Problem of the Day

2014.Oct.11

Discussion

Trickling filters are very robust biological treatment units. They have evolved over the years from simple, shallow, rock-filled cylinders to sophisticated, tall biotowers filled with carefully engineered plastic media. Because the microorganisms reside in a biofilm affixed to the media, they are referred to as "fixed film reactors" as opposed to an activated sludge aeration basins that are referred to as "suspended growth reactors."

Trickling filter math is fairly easy once you understand a few tricky aspects to the way the problems are done. Trickling filter math problems come in three general types:

1. Calculate the recirculation ratio
2. Calculate the hydraulic loading
3. Calculate the organic loading

The next three Problems of the Day, including this one, will go over each one of these types of trickling filter math problems.

Problem

Now for today's problem.

Problem of the Day: The Avon Valley WWTP has two biotowers each 105 feet in diameter with 25 feet of plastic, cross-flow media. The average daily flow to the plant is 8.3 MGD. There are two recirculation pumps each pumping 2,015 gpm of secondary effluent, with a BOD concentration of 18 mg/L, to the mix box upstream of the biotowers where it mixes with primary effluent. The average BOD concentration in the primary effluent is 125 mg/L. What is the recirculation ratio?

Solution

Listing the information given in the problem statement, with appropriate units:

- Q = 8.3 Mgal/d
- Primary effluent BOD = 125 mg BOD/L
- Trickling filters (TF): 2
- Diameter = 105 ft
- Media depth = 25 ft
- Secondary effluent BOD = 18 mg BOD/L
- Recirculation flow = 2 x 2,015 gal/min = 4,030 gal/min

The recirculation ratio is calculated very simply:

$$r = \frac{Q_r}{Q}$$

where r is the recirculation ratio, Q_r is the recirculation flow and Q is the plant flow. However, there is something about calculating the recirculation ratio that you **must** remember: **r is dimensionless so all units have to cancel out**. The railroad track is started using the equation above.

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r	= $\frac{Q_r}{Q}$ =	4,030 gal	d	
		min	8.3 Mgal	

Notice that Q is in the denominator. When you go to enter something in the denominator, in this case 8.3 Mgal/d, be very aware of the word "per" as you say it in your head, "8.3 Mgal **per** d." Whenever the word "per" comes across your lips, that is an indication to you that whatever comes after "per" goes on the opposite side of the railroad track. This is very, very important to keep in mind as you use the railroad track to solve problems.

The conversion factor, 10^6 gal/Mgal, is entered into the railroad track so Mgal and gal cancel. Remember , if you let the units tell you what to do, you don't have to think about whether you divide or multiply by 1,000,000 (10^6).

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r	= $\frac{Q_r}{Q}$ =	4,030 ~~gal~~	d	~~Mgal~~	
		min	8.3 ~~Mgal~~	10^6 ~~gal~~	

Finally, min and d are canceled using the well known conversion factor, 1,440 min/d.

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r	=	Q_r	=	4,030 ~~gal~~	~~d~~	~~Mgal~~	1,440 ~~min~~
		Q		~~min~~	8.3 ~~Mgal~~	10^6 ~~gal~~	~~d~~

Since all the units have canceled and r is **dimensionless** (that is, it has **no units** associated with it), the math is done and the arithmetic gives the answer:

4,030 x 1,440 ÷ 8.3 ÷ 1,000,000 = 0.7.

Typically, the trickling filter recirculation ratio is left as a decimal, as we have done here, and not converted to a percentage. If the problem does ask for it to be expressed as a percentage, just multiply by 100 and add % (in this case it would be 70%). Tomorrow we will use the same problem and calculate the hydraulic loading to these two trickling filters.

Good calculating to all of you. Let us know what you think about Problem of the Day by adding a comment. We'd love to hear from you! Also, if there are problems you'd like us to solve, let us know that, too.