AdvanTex® Design Criteria

Orenco Systems®
Incorporated
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For Treatment of Winery Process Wastewater

Over the past ten years, the number of "boutique wineries" has increased. These wineries produce from 5,000 to 20,000 cases of wine a year. Wineries of this size do not process enough wastewater to justify the lagoon-type treatment systems commonly used at larger wineries. Some boutique wineries are served by municipal sewer systems, where they are charged sewer fees on the basis of their wastewater volume and strength. Many of them – and many larger wineries as well – are also seeking opportunities for reuse or recycling of their process wastewater. As a result of these changes, wineries increasingly need treatment systems that can treat their process wastewater to a high level.

In response, Orenco Systems has prepared this guide for wastewater system designers who wish to use the AdvanTex® Treatment System for winery process wastewater. (For design of AdvanTex Treatment Systems for sanitary wastewater, see *AdvanTex Design Criteria for Commercial and Multifamily Applications*, NDA-ATX-COMM-PKG-1.) After a brief explanation of the AdvanTex Treatment System, this guide reviews the stages of the winemaking process, describes the characteristics of wastewater produced at each stage, and provides guidance for designing process wastewater treatment systems that accommodate the needs of wineries.

The AdvanTex® Treatment System

Because of its high strength and surge flows, winery process wastewater requires ample primary tankage followed by a robust secondary treatment system. Commercial AdvanTex Treatment Systems are a multiple-pass, packed-bed aerobic wastewater treatment technology that is well suited for winery applications. The moist bed of synthetic textile in the AdvanTex filter pod is an environment highly favorable to both anaerobic and aerobic treatment processes, allowing large volumes of wastewater to be treated in a small space. Because effluent is recirculated through the system in timed doses, treatment proceeds consistently regardless of variations in influent flow.

The Winemaking Process

To design a successful treatment system for winery process wastewater, the designer should have a general understanding of the steps in the winemaking process. Most wines are made in four steps, with some variation at wineries that make certain kinds of wine or use unique processes. The following steps should be treated as a general overview of the wine making process and how each step can affect a wastewater treatment system; however, practices at each winery should be thoroughly evaluated when designing and operating a process wastewater treatment system.

1) Harvest and Crush. Harvest typically starts in late summer or early fall, when the grapes have reached their peak level of sugar concentration, and continues for 2-3 months. The first step is the crush, which consists of de-stemming and crushing the grapes before fermentation. The crush is usually completed on a concrete pad with floor drains. The floor drains are equipped with basket strainers, but some stems, seeds, and skins can get through; they should be removed from the waste stream before the biological treatment process. During the crush, the main concerns affecting treatment are surge flow, solids, and organic concentrations.

2) Fermentation. Once the juice is resident in the fermentation tank, yeast is added, and the juice is allowed to ferment, which converts the sugars to alcohol. After fermentation, the liquid (now wine) is drained into barrels for aging.

Occasionally, a second fermentation step is incorporated. The remaining solid material in the fermentation tanks (called pomace) is shoveled out into a press, where additional juice is pressed out of it. The remaining solids are transported to a solid waste facility. After fermentation, the fermentation tanks are cleaned with water and food-grade sodium hydroxide (NaOH) or potassium hydroxide (KOH), which can cause pH problems in the primary wastewater tanks. At some wineries, all sediment is washed into the wastewater system, producing high-volume, high-solids, high-strength waste. Alternatively, the fermentation wastes may be filtered out.

3) Clarification and Racking. During barrel aging, the suspended solids in the wine will settle and collect at the bottom of the barrel, forming a loose sludge called "lees." Winemakers typically rack the wine off the lees a few times during the aging process. Lees are typically disposed of in the onsite wastewater treatment system or filtered out of the wastewater and taken to the landfill. Barrels are typically washed out using a caustic cleaning agent, which is washed into the wastewater system. The winemaker may use a flocculating (fining) agent, such as egg white or bentonite clay, which can also end up in the wastewater.

The wine's acidity may be adjusted with tartaric acid ($C_4H_6O_6$), and it may be chilled to near the freezing point, both of which may affect the wastewater characteristics. To ensure that treatment processes can continue in the primary tanks, system operators must closely monitor pH in the tanks at this stage.

4) Filtering and Bottling. Cleaning of the barrels at this point produces some wastewater, but typically it is not as high in strength as it is during some of the other processes. However if the lees are not properly filtered out, the wastewater strength can increase dramatically.

Differences in vinification philosophy, product lines, equipment, and cleaning techniques can cause variations in wastewater volumes and strength from wineries of similar size. Wastewater can come from cleaning of crush equipment, fermentation tanks, hoses, pumps, barrels, the press, harvest bins, and settled lees. Other contributions to the waste stream may include water softener waste brine, cooling tower and boiler blowdown, distillation, and wine ion exchange regenerations. Although these variations affect the treatment process and the system design, peak flows and concentrations typically occur at the four points described above.

Designing a Winery Process Wastewater System

Depending on the winery, 3-12 gallons of wastewater can be generated for every gallon of wine (11-45 liters of wastewater for every 4 liters of wine). During the crush season, approximately 1.5 gallons of wastewater is produced for every gallon of wine (6 liters of wastewater for every 4 liters of wine). The wastewater treatment system should be sized for the high strength and high hydraulic load seen during the 60-90 day crush period, when influent waste strength ranges from 3000 to 7000 mg/L BOD_5. Most facility managers and engineers will estimate the peak event based on actual crush flows. In many cases, the peak flow rate will be the actual flow rate during the crush period, unless peaking factors have been utilized.

Flow equalization and surge capacity can also be utilized to reduce the hydraulic demand on the treatment system. A surge design is especially valuable in systems with large daily variations in flow during the crushing and racking seasons.

In a winery system, process wastewater is separated from sanitary wastewater. Most of the waste strength in the process wastewater stream consists of sugars. Primary tankage can reduce some of this influent strength. Typically, Orenco recommends sufficient tankage to provide five days of hydraulic retention time (HRT), based on the peak daily flow rate. This provides a safety factor for peak events, and also allows space for the addition of aeration devices to scrub the waste strength down to treatable levels (<1000 mg/L BOD_5).

Following is a diagram and description of a typical winery process wastewater system:

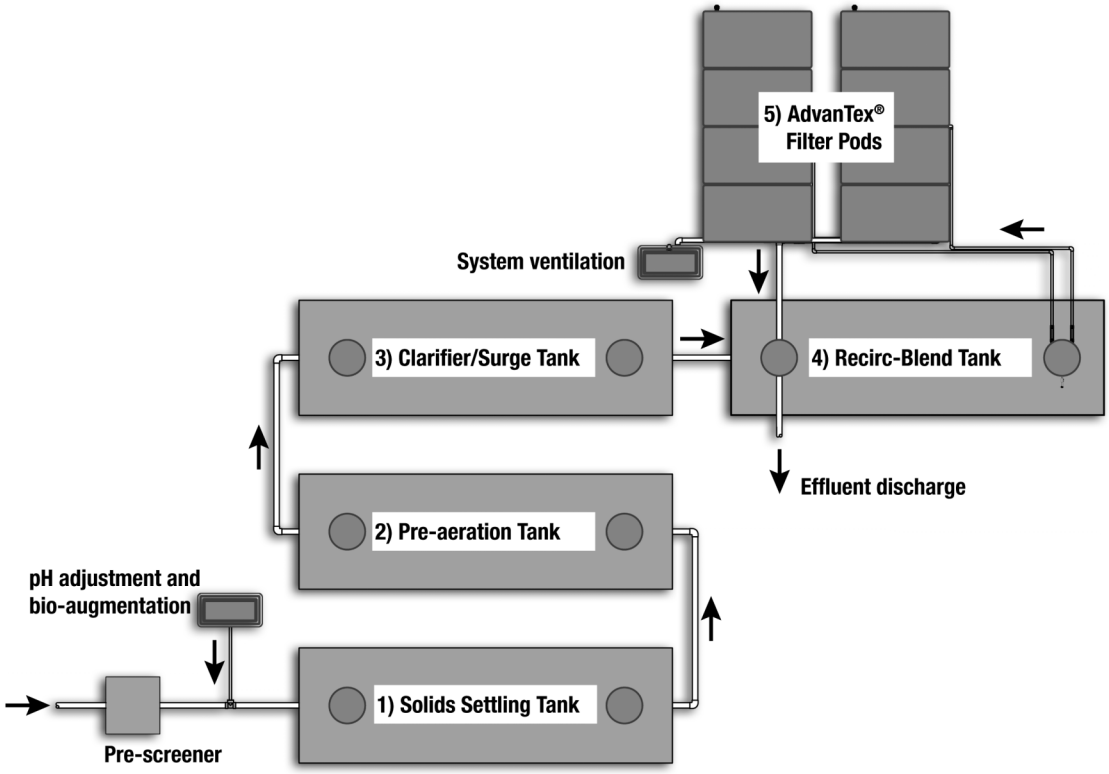

Fig. 1: Components and Flow Path for a Typical Winery Process Wastewater System

The primary tank should have three treatment compartments. Larger systems may use a tank for each compartment, instead.

1) The first compartment or tank is for the settlement of skins and other heavy solids. This compartment or tank should be able to provide one-to-two days of HRT based on peak flow.

2) The second compartment or tank should be designed for additional settlement of solids and one or two days' hydraulic retention time (HRT) for pre-treatment through aeration.

3) The third compartment or tank is for sedimentation of solids and clarification of the aerated effluent, if pre-aeration is used. Access should be provided to both inlet and outlet, and the third compartment or tank should be equipped with an effluent filter.

Orenco has utilized two options for aeration scrubbers: A fine-bubble diffuser, and a shaft fine-bubble aerator.

4) After primary treatment, the effluent enters the AdvanTex system's recirc-blend tank for secondary treatment. ProSTEP™ pump packages in the recirc-blend tank transport the effluent to a distribution manifold in the AdvanTex filter pod(s).

5) In the AdvanTex Filter Pods, effluent percolates down through the textile media, where it is treated by naturally occurring microorganisms that populate the filter.

After passing through the filter media, the treated effluent flows out of the filter pod through the filtrate return line, which directs the effluent to the recirculating splitter valve in the recirc-blend tank. The valve automatically splits the flow between the recirc-blend tank and the final discharge and it controls the liquid level within the tank. During extended periods of low forward flow into the system, 100% of the treated effluent is returned to the recirc-blend tank.

The recirc-blend tank is set up so that incoming effluent from the primary septic tanks and filtrate from the AdvanTex system pods enter opposite the pump discharge to the pods. In this way, mixing, blending, and dilution of the effluent occurs before it is dosed onto the AdvanTex filter pods. Typically, Orenco recommends sufficient tankage to provide one day of HRT based upon the peak daily flow rate.

Additional Design Considerations

Process waste tends to have very pungent odors, so system ventilation should be carefully evaluated. A venting plug in the inlet of the recirculation tank has improved odor control at several facilities. Active ventilation systems are required for all process wastewater treatment facilities.

pH adjustment may be necessary, depending on the sanitizing solutions used and other practices at the winery. pH has been measured as low as 3-4, which retards efficient treatment performance. pH can be adjusted with an ammonia-based solution (such as aqueous ammonia [NH_4^+, at 19% concentration]), or other chemical additions.

Prescreening devices have been used to reduce the build-up in the first primary tank, which can potentially reduce the pumping frequency and waste strength. These screening devices typically use gravity, and solids must be removed from them by hand.

Treatment Performance

Based on data from real-world sites, an actual loading rate on the AdvanTex media of 5 gpd/ft^2 (203.7 mm/day) should be maintained to produce wastewater that is typical of residential-strength waste (360 mg/L BOD_5 and 160 mg/L TSS). Better treatment is possible with lower loading rates and the addition of aeration. If cleaner wastewater is required, use hydraulic loading rates of 3-4 gpd/ft^2 (122-162 mm/day). For effluent limits below 160 mg/L BOD and 80 mg/L TSS, please contact Orenco to discuss options.

Effluent Dispersal

Typically, the effluent from the treatment system will be reused to irrigate vines, thus replenishing nutrient levels in the soil. Other options for dispersal include subsurface and municipal discharge. Subsurface discharges tend to have more stringent effluent requirements.

It is highly recommended that winery process waste and sanitary waste be kept separate. Regulatory requirements on sanitary waste are typically 30 mg/L BOD_5 and 30 mg/L TSS. Restrictions on winery effluent are not as strict as those on sanitary wastewater effluents, so winery effluent can be reused in the fields much more cost-effectively.

Operation and Maintenance

Operation and maintenance (O&M) requirements will be similar to the O&M requirements of sanitary waste systems. However, the frequency of service may increase depending on the system's load. The low nutrient concentration in the waste stream can retard the treatment process, as nutrients are required to maintain healthy microbial populations and activity in the biological treatment system. Bioaugmentation (addition of microorganisms) or nutrient addition may be necessary. Orenco has used commercially available "bioactivators" such as MicroClear-206 (Environmental Leverage, Inc.).

Additional equipment can be added to monitor the system's performance and aid maintenance. This could include DO meters, pH sensors, flow meters, and composite sampling devices. If permanent equipment is not added to the system, the system operator should regularly monitor pH, DO, flow, and wastewater characteristics.

Summary

Some general issues that need to be addressed in each design include:

1. Flow equalization
2. BOD loading and permit requirements
3. Seasonal loading
4. Variations in seasonal activity
5. Solids generation and removal
6. pH neutralization
7. Daily monitoring
8. Analytical data
9. Operation and maintenance

Orenco has installed more than 20 process wastewater treatment systems at wineries and other facilities around the country. Orenco's experience with winery waste could be applied to similar industries, such as fruit and vegetable canning. For information on existing systems, or specific design assistance, please call Orenco at (800) 348-9843 or (541) 459-4449.