Problem of the Day

2014.Nov.21

Introduction

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 before and 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**.

For the last several days, the Problem of the Day has focused on velocity. Hydraulic loading on wastewater treatment ponds, the subject of yesterday's Problem of the Day, also is a "velocity" calculation. Hydraulic loading to ponds is always in units of **inches/day**., which are units of velocity, length/time. Today we shift our attention to calculating **percent removal** also known as **removal efficiency**. This is an important calculation for wastewater treatment plant operators to be able to do; often NPDES permits require calculating the TSS and BOD removal efficiencies across a plant (see, for example, the 2014.Oct.08 Problem of the Day, http://wastewatertechnologytrainers.com/wp-content/uploads/2014/10/2014.Oct_.08.pdf)

Problem of the Day

Given the following information, calculate the primary clarifier TSS and BOD removal efficiencies.

- Influent TSS = 315 mg/L
- Influent BOD = 330 mg/L
- Primary effluent TSS = 100 mg/L
- Primary effluent BOD = 198 mg/L
- **Calculate: primary clarifier TSS and BOD removal efficiencies**.

Discussion

The 2014.Sept.23 Problem of the Day (http://wastewatertechnologytrainers.com/wp-content/uploads/2014/09/2014.Sep_.23-PoD.pdf) discussed the removal efficiency, also known as percent removal or percent removal efficiency, calculation. The following equation is used.

$$\text{Removal efficiency (\%)} = \frac{(C_{in} - C_{out})}{C_{in}} \Big| 100$$

C_{in} = the concentration, mg/L, of BOD, TSS or other constituent, or mL/L of settleable solids in the influent to any process unit or treatment plant

C_{out} = the concentration, mg/L, of BOD, TSS, or other constituent, or mL/L settleable solids in the effluent from any process unit or treatment plant.

As can be seen, removal efficiency is always expressed as a percent. It is important to note that whenever calculating percent, all the units must cancel out.

Solution

WWTT is very specific in how the concentrations given in the problem are expressed, as can be seen below. Otherwise, the percent removal calculation is very simple. Operators should be able to do these calculations quickly and, more importantly, accurately.

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- Influent BOD = 330 mg BOD/L
- Primary effluent TSS = 100 mg TSS/L
- Primary effluent BOD = 198 mg BOD/L
- **Calculate: primary clarifier TSS and BOD removal efficiencies**.

$$\textbf{TSS removal efficiency (\%)} = \frac{(315 - 100)\ \cancel{\text{mg TSS/L}}}{315\ \cancel{\text{mg TSS/L}}} \Big| 100$$

As discussed, whenever calculating percent, all the units have to cancel out, which they have. The arithmetic gives the answer:

(315 − 100) x 100 ÷ 315 = **<u>68.3%</u>**.

$$\textbf{BOD removal efficiency (\%)} = \frac{(330 - 198)\ \cancel{\text{mg BOD/L}}}{330\ \cancel{\text{mg BOD/L}}} \Big| 100$$

Again, as discussed, whenever calculating percent, all the units have to cancel out, which they have. The arithmetic gives the answer:

(330 − 198) x 100 ÷ 330 = **<u>40.0%</u>**.

Happy calculating!