Recapture and Reuse

3 Areas to Cut Non-Product Water Consumption Inside Your Plant

After optimizing your water filtration system to reduce your consumption of water coming into your plant, now you have to identify how you can reduce consumption inside your plant.

Did you know that two areas within a plant consume an average of 66% of all non-product water used in a plant? CIP (clean in place) uses 50% and heat exchange (cooling towers) uses 16%.

The remaining third of water use is split between manual cleaning, sanitization, and miscellaneous utility demands. All of this water leaves the plant in a liquid waste stream - not in final product.

So the question is: How can you maximize re-use of water during its use in the plant?

This technical paper will show you how three main areas inside your plant have the potential to contribute to the bottom line of your plant's financials through attractive continuous improvement or savings projects. The side effect could help cut your non-product water consumption by 50%.

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1. Utility & Cooling Water

Cooling towers are highly efficient at heat exchange by using the evaporative properties of water to cool chiller systems and other factory systems. There is not much that can be done to preserve the water evaporated in the cooling process and the evaporated water does not contribute to a plant's liquid discharge.

Cooling towers are a science and industry in themselves with complications such as fouling, corrosion, and microbial issues abounding, however, here the focus will be exclusively on water consumption. One issue with cooling towers is that they act as a wet air scrubber, meaning that dust and dirt particles from air are trapped in the cooling tower water, leading to an increase in suspended solids, or particles. Also, as water from the cooling tower is evaporated, minerals, salts, and ions remain in the cooling water at an ever increasing concentration.

TDS, or Total Dissolved Solids, is the most common measure of the concentration of these dissolved materials, which is measured with a conductivity meter. If the efficiency of a cooling tower is to be measured in its ability to lose only the evaporated water, consider the following example.

Consider This:

100 tons of chilling capacity requires 180 gallons of water per hour of evaporation in order work effectively. 180 gallons of water evaporated equates to a transfer 1.5 million BTUs of energy to the atmosphere.

In this case, a truly sustainable system would require no more than 180 gallons of make-up water to be added to the system to account for evaporated water. However, you do need to remove the suspended solids and dissolved solids increasing in concentration in the cooling tower as time goes on. Therefore, if you plan on using your water on 10 passes through the cooling system, you will have a ratio of total make-up water to evaporated water ratio of 1.1:1.

Taking into account the 180 gallons of water lost to evaporated water, you can allow 18 gallons of water to be discarded due to high concentrations of suspended and dissolved solids, making your total hourly usage 198 gallons for 100 tons of chilling capacity.

To realistically stretch your cooling tower water to reach 10 passes through the system, you will need to add in some form of filtration technology, with preference to efficiency and low maintenance.

WATER TIP:

Basic Cooling Tower Design Features (Including Retrofits)

The following features should be included in ANY cooling tower in addition to chemical treatment systems:

- Disc Filters for particulate reduction
- Jet nozzles for basin agitation (preventing particle settlement and allowing rejection of particles at the disc filters)
- Precipitation Softening Chemical System
- Minimum 10:1 re-use of basin water

To remove solids, select the disc filter system that was described in our **previous paper on filtration**. To remove dissolved solids, select between other technologies that we have previously written about, reverse osmosis, and precipitation softening aka cold lime softening.

Given that the precipitation softener has a lower cost of ownership and no reject stream of water, it is our first choice if water testing reveals that we can precipitate our dissolve solids into suspended particle solids. In this case, put a precipitation softening system in your cooling tower basin and utilize the disc filters to remove precipitated particles and suspended solids accumulated from ambient air. In the case that you have to use RO, place the disc filters upstream of the RO system and use the RO to create a reject stream highly concentrated with salts, ions, and minerals.

Your permeate stream of filtered water will return to the cooling tower water stream. For all filtration systems, we size the systems to be side-stream or passive, working very similar to an aquarium where only a portion of the basin water is being filtered at any one time.

Finally, if any of your heat exchange water is boiler bound, it is important to deionize the water with a deionizing system. Deionization can be accomplished with a deionization filter membrane or a zeolite water softener, which uses salts as feed material.

In several case studies examined, processors were able to calculate their payback on cooling tower upgrades by considering decreased chemical and water consumption only. They did not need to factor in reductions to de-sludging or take-down of the cooling tower for cleaning. **All paybacks examined are less than one year.**

2. Clean-In-Place (CIP)

Clean in place systems account for 50% of all non-product water used in the food and beverage processing environment. The use of CIP is important because it allows continuous or near continuous processing of liquids without time consuming tear down and re-builds of equipment. However, the side effect is drastically higher water consumption and energy consumption (for water heating). Below are a few design considerations for CIP systems:

CIP Design Considerations

- Locate CIP system central to the cleaning loads to reduce pipe runs. This may require multiple system locations.
- Analyze product pipe size requirements to minimize volume of water required for CIP.
- Invest in a product recovery system (i.e. pig or air blows). This results in higher product yields and reduces rinse water volumes.
- Optimize CIP circuits during commissioning – most systems use significantly more rinse water than is actually required.
- Upgrade CIP systems with current technology – measure turbidity and conductivity to enhance rinse and solvent recovery.

CASE STUDY:

Proper pipe sizing of an ice cream processing system @ 6,500 LF of cleanable piping, assuming 24/7 operation, considered on an annual basis if processing in 2" and 2 ½" pipes versus 3" pipe, throughput is unaffected.

Water Savings:
2.1 million gallons – $52,000

Product Savings:
350,000 gallons @ 90% recapture w/ product recovery = 35,000 gallons - $250,000

Now considering a centrally located CIP versus remote CIP system with our 2" system – average circuit shortening is approximately 240 feet:

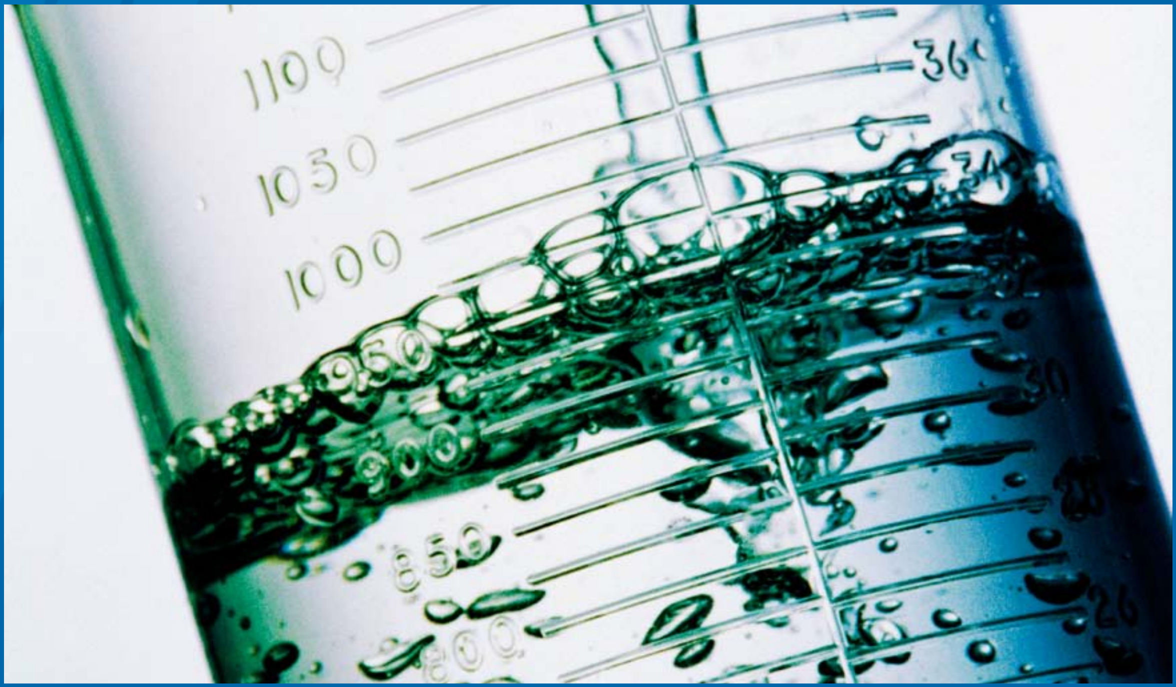
Cost savings in water, chemicals, and treatment - $124,000
Time savings for "up time" due to less CIP time required – 330 hours/year

Profit on additional production =
$260,000

You can see an annual savings of $476,000 in this ice cream processing plant and an increase in production worth $260,000 just by properly sizing and locating our CIP system.

Is Water Conservation a Science?

According to The Ohio State University, it is.



The Ohio State University's Food Science department has found:

1. Reclaim and re-use of cleaning solutions in CIP operations, using micro filtration membranes, is feasible. The residues collected by the cleaning solution can be separated from the alkaline solution, and the solution can be re-used.
2. The amounts of rinse water can be greatly reduced by appropriate control of temperature and velocity. **Read more**
3. Preliminary results indicated that fouling of hot surfaces during UHT processing (ultra-high temperature) fouling can be controlled by optimizing the time-temperature process for the product.
4. High-value components in waste streams from food processing operations can be recovered by utilizing customized micro-filtration membranes, leading to increased water conservation.

3. Recovery of high-value components from waste streams

The following valuable components have been recovered from food processing waste streams. The separation or re-capture of these components also helps water conservation!

- **Wine:** Salt laden water (potassium) has been used as irrigation water; pomace (grape skins) has been used in an anaerobic digester for biogas, residual fiber has been used as an additive to animal feed.
- **Fats, Oils, & Grease (FOG):** Used by alternative energy companies for biofuel, and biogas via an anaerobic digester, residual compounds can be safely used in compost for a fertilizer.
- **Starch:** When centrifuged starches (potatoes, etc.) can be formed into cakes and used for animal feed.
- **Potato Skins:** Create product packaging made from potato skins
- **Protein:** Waste streams carrying fats and proteins can be skimmed to recover components using micro-filtration membranes. Proteins are recovered as product ingredient and fats are not released to the municipal system.
- **Tomatoes:** Skins from tomatoes contain significant amounts of lycopene to be recovered using micro-filtration membrane. technology. Lycopene is the red color and can be added back to the product or used for health-enhancement in other products.

Whether you are recovering valuable components from waste streams or using components for energy production, there is value in the waste streams from nearly every food and beverage processing operation.

Conclusion

To strengthen the bottom line of your plant's financials through continuous improvement and savings projects, focus on these three main contributors to reduce water consumption:

- Utility Water
- Clean-In Place (CIP)
- Recovery of valuable components from waste streams

The side effect of following the highlighted recommendations is that the average food and beverage plant can cut its non-product consumption by 50%.

Have questions or comments?
Contact us.

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Dry Ice Cleaning

For manually washed equipment that is washed in place, such as a tank, blender, or kettle, dry ice (frozen CO_2) can be used for abrasion free cleaning. Dry ice evaporates directly to a gaseous state at atmospheric pressure, thereby cleaning the equipment without ever making it wet.

This means water free cleaning can be accomplished and there is no drying time before the next production run. Dry ice in pellet form (similar to a grain of rice) is accelerated with a blasting gun to the equipment.

The physical properties of the pellets along with the temperature differences allow for an easy removal of residue and no damage to the equipment.

Industries already benefiting from dry ice pellet blast cleaning are: coffee, chocolate, baking, cheese, and seasonings. This is an especially attractive option where wet equipment needs to be totally dried prior to use.

Electro Chemical Activated Water

Electro Chemical Activated Water (ECA) is being used as a substitute to conventional CIP and has been successfully implemented in the following applications: beverage, meat/protein, grains, starch, condiments/seasonings, and liquid foods. ECA saves on water, cleaning cycle time, and energy. It also operates similar to a salt water pool, using water, salt, and electricity to create hypochlorous acid for cleaning and sanitization of pipe work and equipment.

The benefits of ECA are:

- 60% (up to) water savings
- 70% (up to) CIP cycle time reduction
- 98% energy savings – ECA works at ambient water temperatures

Ask your quality department to test an ECA cleaning system to determine if it is right for you. The system has the advantages of increased safety (no chemicals or hot water) and decreased footprint and operational cost. However, the cleaning solvent is corrosive (i.e. salt water) and not all applications have been proven.

Read More

Further Reading

Think Tank Part 1: Optimizing Your Water Filtration System ▶

Think Tank Part 3: Out of Sight, In Mind ▶

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