Medora Corporation

Predict Mixing Requirements

Using the Sludge Volume Index (SVI)

OVERVIEW

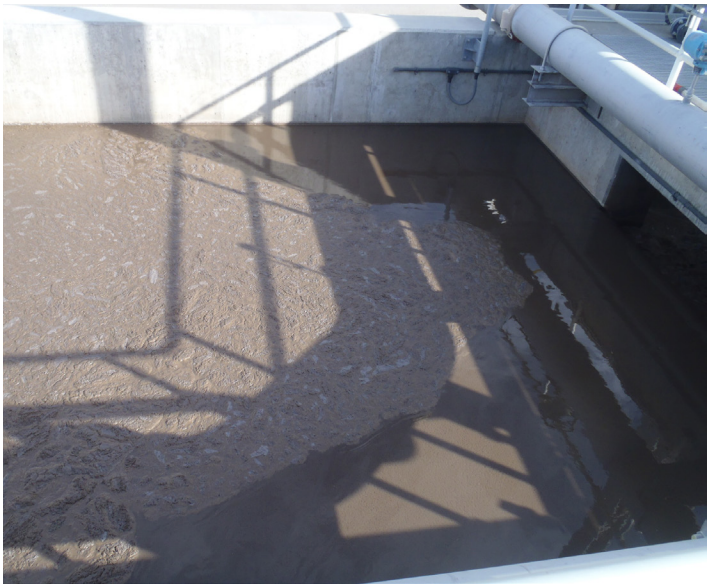
The mixing system in an activated sludge reactor basin needs to keep the solids suspended. The success of suspending the solids will depend on both (a) the concentration of solids, usually expressed as mg/l of mixed liquor suspended solids, MLSS, and (b) the settleability of those solids, which will depend on whether they are made up of low density fluffy material or high density granular-type material.

Suppose a 1000 ml (1 liter) sample of mixed liquor is put into a beaker, and after 30 minutes of settling the beaker has 500 ml of settled solids. The volume of the settled solids, by itself, does not indicate how hard it would be to keep the solids suspended; they may be very light and fluffy, which would be easier to keep suspended, or, just the opposite, they may be very dense and packed tightly, which would be harder to keep suspended.

So to evaluate the difficulty of mixing reactor basins, one has to consider not only the volume of solids that settles out in a given time, but also the density of the solids that settle out. The Sludge Volume Index (SVI) is a number that gives you a combination of these two parameters. It is used mostly by the plant operator to gauge how well solids will settle in the final clarifier, but it can also be used to help design mixing systems to keep the solids suspended in various reactor basins.

The SVI number shows the “volume per weight” of the solids; specifically, the milliliter per gram. (So SVI is the inverse of the specific gravity of the solids, which would be “weight per volume” or grams per milliliter). Therefore a higher SVI number indicates lighter fluffier less-dense solids that settle slower and are easier to keep suspended. And a lower SVI number indicates heavier compact more-dense solids that settle faster and are harder to keep suspended.

Most wastewater treatment plants test the SVI of their mixed liquor at the outlet of the aeration basin(s), just before it’s sent to the final clarifier. Usually the SVI will be similar in all aerated and anoxic basins in the treatment process. But separate attention should be given to potential mixing problem in basins receiving return



activated sludge (RAS) or waste activated sludge (WAS), because the sludge at the inlet of those basins will have a different SVI than at the outlet of the basins. The next 3 sections show how to determine the SVI of a given mixed liquor.

STEP 1: Perform The sludge settleability test

In a 1-liter sample of the mixed liquor, observe how many milliliters of sludge settles out in 30 minutes.

Tips: To keep from overfilling a 1-liter beaker, use a 2-liter beaker but just fill it to the 1-liter line. Try to use a beaker or other container with graduations showing 100 ml, 200 ml, and so on up to 1000 ml, which is 1 liter. Use a wide mouth container, not a tall narrow cylinder. Do not shake or disturb during the contents during the settling test, or set the sample in the sunlight.

Example 1A. A 2-liter beaker is filled to the 1000ml (1 liter) mark. At 30 minutes, 450 ml of sludge has settled out. This sludge settleability test result is 450 ml per liter, or 450 ml/L.

Example 1B. A graduated pitcher is filled to the 1-liter mark. After 30 minutes, 700 ml of sludge has settled out. This sludge settleability test result is 700 ml per liter, or 700 ml/L.

Example 1C. There are no graduated beakers available, so the operator grabs a sample with a small bucket. The depth of the mixed liquor in the bucket is 12 inches. After 30 minutes, there are 7 inches of settled sludge in the bucket. The sludge settleability is 7/12 = 58.3%. So, converting this to the same number as if the operator had used a 1000 ml (1 liter) graduated beaker, the sludge settleability is 58.3% x 1000 ml = 580 ml/L.

STEP 2: Convert the mixed liquor suspended solids, MLSS, from mg/l to grams/l

To convert mg/l to g/l, move the decimal 3 places to the left, the same as dividing by 1000.

Example 2A. MLSS= 4,000 mg/L x 1 gram/1,000mg = 4 grams/L = 4 g/L.

Example 2B. MLSS= 2,500 mg/L x 1 gram/1,000mg = 2.5 grams/L = 2.5 g/L.

Example 2C. MLSS= 20,000 mg/L x 1 gram/1,000mg = 20 grams/L= 20 g/L.

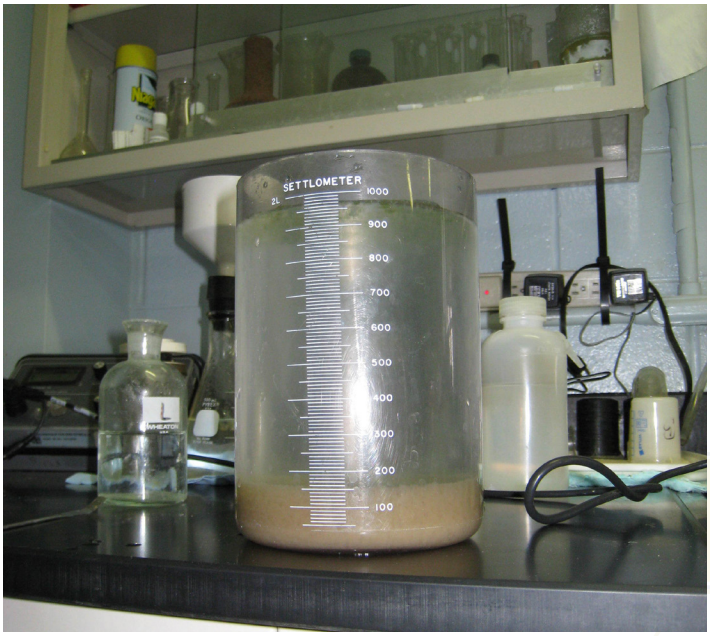
STEP 3 Calculate the SVI

The SVI is calculated by combining the volume/volume result from Step 1 with the weight/volume result from Step 2. It tells you the volume of 1 gram of solids; how “fluffy” or “compact” a gram of solids is from this basin. Also note that SVI is sometimes referred to as “SVI30 “ due to the 30-minute settling time used in the test.

Example 3A. Based on the settled volume from 1A, and MLSS from 2A: SVI = 450 ml/L volume x L/4gr weight = 112 ml/g.

Example 3B. Based on the settled volume from 1B, and MLSS from 2B: SVI = 700 ml/L volume x L/2.5gr weight = 280 ml/g.

Example 3C. Based on the settled volume from 1C and MLSS from 2C: SVI = 580 ml/L volume x L/20gr weight = 29 ml/g.



AN ALTERNATIVE WAY TO CALCULATE SVI

An examination of the above formulas shows that another way to calculate SVI is as follows: SVI in ml/g = (the ml of settled solids in a 1 liter test) divided by (the mg/l of MLSS divided by 1000).

Then SVI in ml/g = (ml of settled solids in 1 liter test x 1000) / (mg/l of MLSS).

Then the example using 1A and 2A becomes: SVI = (450 x 1000)/4,000 =112 ml/g.

The example using 1B and 2B becomes: SVI = (700 x 1000)/2,500 =280 ml/g.

The example using 1C and 2C becomes: SVI = (580 x 1000)/20,000 =29 ml/g.

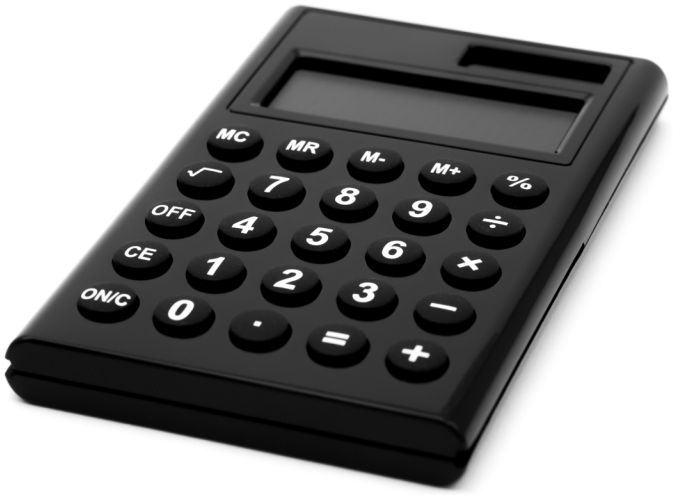
INTERPRETING RESULTS

Each plant has its own SVI “sweet spot”, where the overall treatment results are best and there are the least plant upsets. Generally, operators try to maintain the SVI in a certain range by adjusting the amount of return activated sludge (RAS) from the clarifier. Increasing the RAS increases the MLSS, which in turn lowers the SVI. And decreasing the RAS decreases the MLSS, which raises the SVI.

Below are also some general guidelines on interpreting SVI.

SVI = 1 to 80 ml/g: This is dense sludge with rapid settling characteristics. Usually it is old sludge, over-oxidized, and may be in an extended aeration facility. The floc particles appear to be granular, like BB’s. As it settles, there may be a cloudy appearance left in the water due to very small pin-flocs. In the settleability test, the solids settle out directly without forming larger flocs. The treatment plant probably does well on BOD removal, but could have some TSS issues due to pin-floc.

SVI = 80 to 150 ml/g: This is a good range for most activated sludge plants to be in. Usually within the first 5 minutes of the settling test, the flocs will form a blanket that starts settling through the liquid. As the blanket falls it gets larger, but still leaves channels for water to flow through as it falls. The particles are typically irregularly shaped with several filaments that form a backbone for the bacteria to attach to. It self-compacts, but not very densely. The water on top of the settle sludge is fairly clear.



SVI = 250 to 500 ml/g: This is light fluffy sludge that settles very slowly; it uses most of the 30 minutes to settle. It is commonly seen in new startup plants with young sludge age. It usually occurs, too, when MLSS is less than 1000 mg/l. This condition is sometimes called Classic Sludge Bulking. Often the plant has trouble meeting BOD and TSS limits because the solids are not falling out in the clarifier. Filamentous sludge will also have this high SVI; and usually long stringy material can be seen with a microscope, and the water over the settled sludge is clear. Chlorine or other oxidizers can be applied to control filamentous sludge. Finally, many industrial plants operate just fine with a SVI in this range due to the difference in waste material in these plants from municipal plants.

CONCLUSION

The SVI is an important parameter for operating an activated sludge treatment plant, and is also a good indication of the difficulties that can be expected in mixing various basins. In sizing mixers for activated sludge plants, Medora Corporation considers SVI, MLSS, basin dimensions, flow rates, and other parameters.

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Medora Corporation, Dickinson, N.D., whose brands include GridBee® and SolarBee®, provides solutions for difficult problems in municipal and industrial wastewater treatment. Applications include energy savings, process improvement and odor control.