Problem of the Day

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The influent flow to the facility is 2.3 MGD. The settleable solids concentration measured in an Imhoff cone is 5.4 mL/L in the raw influent and 0.15 mL/L in the primary clarifier effluent. Calculate the percent removal of settleable solids across the primary clarifiers.

Introduction

Settleable solids are easily measured in an Imhoff cone. An Imhoff cone measures settleable solids **volumetrically**, which means the units will always be milliliters of settleable solids per liter of sample, mL/L. **All operators must understand that these units, mL/L, are very unique in the wastewater industry**. The only other place you will see these units is the measurement of mixed liquor settled sludge volume performed at activated sludge plants in either a 1-L graduated cylinder or a 2-L Mallory settleometer. These units should **not** to be mistaken with the gravimetric units, mg/L.

The process objective of primary clarifiers is to remove settleable solids. In other words, that's what primary clarifiers do, they remove settleable solids. If that's what primary clarifiers are supposed to do, then we expect the removal efficiency of settleable solids across primary clarifiers should be very high.

Settleable solids are not the same thing as total suspended solids (TSS), but **all operators should understand that all settleable solids are TSS but not all TSS are settleable**! This is another place where we have made things in wastewater treatment plant operations more confusing than they have to be. For example, is a suspended solid that settles still suspended after settling? The answer to the question is, in our world, yes, it is, but this causes a great deal of confusion to many operators, especially those just starting out in the operations profession. I say it this way, very simply: for all practical purposes TSS are either settleable (TSS_{set}) or non-settleable (TSS_{non}).

The calculation for determining the percent removal of settleable solids is the same we use for TSS and BOD, anything for that matter:

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

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; that's why the calculation is multiplied by 100. It is important to note, also, that whenever calculating percent, all the units must cancel out.

Solution

The problem is done by directly substituting C_{in} and C_{out}—in this case, 5.4 mL/L and 0.15 mL/L, respectively—into the equation above. Note: The flow rate given in the problem statement is superfluous; there is no need for it. Authors of certification exam problems love to put unnecessary information in problems to try to throw you off. Don't let them.

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$$\text{Removal efficiency (\%)} = \frac{(5.4 - 0.15)\ \cancel{\text{mL/L}}}{5.4\ \cancel{\text{mL/L}}} \times 100$$

(5.4 − 0.15) × 100 ÷ 5.4 = **97.2%**.

Discussion

As discussed, we expect the removal efficiency of settleable solids across a primary clarifier to be a large number. It should always be greater than 95%. This is not to be mistaken with TSS removal efficiency across primary clarifiers, 40 to 60% or more in municipal practice, or BOD removal efficiency across primary clarifiers, 25 to 45%. All operators should have these ranges in their heads as certification exams love to ask questions pertaining to them.

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.