



Brewers Association Wastewater Side-Streaming

Prepared by the Brewers Association
Maintenance and Engineering Subcommittee



DOCUMENT PURPOSE AND SCOPE

This whitepaper will focus on the different methods available to perform side-streaming (diverting waste from sewer discharge), a cost-effective and lower capital investment solution for meeting required discharge parameters. Side-streaming helps ensure wastewater compliance by improving commonly regulated wastewater discharge parameters.

Side Streaming Topics Covered Include:

- Review of primary wastewater parameters of concern
- Handling considerations for common side-streaming processes
- Designing appropriate equalizing tanks and solid waste containers

WASTEWATER SIDE-STREAMING

Key terms and variables describing wastewater quality are briefly introduced here, but other resources worth referencing for detailed background information include:

- [BA Wastewater Management Guidance Manual](#)
- [BA Water and Wastewater: Treatment/Volume Reduction Manual](#)

Common wastewater variables relevant to brewery permitting include Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), pH, and temperature.

1. **BOD** is a measure of dissolved nutrients in an effluent stream that, if released into the environment and consumed by microorganisms, depletes dissolved oxygen, and creates potentially toxic environments for larger organisms such as fish. Brewery effluent typically has high BOD.



Image 1. High levels of BOD in effluent streams can be toxic to fish and result in fish kills.

In general, BOD is the most challenging wastewater variable to address. The beer making process generates waste with relatively high BOD, and treatment equipment to lower BOD in the waste stream is typically costly and/or space intensive. Treatment methods to lower BOD already present in a waste stream include aerobic or anaerobic digesters and reverse osmosis (RO) membrane filtration. An alternative treatment method is to side stream waste prior to discharge, removing the impact to the effluent stream.

The Craft Brewers Conference 2021 seminar, [“The Effect of Waste Side-Streaming on Brewery Effluent and Strength”](#) presents examples of methodology to establish the most optimal opportunities to impact BOD via wastewater side-streaming. Opportunities exist on the hot side and the cold side of the process. In general, the more materials removed prior to effluent discharge, the lower the BOD will be.

2. **TSS** is a measure of the concentration of non-dissolved solids in a sample. Spent yeast, hops, trub, and grain in a brewery's effluent all contribute to increased TSS. BOD and TSS are typically measured by concentration (mg/L) for regulatory reasons, but can be measured by weight, which requires one to know their effluent volume.

Each of the side-streams discussed below would significantly reduce TSS. Common physical treatment methods include:

- 1) settling tanks
- 2) screens (fixed and rotary)
- 3) screw press



Image 2. A physical solids separator reduces waste volumes.

To improve solids separation, physical separation methods are often used in conjunction with chemical pretreatments. These typically consist of both a coagulant used to reduce surface charges, which promotes solids particles to coalesce and combine, and a polymer used to ensure those solids adhere to one another and form larger masses that are easier to separate. Specific chemicals and concentrations are waste stream specific, and you can usually work with a chemical provider to perform benchtop studies on your wastewater stream to identify what is appropriate for your brewery.

Chemical Treatment Considerations:

- Typical dosing concentrations are in units of parts per million (ppm) or parts per billion (ppb).
- The appropriate type, typically peristaltic, and size pump must be employed; it is helpful to understand the influent flow rate to the treatment system for pump sizing.
- Most chemical treatments require a tight pH range to work properly; work with your chemical provider on best practices.

Affordable Treatment Solutions

As an alternative to the technical solutions described here, some breweries use a super sack and a drum with holes near the base as a cheap filter for hot side trub. They line the drum with a sack, fill it with trub and, and leave it to drain overnight. The result is a low moisture cake that is removed by forking the sack out of the drum and emptying it over a bin.

3. **pH** is a measure of how acidic or basic a sample is. Brewery effluent on average is typically acidic but depending on the amount of volume equalization prior to discharge, slugs of caustic from cleaning activities can result in extremely basic discharge. A typical allowable range for a municipal system is between 5 and 10 standard units (SU). Extremely low or high pH effluent can have a devastating impact on infrastructure such as sewer piping over time.

SIDE STREAM HANDLING

The term “side-streaming” refers to diverting waste streams away from effluent discharge to a sewer, ideally to more sustainable solutions (e.g., diverting spent grain for use as animal feed). There are many different potential opportunities at the brewery for side-streaming specific waste streams, but the impact on effluent discharge parameters like BOD will vary. Making the effort to understand the impact of each process step on overall effluent can help identify where in the process it is worth the effort to side stream waste to make the greatest overall reduction to parameters like BOD and TSS.

1. Lauter Tun and Whirlpool Trub

Since the sugar content in wort is naturally high, waste streams from the hot side processes are very high in BOD. For, small brewhouses or single-batch brew days at larger ones, the waste stream volumes may be low enough that side-streaming is not warranted or effective. For larger brewhouses or brew processes that entail brewing multiple batches in a day to fill a fermenter, trub, lauter tun, and whirlpool rinses can have a large impact on effluent BOD.

Finding outlets for this waste stream can be challenging, but some examples include:

- Mixing with spent grain for animal feed
- Hauling separately to local publicly owned treatment works (POTW) for digestion
- Land application as fertilizer, or for use at a compost facility



Image 3. The sight glass on this trub waste storage tank helps manage filling and emptying needs.

Because of the high temperatures involved with this waste stream, piping to the storage tank should be copper or stainless steel, and plastic storage containers or tanks are not advised.

Dedicate Separate Storage Containers for Each Side-stream Waste Product

Although examples exist of breweries successfully mixing hot-side and cold-side waste for storage, dedicated storage containers for each side are recommended to prevent any secondary fermentation that could arise in the storage tanks by mixing waste streams from both sides.

2. Spent Grain

Spent grain is a common side-stream for most breweries, with typical uses including animal feed. If conveyance of the spent grain to a storage container (e.g., tank or silo) is required, progressive cavity pumps or Ponndorf-style augers are commonly used, both of which typically have air assist. Additionally, if spent grain is not side-streamed, significant plumbing issues are likely, both in-house and downstream (e.g., it could clog municipal pumps, leading to sewage overflows.)

3. Spent Yeast

A common outlet for spent yeast is animal feed, with the option to combine it with spent grain. Multi-stomached animals (e.g., cows) typically cannot handle yeast in their diet, so you should speak with the farmer taking your waste and determine whether yeast is an acceptable inclusion in the animal feed side stream. Systems for capturing this stream can be as simple as a hose and an Intermediate Bulk Container (IBC) tote to capture while racking off the bottom of a fermenter. If conveyance is required, a centrifugal pump is suitable for this slurry.



Image 4. IBCs help keep spent hops separate from other waste streams.

4. Spent Hops

One potential channel for spent hops are local compost facilities or land application. Like yeast, collection of this side stream can be as simple as a hose and an IBC that capture the spent hops during the racking process, so that they do not go down the drain.

5. Spent Filter Media

If utilizing filters, disposing of spent filter media versus rinsing to drain could be another great source control solution for BOD/TSS/pH.

STORAGE DESIGN CONSIDERATIONS

Over time the brewing process typically results in a consistently acidic ($\text{pH} \leq 5.0$) discharge effluent that risks degrading sewage pipes. As a result, wastewater authorities will often require pH monitoring and adjustment prior to discharge. Relatively simple set-ups exist to monitor pH and dose with either caustic or acid to ensure the discharge pH is in an acceptable range. Permitted ranges will vary by wastewater municipality, but a common range is 5.0-10.0. These set-ups can be either batch or continual discharge, and usually entail the use of an equalization (EQ) tank to smooth out the impact of process steps on effluent characteristics (e.g., caustic or acid slugs from the cleaning process).

1. EQ Tank Design Considerations:

- Generally, it is better to have excess EQ tank capacity than not enough. EQ tanks are typically sized at 0.5x-1x the maximum generation rate over a 24-hour period.
- A flat bottom or conical tank is preferable to a dish bottom tank (e.g., dairy) for ease of tank cleaning and avoiding sludge build-up.
- Beware calculating size using average flow rates, specifically if the timeframe that average is calculated over includes non-operational time.
- A properly sized EQ tank is sufficient to ensure compliance with any temperature requirements.
- Be aware that if effluent is stored a longer period than its own cool-off time, then it should be kept in motion to prevent the material from going septic.
- For smaller operations, IBC totes can be used for batch equalization and cooling.

2. Tank and Silo Design for Side-streams

Factors to consider when sizing side-stream tanks/silos appropriately include:

- Rate of generated waste, r_w (gal/day)
- Frequency tank or silo will be emptied, f (times/week)
- Buffer capacity for time between tank empties, B (days)

Once those values are known, the formula for calculating required tank size of the specific waste stream is:

$$V_{tank} = r_w \left(\frac{7}{f} + B \right)$$

Example Side-stream Tank Size Calculation:

A brewery generates 1500 gallons/day of trub waste off the lauter and whirlpool that will be collected and hauled to an offsite processor. The hauler will empty the tank a minimum of twice weekly and the tank will be sized with a 2-day buffer in case the hauler cannot meet the committed pick-up date.

$$V_{tank} = r_w \left(\frac{7}{f} + B \right) = 1500 \left(\frac{7}{2} + 2 \right) = 8250 \text{ gallons}$$



*Image 5. Spent yeast is stored in tanks outside while awaiting removal and reuse.
Photo Courtesy of Bell's Brewery, Inc.*

3. Other Considerations

- a. Design Considerations: Other considerations when selecting and installing tanks include ease of cleaning (conical bottom tanks and/or accessible manhole covers can make this easier), ease of emptying (elevated tanks make loading trucks much easier), easily monitored level indicators, and anticipated growth factors in the future.
- b. Clean in Place (CIP) Procedures: When a brewery moves from a manual CIP process to an automated CIP unit that recycles rinse water, significant water and chemical savings can be realized. However, the reduction in rinse water going down the drain can also result in a significant

increase in BOD/TSS concentration of the wastewater effluent. While the overall volume discharged can be reduced, breweries that are permitted to a specific concentration of BOD should factor in the impact of the new equipment on effluent properties. Considering the actual weight of BOD will not change with the higher concentration effluent, it is wise to ask regulators to alter their permitting to factor this process improvement into their requirements.

- c. A good lab investment for any brewery that is permitted for BOD is test equipment for monitoring Chemical Oxygen Demand (COD). While BOD is a test that takes five days or more to complete, COD is a test that yields results in just hours, and correlates directly with BOD. Monitoring COD on a regular basis (e.g., once daily) can help identify process upsets and key opportunities for improvement to ensure compliance.
- d. Outdoor Storage of Side-streamed Materials: It is critical to cover any side-streamed materials stored outside. Storing them uncovered could be a violation that leads to fines or worse. In colder environments, it is wise to heat-trace and insulate outdoor pipes, and place pumps inside of insulated and heated cabinets to avoid delays, messes, equipment loss, and non-compliance.

ADDITIONAL REFERENCES

1. “Wastewater Management Guidance Manual.” Brewers Association, September 13, 2022. <https://www.brewersassociation.org/educational-publications/wastewater-management-guidance-manual/>.
2. “Water & Wastewater Sustainability Manual.” Waste and Wastewater: Treatment/Volume Reduction Manual. Brewers Association, September 13, 2022. <https://www.brewersassociation.org/educational-publications/water-wastewater-sustainability-manual/>.
3. “The Effect of Waste Side-Streaming on Brewery Effluent Strength.” Brewers Association, February 10, 2022. <https://www.brewersassociation.org/seminars/the-effect-of-waste-side-streaming-on-brewery-effluent-strength/>.
4. Spevacek, Ann R, and Eric J Ritchson. “The Effect of Waste Side-Streaming on Brewery Effluent Strength.” *Technical Quarterly* 57, no. 4 (2020): 213–17. <https://doi.org/10.1094/tq-57-4-1105-01>.

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