Water Conservation Fact Sheet: Overview of Water Conservation Techniques and Resources for Massachusetts Industries

Introduction

Water has long been considered a utility item to be accounted for as a general overhead expense of production. Since water has become a limiting resource for economic development, and many of the costs associated with using water continue to rise, it is important to treat water as one of the raw materials for production. Water is a resource that, managed properly, can help save money – water conservation projects can have payback periods of a year or less. This fact sheet is designed to help industrial and commercial facilities identify and implement water conservation measures.

OTA Water Conservation Services

The Office of Technical Assistance and Technology (OTA) offers a range of assistance and information services to help facilities improve water use efficiency, comply with federal and state regulations, reduce wastewater discharges and implement effective water conservation measures. These services include site visits to facilities, workshops, and publications, such as a list of best management practices for industries and case studies that highlight successful water conservation practices. For more information, please visit our website: http://www.mass.gov/eea/ota

Getting Started – Develop a Water Conservation Strategy

Two key elements in any water conservation effort are initiating an effort, (typically by assembling a water conservation team), and benchmarking water use. Strong support and continuous oversight of the project by management will help make the effort successful. Ideally, a water team should include a leader and staff involved in production, engineering, maintenance, wastewater treatment, and finance. While water conservation efforts do not require the establishment of a team, a team effort can generate constructive participation, help to gather information quickly, identify and evaluate options, and maintain the effort through time.

Careful monitoring of water use will establish a baseline to which future measurements can be compared. Monitoring of water use may reveal observations of wasteful or excessive use, and ideas for reuse or more efficient use. It will make visible the results of water conservation efforts. When monitoring water use:

- Identify all major use areas at the facilities, characterizing the purposes served by the use of water (such as process, cleaning, heat transfer).
- Conduct a water balance (comparing inflow to outflow) for the entire facility and for the most significant water-using processes at the facility. Track how much water is coming into your facility and match it against measured use, discharges and losses. If the inflow and outflow are not approximately the same, the information is incomplete.
- Investigate water consumption that continues during periods that facility is not operating. It is important to check the water meter to see if it registers flow when flow is not expected.
- Measure flow or quantify use and determine whether there is excessive consumption beyond what is needed.
- Wastewater treatment or raw water pretreatment operations may also present options for optimization. Reducing excessive use in these areas will likely result in chemical and energy use reductions as well.
- Consider installing flow meters to quantify water use for each product line or piece of equipment to understand the true cost of manufacturing. Even one meter that covers the entire facility can be useful in tracking the information and correlating it with water use activities in the facility.
- Note details such as the cost of energy for pumping, heating and/or cooling water, as a reduction in water use will likely result in reductions in energy as well.
- Quantify water use, to the extent practicable, in terms of the task it performs. For example, calculate use per unit of product.
- Look for leaks and potential water losses due to evaporation.
- Note relevant physical and chemical conditions (temperature, color, suspended solids, type and composition of dissolved materials, etc.) of any generated wastewater, as this will be critical for assessing reuse options.

The primary goal of a water conservation effort should be to reduce unnecessary water consumption and to redirect flows where chemical and physical properties of the water are conducive to reuse. To accomplish this goal the water conservation team should assess the amount of water required for each process step and consider alternative (low-flow or non-water) ways of achieving the same purpose. Substantial savings can often be obtained by simply decreasing water pressure or volume on a facility or process level to the needed level. Soliciting employee suggestions can be helpful in identifying areas where water is wasted or could be reused. Simply raising awareness of the need to reduce excessive water use can lead to operational improvements. Information on water conservation is available through vendors, trade associations, consultants, and government agencies.

Water Conservation in Industrial Operations

Water is commonly used for cooling, heating, washing, or as a carrier of dyes, pigments and coatings. The sections that follow detail water conservation options that are common to many industrial operations.

Rinsing

A major industrial use of water is for rinsing. Improving rinse tank design, sizing tanks properly, evaluating alternative rinse tank configurations, and utilizing available control techniques can help to minimize wastewater generation from rinsing operations.

- Utilize spray rinses with fog or atomizing nozzles instead of bath or flood rinses.
- Employ multiple tank countercurrent rinsing techniques, which can reduce water consumption by up to 90% compared to conventional single-stage rinse systems.
- Allow sufficient time for dripping or employ an air-knife to reduce dragout from cleaning tanks to rinse tanks.
- Optimize water flow to rinse tanks by installing conductivity, pH, or turbidity meters or other contaminant measuring devices; only add water when the contaminant level reaches a set level.
- Use air, ultrasonic, or mechanical agitation to improve efficiency of rinsing operations.
- Switch from continuous to on-demand rinsing by using motion sensors or programmable logic controls.
- Select the minimum sized tank appropriate for all parts/ products.

General

- Educate employees; change water use culture.
- Utilize non-chemical/non-aqueous cleaning methods where possible. These could include:
  - Low or no water clean-up – mop, sweep, squeegee, or brush to pre-clean
  - Vacuuming
  - Blow-off
  - Steam cleaning
- Install water-saving fixtures where possible.
- Have a routine maintenance program for leak identification and repair.
- Turn off all water-consuming equipment when not in use.
- Install flow restrictors.
- Plan in advance for restrictions on water use, addressing both process water and outdoor watering
- Use employee incentives – reward employees for identifying ways to reduce water use.

Cooling Towers

- Develop and implement a scale, corrosion, and bio-fouling protection plan.
- Determine whether cooling towers are appropriately sized for the cooling load.
- Reuse water from other areas as make-up water.
- Regularly maintain and clean evaporative surfaces.

Recovery for Reuse

Reusing process water in another area with less stringent water quality requirements can be a cost-effective option.

- Hard-pipe used water streams from wastewater treatment to other production areas where the chemical and physical properties of the water are compatible.
- Design a system to collect, treat, store, and reuse water as an integral part of operations. Simple filtration and/or separation systems can be implemented to make water compatible for reuse.
- Reuse final rinse water for initial cleaning in batch operations.

Steam Systems

Water use by boilers will vary with boiler size, steam use, and condensate return. Proper use and maintenance of boilers will reduce water use.

- Develop a regular inspection and maintenance schedule for steam traps, steam lines, and condensate pumps.
- Ensure proper water treatment to prevent corrosion.
- Install a condensate return system.
- Automate the blowdown system based on conductivity measurements or concentrations of total dissolved solids (measured as conductivity, pH, silica or phosphate).
- Automate chemical feed system(s).

Non-Contact Cooling Water

Non-contact cooling water is used in a production process for cooling the equipment, process, or product. Typically, contaminant concentration is low and the water can be reused many times.

- Install a recirculating (closed-loop) cooling system.
- Recycle non-contact cooling water through a chiller or cooling tower for reuse.
- Insulate cold water piping.
- Check entering and exiting water temperatures to ensure they are within the manufacturer's recommendations. If possible, set the water flow rate near the minimum required by the manufacturer.
- Regularly clean heat exchange coils.
- Many reuse cycles may necessitate use of biocides to address biological growth; biocides may have wastewater discharge permit implications.

- Utilize automatic controllers to monitor the concentrations of dissolved solids and pH and bleed or add chemicals as necessary.
- Evaluate drift losses. If excessive, install drift eliminators or repair existing equipment.
- Minimize blowdown by increasing the concentration ratio.
- Utilize mechanical water treatment to increase cycles of concentration.

Systems and Technologies to Save Water

Advanced technologies can result in substantial water and financial savings for certain high volume and/or high purity applications. These technologies include:

Closed-Loop/Zero Discharge Systems

If facilities are facing limited water supplies and/or limited discharge capacities or if the stability (thermal, ionic, etc.) of the incoming water stream is crucial to operations, a closed-loop system may be a technically and economically viable option. The technologies for a closed-loop system may include membrane filtration, deionization beds, or distillation. Closed-loop systems greatly reduce fresh water needs, as well as the load on the local wastewater treatment facility. It is possible that a closed-loop system can increase energy consumption and generate sludges which will be subject to hazardous waste regulations. However, such systems can offer significant quality and productivity improvements by providing a reliable stream of contaminant-free water. Closed-loop systems are best considered at the planning stages for a new production line or facility.

Clean-in-Place Systems (CIP)

CIP systems are typically automated systems that clean the interior surfaces of pipes, vessels, process equipment, and associated fittings without disassembly. Modern CIP systems have evolved to include fully automated systems with programmable logic controllers, multiple balance tanks, sensors, valves, heat exchangers, data acquisition and specially designed spray nozzle devices. CIP systems can be made and operated to optimize the use of water, solvents, chemicals, and other materials that are used to clean process equipment.

Efficient Membrane Filtration Systems

Simple bag filtration (down to 3 microns and higher) can yield water that can be reused for the same process or other processes. When soluble contaminant levels are high, or high-quality water is required, sophisticated and expensive filtration systems that use micro-, ultra-, or nano-filters or reverse osmosis to treat wastewater can be utilized. Industries that require high purity water often employ such systems for water reclamation. Like closed-loop systems, membrane systems increase energy consumption due to pump use, and the removed solids and filters may pose waste management compliance issues.

Reclaimed Water

Reclaimed water is wastewater that has been treated at a wastewater treatment plant so that the water can be used again for various applications excluding drinking water. The use of reclaimed water will reduce the pressure on the existing water supply. In March 2009, The Massachusetts Department of Environmental Protection (MassDEP) promulgated regulations 314 CMR 20.00, the “Reclaimed Water Permit Program and Standards” (http://www.mass.gov/dep/service/regulations/314cmr20.pdf). These regulations include a permitting program for the construction of a reclaimed water system as well as some requirements for the reuse, sale and distribution of reclaimed water.

Facilities close to their local wastewater treatment plant may want to explore the use of reclaimed water, if the total cost of the water is justifiable. MassDEP may authorize reclaimed water uses for irrigation of parks and playgrounds, landscaping in nonresidential developments and cemeteries, highway landscaping and as cooling water. There are other state requirements; for example, piping must conform to the Massachusetts Uniform Plumbing Code, 248 CMR 10.00 and there shall be no cross connections between a reclaimed water system and a potable water system. Facilities should consult with MassDEP before committing to use reclaimed water.

Energy and Water

Moving and heating water requires large amounts of energy. While some of this energy can be reclaimed through the use of heat exchangers, reducing water consumption can reduce corresponding energy demands. In addition, sizing both heating and cooling systems appropriately, based on necessary loads, will reduce water consumption in boilers and cooling towers. Conducting both water and energy audits will help to optimize your facility’s use of these resources. Information on energy conservation measures is available on OTA’s energy conservation web site.

Sanitary

While sanitary water use may comprise a small percentage of water use, it still presents opportunities for conservation. In addition, these changes may help to remind workers about the company’s overall efforts on water conservation:

Toilets

- Replace older toilets with more efficient models or install dual-flush adapters.

Urinals

- Replace with new, ultra-low-flush or non-water using models.
- Retrofit siphonic jet urinals by installing timers.

Faucets

- Retrofit with aerators or flow restrictors.
- Replace older faucets with models designed to curb excessive use (automatic on and off self-closing and Infrared and ultrasonic faucets).

Showers

- Retrofit with aerators, flow restrictors, or low flow showerheads.

Landscaping

Water that is used for maintaining landscapes and lawns should be used in a manner that minimizes such use through the implementation of water conservation and water efficiency practices. The following water conservation practices are commonly applied to outdoor lawn watering:

- Minimize area of lawns or landscapes to be watered.
- Use low water-use/drought-resistant landscaping techniques.
- Irrigate efficiently by limiting the number of watering days per week or per month; watering only when necessary; and avoiding watering during precipitation events, in windy conditions and during the hottest part of the day (8am to 6pm).
- Maximize water efficiency of automatic irrigation systems by conducting regular irrigation audits, installing equipment such as moisture sensors, rain shut-off devices, and climate-based controllers, and properly operate and maintain automatic irrigation systems.
- Minimize use of potable water and groundwater through reuse of stormwater.

Additional guidance on techniques for reducing water demand associated with landscaping and outdoor lawn watering is available in the Massachusetts Water Conservation Standards.

Rainwater Capture

In some situations it may make sense to capture and use natural rainwater. This is particularly attractive when there is storage from which water can be dispensed by gravity to irrigate landscaping. For process uses it may be necessary to filter and protect against bacterial growth. Using rainwater for flushing toilets is generally only feasible for new construction, as replumbing costs can be significant. Plumbing codes and weight-bearing loads for rooftop storage are also important considerations.

Industry Resources

Different industries employ specialized processes to recover or reuse process water. OTA has published a guidance document — Water Conservation Best Management Practices (BMP):
http://www.mass.gov/Eoeea/docs/eea/ota/resource_conservation/waterbmp.pdf

References

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- Metal Finishing: http://www.nmfrc.org/bluebook/sec27.htm
- Massachusetts Water Conservation Standards: http://www.mass.gov/Eoeea/docs/eea/water/water_conservation_standards.pdf

The Office of Technical Assistance and Technology (OTA) has developed a series of fact sheets on Resource Conservation practices and issues. To see the other fact sheets please visit: http://www.mass.gov/eea/ota. OTA is a non-regulatory office within the Executive Office of Energy and Environmental Affairs (EEA) - http://www.mass.gov/eea - that provides a range of assistance services to help businesses cut costs, improve chemical use and energy efficiency, and reduce environmental impact in Massachusetts. For further information about water conservation, or about OTA's technical assistance services, contact:

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