

4.2 Commercial Ice Machines

Overview

Commercial ice machines use refrigeration units to freeze water into ice for cooling or preserving food and other items. Ice machines have become a mainstay in all types of settings, including restaurants, commercial kitchens, fast food establishments, convenience stores, grocery stores, schools, hotels, hospitals, and laboratories. Ice machines typically use water for two purposes: cooling the refrigeration unit and making ice. There are mechanisms to address the efficiency of both aspects.



Cubed ice machine

Because the ice-making process generates a significant amount of heat, either water or air is used to remove this waste heat from the ice machine's refrigeration unit. In the most basic configuration, water-cooled ice machines pass water through the machine once to cool it, and then dispose of the single-pass water down the drain. Water-cooled systems can use less water by recirculating the cooling water through a chiller or a cooling tower to lower the temperature, returning the water to the machine for reuse. To eliminate using water to cool the refrigeration unit altogether, air can be used to cool the unit instead. Air-cooled ice machines use motor-driven fans or centrifugal blowers to move air through the refrigeration unit to remove heat.⁵

There are three primary types of ice machines: ice-making head units, self-contained units, and remote condensing units. Ice-making head units include the ice-making mechanism and the condenser unit in a single package, and the ice storage bins are sold separately. Self-contained units have the ice-making mechanism, condenser unit, and a built-in storage bin in an integral cabinet. These units are typically small, undercounter units that produce a smaller volume of ice. Remote condensing units are models with the ice-making mechanism

and the condenser unit in a separate section. They transfer the heat generated by the ice-making process outside the building.

Regardless of how the machine is cooled, all ice machines use water to produce ice. If a machine were 100 percent water-efficient and wasted no water when producing ice, the machine would use approximately 12 gallons of water to produce 100 pounds of ice.⁶ However, in order to create ice of acceptable quality, some water is used and sent down the drain during the process. The amount of water used for the ice-making process depends upon the facility's incoming water quality and on the desired end quality of the ice. Specifically, water is used to rinse ice-making surfaces and flush minerals that accumulate as water crystallizes into ice.

As ice is formed in the freezing trays, minerals in the water collect on the equipment and must be rinsed occasionally. Ice machines at facilities with poorer incoming water quality (i.e., incoming potable water that contains high total dissolved solids or minerals) will require more frequent rinse cycles. Some ice machines might be set

⁵ U.S. Environmental Protection Agency (EPA) and U.S. Energy Department's (DOE's) ENERGY STAR. Commercial Ice Machines. www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CIM.

⁶ Alliance for Water Efficiency (AWE). Ice Machines. www.allianceforwaterefficiency.org/Ice_Machines.aspx.

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to rinse more frequently than needed, not taking into account the facility's incoming water quality and resulting in wasted water.

In addition to equipment rinsing, some facilities require a higher quality of ice than other facilities, depending upon the end use of the ice. A restaurant serving ice in beverages, for example, might want very clear, high-quality ice, while a cafeteria using ice to cool prepared food in a display case might not be concerned with the clarity of the ice used. Some ice machines are designed to produce clearer and smoother ice using a repeated freezing and partial thawing process. This method produces ice with fewer air bubbles and is more crystalline, but the process uses more water.⁷

The types of ice that ice machines can make include:

- Cubed ice—clear, regularly shaped ice weighing up to 1.5 ounces per piece and containing minimal amounts of liquid water.
- Flake ice—chips or flakes of ice containing up to 20 percent liquid water by weight.
- Crushed ice—small, irregular pieces made by crushing bigger pieces of ice.
- Nugget ice—small portions of ice created by extruding and freezing the slushy flake ice into a nugget.⁸



Crushed ice machine

Cubed ice machines are the most prominent in the market, accounting for approximately 80 percent of ice machine sales in the United States.⁹ Most cubed ice machines use more water than flake ice machines because they run more water over the freezing ice to remove sediment and minerals left as the water freezes. In general, the higher the quality of ice, the more water is needed for the ice-making process.

Water used for the ice-making process ranges from 15 gallons to more than 50 gallons per 100 pounds of ice,¹⁰ depending upon the amount of water used to rinse the ice-making surfaces and the amount of water needed to produce higher quality ice.

In total, including the ice-making and cooling processes, water-cooled ice machines with single-pass cooling consume between 100 and 300 gallons of water per 100 pounds of ice produced,¹¹ while air-cooled ice machines can consume less than 50 gallons of water per 100 pounds of ice produced. While air-cooled machines are usually more water-efficient, water-cooled machines are usually more energy-efficient. Some air-cooled units, however, are able to match or exceed the energy efficiency of water-cooled units while also providing substantial water efficiency.¹²

⁷ *Ibid.*

⁸ Pacific Gas and Electric Company. *Information Brief: Commercial Ice Machines*. www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hospitality/icemachinetech.pdf.

⁹ *Ibid.*

¹⁰ Koeller, John and Hoffman, H. W. (Bill). Koeller and Company. June 2008. *A Report on Potential Best Management Practices—Commercial Ice Machines*. Prepared for the California Urban Water Conservation Council. Page 6. www.cuwcc.org/products/pbmp-reports.aspx.

¹¹ Bohlig, Charles M. East Bay Municipal Utility District. February 7, 2006. "Water Efficiency in Commercial Food Service." Slides 13-20. www.awwa.org/Resources/Waterwiser.cfm?ItemNumber=33640&navItemNumber=3375.

¹² AWE, *op. cit.*

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The U.S. Energy Department (DOE) sets energy and water use standards for ice machines under the Energy Policy Act (EPA) of 2005. Visit DOE's website for the most up-to-date information.¹³

To recognize energy- and water-efficient ice machines, the U.S. Environmental Protection Agency (EPA) and DOE's ENERGY STAR® issued a specification¹⁴ to qualify certain types of commercial air-cooled ice machines that meet more stringent energy use and potable water use criteria. Commercial ice machines that are ENERGY STAR qualified are, on average, 15 percent more energy-efficient and 10 percent more water-efficient than standard air-cooled models.

Operation, Maintenance, and User Education

For optimal ice machine efficiency, consider the following:

- Periodically clean the ice machine to remove lime and scale buildup; sanitize it to kill bacteria and fungi. For self-cleaning or sanitizing machines, run the self-cleaning option. For machines without a self-cleaning mode, shut down the machine, empty the bin of ice, add cleaning or sanitizing solution to the machine, switch it to cleaning mode, and then switch it to ice production mode. For health and safety purposes, create and discard several batches of ice to remove residual cleaning solution.
- Keep the ice machine's coils clean to ensure the heat exchange process is running as efficiently as possible.
- Keep the lid closed to keep cool air inside the ice machine and maintain the appropriate temperature.
- Install a timer to shift ice production to nighttime or off-peak hours. This will decrease the facility's peak energy demand.
- Keeping in mind local water quality and site requirements, work with the manufacturer to ensure that the ice machine's rinse cycle is set to the lowest possible frequency that still provides sufficient ice quality. If available, use the ice machine's ability to initiate rinse cycles based on sensor readings of minerals.
- Follow the manufacturer-provided use and care instructions for the specific model ice machine used at the facility.
- Train users to report leaking or otherwise improperly operating ice machines to the appropriate personnel.

Retrofit Options

If the machine is cooled using single-pass water, modify the machine to operate on a closed loop that recirculates the cooling water through a cooling tower or heat

¹³ DOE, Energy Efficiency & Renewable Energy. Building Technologies Program: Automatic Commercial Ice Makers. www1.eere.energy.gov/buildings/appliance_standards/commercial/automatic_ice_making_equipment.html.

¹⁴ EPA and DOE's ENERGY STAR. Commercial Ice Machines Key Product Criteria. www.energystar.gov/index.cfm?c=comm_ice_machines.pr_crit_comm_ice_machines.

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exchanger, if possible. If eliminating single-pass cooling is not feasible, consider reusing the cooling water for another application. See *Section 8: Onsite Alternative Water Sources* for more information.

Replacement Options

When replacing an ice machine or installing a new one, ensure that the new model is sized appropriately to fit the facility's need. If the machine produces too large of a yield, water will be wasted by producing unnecessary ice. Choose an ice machine that is appropriate for the quality of ice needed. Producing ice of higher quality than required will use water unnecessarily. Look for ENERGY STAR qualified models,¹⁵ all of which are air-cooled. Also consider air- or water-cooled ice machines that meet the efficiency specifications outlined by the Consortium for Energy Efficiency.¹⁶ If feasible, consider selecting air-cooled flake or nugget ice machines, which use less water and energy than cubed ice machines.

Savings Potential

A facility will see varying levels of water savings, depending upon whether it is replacing an existing air-cooled ice machine or an existing water-cooled model.

The Food Service Technology Center has a life cycle and energy cost calculator, which can be used to calculate the savings potential from replacing many types of commercial kitchen equipment, including commercial ice machines.¹⁷

To estimate facility-specific water savings and payback, the facility can also use the following information.

Air-Cooled Ice Machine Replacement

ENERGY STAR qualified ice machines are, on average, 15 percent more energy-efficient and 10 percent more water-efficient than standard air-cooled models. Total savings depend upon the type of machine selected.

Use ENERGY STAR's commercial kitchen equipment savings calculator¹⁸ to estimate facility-specific water, energy, and cost savings for replacing an existing ice machine with an ENERGY STAR qualified model.

Water-Cooled Ice Machine Replacement

A facility will see the most water savings from replacing a water-cooled ice machine with an air-cooled model. When replacing an ice machine, select an ENERGY STAR qualified model.

¹⁵ EPA and DOE's ENERGY STAR. Commercial Ice Machines, *op. cit.*

¹⁶ Consortium for Energy Efficiency, Inc. Commercial Kitchens. www.cee1.org/com-kit/com-kit-equip.php3.

¹⁷ Food Service Technology Center. Commercial Foodservice Equipment Lifecycle Cost Calculator. www.fishnick.com/saveenergy/tools/calculators/.

¹⁸ EPA and DOE's ENERGY STAR. Savings Calculator for ENERGY STAR Qualified Commercial Kitchen Equipment. www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/commercial_kitchen_equipment_calculator.xls.

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Current Water Use

To estimate the current water use from a water-cooled ice machine, identify the following information and use Equation 4-1:

- The ice machine's harvest rate, or how many pounds of ice it produces per day.
- The ice machine's maximum water use rate. EPAAct of 2005 provides different water use maximums for water-cooled, self-contained units with harvest rates less than 200 pounds per day and those with harvest rates greater than or equal to 200 pounds per day. It also provides different water use maximums for water-cooled, ice-making head units with harvest rates less than 500 pounds per day; those with harvest rates greater than or equal to 500 pounds per day and less than 1,436 pounds per day; and those with harvest rates greater than or equal to 1,436 pounds per day.¹⁹
- Days of facility operation per year.

Equation 4-1. Water Use of Ice Machine (gallons per year)

$$= \text{Harvest Rate} \times \text{Water Use Rate} \times \text{Days of Facility Operation}$$

Where:

- Harvest Rate (pounds of ice per day)
- Water Use Rate (gallons per 100 pounds of ice)
- Days of Facility Operation (days per year)

Water Use After Replacement

To estimate the water use of a replacement air-cooled model, use Equation 4-1, substituting the harvest rate (if it will change) and the new water use per hundred pounds of ice. ENERGY STAR provides different water use maximums for qualified air-cooled models depending on the machine type and the harvest rate.²⁰

Water Savings

To calculate the water savings that can be achieved from replacing an existing water-cooled ice machine, identify the following information and use Equation 4-2:

- Current water use as calculated using Equation 4-1.
- Water use after replacement as calculated using Equation 4-1.

¹⁹ Energy Policy Act of 2005, Public Law 109–58, August 8, 2005.

²⁰ EPA and DOE's ENERGY STAR. Commercial Ice Machines Key Product Criteria, *op. cit.*

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Equation 4-2. Water Savings From Ice Machine Replacement (gallons per year)

$$= \text{Current Water Use of Ice Machine} - \text{Water Use of Ice Machine After Replacement}$$

Where:

- Current Water Use of Ice Machine (gallons per year)
 - Water Use of Ice Machine After Replacement (gallons per year)
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Payback

To calculate the simple payback from the water savings associated with replacing a water-cooled ice machine, consider the equipment and installation cost of the replacement air-cooled model, the water savings as calculated in Equation 4-2, and the facility-specific cost of water and wastewater.

The facility should also consider the energy impact of replacing old equipment. While air-cooled machines are usually more water-efficient, water-cooled machines are usually more energy-efficient. Some air-cooled units, however, are able to match or exceed the energy efficiency of water-cooled units while also providing substantial water efficiency.²¹

Additional Resources

Alliance for Water Efficiency (AWE). Commercial Food Service Introduction. www.allianceforwaterefficiency.org/Commercial_Food_Service_Introduction.aspx.

AWE. Ice Machines. www.allianceforwaterefficiency.org/Ice_Machines.aspx.

California Urban Water Conservation Council. Resource Center, Commercial Food Services, Ice-Makers. www.cuwcc.org/products/commercial-ice-makers.aspx.

Consortium for Energy Efficiency, Inc. July 1, 2011. High Efficiency Specifications for Commercial Ice Makers. www.cee1.org/com/com-kit/com-kit-equip.php3.

DOE, Energy Efficiency & Renewable Energy, Federal Energy Management Program. Covered Product Category: Air-Cooled Ice Makers. www1.eere.energy.gov/femp/technologies/eep_ice_makers.html#buying.

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages FOOD3-5. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

EPA and DOE's ENERGY STAR. Commercial Ice Machines. www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CIM.

²¹ AWE, *op. cit.*

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Food Service Technology Center (FSTC) Commercial Foodservice Equipment Lifecycle Cost Calculators. www.fishnick.com/saveenergy/tools/calculators/.

FSTC. Ice Machines. www.fishnick.com/savewater/appliances/icemachines/.

Koeller, John and Hoffman, H. W. (Bill). Koeller and Company. June 2008. *A Report on Potential Best Management Practices—Commercial Ice Machines*. Prepared for the California Urban Water Conservation Council.
www.cuwcc.org/products/pbmp-reports.aspx.

Pacific Gas and Electric Company. Information Brief: Commercial Ice Machines.
www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hospitality/icemachinetech.pdf.