014, I gave a 6-hour Math for Operators Workshop at the annual conference of the Pacific Northwest Clean Water Association (PNCWA). PNCWA represents Idaho, Oregon and Washington (http://www.pncwa.org/). All operators should seriously consider joining their local association. In California it is the California Water Environment Association (http://www.cwea.org/).

Long story short: I randomly covered a series of math problems in the PNCWA workshop, and I have been requested by several attendees to send them the problems. Instead, I am going to post them here (starting with the 2014.Nov.04 Problem of the Day). They are good practice for all visitors to WWTT's Problem of the Day.

For those of you who may be new to WWTT's Problem of the Day, we insert a page break after the problem statement so you can print it without looking at the solution. **See what you can do to solve the problem before looking at the solution**.

Problem

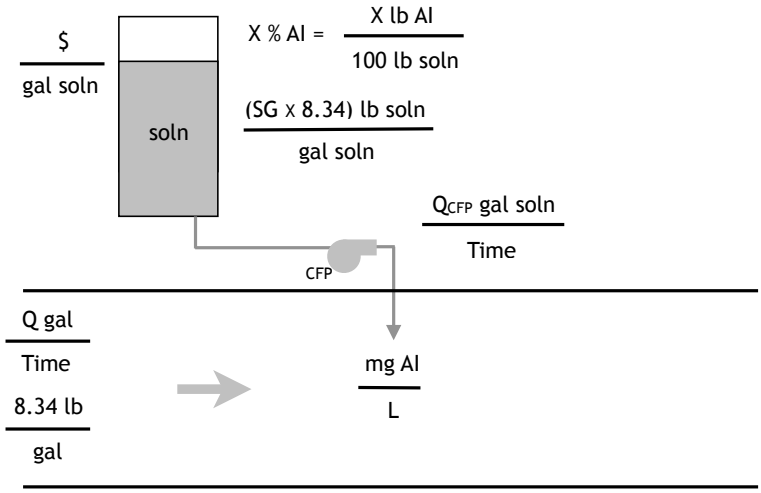
Sometimes it takes a couple of steps to express the "active ingredient" in chemical solutions. Today's problem is about **alum**, chemical name **aluminum sulfate**. **Aluminum (Al) is the active ingredient in alum**. Delivered to water and wastewater treatment plants is liquid aluminum sulfate, or **liquid alum**. Liquid aluminum sulfate is made from dry aluminum sulfate, or **dry alum**. Dry alum is only 9.1% aluminum.

Problem of the Day: Given the following information, calculate the daily cost of alum addition.

- Effluent flow = 2.16 Mgal/d
- Liquid alum (LA) is 49% dry alum (DA) = 49 lb DA/100 lb LA
- Specific gravity of LA = 1.32
- Liquid alum costs $2.95/gal = $2.95/gal LA
- The aluminum dose to secondary effluent before filtration = 14 mg Al/L
- **Calculate: daily cost of liquid alum addition**.

Solution

This is a chemical dosing problem. WWTT puts all chemical dosing problems in terms of the following graphic:



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).

The six elements (sometimes more) that are important in doing these calculations were discussed in the 2014.Oct.18, 20 and 26 Problems of the Day (http://wastewatertechnologytrainers.com/wp-content/uploads/2014/10/2014.Oct_.18.pdf, http://wastewatertechnologytrainers.com/wp-content/uploads/2014/10/2014.Oct_.20.pdf, http://wastewatertechnologytrainers.com/wp-content/uploads/2014/11/2014.Oct_.26.pdf). These are listed below in the same order as described in those problems.

Problem of the Day: Given the following information, calculate the daily cost of alum addition.

1A. Percent dry alum (DA) in liquid alum (LA) = 49% DA = 49 lb DA/100 lb LA
1B. Percent aluminum (Al) in dry alum = 9.1% Al = 9.1 lb Al/100 lb DA
2. Specific gravity of liquid alum = 1.32: 8.34 lb/gal x 1.32 = 11 lb LA/gal LA
3. Cost of LA = $2.95/gal LA; **calculate daily cost of adding LA**
4. Flow rate of water to which LA is being dosed, Q = 2.16 Mgal/d
5. Density of water = 8.34 lb/gal
6. Al dose to secondary effluent = 14 mg Al/L.

$	=	**$2.95**	~~gal LA~~	100 ~~lb LA~~	100 ~~lb DA~~	14 ~~mg~~ Al	~~L~~	2.16 ~~Mgal~~	8.34 ~~lb~~
d		~~gal LA~~	11 ~~lb LA~~	49 ~~lb DA~~	9.1 ~~lb~~ Al	~~L~~	~~M~~mg	**d**	~~gal~~

All the units have canceled except those needed in the answer, **$/d**. The arithmetic gives the answer:

2.95 x 100 x 100 x 14 x 2.16 x 8.34 ÷ 11 ÷ 49 ÷ 9.1 = **$1,517/d**.

Happy calculating!

Let us know if you see any mistakes or want us to do a specific problem.