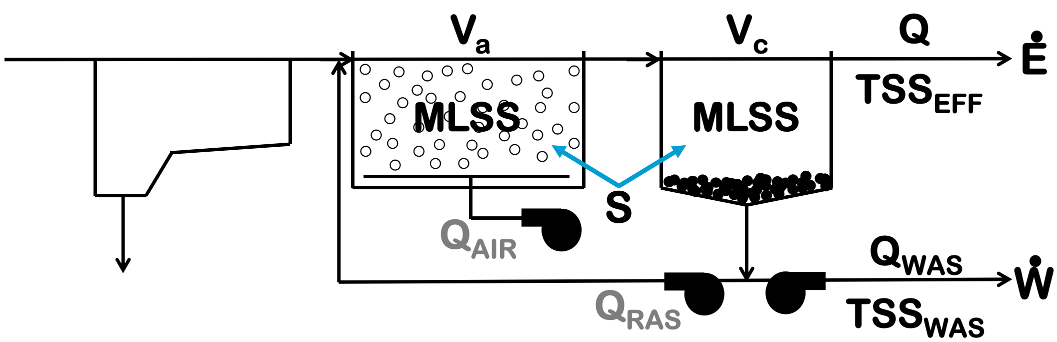
Problem of the Day

2014.Nov.02

Discussion

In many instances operators need to be able to perform what I'll call a "reverse pounds equation." In these kinds of calculations pounds or pounds per day are given and either flow rate or concentration need to be determined. While there are equations or piecharts that can assist you setting up these kinds of problems, WWTT advocates, once again, to let the units tell you how to do the problem. Remember, the units have to always work out.

In the 2014.Oct.04 Problem of the Day (http://wastewatertechnologytrainers.com/wp-content/uploads/2014/10/2014.Oct_.04.pdf), the following graphic was introduced, showing the information needed to calculate and control the MCRT.



Activated sludge process schematic showing information needed to calculate and control the MCRT.

Today's Problem of the Day focuses on the arrow in the graphic pointing to Ẇ, the pounds of TSS per day intentionally removed from the system in the waste activated sludge (WAS) flow (Q_{WAS}).

Problem

The MCRT is the most important parameter an activated sludge operator controls.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

Solution

The following summarizes the information given in the problem statement. Again, WWTT puts this information in very specific units.

- WAS solids to be intentionally removed = 9,500 lb TSS/d
- WAS TSS concentration = 5,890 mg TSS/L
- MCRT target = 6.5 d (not needed in problem)
- **Calculate: Q_{WAS} in gal/min**.

The question specifically asks for the answer to be in the units, **gal/min**. Since these are the units wanted in the answer, they are entered between heavy vertical lines followed by an equals sign and the blank track.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	
min		

The units, **min**, needed in the denominator of the answer, obviously, are a unit of time. This railroad track is started by entering the only other unit of time in the list above, 9,500 lb TSS/**d**, so the time units, **d**, are in the denominator.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 lb TSS	
min		d	

There are a couple of different approaches we could take here. WWTT likes to cancel the unit, **TSS**, by dividing by the WAS TSS concentration as shown.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 lb ~~TSS~~	L	
min		d	5,890 mg ~~TSS~~	

As has been demonstrated before, if the problem is not solving for concentration (mg/L), then mg and L are canceled out using the conversion, M·mg/L, as soon as they are entered.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 lb ~~TSS~~	~~L~~	M·~~mg~~	
min		d	5,890 ~~mg~~ ~~TSS~~	~~L~~	

The units, **lb**, in the numerator are now canceled by dividing by the density of water as shown.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 ~~lb~~ ~~TSS~~	~~L~~	M·~~mg~~	gal	
min		d	5,890 ~~mg~~ ~~TSS~~	~~L~~	8.34 ~~lb~~	

The units in the railroad track now are Mgal/d. In order to cancel the M, we need the unit, Mgal, so the conversion, **10^6 gal/Mgal**, is entered, remembering that 10^6 is shorthand (scientific notation) for 1,000,000 (that is, there are a million gallons in a Mgal) and units are canceled as appropriate. Notice that the units, **gal**, needed in the answer, are now in the railroad track and indicated in **bold**.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 ~~lb~~ ~~TSS~~	~~L~~	~~M·mg~~	~~gal~~	10^6 **gal**	
min		d	5,890 ~~mg~~ ~~TSS~~	~~L~~	8.34 ~~lb~~	~~Mgal~~	

Finally, **d** has to be converted to **min** using the well known conversion factor.

Problem of the Day: The process control operator at the Washington County WWTP has determined he must waste 9,500 pounds of solids in the WAS flow today to maintain a target MCRT of 6.5 days. From historical data, the WAS TSS concentration is expected to average 5,890 mg/L today. What should the WAS pumping rate be set at in gal/min.

gal	=	9,500 ~~lb~~ ~~TSS~~	~~L~~	~~M·mg~~	~~gal~~	10^6 **gal**	~~d~~
min		~~d~~	5,890 ~~mg~~ ~~TSS~~	~~L~~	8.34 ~~lb~~	~~Mgal~~	1,440 **min**

Since all the units have canceled except the ones needed in the answer, **gal/min**, the math is done and the arithmetic gives the answer:

9,500 x 1,000,000 ÷ 5,890 ÷ 8.34 ÷ 1,440 = **<u>134 gal/min</u>**.

This is a great example of a “reverse pounds” calculation. While there may be formulas or piecharts that you can memorize to help you set this kind of problem up, we just let the units tell us what to do, and it works every time.

Happy calculating!