Problem of the Day

2014.Dec.17

Introduction

I have always heard that the Chinese character meaning "crisis" is two characters superimposed on each other. The first, taken by itself, means "danger." The second, taken by itself, means "opportunity." With the drought in California, we have certainly been in crisis mode. But what amazing opportunity! **It is a good time to be in the water business**. We really can live without oil. It's impossible to live without water.

But the water business is getting more and more sophisticated. So much of protecting the public's health rests on the shoulders of water and wastewater treatment plant operators. We also must do our jobs as cost effectively as possible to protect our ratepayers' hard earned money. Our jobs aren't just about "meeting permit." Consider this, or something like it, as the professional operator's credo:

> **The mission of wastewater treatment plant operators is to remove pollutants from the incoming water while complying with all permit requirements—water, land and air—and convert them to safe disposable biosolids as sustainably and cost effectively as possible.**

How do we prove to our ratepayers, regulators and ourselves that we're up for the task: **by attaining increasing levels of certification**.

Primary clarifiers remove more organics for less money than any other process unit at a wastewater treatment plant. The process objective of primary clarification is the removal of settleable total suspended solids (TSS_{set}). The BOD (or COD) associated with those solids is removed when the solids are removed. This is important. The reason it is important is because secondary treatment, where the remaining BOD is "removed" (I will explain "removed" in a subsequent post), is expensive, so **the more BOD removed in the primary clarifiers, the better**.

Indeed, wastewater treatment **is** expensive (see operator's credo above: "... as cost effectively as possible."). The organic carbon captured by primary clarifiers, measured in terms of BOD, COD, or VS, can be converted to methane in anaerobic digesters that can then be burned in engines driving electrical generators. Augmenting the organic carbon captured in primary clarifiers, some plants feed fats, oils and grease (FOG) to their digesters to increase methane production and electricity generation. East Bay Municipal Utilities District (EMBUD) has been so successful doing so, they produce more electricity than they use. **This is the future**.

Problem of the Day

The Running Springs wastewater treatment plant receives an average dry weather flow of 2.5 MGD. The peak wet weather flow is 8 MGD. There are two primary clarifiers, each is 60 feet in diameter with an average depth of 16.5 feet. There is a single effluent weir around the periphery of each primary clarifier. The average influent TSS and BOD concentrations during dry weather flow are 325 and 350 mg/L, respectively. The influent TSS are 72% volatile. The average primary effluent TSS and BOD concentrations during dry weather flow are 105 and 205 mg/L, respectively. Each primary sludge pump pumps 30 gpm. Calculate the BOD removal efficiency.

Discussion

Because primary clarifiers are such treatment plant workhorses, operators really need to "get their heads around them." We're going to use this same problem statement and do every primary clarifier type problem we can think of, maybe even make up a few! We'll keep track of the types of problems in the following list so you can refer back to individual Problems of the Day if you have a question on a specific type of primary clarifier problem.

- 2014.Dec.16—TSS removal efficiency
- 2014.Dec.17—BOD removal efficiency

Solution

Calculating percent removal of various pollutants across different process units and across the entire plant is important. The equation, in railroad track format, is:

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

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 **when calculating percent, all the units must cancel out**.

Problem of the Day: The Running Springs wastewater treatment plant receives an average dry weather flow of 2.5 MGD. The peak wet weather flow is 8 MGD. There are two primary clarifiers, each is 60 feet in diameter with an average depth of 16.5 feet. There is a single effluent weir around the periphery of each primary clarifier. The average influent TSS and BOD concentrations during dry weather flow are 325 and 350 mg/L, respectively. The influent TSS are 72% volatile. The average primary effluent TSS and BOD concentrations during dry weather flow are 105 and 205 mg/L, respectively. Each primary sludge pump pumps 30 gpm. Calculate the BOD removal efficiency.

Information summary, specifically labeled (**bold** indicates used in today's problem):

- Average dry weather flow = 2.5 MGD
- Peak wet weather flow = 8 MGD
- Number of primary clarifiers = 2 PC
- Primary clarifier diameter = 60 ft
- Primary clarifier depth = 16.5 feet
- Primary influent dry weather TSS = 325 mg TSS/L
- Primary influent dry weather BOD = **350 mg BOD/L**
- Primary influent TSS = 72% VSS
- Primary effluent dry weather TSS = 105 mg TSS/L
- Primary effluent dry weather BOD = **205 mg BOD/L**
- Primary sludge pumps, each = 30 gal sldg/min
- Calculate: **BOD removal efficiency**.

$$\textbf{Removal efficiency (\%)} = \left| \frac{(350 - 205)\ \cancel{\text{mg BOD/L}}}{350\ \cancel{\text{mg BOD/L}}} \right| 100$$

= **<u>41.4%</u>**.

Math is not random. Use units, PRACTICE, and you will succeed.

Why is the primary clarifier BOD removal efficiency (today: 41.4%) always less than the primary clarifier TSS removal efficiency (yesterday: 67.7%)? Two reasons: (1) not all of the TSS is BOD, and (2) soluble

BOD (there is no such thing as “soluble” TSS by definition) in the primary influent passes right through primary clarifiers).

Happy calculating. Let us know, by leaving a comment, if you want us to do a specific problem or if you see a mistake.