6.2 Single-Pass Cooling

Overview

Single-pass or once-through cooling systems use water to remove heat and cool equipment components. After water is passed once through a coil within or casing around a piece of equipment, the water is discharged to the sewer. Types of equipment that use single-pass cooling include:

- Point-of-use chillers or other refrigeration systems
- Condensers
- Air compressors
- Air conditioners
- Hydraulic equipment
- CAT scanners
- Degreasers
- Welding machines
- Vacuum pumps
- X-ray equipment
- Ice machines
- Wok stoves

Vacuum pumps, X-ray equipment, ice machines, and wok stoves use water for processes in addition to the water used for single-pass cooling. Such equipment and its associated water use, apart from single-pass cooling, are discussed in other sections within *WaterSense at Work*.

Eliminating single-pass cooling offers a significant opportunity for water savings. Single-pass systems use approximately 40 times more water to remove the same heat load than a cooling tower operating at five cycles of concentration.[3] Many types of equipment cooled with single-pass water can be replaced with air-cooled systems.

For equipment that requires cooling with water, installing an air-cooled, point-of-use chiller or converting to a recirculating water system that makes use of a process water chiller and/or a cooling tower will eliminate single-pass cooling.

The International Association of Plumbing and Mechanical Officials *2010 Green Plumbing & Mechanical Code Supplement*, which establishes requirements for green building and water efficiency applicable to plumbing, prohibits the use of single-pass cooling. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings* (ASHRAE Standard 189.1) also prohibits the use of single-pass cooling.

[3] U.S. Environmental Protection Agency and U.S. Energy Department, Energy Efficiency & Renewable Energy, Federal Energy Management Program. May 2005. *Laboratories for the 21st Century: Best Practices, Water Efficiency Guide for Laboratories*. Page 4. www1.eere.energy.gov/femp/program/labs21_bmp.html.

Operation, Maintenance, and User Education

As a first step, identify all equipment using single-pass cooling and follow these tips to minimize or eliminate this water use:

- Use the minimum flow rate required to cool the system recommended by the manufacturer.
- Install solenoid valves that shut off single-pass cooling water when the equipment is turned off.
- Regularly check operation of the water control valve so that cooling water only flows when there is a heat load that needs to be removed.
- Keep coil loops clean to maximize heat exchange.
- If single-pass cooling cannot be eliminated, consult the *Section 8: Onsite Alternative Water Sources* to identify methods of reusing single-pass cooling water in other applications.

Retrofit Options

For maximum savings, eliminate single-pass cooling by modifying equipment to recirculate cooling water. This can be achieved by installing a closed-loop recirculation system that will reuse cooling water instead of discharging it. A dedicated air-cooled, point-of-use chiller can be added to most cooling systems to reject heat and allow the cooling water to be reused. Alternatively, at some facilities, the single-pass cooling water can be replaced with water from an existing recirculating chilled water loop or cooling tower water loop, which are mechanical systems used to remove heat from the water.

If single-pass cooling water cannot be eliminated through cooling water recirculation, consider installing an automatic control that stops cooling water flow when the equipment is not in use or no heat load is present. This retrofit will not entirely eliminate water use, but it will minimize unnecessary water use.

Replacement Options

When possible, replace single-pass, water-cooled equipment with air-cooled equipment. Air-cooled equipment uses no water for cooling purposes. If considering air-cooled equipment as a replacement, evaluate the potential energy use of the equipment in addition to the water use to ensure that the cost benefit from water savings is not offset by an increase in energy use.

For detailed replacement options for specific equipment using single-pass cooling, refer to the *WaterSense at Work* sections covering vacuum pumps, X-ray equipment, ice machines, and wok stoves.

Savings Potential

Single-pass cooling can be eliminated by retrofitting the existing equipment with a recirculating system or replacing with air-cooled equipment.

Potential savings can be estimated by measuring the existing cooling water discharge with a gallon bucket and stopwatch and determining how often the cooling water flows (e.g., how many hours per day and days per year). Many applications of single-pass cooling water flow continuously. To estimate facility-specific water savings and payback, use the following information.

Current Water Use

To estimate the current water use of existing equipment cooled with single-pass water, identify the following information and use Equation 6-1:

- Flow rate of the discharge water from the equipment cooled with single-pass water.
- Average daily use time. This will vary by facility and the type of equipment cooled with single-pass water.
- Days of facility operation per year.

Equation 6-1. Single-Pass Cooling Equipment Water Use (gallons per year)

= Single-Pass Cooling Equipment Flow Rate x Daily Use Time x Days of Facility Operation

Where:

- Single-Pass Cooling Equipment Flow Rate (gallons per minute)
- Daily Use Time (minutes per day)
- Days of Facility Operation (days per year)

Water Savings

Replacing existing equipment cooled with single-pass water with an air-cooled system or retrofitting with a recirculating cooling water system will entirely eliminate discharge water use, as shown in Equation 6-2.

Equation 6-2. Water Savings From Retrofitting or Replacing Single-Pass Cooling Equipment (gallons per year)

= Current Water Use of Single-Pass Cooling Equipment

Where:

- Current Water Use of Single-Pass Cooling Equipment (gallons per year)

Payback

To calculate the simple payback from the water savings associated with replacing existing equipment cooled with single-pass water, consider the equipment and installation cost of the replacement option, the water savings as calculated using Equation 6-2, and the facility-specific cost of water and wastewater.

If single-pass cooling is eliminated by replacing equipment with air-cooled models, facilities might see an increase in energy usage. The increased energy use, depending upon how significant, might increase the payback time and decrease replacement cost-effectiveness.

Additional Resources

EPA and DOE, Energy Efficiency & Renewable Energy, Federal Energy Management Program. May 2005. *Laboratories for the 21st Century: Best Practices, Water Efficiency Guide for Laboratories*. www1.eere.energy.gov/femp/program/labs21_bmp.html.