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In Pursuit of the Sustainable Distillery:

The Wastewater Dilemma

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In Pursuit of the Sustainable Distillery: The Wastewater Dilemma

Craft distilling is a growing industry in the United States increasing by 15.5% over the last year from 1,589 active craft distilleries in August 2017 to 1,835 in August 2018 according to the American Craft Spirits Association (ACSA).[1] The ACSA define active craft distillers as "licensed U.S. distilled spirits producers that removed 750,000 proof gallons or less from bond, market themselves as craft, are not openly controlled by a large supplier, and have no proven violation of the ACSA Code of Ethics." In an industry that requires large amounts of water for production and produces more wastewater than product, the constant increase of craft distilleries makes water availability and wastewater disposal more challenging. In some areas, state and local authorities have established effluent guidelines programs in accordance with the Clean Water Act.[2] Due to business and regulatory pressures, craft distilleries are finding ways to become more sustainable. Distilleries are looking to treating their wastewaters as a viable solution. Treating distillery wastewater reduces the impact to the environment, can create extra revenue from the separated solids, and can reduce the costs of wastewater disposal.

Current Disposal Methods

The brewing and distilling industries have many similarities. Both industries have fermentation and separation operations, are large water consumers, and are wastewater producers.[3] Wastewater disposal for both industries will have similar regulations differing in the discharge limits of their effluents' contents. In urban areas, craft breweries and batch distilleries could usually dump their wastewater down the drain. With large municipal sewer systems, a craft distillery's effluent is insignificant compared to the total effluent being treated at a large municipal plant. However, in recent years, local municipal sewer districts have become more concerned with the continued rapid growth of craft brewing and batch distilling in the United States. Due to the popularity of distilleries, the increasing levels of treating distillery wastewater can eventually lead municipalities characterizing batch distilleries as significant industrial users that should be permitted, monitored, and charged significant surcharges to

[1] Distillery Trail. "ACSA Releases 2018 Craft Spirits Data Project – Sales up 24%, Number of Distilleries up 15% [Full Report]". *Distillery Trail.* 28 Sep. 2018, https://www.distillerytrail.com/blog/acsa-releases-2018-craft-spirits-data-project-sales-up-24-number-of-distilleries-up-15-full-report/. Accessed 3 Dec. 2018.

[2] U.S. EPA. "Final 2016 Effluent Guidelines Program Plan". *United States Environmental Protection Agency*. Apr. 2018, https://www.epa.gov/sites/production/files/2018-05/documents/final-2016-eg-plan_april-2018.pdf. Accessed 4 Dec. 2018.

[3] Fillaudeau, Luc; Bories, Andre; Esteban-Decloux, Martine. "Brewing, winemaking and distilling: An overview of wastewater treatment and utilisation schemes". Dec. 2008, https://www.researchgate.net/publication/285462447_Brewing_winemaking_and_distilling_An_overview_of_wastewater_treatment_and_utilisation_schemes. Accessed 4 Dec. 2018.

treat distillery effluent. Smaller and more local municipalities may not be designed to treat the large volume of distillery wastewater compared to domestic wastewater. Therefore, there will be a surcharge to properly treat distillery wastewater. If a distillery is located in an area where there is no sewer system available, proper wastewater treatment and disposal is essential.[4]

Why Wastewater Can Be Harmful

Without proper treatment, distillery wastewater (also known as stillage or spent wash) poses a serious threat to the environment. Distillery wastewater may contain metals from the plants and the water used in the distillation process as well as from metal contamination by washing down any metal equipment and the floor. Heavy metals are hazardous to plants and animals, and therefore, need to be monitored to prevent high toxic levels in the soil and water. The elevated levels of nitrogen and phosphorous in distillery wastewater can often cause an algae bloom in any water source receiving the wastewater.[5] Excessive algae growth causes problems within aquatic ecosystems blocking sunlight from other plants and depleting available oxygen in the aquatic system.[6] The Environmental Protection Agency (EPA) requires distilleries to monitor their wastewater for the following parameters: discharge volume, organic matter, alkalinity/acidity, nutrients, salinity, heavy metals, and total suspended solids (TSS).[7]

The three main distillery wastewater issues to address are pH, biochemical oxygen demand (BOD), and total suspended solids (TSS).[8] Low pH wastewater is corrosive and high pH wastewater leads to deposits. Any wastewater with a pH outside the EPA pH discharge limits of 5 to 11 would harm any workers doing maintenance on sewer lines, the structural integrity of sewer lines, and the biological organisms at treatment facilities.[9] BOD is the measure of the organic content of wastewater. It is measured by the amount of dissolved oxygen needed to break down organic material present in a given

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[4] "Wastewater Management Guidance Manual." *Brewers Association*. https://s3-us-west-2.amazonaws.com/brewersassoc/wpcontent/uploads/2017/05/Wastewater_Management_Guidance_Manual.pdf . Accessed 5 Nov. 2018.

[5] Lindermann, Garrett W. "Characteristics of Wastewater in a Distillery." *Sciencing*, 25 Apr. 2017, https://sciencing.com/characteristics-wastewater-distillery-7655.html. Accessed 5 Nov. 2018.

[6] Scott, Laura. "What are Algae Blooms?" *Sciencing*, 25 Apr. 2017, https://sciencing.com/algae-blooms-8266246.html. Accessed 5 Nov. 2018.

[7] Environment Protection Authority. "EPA Guidelines for Wineries and Distilleries." Apr. 2017, http://www.epa.sa.gov.au/xstd_files/Industry/Guideline/guide_wineries.pdf. Accessed 5 Nov. 2018.

[8] Mercer, John. "Wastewater basics for a growing craft brewery." *Craft Brewing Business*. 22 Sep. 2014. https://www.craftbrewingbusiness.com/equipment-systems/wastewater-basics-growing-craft-brewery/. Accessed 5 Nov. 2018.

[9] "Water and Wastewater: Treatment/Volume Reduction Manual." *Brewers Association*. 2013. https://www.brewersassociation.org/attachments/0001/1517/Sustainability_-_Water_Wastewater.pdf. p. 36-39. Accessed 6 Nov. 2018.

volume of water. Wastewater with high BOD values released into surface waters can cause high rates of mortality to aquatic life and can lead to the production of sulfide and methane. TSS is a measure of how turbid the water is in terms of suspended and dissolved organic materials. High levels of TSS block UV light from aquatic flora and can clog filter-feeding organisms. The wastewater will need to be treated by neutralizing the pH and removing BOD and TSS before disposal.

Different Treatment Methods

Wastewater treatment can be broken down into three categories: physical, chemical, and biological. Implementing one treatment can reduce the amount of organic material in distillery wastewater before it is further treated in municipal treatment plants. A combination of treatments can produce a more sustainable distillery as well as reduce future surcharges for any wastewater that cannot be treated on site.

Physical treatments (e.g. screening, sedimentation, flotation, and adsorption) separate coarse solids and other large materials from the wastewater. Physical treatments can reduce a majority of BOD and TSS content in distillery effluent driving down surcharges from wastewater treatment facilities. The separated grains from the wastewater can be used or sold as fertilizer or animal feed.[10] By physical treatment alone, BOD and TSS in distillery effluent can be lowered by about 80 percent.[8]

Chemical treatments (e.g. oxidation and flocculation) are used in conjunction with physical treatments to increase color removal and reduce chemical oxygen demand (COD), a measure of all substances that can be oxidized in water. Added chemical compounds oxidize the wastewater into carbon dioxide, water, inorganic matter, and other harmless products. However, chemical treatments, though effective, are difficult to implement due to high concentrations needed, sludge generation from treatment and subsequent disposal, metal accumulation, and purchasing costs. Chemicals for pH neutralization are common and inexpensive, but are highly concentrated making them dangerous to work with.

Biological treatments (aerobic and anaerobic) are sustainable ways to treat distillery wastewater and produce usable byproducts. Aerobic systems use oxygen and bacteria to metabolize any organic material in the wastewater, thereby increasing bacteria production and generating inorganic end products. Aerobic treatments yield 99% BOD reduction but have high-energy use; generate sludge,

[10] Gribbins, Keith. "The growing challenges of brewery wastewater systems." *Craft Brewing Business.* 6 Sep. 2013. https://www.craftbrewingbusiness.com/equipment-systems/growing-challenges-wastewater-control-craft-brewing/. Accessed 6 Nov. 2018.

which requires disposal; have high operating costs, and have larger footprints than anaerobic treatments. Anaerobic systems work without oxygen using bacteria to convert organic material into biogas. Anaerobic treatments provide renewable energy in the form of biogas; produce low biomass; have low operating costs; and have smaller footprints. However, installing anaerobic systems can cost as much as aerobic systems for only an 80% COD reduction.[9]

Municipalities have generally used aerobic systems to treat brewery and distillery wastewater; however, anaerobic systems are becoming the more attractive option since the treatment generates a renewable energy source. On the small-scale, anaerobic digesters (in-ground rubber-balloon, in-ground fixed dome, and floating drum) have small land use, have low to moderate installation costs (built with local available materials), have low operating costs (no electrical energy required), and generate renewable energy. The biogas produced from anaerobic treatment can be used for cooking or as a heat source. The spent grains can be used as animal feed or solid fertilizer. Any leftover wastewater can be used as liquid fertilizer. Nonetheless, digesters require expert design, skilled construction, proper temperature maintenance, and regular cleanings.[11]

In-ground rubber-balloon digesters are simple continuous-flow designs and can cost as little as $50 for parts. The rubber-balloon digester works well in moderate to high temperature climates and is easy to clean and empty. Its life span can be short due to its susceptibility to weather damage. In-ground fixed dome digesters are slightly more expensive (~$350 for 4-6 cubic meters) but, if well designed, have a long life span. Fixed dome digesters can also be constructed underground to save space and prevent temperature changes. Floating-drum digesters are easy to construct, but the materials may be expensive if they are not readily available. Because the slurry and biogas can corrode steel fairly rapidly, plastic containers are preferable to steel drums.[12]

Customizing a Treatment Plan

Determining a wastewater treatment strategy for a distillery depends on a few key parameters: location of the distillery and type of sanitation system used in the area, estimated volume of total wastewater, and available space in the distillery. Distilleries in large cities can utilize the city's existing infrastructure with little to no on site pretreatment of the wastewater. Distilleries in areas with smaller

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[11] Eawag and Spuhler, Dorothee. "Anaerobic Digestion (Small-scale)." *Compendium of Sanitation Systems and Technologies, 2nd Revised Edition.* 19 Jun. 2018. https://sswm.info/arctic-wash/module-4-technology/further-reseources-wastewater-treatment/anaerobic-digestion-%28small-scale%29. Accessed 17 Oct. 2018.

[12] Dana, Rich. "Micro-scale Biogas Production: A beginner's guide." *National Sustainable Agriculture Information Service, ATTRA.* 2010. http://www.build-a-biogas-plant.com/PDF/Micro-Scale%20Biogas%20Production.pdf. Accessed 17 Oct. 2018.

treatment facilities can use physical and chemical treatments to separate the solids from the wastewater before disposing the wastewater down the drain. More rural distilleries probably would have the most benefits from having on site biological treatments. Using anaerobic digesters, the biogas produced can be used to provide energy to the distillery or warm a greenhouse. Becoming a more sustainable distillery is a great way to reduce surcharges while staying ahead of future environmental regulations.

Freer Consulting is available to help create a wastewater treatment plan that is a good fit for your craft distillery. We can research local regulations and local options for wastewater disposal; take samples to determine the contents of your wastewater; determine different wastewater treatment options that align with your needs and goals; and provide engineering support. If you are interested in our assistance with any aspect of creating a more sustainable distillery, contact Freer Consulting at 206-285-9044 or info@freerconsulting.com.