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. In yesterday's Problem of the Day it was found that 108,199 lb TSS/d are removed in the primary clarifiers. Calculate the pounds of VSS removed in the primary clarifier per day.

Introduction

This is the second 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.

As discussed yesterday, 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...").

The process objective of primary clarifiers is the removal of settleable solids. While the Imhoff cone is used to measure the volumetric concentration (mL/L) of settleable solids, they can also be determined gravimetrically by measuring the TSS concentration and then performing a non-settleable TSS test. There is no "standard method" to do so, but the test advanced by yours truly (that is, Eric J. Wahlberg) is gaining popularity. Operators need to know that all settleable solids are TSS (designated TSS_{set}), not all TSS are settleable because some TSS are non settleable (designated TSS_{non}).

In contrast, the process objective of digesters, anaerobic or aerobic, is the reduction of volatile solids (VS). "Reduction" isn't the best choice of words because the organic carbon in the VS isn't reduced but converted to methane (CH_4) and carbon dioxide (CO_2). This is why it is so important to calculate how many VS are being applied to digesters.

While it is not often specifically stated so, operators should understand and appreciate that TSS **and** VSS are removed at same rate in primary clarifiers. In other words, if the TSS removal efficiency, calculated above, is 72.5%, than the VSS removal efficiency is also 72.5%. What this means is that if the percent volatile solids in the effluent is 74.2%, the TSS in the primary effluent is 74.2% volatile and the TSS—and TS, as discussed tomorrow—in the primary sludge also is 74.2% volatile.

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. Pounds TSS per day removed = 108,199 lb TSS/d

This is a simple, two-step solution bridge. The arithmetic gives the answer.

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$$\frac{\textbf{lb VSS}}{\textbf{d}} = \frac{74.2\ \textbf{lb VSS}}{100\ \cancel{\text{lb TSS}}} \times \frac{108{,}199\ \cancel{\text{lb TSS}}}{\textbf{d}}$$

74.2 x 108,199 ÷ 100 = **<u>80,284 lb VSS/d</u>**.

Discussion

As discussed above, this is the second 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.