Optimizing Your Water Filtration System

Why Water Use Master Plans Should Precede Your Investment
The key to success in water filtration is to right-size your investment and consider future concerns, all while reducing the water wastage. It is fairly common in beverage production to use six times more water in the facility than the volume of water used in a product. While a lofty goal may be to reach 1:1 or 100% of incoming water leaving in product containers, moving toward a water usage of 2:1 could be more realistic than you think.

What about food processing plants? Beyond the treatment of ingredient water, many food manufacturers could be more efficient with their water use. This is mostly because operators find it easier to spray-to-drain than to sweep-to-trash-bin. During this washing and cleaning process, both water and food ingredients go down the drain, putting strain on waste water infrastructure.

This technical paper will address how manufacturers can optimize the water coming into their plants. It will define water filtration vocabulary and technical terms, highlight new technologies and outline how to decrease water usage through master planning.

**Contributors**

Adam Thibodeau  
Senior Design Engineer  
PET Terra Systems  
athibodeau@petsystems.com

Matthew Chang  
Senior Project Manager  
Haskell  
info@haskell.com
New Technology Spotlight

Disc Filtration
A particle filter to reduce suspended solids with a non-mechanical cleaning mechanism. It operates on system water pressure and offers between 0.1% - 1% reject water.

ULE (ultra low energy) RO
ULE RO came from the technology required to run RO in residential applications. A common system pressure is 70psi in contrast to conventional RO which runs at 150 - 300 psi. An additional benefit is that some ULE ROs can operate with variable rates rather than in an on/off fashion.

Rain Water Harvesting + Siphonic Roof Drainage
Rain water harvesting is very popular in residential applications, but has been difficult to implement in industrial applications due to the difficulty in routing water from the roof to a single tank location. The introduction of syphonic roof drainage now allows water from all discharge points of the roof to be routed to one collection basin or tank.
## Technology Map

<table>
<thead>
<tr>
<th>Category</th>
<th>Technology</th>
<th>Filter Types</th>
<th>Lowest Micron Filtration</th>
<th>Reject Stream</th>
<th>%Lost Water</th>
<th>Auto Cleaning</th>
<th>CIP able?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Filtration</td>
<td>Sanitary Strainer</td>
<td>Particle 30</td>
<td>No</td>
<td>0</td>
<td>No</td>
<td>Yes</td>
<td>Removes large particles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Auto Flush Strainer</td>
<td>Particle 4</td>
<td>Yes</td>
<td>1-10%</td>
<td>Yes</td>
<td>No</td>
<td>Removes large particles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bag Filter</td>
<td>Particle 1</td>
<td>Yes</td>
<td>0</td>
<td>No</td>
<td>Yes</td>
<td>Labor intensive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disc Filter</td>
<td>Particle 20</td>
<td>Yes</td>
<td>&lt;1%</td>
<td>Yes</td>
<td>Yes</td>
<td>New technology</td>
<td></td>
</tr>
<tr>
<td>Media Filter</td>
<td>Sand Filters</td>
<td>Particle 10</td>
<td>Yes</td>
<td>&lt;1%</td>
<td>Yes</td>
<td>No</td>
<td>Cooling towers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon Towers</td>
<td>Particle 25</td>
<td>Yes</td>
<td>1-2%</td>
<td>Yes</td>
<td>Yes</td>
<td>Odor and chlorine removal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green Sand</td>
<td>Particle N/A</td>
<td>Yes</td>
<td>0.01</td>
<td>Yes</td>
<td>No</td>
<td>Removal of Iron, Manganese, Sulfur</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multi Media Filters</td>
<td>Particle 10</td>
<td>Yes</td>
<td>1%</td>
<td>Yes</td>
<td>No</td>
<td>Aquariums, high solids loading</td>
<td></td>
</tr>
<tr>
<td>Cartridge Filter</td>
<td>Membrane Cartridge</td>
<td>Micro 0.1</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Expensive filter costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Micro Filtration</td>
<td>Micro 0.05</td>
<td>Yes</td>
<td>10%</td>
<td>Yes</td>
<td>Yes</td>
<td>Fermentation, Turbidity, Milk Separation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultra Filtration</td>
<td>Ultra 0.01</td>
<td>Yes</td>
<td>15%</td>
<td>Yes</td>
<td>Yes</td>
<td>Recovery of NF System, RO Pre-treat</td>
<td></td>
</tr>
<tr>
<td>Membrane</td>
<td>RO - Cross Flow</td>
<td>RO 0.01</td>
<td>Yes</td>
<td>25%</td>
<td>Yes</td>
<td>Yes</td>
<td>Beverage Water, Desalination, Waste Water Re-use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nano Filtration (Loose RO)</td>
<td>Nano 0.01</td>
<td>Yes</td>
<td>20%</td>
<td>Yes</td>
<td>Yes</td>
<td>Beverage Water, Water Softener</td>
<td></td>
</tr>
</tbody>
</table>

### Filtration Levels
- **Particle** – 1-40 microns; sand, dissolved solids
- **Micro** – 0.1 microns; bacteria
- **Ultra** – 0.01 microns; virus
- **Nano** – 0.01 microns; product water for high acid beverages (CSD, milk)
- **RO** – 0.01 microns; bottled water, low acid beverage products

### Filter Types
- **Coarse** – screen, bag, (ex. coffee filter)
- **Media** – sand, carbon, multi media
- **Cartridge** – space constraints, high surface area to volume, coarse to membrane cartridges, dead end, no waste, good for low solids loading
- **Membrane** – micro to RO

---

[www.haskell.com](http://www.haskell.com)
The Proactive Solution: Water Use Master Planning

Most plant operators know the limitations of their plant’s water infrastructure and understand how difficult it can be to change once constructed. For example, for new equipment requiring drainage inside a room without a floor drain, the drain may cost more than the equipment itself. Likewise, some parts of a plant are water poor, having no piping infrastructure. Routing a new pipe is expensive and may require undesirable construction work in the operating facility.

Consider how real estate professionals have long considered master planning for future development a critical necessity to get the most out of their fixed resource: land. With consideration of water as a precious resource, manufacturers should take the same forward thinking approach to master planning water use in a plant. Implementing the following actions prior to your next water investment will help you save time, money, and water:

1. Identify your sustainability targets
2. Pick a team for water analysis
3. Define what water streams you have in your facility
4. Develop basic current infrastructure and leave room for growth
5. Right size the technology to your water stream

Sustainability Targets

Benchmarking
Does your manufacturing plant have accurate data on how much water is used, how much goes into product, and how much gets wasted? If not, outline a plan to measure your water use and efficiency over a given production cycle or year. Select one of the following benchmarks as a master planning target:

Year Over Year Improvement: One simple metric for sustainability is to measure what you did this year versus last year, accounting for variations in production quantity. As a corporation, outline an improvement metric – plan for 10% improvement per year or greater.

2:1 Water to Product Ratio: The holy grail of food and beverage processing plants is to have water use that is two times (or less) than the volume of water used in the product.

Zero Liquid Discharge: The goal of this benchmark is to have zero plant discharge going to municipal waste water treatment. The filtered by-products of your water streams (minerals, salts, etc.) leave the factory in a solid waste stream. This is a particularly attractive option for food producers who are located close to agriculture (where mineral and salt-rich water can be used for irrigation) or have a neighbor with a need for less than perfect water.
Pick your Water Analysis Team

When it comes to testing your incoming water sources, do it sooner rather than later. In order to begin, first, select a water analysis team. This team will be the backbone of the water reduction initiative because of the data collection process. The use of that data will drive the success or failure of the initiative. The water analysis team will be required to establish water use benchmarks by:

- Testing several different times with several different laboratories to ensure proper results.
- Recording the temperature of the incoming water in the various seasons, as some filter types are temperature sensitive.
- Including your quality department in the discussion from the beginning.
- Running a pilot study (if time allows) on a process with water streams of two different quality levels in order to validate the need for stricter water requirements.

WATER TIP:

Have you been washing your equipment and tooling with filtered water?

If so, try washing with your domestic tap water and have the quality department monitor to see if there is actually a benefit to using the filtered water.

You may even consider using reclaimed water.

Don’t Forget to Account for Electrical Demand

Water filtration often comes at the cost of higher energy bills. A typical reverse osmosis (RO) system runs at 150-300 pounds per square inch (psi). Even then, it has several pre-filtration levels that require pressurization and release to atmospheric pressure. In order to consider the payback and environmental benefit of new water systems, consider the whole picture.
Define Water Streams

What water streams do you require in your manufacturing facility? It is very likely that each stream requires a different quality of water. Identify each of these streams on your water use master plan to match an appropriate technology. Here are some examples of water streams and their appropriate technologies:

<table>
<thead>
<tr>
<th>Water Stream</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>External uses such as irrigation</td>
<td>Rain water harvesting</td>
</tr>
<tr>
<td>Internal Human Use such as sinks and fountains</td>
<td>Domestic water</td>
</tr>
<tr>
<td>Gray Water Needs such as toilets and some cooling water</td>
<td>Gray water harvesting</td>
</tr>
<tr>
<td>Mechanical Systems such as chilled water or cooling tower water</td>
<td>Domestic water or reclaimed process water</td>
</tr>
<tr>
<td>Cleaning &amp; CIP</td>
<td>Domestic water, reclaimed process water, or filtered water</td>
</tr>
<tr>
<td>CIP final rinse only</td>
<td>Filtration to product water level</td>
</tr>
<tr>
<td>Product water</td>
<td>Filtration to product water level</td>
</tr>
</tbody>
</table>

Develop Basic Infrastructure

All processing facilities face the challenge of limited capital for improvement projects and pressures of cost cutting and productivity boosts. After analyzing your water streams, you may find you can begin immediately with a single domestic water stream or filtered water stream. If several streams have one common source, the most demanding stream should drive the requirements for the technology selection. It is possible the water wasted from reject streams, concentrate streams, or backwash streams will be higher quality than needed for streams with lower requirements.

If your budget is strained and adding water recovery systems or second/third pass filtration systems cannot be justified, you should still master plan for them. Minor adjustments to your facility layout and piping infrastructure today can make future upgrades easy to install and cost justify. In your water filtration room, you may need to allocate the space for future equipment, piping skids, or tanks. In your piping, you can add in a Tee, blind flange or valve to allow for future addition or expansion of the piping system.

WATER TIP:

To avoid draining a back-wash or reject stream to the sanitary sewer, drain to the process sewer instead, and allow for recapture of the process sewer discharge in future upgrades.
Keep it Simple: Using Real World Examples

Ready for a Home Renovation?

If you were planning to convert your garage to a master bedroom suite, how much work would that take? Consider your master bathroom and all the piping required to be fully functional. How invasive would the renovation be?

Now think about how much easier it would be if you master planned your garage to have piping connections stubbed and capped behind the wall. You would have a much easier time moving your bathroom because of this early planning.

Your facility is very similar. If you plan for the future and develop a water use master plan prior to your next investment, you will have more options for future flexibility.
Right-size Your Technology

One of the most confusing parts of improving water efficiency is the technology selection. Vendor representatives may pressure you into a technology of theirs that will work, but at the expense of higher water waste, energy, and equipment cost, compared to a more appropriate technology. So how can you right-size the technology?

Consider your basic requirements for water treatment. Is it chlorine removal, metals removal, odor control, particle removal or micro removal? It could be all of these. Once you have identified your basic requirements, consider the efficiency and downsides of each system with consideration given to water recovery, low maintenance systems, and low pressure (i.e. low energy) systems. RO is generally regarded as the highest level of filtration available, but also the most energy consumptive and generally has the lowest recovery.

To optimize the RO system, consider the following technology selections with waste amount indicated in Figure 1.

Why This Works

(Volume and percentages are intentionally simplified for general understanding)

From an energy point of view, you have a very efficient system with water waste of $(2 + 1 + 2 + 10 + 20)$ 35%. All of the technologies are sized correctly and require minimal maintenance, since all self-cleaning technologies were selected. The micro filter and RO filter have a cross-flow design, meaning they have a dedicated reject stream. Of the 35% water lost, 30% from the micro filter and RO membrane are easily recoverable.

If you allow enough space in your facility, and design the piping on the equipment for future needs, you can easily add a recovery system, reclaim any water coming from the reject streams, and secure your company’s sustainability improvements in the future for just the cost of equipment.
Conclusion

Have you heard the phrase, *one man’s trash is another man’s treasure*? The same is true for your facility when you word the famous idiom this way:

**One area’s trash can be another area’s treasure.**

Reclaimed water can be that trash-turned-treasure in several sections of your facility. Ask yourself if you need perfectly filtered water to water your grass or flush your toilets.

Here are a few places within your facility where you could use reclaimed water:

- Cleaning water
- Toilets and sinks
- Housekeeping
- Cooling towers
- Boilers and utility systems

By creating a water use master plan before your next investment and efficiently using reclaimed water, you can save time, money, and your precious resource: water.

**Have questions or comments?**
**Contact us.**

Adam Thibodeau  
Senior Design Engineer  
PET Terra Systems  
athibodeau@petsystems.com

Paul Tyler  
Food & Beverage Division Leader  
Haskell  
paul.tyler@haskell.com

Further Reading

**Think Tank Part 2:**  
Reusing and Recapturing

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