Problem of the Day

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The influent to the Oxbow Water Reclamation Facility averages 46.5 MGD. The influent TSS concentration is 385 mg/L, 74.2% of which is volatile. Using small dosages of ferric chloride and anionic polymer for chemically enhanced primary treatment (CEPT), the operators keep the primary effluent TSS concentration to a fairly stable 106 mg/L. Calculate the pounds of TSS removed in the primary clarifiers each day.

Introduction

This is the first in a series of Problems of the Day that will lead up to the daily heat content in the anaerobic digester gas. This series of problems deals only with the primary sludge that is directed to the anaerobic digesters.

Operators taking the Grades I and II Operator Certification Exams in California need to remember that primary clarifiers receiving municipal wastewater achieve the following:

- Greater than 95% settleable solids (TSS_{set}) removal
- 40 to 60% TSS removal
- 20 to 45% BOD removal

With a little CEPT, the operators at the Oxbow Water Reclamation Facility are getting 72.5% TSS removal (you should be able to calculate this for yourself). Not bad for what we'd expect is a modest chemical cost ("... small dosages of ferric chloride and anionic polymer...").

Solution

The following information is given, expressed in the units recommended by WWTT:

1. Influent flow = 46.5 Mgal/d
2. Influent TSS concentration = 385 mg TSS/L
3. Influent VSS concentration = 74.2% = 74.2 lb VSS/100 lb TSS
4. Primary effluent TSS concentration = 106 mg TSS/L
5. TSS concentration removed to primary sludge = (385 − 106) mg TSS/L = 279 mg TSS/L

The question asks for pounds of TSS per day so the units lb TSS/d are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

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$$\left| \frac{\text{lb TSS}}{\text{d}} \right| = \frac{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{}$$

This is a pounds-per-day calculation. While some people like to start pounds-per-day calculations with flow and others like to start them with 8.34 lb/gal, WWTT likes to start them with the concentration of the parameter of interest, in this case TSS.

$$\left| \frac{\text{lb } \mathbf{TSS}}{\text{d}} \right| = \left| \frac{279 \text{ mg } \mathbf{TSS}}{\text{L}} \right| \frac{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{}$$

Whenever mg/L are entered on the solution bridge, they are cancelled with the conversion factor M·mg/L.

$$\left| \frac{\text{lb } \mathbf{TSS}}{\text{d}} \right| = \left| \frac{279 \text{ } \cancel{\text{mg}} \text{ } \mathbf{TSS}}{\cancel{\text{L}}} \right| \left| \frac{\cancel{\text{L}}}{\text{M}\cdot\cancel{\text{mg}}} \right| \frac{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}{}$$

The M in the denominator reminds us we need an Mgal in the pounds-per-day calculation so flow is entered.

$$\frac{\text{lb } \mathbf{TSS}}{\mathbf{d}} = \frac{279\ \cancel{\text{mg}}\ \mathbf{TSS}}{\cancel{\text{L}}} \times \frac{46.5\ \cancel{\text{M}}\text{gal}}{\cancel{\text{M}}\cdot\cancel{\text{mg}}} \times \frac{}{\mathbf{d}}$$

Finally, to convert gal to lb the density of water is entered.

$$\frac{\mathbf{lb\ TSS}}{\mathbf{d}} = \frac{279\ \cancel{\text{mg}}\ \mathbf{TSS}}{\cancel{\text{L}}} \times \frac{46.5\ \cancel{\text{M}}\text{gal}}{\cancel{\text{M}}\cdot\cancel{\text{mg}}} \times \frac{8.34\ \mathbf{lb}}{\mathbf{d}} \times \frac{}{\cancel{\text{gal}}}$$

Since all the units have now canceled except those needed in the answer, lb TSS/d, we know the solution bridge is complete. The arithmetic gives the answer.

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$$\frac{\mathbf{lb\ TSS}}{\mathbf{d}} = \frac{279\ \cancel{\text{mg}}\ \mathbf{TSS}}{\cancel{\text{L}}} \times \frac{46.5\ \cancel{\text{M}}\text{gal}}{\cancel{\text{M}}\cdot\cancel{\text{mg}}} \times \frac{8.34\ \mathbf{lb}}{\mathbf{d}} \times \frac{}{\cancel{\text{gal}}}$$

279 x 46.5 x 8.34 = **108,199 lb TSS/d**.

Discussion

As discussed above, this is the first in a series of Problems of the Day that will lead to a calculation of the heat content of the digester gas produced each day.

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.