



**Wastewater Opportunities
for the Craft Brewer**

Successful examples of real world
craft brewery wastewater solutions




John Mercer
Deschutes Brewery











Purpose

- Help everyone understand wastewater and how wastewater treatment works
- Give examples of successful real-world craft brewery wastewater strategies
- Discuss what types of technologies are out there
- Share tried and true materials and equipment
- Talk about other brewery byproduct disposal options



What is the problem with brewery wastewater?

- In a word, it's nutrient pollution.
 - Very simply, whether brewery wastewater were to get in to a river or a treatment plant, algae and bacteria will grow in it.
 - These microorganisms consume oxygen, which could eventually lead to fish kills in a river or anaerobic conditions in a treatment plant.
 - These nutrients cannot be filtered out of the wastewater.
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Example of a blower





Wastewater metrics

- Biochemical Oxygen Demand (BOD) is a measurement of everything in the wastewater that can be *biologically* oxidized.
- A BOD test takes five days. 5 days is the longest time that river water takes to travel from source to estuary in the UK.
 - Test is done under anaerobic conditions
- Chemical Oxygen Demand (COD) is a measurement of everything in the wastewater that can be oxidized.



Wastewater metrics

- BOD, COD, and TSS loading rates are commonly expressed as Pounds Per Day (PPD).
- The volume of water per pound of BOD varies depending on the strength of the wastewater (the BOD).

Pounds Per Day =


$$(8.34 \times \text{BOD} \times \text{gallons}) / 1,000,000$$




What does this have to do with beer?

- Breweries make beer, but they also make high strength wastewater.
- With this in mind, brewers need to be prepared for wastewater challenges.
- In most cases, the city is going to force changes at the brewery.
 - A common tactic is to threaten to cut off sewer service if regulations are not met



Who participated in the survey?

- 18 craft brewers were surveyed, located all over the country.
- All data is anonymous but was consolidated in to 3 categories of brewers:
 - Small Craft Brewers
(100 to 15,000 bbls/yr)
 - Medium Craft Brewers
(16,000 to 99,000 bbls/yr)
 - Large Craft Brewers
(more than 100,000 bbls/yr)



Themes from all interviews

- No brewer interviewed does absolutely nothing to their wastewater.
- Growth in your city can be a competing factor for a brewery.
- Some cities charge brewers hefty wastewater surcharges in addition to normal wastewater fees. Other cities do not charge surcharges, just normal wastewater fees. Size of the brewery and size of the city seems independent in this situation.



Themes from all interviews

- A big theme you will learn is how important local regulations are to the overall operations of a brewery, and to be absolutely clear what these regulations actually are at the very earliest phases of planning your brewery.
- If you are a significant industrial user in your town, watch out- especially if you are the only significant industrial user.










Small Craft Brewers
(100 to 15,000 bbls/yr)

- There were 6 breweries surveyed at this size. All of them are small production breweries with small packaging lines.
 - Brewpub only operations were not surveyed
- Generally, small breweries in small towns don't have to do much to their wastewater.
- In most cases, the effluent management system was designed in house.










Small Craft Brewers (100 to 15,000 bbls/yr) - con't

- 3 of the 6 small brewers interviewed do very little to their ww before discharge to sewer.
 - Everything is dumped to the sewer, often including spent yeast
 - Most small brewers did not do pH control or flow control
 - Some brewers kill the yeast before dumping
 - One “big” small production brewer discharges to a septic system
- In 3 cases, the small towns were eager to get a brewery in town.



Small Craft Brewers (100 to 15,000 bbls/yr) - con't



- One brewer recently moved their production facility to an adjacent town as an expansion project to escape excessive wastewater fees and regulations.













Small Craft Brewers (100 to 15,000 bbls/yr) - con't

- One of the 6 brewers surveyed was segregating their wastes and hauling off their high strength stuff. This brewer was also the only small brewer to test for BOD. This brewer also has a small aerobic treatment system.
 - Influent BOD is 8000-12000 mg/L
 - Effluent BOD is 2500 mg/L after 24hrs aeration
- There is no excess capacity available at the local treatment plant.










Medium Craft Brewers (16,000 to 99,000 bbls/yr)

- There were 5 breweries surveyed at this size. Some had a restaurant on site, but the focus of the operation is the brewery.
- 2 themes are beginning to appear.
 - Separation of high strength and low strength waste streams
 - Aerobic treatment




Medium Craft Brewers (16,000 to 99,000 bbls/yr) - con't

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- All 5 brewers practice segregation of wastes to some degree. The high strength wastes are separated at the source and hauled off site.
 - 2 of the 5 separate trub and spent yeast
 - Trub goes out with spent grain and yeast goes out for land application as fertilizer
 - These two brewers have on-site aerobic treatment of the rest of their wastewater
 - Effluent BOD from one of these guys is 39 mg/L, from the other is 3000-4000 mg/L
 - Neither of these brewers test influent BOD
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Medium Craft Brewers (16,000 to 99,000 bbls/yr) - con't

- The other 3 collect more wastes at the source. Things like lauter tun plate rinsings, hop back rinsings, whirlpool rinsings, and waste beer.
 - These wastes were ultimately used for off-site cattle food or fertilizer
 - These 3 brewers have no onsite biological pretreatment, but they're all in various stages of considering it
 - Average low strength wastewater BOD is 1850 to 4000
- One of these brewers is currently putting in an aerobic membrane treatment system. The guaranteed effluent BOD is between 5-10 mg/L.











Large Craft Brewers (more than 100,000 bbls/yr)

- There were 7 craft brewers surveyed in this category.
- Wastewater operations varied widely between those surveyed, depending on restrictions coming from the city.
- 2 brewers dump everything down the drain with the exception of spent yeast.
- 4 brewers were segregating high strength and low strength streams and land applying, as mentioned before in the medium sized category.













Large Craft Brewers
(more than 100,000 bbls/yr) - con't

- 2 of the 4 brewers segregating their wastes have *very* strict regulations coming from the city:
 - Low BOD PPD limit
 - Low instantaneous BOD limit
 - Low GPD limit, and
 - Low instantaneous GPM limit.
- So there is a wide variety of restrictions coming at brewers, from very strict to very lax, and plenty in between



Large Craft Brewers (more than 100,000 bbls/yr) - con't

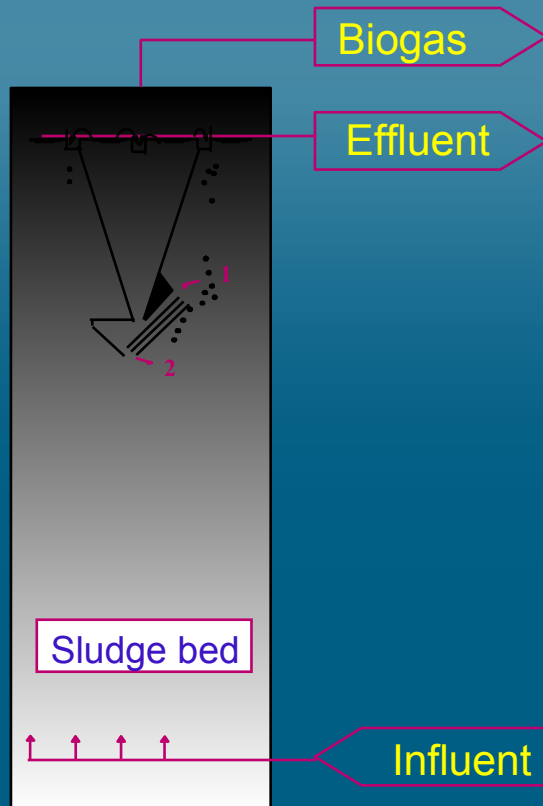
- 2 of the brewers have anaerobic pretreatment followed by aerobic polishing of the anaerobic effluent, then discharge to city sewer.
 - One brewer sees 95% total BOD removal rates
 - The other is seeing 98.9% total BOD removal
 - Raw effluent BOD ranges from 1100 to 5400 mg/L.
 - Treated effluent BOD ranges from 10 to 250 mg/L.
 - TSS ranges from 200 to 1000 mg/L.
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Large Craft Brewers (more than 100,000 bbls/yr) - con't

- Anaerobic Pretreatment
 - Plan on 80% BOD removal from an anaerobic system.
 - If you follow the anaerobic with aerobic polishing, you can expect 95% total BOD removal rates- clean enough for direct discharge if you like to take risks.
 - When operating an anaerobic pretreatment plant, it pays to pay attention to the details of the system. Things like micronutrients, solids removal, alkalinity, biogas handling...
 - One brewer mentioned that operating an anaerobic digester is not rocket science, but it is science.

Basic Anaerobic Schematic



- Anaerobic pretreatment is very common in breweries and food plants around the world
 - The US has 478 industrial anaerobic pretreatment systems
 - Globally, most systems are in Europe, and most systems are in breweries
- Why breweries?
 - Highly soluble, easily digestible food source
 - High temperature, concentrated waste stream
 - Highly efficient, +90% COD removal is common at 0.6-1.0 lb COD/ft³/day (10-15 kg COD/m³/day)

Diagram courtesy of Biothane






Onsite wastewater disposal

- Two of the brewers I talked with are in a fairly remote location and dispose of all their wastewater on site
 - 1 medium brewer
 - 1 “large” small brewer
- In each case there is no “city” to discharge to, or there was no available capacity at the treatment plant



Onsite wastewater disposal- con't

- One system is essentially a septic system, effluent eventually leading to a leach field.
 - Described as under engineered but it works as far as the State is concerned
 - State discharge permit, GPD is the limiting factor- not BOD, TSS, P, K, N, pH
 - The other system starts with aerobic treatment, then settling/clarification (to settle out the aerobic sludge), then drip irrigation on their property.
 - Pasture land, not crops
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Water reuse

- In general, the concept is biological pretreatment, sand filtration of the pretreated effluent, microfiltration, then reverse osmosis.
- Uses of this water in the brewery can be cooling tower water, boiler water, CIP water, irrigation water, or even product.



Water reuse - con't

- With a system like this, it's possible that the only industrial effluent would be reject water from the RO unit.
- One brewer engineered the system, bought most of the components, then backed out before startup due to marketing concerns.
- Another brewer, one with the really strict limits mentioned above, is currently considering water reuse.
- It is unclear if any brewer is actually doing this at this time.

A vertical column of ten white squares of varying sizes is positioned on the left side of the slide. The squares are arranged in a roughly descending order of size from top to bottom, with some smaller squares interspersed among the larger ones.

Types of permit limits

- No limit, give the city what you got. Based on my interviews, this isn't just the small guys.
- pH limit only and/or
- TSS PPD limit and/or
- BOD PPD limit and/or
- Maximum instantaneous BOD limit and/or
- GPD plus BOD PPD limit and/or
- Upper temperature limit.
- Most are city permits, a few were state permits.



Types of permit limits - con't

- Make sure you are very clear about types of regulations your city is going to enforce.
- In the case of the 2 brewers with the very strict regulations mentioned earlier, these regulations appeared after the brewery was already built.



Types of permit limits - con't

- It is technically illegal to knowingly dump wastewater to sewer if the pH is below 5 or above 11.
- Spent grain & hops are generally prohibited from entering the sewer system
- Most cities will charge Extra Strength Sewer Charges (ESSC's) to breweries to help offset their costs of treating your wastewater.



Lessons

- Benefits of brewery wastewater to a municipal treatment plant.
 - Municipal wastewater treatment plants utilizing a nitrification/denitrification activated sludge process can often benefit from the presence of brewery wastewater in their influent waste stream



Lessons- con't

- 1 very common piece of wisdom among all brewers is to keep the regulatory agency on your side.
- Keep communication channels open between your brewery and their treatment facility.
 - A positive relationship reaps huge rewards in the long run
- Do not get in to an adversarial relationship!
- Some cities aren't concerned about pH or BOD.
- Some cities are concerned only with pH or BOD, but not both.
- Some cities are concerned with both and are very strict.



Lessons - con't

- Do spend the money in the design phase of your brewery to do the wastewater thing right. It doesn't need to cost a fortune, but little things make a big difference.
- Depending on the situation with the sewer authority, sometimes a no-frills, low-cost storage tank system will get you where you need to be, even though nobody would intentionally design a system that way.
- Make sure you are not paying sewer fees on beer, evaporation, water in spent grains, etc.



Good ideas

- Aeration can make a lot of sense in certain cases where BOD reduction is needed.
 - However, aeration is energy intensive and you are losing the energy available in biogas from anaerobically treated ww
 - Be aware of potential foaming issues and solids generation



Good ideas - con't

- One brewer worked with a local University's engineering department. For 3 semesters the students would create a theoretical engineering firm to develop the best solutions for the brewery's wastewater problems.
- 1 of the interviewees is separating restaurant scraps from landfill waste and giving these scraps to a local pig farmer, then serving the pork in the restaurant.

A vertical column of ten white squares of varying sizes is positioned on the left side of the slide. The squares are arranged in a roughly staggered pattern, with some appearing in pairs or small groups.

Good ideas- con't

- The “Carper Drain”; instead of putting a trench drain down the middle of the aisle in your cellar, put the trench drain behind the tanks against the wall. This makes cleanup a lot easier.



Good ideas - con't

- Some brewers thought it was a good idea to do the absolute minimum treatment needed, and do it cheap but do it right.
- Other brewers see wastewater as a resource, especially those operating anaerobic digesters.
- They're both right, it's really a matter of perspective and available capital.











pH adjusting chemicals

- Most brewers use caustic to raise the pH and CO₂ to lower the pH.
- Some brewers use phosphoric or sulfuric acids as the acid source, but these are dangerous.
- One brewer uses powdered food grade lime instead of caustic. Cost was the driver here.
- Magnesium hydroxide has also been tried instead of caustic.



Materials

- Don't use galvanized pipe!
- It was hard to find a favorite material for piping and floor drains.
 - PVC and CPVC of various schedules is most common for piping
 - ABS is fairly common for piping
 - A few brewers are using HDPE
 - At least 3 of the interviewees are using ductile iron pipe
 - Stainless steel use is growing as brewers replace failed piping
 - Most plastics have an upper temperature limit



Materials - con't

- Lesson #1: If you don't want to dig it up, do it in stainless.
- Lesson #2: If you can't afford stainless, be very selective about what type of piping material to use. CPVC or HDPE are probably second best.

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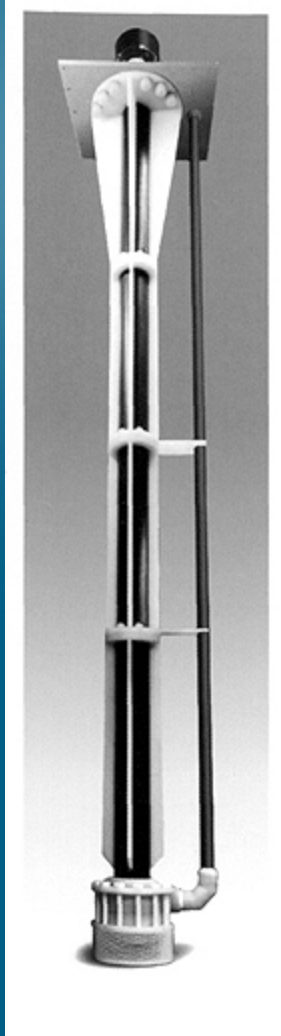
Equipment

- pH electrodes
 - Sentron
 - ABB
 - HACH
- Level detection
 - Pressure transducer
 - Aquatape



Equipment

- Try to avoid submersible pumps whenever possible.
- Pumps mounted on the surface have the electrical wiring out of the water, are easy to maintain, suffer from less corrosion, and often times cost less.
- A style of pump we have had good luck with is line shaft pumps, where the pump head is submerged in the water and the motor is above grade.



Sample line shaft pump

- This style of pump has flooded suction.
- All material in the pit is thermoplastic.
- The electrical components are above grade, out of the corrosive environment in the pit.



Other Byproduct Solutions

- Spent grain
- Spent yeast
- Trub
- Diatomaceous earth



Thank you all very much

