EBMUD Commercial Guidebook: Process Water

EBMUD

PROCESS WATER

Water used in commercial or industrial operations to manufacture a product is known as "process water." Much of the information in this chapter is specific to certain products or industries. However, on the whole, increasing water conservation in industrial processes can range from simply adjusting equipment or behaviors to use less water, to adopting entirely new practices or processes that use little to no water at all.

Beverage bottling plant conveyor belt in action

This section discusses the following industries and their uses of process water:

- Food and beverages, page 3
- Auto repair and service, page 9
- Paper manufacturing, page 10
- Metal finishing, page 12

This chapter will not cover opportunities to save water by using efficient plumbing fixtures [link to chapter] and irrigation systems [link to chapter], since these are covered elsewhere.

General Discussion

All industrial operations use water in a wide variety of ways. However, the opportunities to reduce water use in any operation can be analyzed by using the following ranking of possible measures. All will result in water savings, but savings are increased as one moves down the list.

Ranking of Possible Measures

Good
1. Adjust equipment
2. Modify equipment or install water saving devices
3. Replace with more efficient equipment
4. Water reuse/recycle
5. Change to waterless process

Best

Site Assessment

There are seven basic questions to ask about how water is used in any industrial operation. The purpose of these questions is to stimulate the water reduction thought process:

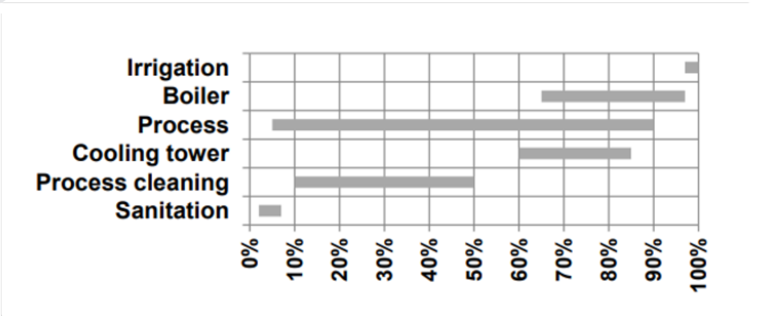
1. **How much?** Water needs to be measured to be properly managed
2. **Where is it being used?** What processes are using water
3. **When is it being used?** Pay attention to "off-hours" flows
4. **Why is it being used?** What is the purpose of the water usage
5. **Who is in charge?** Who is responsible for the design and control of water use
6. **Is there another way?** Can any process needs be met with less or no water

It is also important to distinguish between water use, water consumption, and return flow:

- **Use** means the total water purchased or withdrawn from a fresh or saline body of water or from a well
- **Consumption** refers to water that is included in the product, evaporated, or otherwise not returned as an effluent from the facility
- **Return flow** refers to water that is returned to either a wastewater facility or made available for additional reuse by another entity such as a farm for crop irrigation.

The following figure shows that the amount of water consumed in various types of industrial and commercial operations can vary considerably:

Figure 6-1: Range of Consumptive Use in Industrial Operations



Source: HW (Bill) Hoffman & Associates, LLC – independent research.

Industrial uses of water in manufacturing or building maintenance processes can vary significantly, but generally fall into the following categories:

1. Manufacturing process
   a. Inclusion in product
   b. Equipment cleaning
   c. Process cooling
2. Refrigeration cooling
3. Employee sanitation
4. Air pollution/dust control
5. Area wash-down
6. Miscellaneous uses

Figure 6-2: Typical Industrial Water Use Breakdown

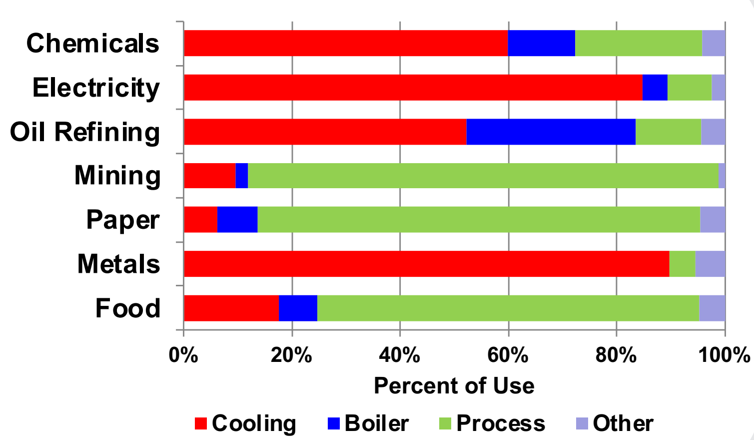


Figure 6-2 shows how water has historically been used in industrial settings. Cooling water, boiler water and process water are the major uses.

Water savings considerations for the industrial operations listed above will be discussed in detail. Two case studies are described here; in many cases, implementing measures like these can have almost instantaneous payback.

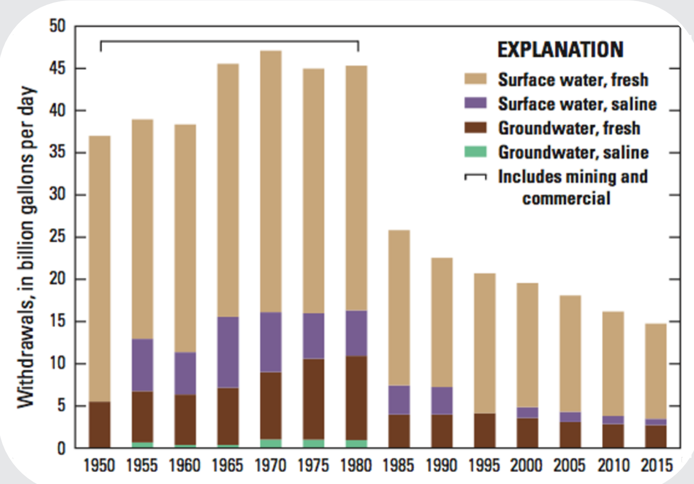
- A simple example is from a factory manufacturing windshield wiper blades. One of the manufacturing steps included running the rubber through a strong chorine solution. This process involved a makeup water flow of eight gallons per minute to the process tank. To remove chlorine fumes generated from this process tank, a flow of approximately eight additional gallons per minute was needed. By using the scrubber water from chlorine fume removal as the makeup water for the process tank, the facility cut water use in half at almost zero cost to implement.
- Another major water user is single pass cooling water for pumps. A brewing operation in EBMUD's service area, Drakes Brewing Company, previously used a vacuum pump on their bottling line that required water for cooling. After hearing about the EBMUD rebate for engineered water reduction solutions, Drake's created a closed loop cooling system. The new system reduced water for that particular process by 99% and reduced overall usage in that department by 38%. *Info provided by Hal McConnellogue of Drake's.*

Beginning with the US Environmental Protection Agency Clean Water Act in 1970's, industrial water use has been dropping steadily despite manufacturing increasing or remaining constant.[1] The first major decrease in water use was due to the new requirements for industry to treat wastewater to acceptable limits. Further reductions have been the result of higher water costs and other factors encouraging more efficient water use.

The cost of water has also been increasing faster that the consumer price index and the cost of energy. These cost increases have also been a driving factor in the reduction in industrial water use.

1 https://www.macrotrends.net/2583/industrial-production-historical-chart

Figure 6-3: Self-Supplied Industrial



Source: https://www.usgs.gov/media/images/self-supplied-industrial-withdrawals-1950-2015

Technological Advances

There have been many recent technological advances allowing CII users to decrease their process water use. Three of these advances are internal recirculation and reuse, zero liquid discharge processes, and process control and monitoring

- **Internal recirculation and reuse** – One of the most cost-effective ways to reduce water and wastewater costs. For more details, please see [link to Alternative On-Site chapter]. Some examples of on-site sources of water for reuse include:
    - Air conditioner condensate
    - Air pollution scrubber water
      Cooling tower blowdown
    - Equipment wash water
    - Foundation drain water
    - Graywater
    - On-site treated wastewater systems
    - Process water
    - Rainwater harvesting
    - Reverse osmosis (RO) and Nanofiltration (NF) reject water
    - Stormwater harvesting
    - Swimming pool filter backwash water
- **Process control & monitoring** – Improved process control and monitoring has allowed significant reduction in water that once was wasted due to lack monitoring data. One example is in the operation of cooling towers. Conductivity and pH controllers, as well as flowmeters on the make-up and blowdown lines, allow for fine control of water chemistry and usage. Wifi-enabled models and a data aggregation platform are recommended in tandem for ease of monitoring, setting up alerts, and more. Prior to the wide usage of these technologies, water quality testing and water use tracking was less frequent. This resulted in cooling tower chemistry being programmed for a “worst case scenario” setting of the cycles of concentration, or in the case of an equipment malfunction such as a stuck float valve.
- **Zero Liquid Discharge** – Most commonly used in wastewater processing, this practice recovers all wastewater and concentrates dissolved minerals and chemicals to be recovered in a solid form. This method offers significant reduction in other wastes since much of the solids recovered have a marketable value. However, these systems can be energy intensive and come with a hefty price tag.[2]

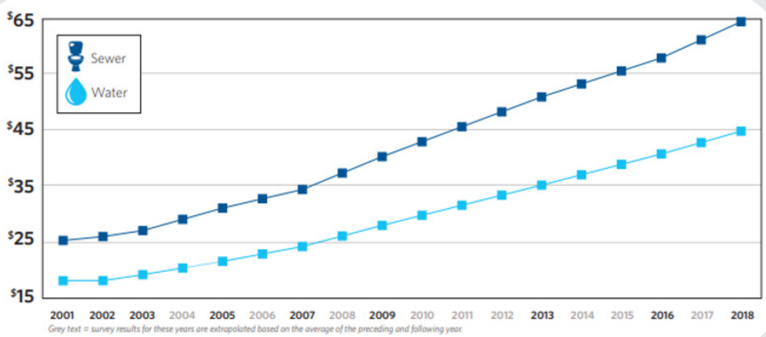
Food and Beverage Processing

Before beginning this discussion of water conservation in food processing, one should remember that health and sanitation are overriding concerns. All actions to reduce water use must be measured against this primary consideration. The food and beverage processing industry includes a wide range of products and manufacturing processes:

- Bakery/pastry shops
- Breweries
- Canneries
- Dairy food processors
- Frozen food producers
- Grocery stores and restaurants that produce food products for sale
- Industrial bakeries
- Meat, fish, and poultry processing
- Snack food manufacturers
- Soft drink and juice manufacturers
- Wineries

2 https://pubs.acs.org/doi/10.1021/acs.est.6b01000

Figure 6-4: Average Industrial Water and Sewer Costs per Month (10 Million Gallons)



Source: https://webassets.bv.com/2019-10/50_Largest_Cities_Rate_Survey_2018_2019_Report.pdf

For each manufacturing process, it is important to consider all instances of water use throughout to identify savings opportunities. The quality and purity of the water is of primary concern since it is used to make products that will be consumed. In addition to being a key production ingredient, water is also used to clean and sanitize floors, processing equipment, containers, vessels, and raw food products prior to their processing. Hot water, steam, cooling, and refrigeration also require source water.

Designing and building a food and beverage processing facility that has a reduced requirement for water includes:

1. Designing the facility for ease of cleaning
2. Providing adequate metering, submetering, and process control
3. Taking advantage of dry methods for cleanup and transport
4. Using product- and byproduct-recovery systems
5. Incorporating water reuse and recycling
6. Designing for minimal or no water use

End-Use Example: Soft Drink Manufacturing

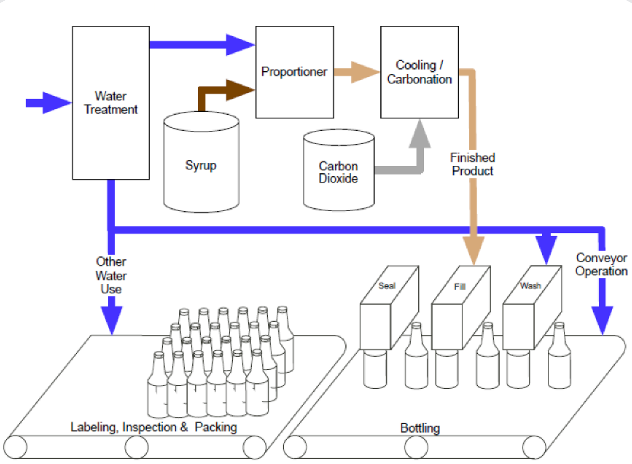
Because of the complicated and highly varied nature of the food and beverage manufacturing industry, providing a simple guide to water efficiency that covers all types of facilities is not possible. This section will instead use soft drink manufacturing as a general example; much of the advice herein can also be applied to other types of processes.

The following example illustrates ways water can be used in the soft drink industry. Potable water is first treated to soften it and, if needed, to remove additional minerals. It is chilled and blended with flavorings and sweeteners, then carbonated. Cans or bottles are filled and sealed, then rinsed and sent through a warming bath to avoid creating condensate in the open air and ensure they are dry before packing.

The major water using processes in soft drink creation are:

- Water softening, which requires periodic filter backwash
- Water included in the product
- Water to clean and rinse cans
- Water to warm cans after processing
- Water sprayed on the conveyor line as a lubricant
- Water to operate cooling towers for refrigeration equipment and boilers for heat
- Water to sanitize and clean the plant and vessels
- Water for employee sanitation, irrigation, etc.

Figure 6-5: Carbonated Soft Drink Manufacturing



Source: https://www.usgs.gov/media/images/self-supplied-industrial-withdrawals-1950-2015

Major Water Using Activities

Top water intensive processes in the food and beverage manufacturing sector are described below, along with examples from specific industries where appropriate.

Cleaning and Sanitation

Information on floor cleaning and the cleaning of outdoor areas is found in all sectors [link "Food Service" chapter]. Dry cleanup, preventing spills by controlling processing equipment and leaks, and proper storage and handling of ingredients all reduce water needed for cleaning

For example, breweries are one type of beverage manufacturing that use a large percentage of their total water for various cleaning processes. The Brewers Association, which publishes benchmarking data from craft breweries of all sizes, shows that breweries use, at best, 25% of their total water usage for the product.[3] A brewing company in EBMUD's service area, Drake's Brewing, uses 20% and even smaller breweries only use 6-13%, with the lion's share of water use dedicated instead to cleaning and related processes.

Brewery tanks

Two solutions for water use reduction in brewery cleaning is burst rinsing, a type of Clean In Place (CIP) methodology, and metered rinsing.[4] Burst rinsing includes an initial water rinse, followed by a series of caustic and acid washes, an intermediate water rinse, and a final hot water or sanitizer disinfection rinse. If multiple tanks are present, the acid and caustic washes can also be reused.[5] Metered rinsing involves using mechanical or electric timers to start and stop rinsing procedures to eliminate behavioral bad practices.

Thermodynamic Processes

Another common use of water is in the production of steam and hot water. Steam sterilization and pasteurization are most common examples of these thermodynamic processes. Metering and submetering [See Chapter 5] are important in understanding how much water is used in each process or type of equipment. Proper process controls are essential to managing water and energy use.

Transportation and Cleaning of Food Products

Some food processing facilities will use flumes (open channels or chutes carrying a stream of water) to transport and clean produce. Water is also used in the cleaning and processing of meat, poultry, and fish. Common water conservation techniques begin with reducing water use by:

- Recycling transport water
- Adjusting design of flumes to minimize water use
- Using flumes with parabolic cross sections
- Providing surge tanks to avoid water loss
- Including float control valves on makeup lines
- Installing solenoid valves to shut off water when equipment stops
- Using vibration and air to help clear fruit and vegetables of debris and dirt before fluming or washing
- Can cooling water for first flush
- Installing electronic monitoring equipment to manage the process
- Installing systems to treat and reuse water

All these techniques can reduce the need for water, but changing the process has even more potential:

- Replace fluming with conveyor belts, pneumatic systems, or other dry techniques to move food products
- Install sprays to wash food
- Use mechanical disks and brushes
- Install counter-flow washing systems
- Control sprays on belts
- Control process equipment to reduce waste

3 https://www.brewersassociation.org/the-new-brewer/jan-feb-2020/
4 https://www.brewersassociation.org/seminars/clean-up-your-act-safe-cip-practices/
5 https://brewerycleaners.com/wp-content/uploads/2019/02/CleaningSystemForBreweries.pdf

Larger equipment that cannot be disassembled easily must be cleaned in place. A clean-in-place (CIP) system allows such large equipment to be sanitized while also carefully controlling the facility's water and chemical use.

Grocery stores and smaller bakeries should follow good food service sector washing practices for meats, fruits, vegetables, and other food products before final packaging. Further, ensure that all water using process equipment has proper level and flow controls.[6]

As an example, a Minnesota vegetable-processing firm reduced water use for conveying corn by 20 percent, or 1,000 gpd, just by employing proper controls and recycling 20 percent of the water in the flumes.[7]

Equipment Cleaning

Equipment to be cleaned ranges from large process facilities and equipment to the hand-held equipment and cooking utensils found in smaller bakeries and grocery stores. Smaller utensils should be washed following the ware-washing considerations found in Chapter 9, Food Service Operations.

Choices of procedures for cleaning equipment can yield multiple advantages include:

- Product recovery
- Reduced wastewater loading
- Reduced water use
- Reduced chemical use
- Reduced energy use

Good design and layout of equipment are essential to easy cleaning:

- Design equipment that minimizes spills, leaks, and residual product that must be removed before cleaning
- For closed systems such as tanks and piping, eliminate "low spots" so equipment can easily and completely drain
- Provide easy access to all areas of the equipment that must be cleaned
- Select materials and surfaces that are easily cleaned
- Change procedures to reduce the need for cleaning

CIP methods range from flooding the equipment with hot water, detergent, and chemicals, to dry cleaning. Dry cleaning as a first step is essential for saving water, since it reduces the water needed in the wet cleaning phase, sometimes eliminating it completely. Dry cleaning includes:

- Removing and storing as much otherwise-wasted product as possible
- Scraping equipment and vessels to remove as much waste as possible
- Using dry brushes, cloths, and paper towels to remove waste
- Using wet towels

Dry cleaning can be labor intensive, but the labor costs are offset by the potential to recover product, reduce pollution loading, and potentially clean equipment more thoroughly. It also allows employees to closely examine equipment and discover possible mechanical problems at an early stage.

For open equipment such as mixers, extrusion and molding equipment, or conveyor belts, cleaning should start with the physical removal of residual materials and then be followed by wet washing. Install and locate drains and sumps so water and wastes enter quickly to prevent the use of a hose as a broom. Four water efficient principles of wet cleaning are:

- Use targeted small volumes of water, instead of one large volume at once
- Use high pressure, low volume sprays
- Install shutoffs on all cleaning equipment
- Use detergents and sanitizing chemicals that are easily removed with minimal water use

For closed vessels like pipes and delivery tubs, cleaning

6 Costello, Jim. Spring 2001. "Brewing Up Prevention Ideas." Newsletter. University of Minnesota Technical Assistance Program.

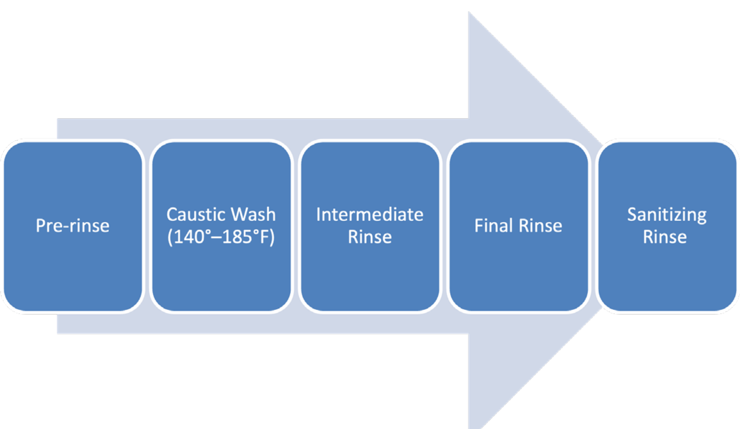
7 North Carolina Department of Environment and Natural Resources, Division of Pollution Prevention. August 1998. Water Efficiency Manual for Commercial, Industrial, and Institutional Facilities.

techniques are very different. They require “Clean in Place” (CIP) and “Sanitize in Place” (SIP) methods. Before cleaning a process piping system, it is essential to remove as much of the product as possible. At its simplest, this involves draining the tank or piping system. Designing the piping to eliminate low spots that can trap product is a major aid in this process. Following this, several methods can be employed to remove extra product and clean the vessel and piping. For piping, three methods find common use, including:

- Slug rinsing
- Air blowing
- Pigging

A medium sized bakery in Minnesota used 65 to 100 buckets a day for storing icing. Washing these buckets required approximately three hours of labor each day, and icing that stuck to the bottom and sides was wasted. **The bakery replaced the one-bucket-at-a-time preparation method with a large vat.** This reduced the number of containers that had to be washed to three large vats which in turn **reduced washing time from three hours a day to a few minutes,** thus saving water.[8]

Clean-in-place (CIP) systems are found throughout the food and beverage industry. As an example, dairy processing facilities typically use a five-step process as outlined below:



Water is cascaded from one type of wash or rinse to the next phase. For example, caustic wash water which also contains detergents is used for pre-rinse water, the intermediate rinse water is used to make up the caustic wash water, the final rinse water can be used for the intermediate rinse, etc. Final rinse water is always very clean water, potable water or in some cases water that has been treated with reverse osmosis. As this shows, CIP water is used many times in the process, thus conserving water.

***Pigging** is a process in which a flexible rubber or plastic projectile is forced through a pipe to push the product out. In Europe a technique using “ice pigging” has recently been developed that uses ice slurry. The pig is forced through the pipe with air, water, or cleaning fluids. CIP systems can also be designed to reuse water and chemicals, if product safety allows.*

CIP Equipment at a Dairy Processing Facility

Image source: HW (Bill) Hoffman & Associates, LLC

For vessels, a ball that sprays water in all directions has historically been employed for washing. Replacing that with a high-pressure, low volume rotating spray that washes product down the sides can reduce the amount of water needed. In many cases, this dilute first rinse can be captured and product recovered. In the dairy industry, pasteurization tanks must be filled with hot water after cleaning to pre-pasteurize the vessels. This water is often captured and reused as wash water for other CIP needs, thus saving both water and energy, since the water is already hot.

8 *http://www.mntap.umn.edu/wp-content/uploads/simple-file-list/Water/Water-Conservation-Tips.pdf*

Vessel, barrel, and cask-cleaning water can also be used for irrigation in the wine industry and, to some extent, in the brewing and vegetable and fruit processing industries. The use of this water for irrigation also removes solids and biological oxygen demand from the waste stream and places it where it can be an asset to growing plant material.

Container (Bottles, Cans, Cartons, etc.) Cleaning

Cleaning bottles, cans, and containers prior to filling is common throughout the food and beverage industry. For returnable bottles, the use of air bursts to remove lose debris and materials and the reuse of water from can warming and other operations are common ways to reduce water use. Other methods include use of pressure sprays and steam instead of high volumes of hot water to clean containers.

One brewery recovered the bottle wash water and used it for washing the crates in which the bottles are placed. This saved more than 4,500 gallons of water a day (Hagler).

Cleaning cans, bottles, and containers after they have been filled offers other opportunities. Some spillage and overfilling are inevitable, but with proper equipment control this can be minimized. Reducing water use to a minimum and passing the wash water through nanofiltration can recover both the sugars and product for use as animal feed or for growing yeast, while the water is cleaned and made available for additional reuse.

Additional water savings techniques:

- Reuse pump seal wastewater or other available sources for washing crates and pallets
- Use self-closing valves and automatic sensors to only allow sprays when items are passing spray nozzle
- Use ozone as a sanitizing agent instead of steam or hot water

Lubricating Can and Bottle Conveyor Belts

One of the most unusual uses of water in the food and beverage industry is as a lubricant for conveyor belts that move cans and bottles, so they can "slip" easily on the high-speed conveyor belts and not tip over. This water is softened and mixed with biocides and soaps before it is sprayed onto the conveyors. Many attempts have been made to use dry lubrication systems or find other ways to move the cans and bottles at the high speeds needed in modern operations, but the use of water as a lubricant remains the standard for the industry. Many have been able to reduce water use or even capture and recover belt lubricant water. In Australia, eight Cadbury Schweppes plants tested dry lubricant conveyor systems[9]. For now, ensuring that the spray nozzles are properly sized, well aligned, and equipped with automatic shutoffs is the best that can be done.

Beverage Bottling Plant Conveyor Belt in Action

Can and Bottle Warming and Cooling

Water is often used in cooling or heating cans as a heat-transfer agent. This water remains relatively clean and is an excellent source of water for reuse. Water is used to cool cans after they have been removed from pressure cookers in the canning process. In most cases this water is cooled in a cooling tower or a refrigeration unit that employs a cooling tower in the process.

In the warming process, cans and bottles that have been filled with cold liquids are heated so condensate does not form on them, and they dry more quickly before packing. These operations offer significant opportunities for reuse for almost all the other water needs in the operation, except where potable quality is required by regulation. Please see [Alternate On-Site Water chapter] for more details.

9 *https://water360.com.au/wp-content/uploads/2022/10/1132-installation-of-waterless-conveyer-technology-final-report.pdf*

Recommendations

- Require that new facilities provide a list of possible areas of water recovery and reuse
- Require that all major water-using areas be separately metered
- Consider using telemetry to track real-time usage
- Require automatic shutoff and solenoid valves on all hoses and water-using equipment, where applicable
- Incorporate routine inspection for leaks, identification of leaks and leak repair in normal operation
- Monitor daily water use to track unexplained increases in use.
- Use low volume high pressure cleaning
- Develop a procedure for facilities to self-audit
- Use pigging (using mechanical devices to perform pipeline or tubing maintenance operations), air blowing, or slug washing as part of CIP systems for process pipes
- Use floor cleaning and vacuum machines where possible
- Minimize the use of water-lubricated conveyor belts
- Minimize the need to use a hose as a broom by installing drains close to areas where liquid discharges are expected
- Provide pressure-washing equipment in place of washdown hoses
- Utilize reverse osmosis and nanofiltration to increase water reuse
- Engage employees in water conservation efforts and audits
- Use vibration and air to help remove dirt and debris prior to washing

Design principles

- Design the facility for ease of cleaning
- Provide adequate metering, submetering, and process control
- Take advantage of dry methods for cleanup and transport
- Use product and byproduct recovery systems
- Incorporate water reuse and recycling
- Design for minimal or no water use

Automotive Services

The automotive service and repair industry is one of the most ubiquitous types of commercial enterprises in any city. Establishments include:

- Service stations
- Oil change/lubrication
- Body repair
- Tune-up shops
- Full-service repair shops
- Fleet maintenance
- Tire service

The design of a water efficient shop depends to some extent upon the type of service offered. New air quality regulations[10] have also meant that shops have switched from solvent based parts and brake cleaning systems to aqueous based systems. Floor cleaning with dry methods, preventing spills and leaks from entering the wastewater discharge system, and the proper design of oil separators have as much to do with pollution prevention as they do with water conservation.

Three areas of operation offer both reduced water use and pollution loading possibilities:

- Proper design of aqueous parts and brake cleaning
- Pollution prevention and water use reduction in shop floor cleaning
- Proper handling of spent fluids and oils

Aqueous Cleaning Equipment

The development of aqueous parts and brake cleaning equipment has been driven by air quality requirements. Such systems can employ filtration for sludge removal and oil skimming. By filter cleaning water used during this cleaning process, it can be recycled, thus saving on total water use.

Floor Cleaning

Keeping floors clean in the first place reduces the need for frequent washing.

- Install secondary containers under fluids-storage containers to catch leaks and using drip plans under vehicles being worked on
- Use dry cleanup with hydrophobic mops for oil and using absorbent materials (kitty litter, rice hulls,

10 *https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/rules/RuleID276.pdf*
https://www.baaqmd.gov/~/media/files/compliance-and-enforcement/tips-and-faq/compliancetips_reg8_16_102104.pdf

Table 6-1: Virgin Fiber vs Recycled Copy Paper

	1 Ton Virgin Fiber Paper	1 Ton 100% Recycled Paper	Environmental Savings from Recycled Content
Trees	24 trees	0 trees	100%
Energy	33 million BTUs	22 million BTUs	33%
GHG released - CO2 equivalent	5,601 lbs	3,533 lbs	37%
Wastewater	22,853 gal	11635 gal	49%
Solid waste	1,922 lbs	1,171 lbs	39%

Source: Pulp and paper mills have significant recycling of process water opportunities, https://samcotech.com/reduce-water-usage-in-pulp-and-paper-industry/

pads, rags, pillows, and mats) to clean up spills

- → Seal floors with an epoxy material, which significantly aids in cleanup and prevents oils and liquids from penetrating concrete floors
- → Provide floor cleaning equipment that scrubs and vacuums up its own water
- → Eliminate the use of open hoses for cleanup and using pressure-washing equipment infrequently and for major cleanup events only
- → Mark drains clearly to ensure that floor drains are clearly differentiated from storm drains and all floor drains are connected to an oil separator

Handling of Spent Fluids

Recovery and recycling of radiator flush water both saves water and reduces pollution loading. Using storage vessels designed to hold spent antifreeze and other fluids, such as oil and transmission fluid, both eliminates the need to clean and flush these fluids down a drain and is required as part of modern pollution control methods. Water use in facilities that recycle radiator flush water has been shown to be less than 10 percent of water use in non-recycling facilities (San Antonio Water System).

Recommendations

- → Require new facilities to provide secondary containers to catch drips, leaks, and spills from stored liquids and solvents
- → Require shop floors to be sealed to ensure easy cleanup
- → Require automatic shutoff and solenoid valves on all hoses and water-using equipment, where applicable
- → Require aqueous parts- and brake-cleaning equipment to employ recirculating filtration to minimize the need to dump water
- → Require all drains to be properly identified
- → Have proper facilities for the capture, storage, and recycling of spent fluids, oils, and fuels, including antifreeze and radiator flush-water
- → Have pressure-washing equipment available
- → Have drip pans available at workstations to place under vehicles

Paper Manufacturing

Paper manufacturing ranges from making paper from trees to manufacturing converted paper products, such as paper containers, cups, boxes, bags, coated paper, envelopes, and stationery products. The focus of this discussion is the creation of paper products.

Producing paper from pulpwood or other fiber sources is the first step in the process. It is also the most water and energy intensive stage in the life of a paper product.

An average of six gallons of water are used to make one pound of paper.[11]

11 https://www.sierraclub.org/sierra/2015-1-january-february/ask-mr-green/hey-mr-green-what-about-all-water-it-takes-make-paper

Paper and Pulp Mill

Sourcing recycled paper eliminates the water and energy intensive raw material pulping stage of the production process. During paper recycling, scrap paper is shredded and put into a hydro-pulper. The pulp is washed to remove ink and dirt and then remade into new paper products. A 2012 publication, Paperwork: Comparing Recycled to Virgin Paper, provides a detailed comparison of resources used to produce virgin and recycled paper.

The manufacture of products from recycled paper, cardboard stock, or dry pulp represents the types of paper manufacturing operations found in most urban areas, which most commonly involve:

- Cutting and folding
- Gluing
- Coating
- Printing

Cutting and folding, along with the handling of paper stock and products, is principally a dry process. Floor cleaning should follow principles outlined in the section on Cleaning and Sanitation. The last three of these operations involve wet or solvent cleaning of some type. The advent of water-soluble paints and inks has reduced volatile-organic-compound (VOC) emissions, but the use of water as a cleaning agent is more prevalent. The same principles used in cleaning equipment in the food and beverage processing industry apply here, with the addition of solvent cleaning, which is still used in many non-aqueous printing processes.

Recycling paper and cardboard products cuts this energy and water use in half.[12] According to Conservatree, an organization that promotes paper recycling, most repulping for recycled paper is done at pulp and paper mills, or in special facilities that manufacture products such as cellulose insulation or pulp products such as egg cartons.

Pulp and paper mills use mixture of virgin and recycled pulp, the latter of which is rapidly becoming the most common source of paper and cardboard stock for commercial converted products. Most paper pulp is destined for the printing industry (California EPA). Examples of finished products include cardboard tubes, roofing paper, corrugated boxes, paper bags, tissue and toweling, folded boxes, cellulose padding, stationery and envelopes, and paper cups and liquid containers.

During the initial manufacturing process, wood pulp is suspended in water. Depending on the end use of the pulp, bleaching and further refining processes can occur. These processes produce a wastewater that must be treated. The pulp is then washed several times to remove lignin and other products from the wood as well as pulping chemicals. Many water recovery processes are available to the pulp and paper industry, from conventional physical and chemical treatment to membrane biological reactors and reverse osmosis systems

Recommendations

Manufacturing of Recycled-paper Products

- Properly remove as much waste product as possible by pouring and storing for future use
- Scrape equipment and vessels to remove as much waste as possible
- Use dry brushes, cloths, and paper towels to remove waste
- Use wet towels or solvent-soaked towels
- Apply water or solvent only to areas to be cleaned

12 *https://www.stopwaste.org/sites/default/files/Documents/1030136122004paperfactsheet.pdf*

Printing Operations (including flexography, gravure, screen-printing, lithography, and digital processing)

- Design the layout of equipment for easy access
- Ensure that ink containers are easily sealed
- Provide non-drying aerosol sprays to keep ink fountains from drying overnight
- Ensure that presses have proper controls, such as automatic ink levelers

Metal Finishing

The metal finishing industry offers many opportunities to reduce both water use and pollution abatement costs. The plating and anodizing processes involve a multi tank, multi-step process. Water saving practices include:

- Drag-out control
- Good tank design
- Efficient rinse practices
- Process controls and meters
- Chemical recovery
- Good exhaust-hood design

As with all industrial and commercial operations, efficient cleaning methods are key practices that will result in reduced water use.

Description of End Use

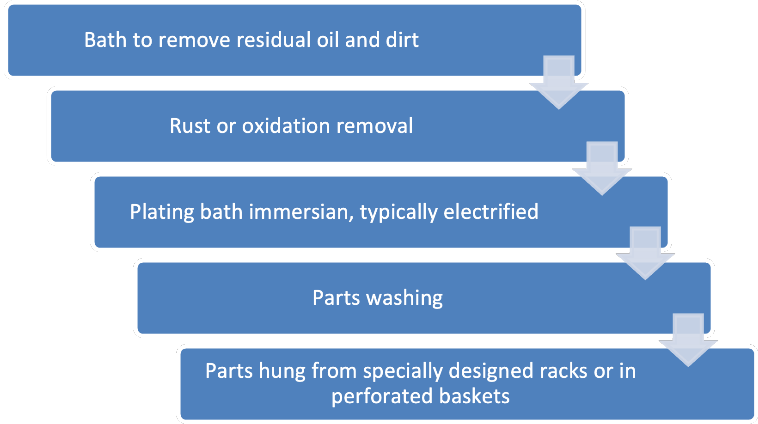
The classic example for the metal-finishing industry was once the plating of car bumpers (when chrome car bumpers were still manufactured). In the present-day, chrome, zinc, copper, tin, nickel, gold, and silver are among the more common metals plated onto objects. In some processes objects are plated with two layers of metals, such as an under layer of copper followed by chrome.

In one common process, parts to be plated are moved sequentially from a treatment tank to a rinse or wash tank to another treatment tank to another rinse tank, until the desired number of plating steps have been accomplished.

Water is used for the following process purposes:

- Chemical and plating solution make-up
- Rinsing
- Fume-hood scrubbing
- Equipment cleaning

Typical Metal Plating Sequence



As chemicals from one step build up in the following rinsing tanks or contaminate the process chemicals, water must be replaced. Fumes produced from all the tanks, and the acid (pickling) and plating processes in particular, must be safely removed with fume hoods which then pass this contaminated air to scrubber systems to prevent air pollution.

Recommendations

Drag-out control
(Tank-to-tank liquid recovery)

- Design racks, baskets, and barrels so parts drain and do not retain liquids
- Use sprays in place of dipping parts
- Use turning, tilting, and “bumping” to remove excess liquid
- Using air knifes, fogs or misting to remove solution
- Use drip or drain boards to collect and drain liquids back into the source tank
- Install drip guards between tanks
- Allow parts to remain over the tank for a few seconds (dwell time)
- Vibrate parts to knock liquid off
- Ensure parts are pointed down for efficient drainage
- Wash or blow contaminants back into process or dead tanks using fogs, sprays, or air knives
- Use wetting agents
  - Using chemicals or heat to reduce plating-solution viscosity
- Operate the solutions at minimum possible concentration

Tank Design Methods
(Good design reduces water use or allows for better reuse and recovery of metals)

- Use air or mechanical agitation to promote mixing and good contact
- Hard plumb all piping so hoses cannot be left on inadvertently
- Prevent short-circuiting of fluids
- Size tanks to the minimum for the pieces to be plated
- Segregate waste streams so both metals and water can be recovered more easily

Rinsing Methods
(Efficient rinsing saves water and chemicals, and reduces associated wastewater costs)

- Use sprays on flat pieces of metal
- Employ counter-current rinsing, where the piece is rinsed in successively less concentrated tanks, with the water from the first tank being used as feed for the second, and so on
- Employ reactive rinsing, where the rinse water from the final tank is used for the pickle-rinse tank and the pickle-rinse tank water is used as feed to make up the alkaline-rinse tank (see figure following)
- Use air agitation in the tanks

Flow and Process Control

- Install conductivity controllers to discharge water only if the chemicals have become too concentrated
- Meter makeup water for good process control and to identify problems
- Use flow restrictors to limit the amount of water being added

Chemical and Water Recovery

- Filter plating fluid to remove suspended matter
- Use membrane technology to recover metals and water
- Use reverse osmosis (RO) or deionization for the feed water for both rinse and process-fluid tanks to reduce interference from other ions
- Regenerate spent acids
- Use RO-reject water for cleanup around, but not in, the tanks

Exhaust Hood Design

- Recirculate scrubber liquid
- Use scrubber water above plating tanks as make-up water for that process
- Use RO-reject water or similar reject streams as make-up water for scrubbers for which scrubber effluent will not be reused

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