Problem of the Day

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The BOD removal efficiency through the primary clarifiers averages 35%. If the influent flow averages 4.5 MGD during the dry weather season and the influent BOD concentration averages 450 mg/L, calculate the BOD load to the aeration basins.

Introduction

Whenever reference is made to "load," as in today's problem, that means "pounds per day," in this case, pounds of BOD per day, or lb BOD/d. So, again, this is a simple "pounds" calculation, but we need to know how to take into account the removal of influent BOD in the primary clarifiers.

A BOD removal efficiency of 35% (remember, in almost all wastewater treatment problems, percent is on a weight basis) means that for every 100 pounds of BOD going into the primary clarifiers, 35 pounds ends up in the sludge hopper. So if 35 pounds of BOD are going to the sludge hopper, where does the other 65 pounds go? Yes, it's in the effluent going to the downstream aeration basins.

In a lot of instances WWTT likes to express percent in so many pounds per 100 pounds as in the preceding paragraph. When it comes to removal efficiencies, though, WWTT works with the decimal equivalents of percent. In this problem, what we are interested in is the percent of the influent BOD that makes its way to the effluent. That's 65% = 0.65.

Solution

As discussed, "load" is the same thing as "pounds per day." Therefore, these units, lb BOD/d, are entered between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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$$\left|\frac{\text{lb BOD}}{\text{d}}\right| = \_\_\_\_\_$$

The following list summarizes the information given in the problem statement expressed in the appropriate units:

1. Influent BOD concentration = 450 mg BOD/L
2. Influent flow = 4.5 Mgal/d
3. Percent influent BOD in primary **effluent** = (100 − 35)% = 65% = 0.65

WWTT prefers to start the solution bridge for pounds and pounds-per-day calculations with the concentration of whatever we're calculating pounds of; in this case, BOD. This unit is needed in the answer so is shown in bold on both sides of the equals sign.

$$\left|\frac{\text{lb } \mathbf{BOD}}{\text{d}}\right| = \left|\frac{\text{450 mg } \mathbf{BOD}}{\text{L}}\right| \_\_\_\_\_$$

Whenever the units mg/L are entered on the solution bridge, WWTT cancels them.

$$\left|\frac{\text{lb } \mathbf{BOD}}{\text{d}}\right| = \left|\frac{\text{450 } \cancel{\text{mg}}\ \mathbf{BOD}}{\cancel{\text{L}}}\right| \left|\frac{\cancel{\text{L}}}{\text{M}\cdot\cancel{\text{mg}}}\right| \_\_\_\_\_$$

The 450 mg BOD/L is the influent BOD concentration. This has to be multiplied by the percent of the influent BOD (as a decimal) that goes to the primary effluent. When a percent is expressed as a decimal, it has no units associated with it.

$$\left|\frac{\text{lb } \mathbf{BOD}}{\text{d}}\right| = \left|\frac{\text{450 } \cancel{\text{mg}}\ \mathbf{BOD}}{\cancel{\text{L}}}\right| \left|\frac{\cancel{\text{L}}}{\text{M}\cdot\cancel{\text{mg}}}\right| \left|\frac{0.65}{\ }\right| \_\_\_\_\_$$

The M in M·mg in the denominator reminds us we need an Mgal in the numerator to cancel the Ms. Entering the flow also puts d, needed in the denominator of the answer, in the solution bridge.

$$\frac{\text{lb } \mathbf{BOD}}{\mathbf{d}} = \frac{450\ \cancel{\text{mg}}\ \mathbf{BOD}}{\cancel{\text{L}}} \quad \frac{\cancel{\text{L}}}{\cancel{\text{M}}\cdot\text{mg}} \quad 0.65 \quad \frac{4.5\ \cancel{\text{M}}\text{gal}}{\mathbf{d}}$$

There are gal to cancel in the numerator and lb are needed in the numerator of the answer. We accomplish both by entering the density of water. Since all the units have canceled except those needed in the answer, we know the solution bridge is complete. The arithmetic gives the answer.

$$\frac{\mathbf{lb\ BOD}}{\mathbf{d}} = \frac{450\ \cancel{\text{mg}}\ \mathbf{BOD}}{\cancel{\text{L}}} \quad \frac{\cancel{\text{L}}}{\cancel{\text{M}}\cdot\text{mg}} \quad 0.65 \quad \frac{4.5\ \cancel{\text{M}}\text{gal}}{\mathbf{d}} \quad \frac{8.34\ \mathbf{lb}}{\cancel{\text{gal}}}$$

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$$\frac{\mathbf{lb\ BOD}}{\mathbf{d}} = \frac{450\ \cancel{\text{mg}}\ \mathbf{BOD}}{\cancel{\text{L}}} \quad \frac{\cancel{\text{L}}}{\cancel{\text{M}}\cdot\text{mg}} \quad 0.65 \quad \frac{4.5\ \cancel{\text{M}}\text{gal}}{\mathbf{d}} \quad \frac{8.34\ \mathbf{lb}}{\cancel{\text{gal}}}$$

450 x 0.65 x 4.5 x 8.34 = **10,978 lb BOD/d**.

Discussion

For every pound of BOD that enters an activated sludge process, about three-quarters of a pound of biomass, as MLVSS, grows. Therefore, the amount of BOD we just calculated will generate about 8,234 lb MLVSS in the activated sludge process.

Happy calculating! Let us know, by leaving a comment, if you want us to do a specific problem, if you see a mistake, or if you have a question on any of the Problems of the Day you are looking at.