Spiral Water™
Technologies, Inc.

Solids Removal in Brewery Wastewater

Brewery wastewater contains significant amounts of organic matter consisting of hops, spent grains and yeast. Many breweries are installing onsite wastewater pre-treatment systems to remediate their wastewater before discharging it to a municipal wastewater treatment plant, septic system or surface water source. These systems often include a bioreactor to reduce the amount of organic matter and convert it to biogas. Bioreactors operate better on dissolved solids than they do on suspended solids. The solid particulate is less accessible to the organisms of the bioreactor than are the dissolved solids, like sugars. Suspended solids reduce the efficiency of the process by reducing the liquid fraction of the bioreactor. They may also settle on the bottom of the reactor, taking up space and progressively reducing the throughput and efficiency of the reactor.

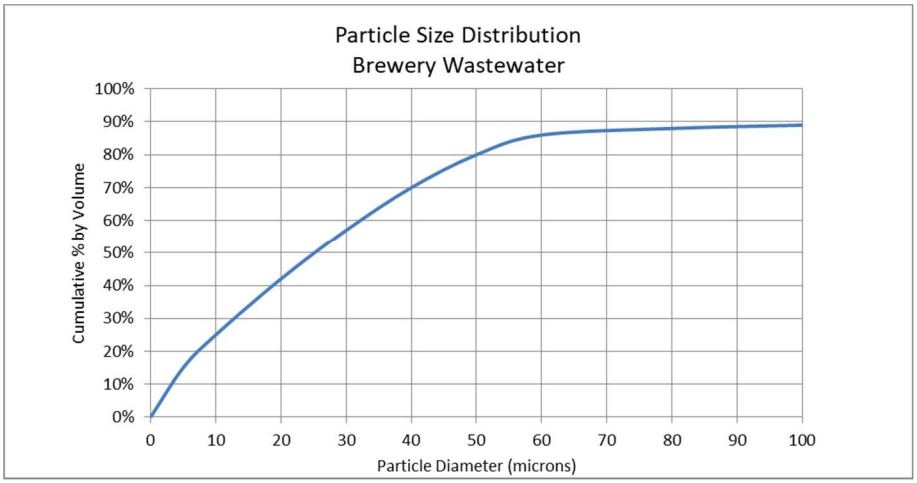

Figure 1. Particle Size Distribution of Brewery Wastewater.

The wastewater operator from a brewery in Northern California contacted Spiral Water Technologies to discuss the problems with his bioreactor. He was struggling to successfully remove suspended solids prior to the bioreactor. The back-flushing automatic filter, originally included with the system, was insufficient to remove suspended solids. And a secondary system, consisting of a cone settling tank and chemical flocculants, was costly to operate and still failed during peak solids loading. The working volume of the bioreactor was originally sized for 18,000 gallons per day of liquid throughput. Though the system was designed for flow rates averaging 12.5 gpm, instantaneous flow rates can peak at 60 gpm. Additionally, the brewery makes a Double IPA once a quarter which produces higher concentrations of solids in their wastewater. As solids spill over the removal system, they fill the working volume of the bioreactor and displace the liquid. The smaller working volume has lower capacity and reduces the volume of wastewater that can be treated. Less wastewater means less beer and less revenue to the brewery.

This wastewater operator tracked the performance of his bioreactor and correlated it to the performance of his suspended solids removal system. Since he couldn't measure real-time TSS he instead measured total COD before and after his solids removal system. He then correlated the reduction in COD, from solids removal, to increases in bioreactor performance. He was able to determine that a minimum reduction in total COD of 11% with a target of 15% optimized performance of his bioreactor.

	TCOD (mg/l)		
Samples	Influent	Effluent	Reduction
1	4420	4420	0%
2	4129	4090	1%
3	4550	3450	24%
4	4650	4110	12%
5	4240	3130	26%
6	3930	3350	15%
		Average Reduction:	13%

Figure 2. A 25 micron filter reduced COD by an average of 13% to optimize bioreactor performance. The COD reduction was primarily a reduction of insoluble COD.

Automatic self-cleaning filters are often specified to reduce insoluble COD and TSS prior to a bioreactor. But most automatic filters are limited by peak loading capacity, and will foul under upset conditions. Therefore, it is important to properly specify peak loading of TSS when selecting an automatic filter. Wastewater system designers often underestimate the amount of suspended solids in brewery wastewater, with written requirements of less than 1000 mg/l. These underestimates stem from the variability of TSS in brewery wastewater. The TSS is highly dependent on the time of day and the time of year. Solids content can remain low for long periods of the day, and then spike during tank cleanouts and wash downs. Also brewers make seasonal products, which may produce high or low TSS wastewater. Solids content can vary so much that buffer tanks aren't sufficient to even out the load. A *comprehensive* study[1] of brewery wastewater placed the average TSS *not below* 1000 mg/l, but at 1827 mg/l, with a high of 3728 mg/l.

Spiral Water Technologies manufactures and sells filtration products for food and beverage applications. Spiral Water analyzed the wastewater of a brewery in Northern California for TSS and Particle Size Distribution (PSD). The average TSS was found to be 1524 mg/l, thus validating the research above. Furthermore, the PSD (illustrated in Figure 1) shows that 80% of the particles are smaller than 50 microns, explaining why it is so difficult to reduce TSS. Spiral Water's automatic filters are well suited to handle ultra-high and variable TSS with fine filtration ratings. Reductions in TSS can be estimated by using the filtration efficiency curves of the filter screens and the particle size distribution of the wastewater.

Figure 3. Spiral Water Model S1000 Filter Unit

Figure 4. Collected Solids from brewery wastewater.

The TSS measurement is often overlooked because wastewater system operators typically monitor only total Chemical Oxygen Demand (COD) and not TSS. COD is measured because it provides a good baseline for gauging bioreactor performance and it can be measured in real-time. But COD measurements do not differentiate between soluble COD, which bioreactors like, and insoluble COD, which bioreactors do not like. It is the insoluble COD, which correlates with TSS and which causes problems for bioreactor

performance. Though total solids loading may vary significantly throughout the day, it reasonable to assume that that the ratio of soluble to insoluble COD remains relatively constant. Using data from Study [1] it was estimated that insoluble COD, which is equal to TSS, is approximately 27% of total COD in brewery wastewater.

Wastewater operators had requested a total COD reduction of 11% to 15%. This translates into a TSS reduction of 39% to 57%. Combining the filtration efficiency curves of the filter screen and the particle size distribution of the wastewater, it was predicted that filter screens of between 25 and 15 microns would achieve the desired result. A Spiral Water filter unit, with a 25 micron screen, was installed and operated. Six sets of grab samples were analyzed for total COD by a certified laboratory. As illustrated in Figure 2, the 25 micron filter screen produced an average reduction in total COD of 13%, thus validating the predictions.

Spiral Water's Model 1000 (Figure 3) is a liquid/solid separator and automatic self-cleaning filter designed to remove Ultra High and Variable Total Suspended Solids (TSS) from a fluid stream. Each filter unit contains a motor driven, spiral-shaped brush that continuously cleans collected debris from inside the filter element. Each unit can filter upwards of 100 gpm at 15 to 25 microns, and units can be combined for higher flow rates. Solids collect at the bottom of the filter housing to be expelled through an automatic purge valve. The system does not require high pressures to operate and performs at very low differential pressures. Since the filter units do not use a backwash to clean the filter screen, they can concentrate solids to a high degree. Collected solids can be purged as a sludge ready for dewatering (Figure 4).

Spiral Water's automatic filter units stand alone in their ability to handle ultra-high and variable TSS at fine filtration ratings as low as 15 microns. Average TSS of 1827 mg/l with peaks of 3728 mg/l is well within the capability of Spiral Water; and TSS reductions in brewery wastewater have been demonstrated in the field. These features make Spiral Water filter units well suited to remove suspended solids from brewery wastewater, especially in pretreatment for bioreactors.

Dated: February 29, 2019

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[1] Enitan et al, 2015. *Characterization of Brewery Wastewater Composition*, World Academy of Science, Engineering and Technology International Journal of Environmental and Ecological Engineering, Vol:9, No:9.