Recycling Earth's rapidly shrinking resource

A BASIC PRIMER ON HOW FOOD AND BEVERAGE PLANTS CAN REUSE WATER EFFECTIVELY AND EFFICIENTLY

xylem
Let's Solve Water

Water is required throughout a food and beverage facility for various uses, including makeup water for cooling towers and boilers, washing of equipment and input for the production of goods. That water can be delivered through a supply connection from a municipal system, extracted from the local environment's natural water supply, such as a ground well, or by reclaiming existing wastewater from the facility's processes with advanced reuse treatment, lowering the plant's fresh water requirements.

Since water is an essential element in food or beverage operations, reusing it can reduce a business's water usage ratios, help meet sustainability goals, lower supply risk and contribute to cost savings, making it a top priority for many companies today.

The benefits of reusing wastewater

Water is a resource that has been taken for granted for decades but is now a critical focal point for many companies, communities and governments as the earth faces a water crisis.

Only 2.5 percent[i] of the world's water is fresh water, and of that, only 1 percent[i] is accessible as much is trapped in glaciers and snowfields. As a result, only a tiny fraction of the planet's water is available for everyday use. By one estimate, global fresh water demand will exceed supply by a staggering 40 percent[ii] in 2030 if current trends continue.

As corporate citizens, businesses must look at their impact on the environment and assess how their operations affect the communities they operate in and serve. By reducing their source water requirements, food and beverage companies of any size can do their part to reduce environmental impact, while reinforcing their corporate social responsibility. Many companies also realize substantial cost savings from water-related investments.

Other benefits of water reuse include:

- Enhancing sustainability practices
- Ensuring the appropriate water quality standards for food and beverage processes
- Mitigating business risk by lessening dependency on external water sources

These reasons help explain why water reuse is growing around the world. From this white paper, business leaders will gain an understanding of the deployment of water reuse technologies, including which elements should be considered when investing in a system.

National Raisin Company

The National Raisin Company, in Fowler, Calif., is one of the largest independent raisin processors in the global industry. Processing approximately 200 tons of raisins daily, the company generates between 60,000-80,000 gallons of wastewater per day, primarily resulting from washing raisins.

During washing, dust, sugar and other contaminates soak into the water. The company needed a solution that would enable them to clean and reuse this large volume of water effectively.

The company called upon Xylem to provide a customized treatment system designed specifically for their unique water requirements. National Raisin recouped installation costs in less than two years, and continues to save hundreds of thousands of dollars a year on its wastewater disposal bill.

Wastewater effluent

Wastewater that is discharged into a collection network is generally handled by a Publically Owned Treatment Works (POTW) or treated under the National Pollutant Discharge Elimination System (NPDES).

POTW

In the U.S., POTW facilities are typically owned by local governments or municipalities, and are designed to treat domestic sewage, not industrial wastewater. Some industrial facilities can be permitted to discharge water to these treatment plants if they follow certain pretreatment processes, such as removal of solids, reduction of biochemical oxygen demand (BOD) and adjustment of pH.

POTWs are sensitive to industrial discharge because of the potential impact it can have on their facility's operations. As a result, many require corporations to pull permits for discharge and charge significant fees. In addition, fines and other penalties can be imposed for discharge permit violations.

NPDES

Discharging water into a river, lake, creek or other body of water falls under the NPDES, a division of the Environmental Protection Agency (EPA). Companies wishing to discharge wastewater through the NPDES need to treat the water more heavily than if they were to discharge to a POTW facility.

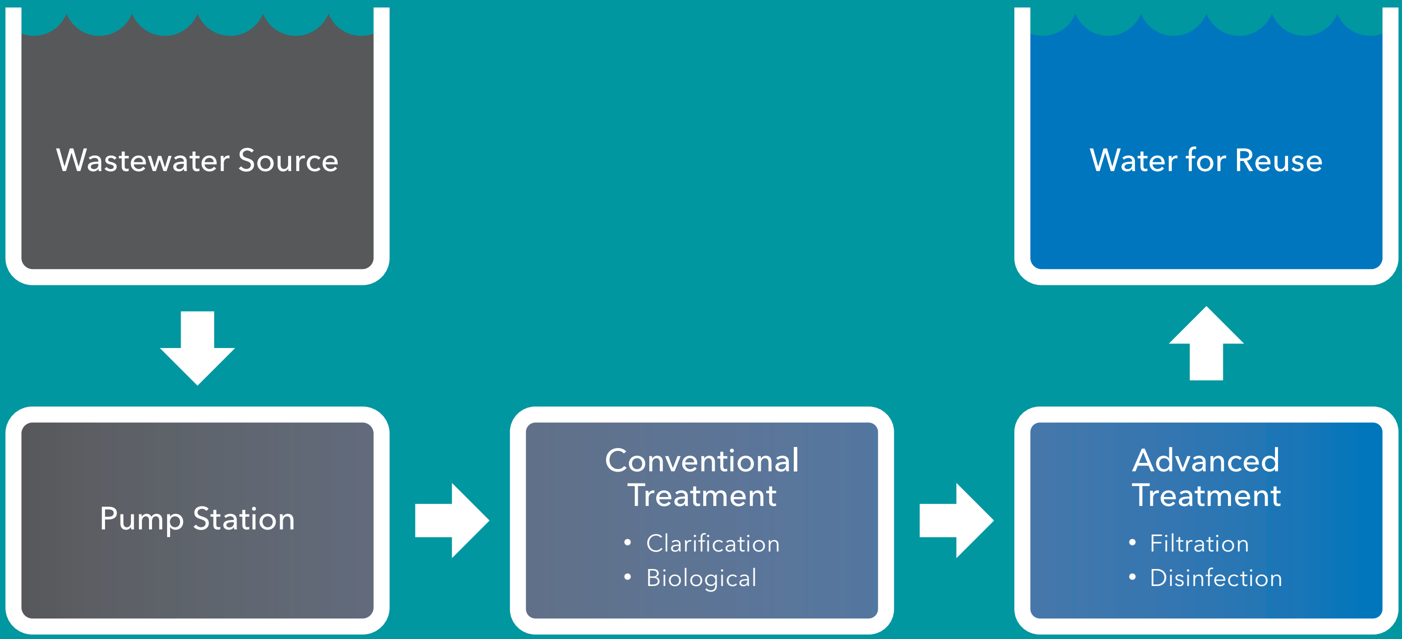
As a government-regulated system, there are strict permit requirements for this type of discharge. In fact, many of these standards are more stringent than those imposed for reuse. Violations of these discharge requirements can result in the EPA issuing punitive fines and consent decrees, which subject plants to routine inspections to ensure compliance to standards. By not following the mandated provisions, companies can also find themselves responsible for environmental damage remediation.

Companies that are discharging wastewater either through POTW or NPDES should consider their full cost of wastewater disposal when evaluating treatment and reuse of wastewater.

Identifying the right treatment option

There are a wide variety of technologies commercially available for wastewater treatment in reuse applications. Those technologies can be classified as conventional treatment processes, which can remove solids, and adjust pH and chlorine levels, or advanced processes, which filter and oxidize water resulting in a higher quality product. Advanced methods give the plant more flexibility with how and where the recycled water is used.

Example treatment process



Conventional treatment process

A conventional treatment process removes solid waste found in water. The technologies in this category provide minimal disinfection and include the use of screens, dissolved air flotation and primary clarifiers, filters, biological treatment via conventionally-activated sludge, chlorination and pH adjustment, reducing solids and Biochemical Oxygen Demand (BOD). For some reuse applications, such as turf irrigation, conventional treatment may be all that is needed.

Advanced treatment process

When a conventional treatment process isn't adequate for meeting the required treatment standards, advanced treatment technologies can be implemented. These technologies go further to remove contaminants that conventional treatment processes can't. They are arranged for specific needs, including:

- Removal of solids and bacteria via microfiltration or ultrafiltration membranes.
- Biological nutrient removal with sequencing batch reactors (SBR) or membrane bio reactors (MBR).
- Removal of dissolved organics or salts with reverse osmosis.
- Removal of trace contaminants and pathogens via oxidation and disinfection.
- Removal of dissolved organics and contaminants via an adsorption process or ozone-enhanced biological active filtration.

When to apply each advanced treatment process

Advanced treatment processes can be broken down into two categories: biological and disinfection.

Biological treatment

Under biological treatment there are two subcategories: Sequencing Batch Reactor (SBR) and Membrane Bio Reactor (MBR). Generally, SBR will have lower capital requirements than MBR, but MBR systems will cost less to operate. They combine biological treatment with membrane filtration to provide a high quality effluent, meet stringent nutrient limits for phosphorus and nitrogen, and have a smaller footprint compared to SBR technology. For a more detailed comparison of SBR to MBR, refer to Table 2.

Table 2

SBR Versus MBR Cost-Benefit Analysis		
Category	**Sequencing Batch Reactor (SBR)**	**Membrane Bio Reactor (MBR)**
Footprint	Large	Medium to small
Installation Costs	Higher	Lower
Operating Costs	Lower operation and maintenance cost	Higher operation and maintenance cost
Other	Requires pre-treatment for most reuse applications	Can be customized depending on wastewater composition

Disinfection

Under disinfection treatment there are three categories: chlorine, ultraviolet (UV) and ozone.

The most basic form is chlorine disinfection. In this treatment type, water is filtered with hypochlorite to generate chlorine residual that inactivates pathogens such as bacteria.

UV technologies are chemical-free and require less contact time than chlorine disinfection. In these systems, water is channeled through a reactor that emits UV light at low wavelengths to destroy the DNA structures of microorganisms, including bacteria, viruses, yeasts and molds. Virtually any liquid can be used with this technology, so it is often found in beverage-processing plants; however, UV is sensitive to the clarity of the water. Higher clarity water requires less energy to treat, and, as a result, pretreatment of wastewater is common in systems where UV disinfection is used.

Ozone and Advanced Oxidation Processes (AOP) are powerful oxidation treatment technologies that generate hydroxyl radicals, the strongest oxidant used in water treatment. AOP is an ideal disinfection approach to treat recalcitrant contaminants that are otherwise not removed by other technologies. AOP and ozone technologies are commonly coupled with other filtration technologies.

Table 3 outlines a cost-benefit analysis of common disinfection technologies.

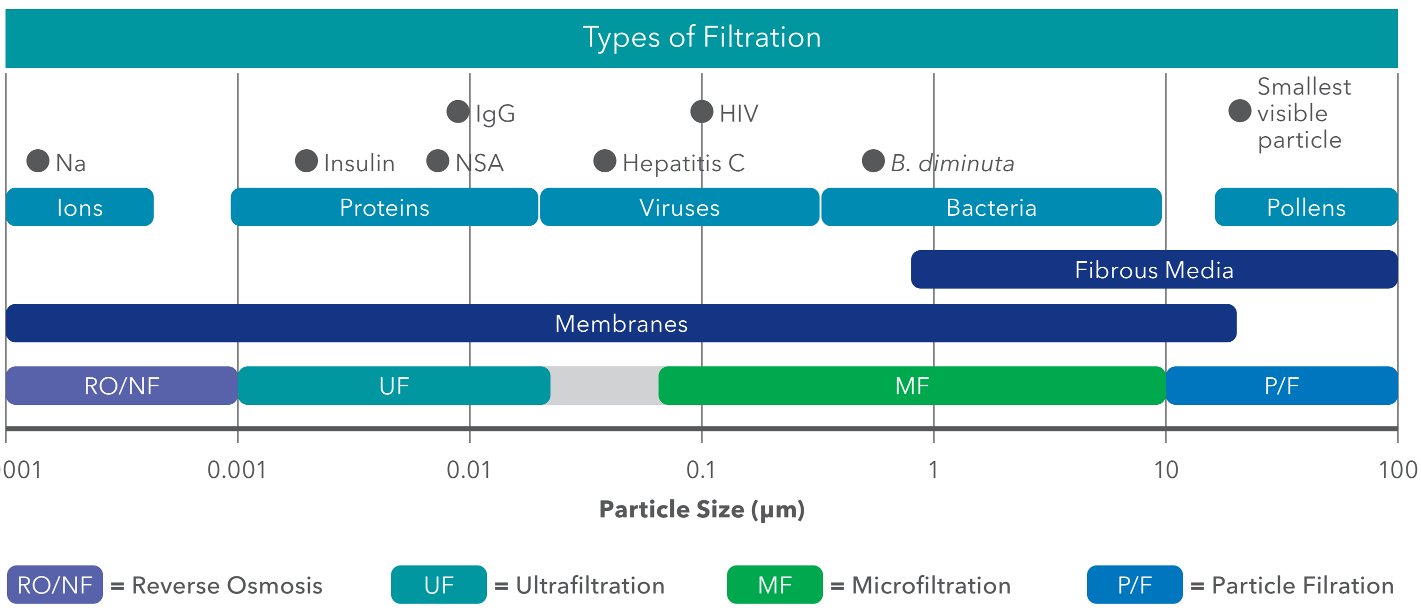
Table 3

Disinfection Technologies Cost-Benefit Analysis			
Category	**Chlorine**	**UV**	**Ozone**
Footprint	Large	Small	Medium
Installation Costs	Low	Medium	High
Operating Costs	Low to medium	Average to high	Average to high
Other	Requires the intensive use of chemicals	Energy intensive but no chemical	Requires additional mixing processes

In addition to the biological and disinfection techniques presented above, there are other advanced treatment technologies that can be used either separately or in conjunction to fulfill wastewater discharge requirements.

Membranes
Membrane filtration, using technologies such as microfiltration and ultrafiltration, provides suspended solids removal found in the processing of foods and beverages. These technologies can remove some pathogens, viruses and bacteria. See Table 4 for a breakdown of filtration types.

Table 4[iii]



Reverse osmosis (RO)
In reverse osmosis, salts and many dissolved organics are removed through a semi-permeable membrane. RO is used when the highest quality reuse water is needed, such as high-pressure boiler feedwater or any use where low salt and contaminant levels are required. RO can be expensive and generate a concentrate brine waste stream that must be managed via proper disposal.

Pumping Systems

Treating water is only the first step to ensuring wastewater is recycled and reused efficiently and effectively within a plant. It is important for organizations to also consider the transportation and storage of water reuse.

Treatment and pumping systems are primary energy consumers within a water or wastewater loop. Sizing the system and selecting the right equipment to meet specific reuse requirements are critical to maximizing energy savings over the life of the equipment.

Pumps serve two purposes in a reuse system: transporting and pressure boosting. Water needs to be moved from one location to another for treatment, storage purposes, or for use. Pressure boosting is required for some treatment technologies, including RO, where specific pressures are required to move water through a membrane. Many reuse applications, such as irrigation and equipment washing, also require boosting capabilities.

Selecting the right pump

The pump and piping selection can have a considerable impact on the energy consumed over the course of the system's life. Pumps should be selected to operate at their Best Efficiency Point (BEP) and the plumbing should be engineered to minimize friction loss. A leader in global water technology, Xylem, estimates that a water reuse system using improperly sized piping and pumps can increase energy consumption by 200 to 300 percent.

Implementing a water reuse system

1. **Define Objectives**
   When deciding what type of water reuse system is needed in a facility, a plant must define its objectives both from sustainability and cost perspectives.

2. **Select Applications**
   Next, plant owners and/or operators should define the applications for which the water will be used. It is best to start with high-volume reuse applications that have lower water quality requirements, therefore requiring less treatment, such as landscape irrigation. By following this approach, the facility will achieve the greatest return on investment, as higher levels of treatment drive costs up.

3. **Determine Treatment Levels**
   Finally, determine the treatment levels required for the selected applications by measuring current wastewater quality to establish a baseline, and then compare that to the quality level required for the selected applications. This gap in water quality will determine the treatment intensity.

Pump Selection Framework

By following the steps below and working with a trusted water technology partner, a food and beverage plant can substantially improve its energy efficiency in water reuse.

1

Determine the flow rate, or the volume of fluid that must pass through the pump per unit of time.

2

FOR A TRANSPORT APPLICATION:
Determine the static head and friction loss for the piping system. Be sure to minimize friction loss when designing the plumbing layout.

FOR A BOOSTING APPLICATION:
Determine the pressure requirement and friction loss for the piping system.

Static head: The height of a column of water that would be produced at a given pressure. The calculation represents the internal energy of a fluid due to the pressure exerted on it from the pump.

Friction loss: The loss of energy (reduction of static head) that occurs in the pipe due to viscous effects generated by size and surface of it. Narrow pipes, corners and valves that impede flow create friction loss.

3

Determine the water makeup and comparability.

- Check the density of the water.
- Check chemical compatibility, such as pH levels.

4

Select the pump.

- Find the flow curves and Best Efficiency Point (BEP).
- Choose the Net Positive Suction Head (NPSH) or the suction head value at a specific flow point that is required to keep the pump out of cavitation.
- When making the final decision, include the following in your list for consideration:
  - Certifications (Underwriters Laboratories (UL), CE Marking, NSF-61 for potable water).
  - Environmental conditions, which are needed to determine the correct motor enclosure.
  - Voltage requirements.
  - Variable speed options and controllers.

When purchasing new equipment or updating existing systems, it is essential to contact a water solutions expert who can ensure proper selection for the facility.

Sustainability

With increased reports of drought in the news, water reuse is at the forefront of how businesses can expand sustainability efforts and help ensure the available water supply. Beyond water shortage, there is also greater focus on social responsibility and water stewardship. In part, due to public indices such as the Dow Jones Sustainability Index, companies are investing more heavily in their sustainability efforts than ever before and are better managing their water use.

Health and safety

Another driver of water reuse is health and safety mandates. Food and beverage operations must comply with the Food and Drug Administration (FDA), as well as the EPA and other relevant regulatory bodies. These standards put in place by these organizations to regulate wastewater quality vary, but apply in some form to all plants, regardless of size. For example, in 2012, the EPA released a document[iv] outlining state and federal water reuse guidelines for all industries, including food and beverage processing.

Any company that operates in a foreign country should also be aware of international regulatory bodies and standards. Reuse mandates vary from country to country, but many businesses are looking to the U.S. and Europe as examples of countries implementing regulations that could impact them.

Work Cited

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The takeaway

There are five key takeaways regarding water reuse in food and beverage facilities.

1. **Water scarcity is a serious challenge**
   While the earth's population continues to increase, readily useable water supply is decreasing. Many businesses, regardless of size, are using water reuse to help fill this gap.

2. **Water reuse solutions mitigate business risk**
   Reuse systems enable companies to become less reliant on source water from aquifers and local municipalities, thereby lowering their risk of supply disruption and future water tariff increases.

3. **Multiple treatment options are available for specific needs**
   There are a variety of conventional and advanced treatment processes that can be configured for each facility and tailored to be fit-for-purpose depending on the application.

4. **Choosing the right equipment results in long-term benefits**
   A plant's total water and wastewater costs are significant and will continue to rise due to the factors described in this white paper. Employing the correct reuse technologies can result in both hard and soft savings for your organization, including reduction in supply risk and benefits to the environment.

5. **Collect the necessary information to start the process**
   Now that you've decided to start reusing water, the first step is to define your objectives. Consider both your financial and environmental goals.

To implement a water reuse system in your facility, visit Xylem at:
www.xyleminc.com/food

Together, Let's Solve Water!

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're 12,500 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to www.xyleminc.com

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