



WaterSense at Work

Commercial Kitchen Equipment 4.10 Dishwashers



Best Management Practices for
Commercial and Institutional Facilities



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WaterSense® is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA) that seeks to protect the nation’s water supply by transforming the market for water-efficient products, services, and practices.

WaterSense at Work is a compilation of water efficiency best management practices intended to help commercial and institutional facility owners and managers from multiple sectors understand and better manage their water use. It provides guidance to help establish an effective facility water management program and identify projects and practices that can reduce facility water use.

An overview of the sections in *WaterSense at Work* is below. This document, covering water efficiency for dishwashers, is part of **Section 4: Commercial Kitchen Equipment**. The complete library of best management practices is available at www.epa.gov/watersense/best-management-practices. WaterSense has also developed worksheets to assist with water management planning and case studies that highlight successful water efficiency efforts of building owners and facility managers throughout the country, available at www.epa.gov/watersense/commercial-buildings.

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Overview

Commercial dishwashers are some of the largest water-using equipment in commercial kitchens. They clean and sanitize plates, glasses, bowls, utensils, and other foodservice ware. These machines can account for more than two-thirds of the overall water use in a commercial kitchen. In addition, some commercial and institutional buildings include residential-style dishwashers in places such as employee break rooms.

Commercial Dishwashers

Commercial dishwasher design can vary greatly by application, depending on how many employees, visitors, and/or customers are served by the commercial kitchen (i.e., the amount of facility throughput).

Commercial dishwasher design can be separated into several types:

- Undercounter
- Stationary single-tank door-type
- Pot, pan, and utensil
- Single- or multiple-tank conveyor-type
- Single- or multiple-tank flight-type



Stationary single-tank door-type dishwasher

Smaller facilities serving up to 50 meals per hour often use undercounter dishwashers, which are similar to residential dishwashers and tend to be smaller in size.¹

Stationary door-type commercial dishwashers are often used for slightly larger throughputs of 50 to 250 meals per hour.² They are usually manually loaded with racks, which are generally 20 inches by 20 inches (50 centimeters by 50 centimeters), to hold dishes and other kitchenware.

Pot, pan, and utensil dishwashers are another type of stationary rack machine intended for washing cookware and other large kitchen items.

¹ Fisher-Nickel and PG&E Food Service Technology Center. December 2016. *Design Guide: Improving Efficiency of Rack Conveyor Dishwashers Water, Energy, and Chemical Savings*. Page 4.

https://caenergywise.com/design-guides/Rack_Conveyor_Dishwasher_Design_Guide.pdf.

² *Ibid.*

Conveyor-type machines wash dishes that are manually loaded on removable racks; however, multiple racks can be washed at a time, and the racks are pulled through the washer using a conveyor to complete each cycle. The conveyor is typically turned off between loads. Single-tank rack conveyor-type machines work best for facilities serving 250 to 400 meals per hour, while double-tank rack conveyor-type machines are best for 400 to 750 meals per hour.³



Flight-type dishwasher

Flight-type machines are used in facilities with the highest throughputs. They also use a conveyor, but instead of loading racks full of dishes onto the conveyor, the conveyor itself serves as a rack, and dishes are loaded onto the pegs or fingers of the conveyor rack as it comes around. The conveyor is typically continuously moving as dishes are loaded, washed, and removed. Flight-type machines are designed for facilities serving 750 or more meals per hour.⁴

Commercial dishwashers use one of two methods for sanitation. Low-temperature dishwashers wash dishes between 120°F (49°C) and 140°F (60°C), with a final rinse at 140°F (60°C). These machines sanitize dishes with the aid of chemical sanitizing agents. High-temperature dishwashers wash dishes between 150°F (66°C) and 160°F (71°C), with a final rinse at 180°F (82°C), which is high enough to sanitize without chemical additives. High-temperature dishwashers typically require use of a booster water heater to reach higher water temperatures. Therefore, they generally use more energy, but they require less water and chemicals than low-temperature machines.^{5,6}

The most efficient commercial dishwashers save water by incorporating multi-staging rinse water reuse. Some efficient dishwashers also have sensors to ensure water flow stops when no dishes are present. These features not only reduce water use, but also reduce the amount of energy required to heat the water.

There are no federal standards limiting the water or energy consumption of commercial dishwashers. However, ENERGY STAR® qualifies energy- and water-efficient commercial dishwashers, including undercounter; stationary single-tank door-type; pot, pan, and

³ *Ibid.*

⁴ *Ibid.*

⁵ TRC Companies and Frontier Energy, Inc. 2023. *Operating Guidelines for Advanced Water Heating Within the Foodservice Industry*. Prepared for CalNEXT Program administered by Southern California Edison. Page 22. https://caenergywise.com/design-guides/Operators_Guide.pdf.

⁶ Fisher-Nickel and PG&E Food Service Technology Center, *op. cit.* Page 2.

utensil; single-tank conveyor; multiple-tank conveyor; single-tank flight-type; and multiple-tank flight-type machines.⁷

To earn the ENERGY STAR label, commercial dishwashers must demonstrate they do not exceed a maximum water consumption in gallons per rack or gallons per hour, depending on the machine type and sanitation approach. In general, high-temperature, stationary-rack machines and conveyor machines have water use maximums ranging between 0.54 gallons (2.04 liters) per rack and 0.89 gallons (3.37 liters) per rack, while low-temperature models of the same type have water use maximums up to 1.19 gallons (4.50 liters) per rack. Flight-type machines have water use maximums in gallons per hour that are calculated based on maximum conveyor speed and conveyor belt width. More detailed information on ENERGY STAR's product criteria for commercial dishwashers can be found at

www.energystar.gov/products/commercial_food_service_equipment/commercial_dishwashers/key_product_criteria. In general, ENERGY STAR certified commercial dishwashers are about 50 percent more water-efficient and 12 percent more energy-efficient than standard models.⁸

Residential Dishwashers

Residential dishwashers, typically installed under counters, may be used in commercial and institutional buildings in employee break rooms or kitchens. Residential dishwashers are generally more water-efficient than washing dishes by hand, and it takes less than half the energy to run a dishwasher load as it would to wash dishes by hand.⁹

The U.S. Department of Energy (DOE) sets energy and water use standards for residential dishwashers in the *Code of Federal Regulations*.¹⁰ Standard-size dishwashers must use no more than 5.0 gallons per cycle (18.9 liters per cycle), and compact-size dishwashers may use no more than 3.5 gallons per cycle (13.2 liters per cycle). Standard-size dishwashers can hold more than eight place settings and six serving pieces, and compact-size dishwashers have a lower dish loading capacity.



Residential dishwasher installed in employee breakroom

⁷ ENERGY STAR. Commercial Dishwashers. www.energystar.gov/products/commercial_dishwashers.

⁸ *Ibid.*

⁹ ENERGY STAR. Dishwashers. www.energystar.gov/products/dishwashers.

¹⁰ Office of the Federal Register. *Code of Federal Regulations*, Title 10 Energy, Chapter II, Subchapter D, Part 430, Subpart C, Energy and Water Conservation Standards and Their Compliance Dates, § 430.32. www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32.

ENERGY STAR qualifies more efficient residential dishwashers, which have built-in features such as soil sensors, more efficient jets, innovative designs for dish racks, and improved water filtration, allowing them to use less water and energy while improving performance. ENERGY STAR certified standard-size residential dishwashers use no more than 3.2 gallons of water per cycle (12.1 liters per cycle), and ENERGY STAR certified compact-size dishwashers use no more than 2.0 gallons per cycle (7.6 liters per cycle). Many dishwashers are equipped with several cycle choices, so users can also manually vary the amount of water used based on the size and soil level of the load. ENERGY STAR certified residential dishwashers are 30 percent more water-efficient and 12 percent more energy-efficient than standard models.¹¹

Operation, Maintenance, and User Education

For optimum efficiency with a commercial or residential dishwasher, consider the following:

- Only run dishwashers when they are full. Each dishwasher rack or cycle should be filled to maximum capacity.
- Educate staff to scrape dishes using a scraper, squeegee, or absorbent into a compost bin or trash receptacle instead of rinsing them prior to loading the dishwasher.¹²
- If possible, select the least amount of rinse cycles necessary for the soil-level of the dishwasher load.



Employee filling dishwasher rack to maximum capacity

These tips specific to commercial dishwashers can also increase efficiency:

- Ensure that the final rinse pressure and water temperature are within the manufacturer's recommendations. Most dishwashers are recommended to operate around 20 pounds per square inch (psi) (138 kiloPascals [kPa]) for optimum water efficiency.¹³
- Operate the dishwasher close to or at the minimum flow rate recommended by the manufacturer. Set the rinse cycle time to the manufacturer's minimum

¹¹ ENERGY STAR, Dishwashers, *op. cit.*

¹² Southwest Florida Water Management District. Water Conservation in Restaurants. www.swfwmd.state.fl.us/residents/water-conservation/water-conservation-restaurants.

¹³ Southern California Gas Company. 2021/2022. *Natural Gas Foodservice Equipment Cleaning & Maintaining User's Guide*. Page 35. https://caenergywise.com/design-guides/SCG_FSEC_CleaningGuide_FE-v2-published.pdf.

recommended setting and periodically verify that the machine continues to operate with that rinse cycle time.

- Use the correct amount of detergent and other chemicals for the load size to minimize the need for extra rinsing.
- Turn off machines at night when not in use.
- Make sure that manual fill valves close completely after the wash tank is filled.
- Find and repair any leaks. Inspect valves and rinse nozzles for proper operation and repair worn nozzles.

For conveyor-type machines, these further steps can be taken to ensure optimum efficiency:

- Install and/or maintain wash curtains. Wash curtains are able to retain heat within the machine.
- Ensure the rinse bypass drain is properly adjusted so that the wash tank is adequately replenished during operation.
- Operate conveyor-type machines in auto-mode. This will save energy by running the conveyor motor only when needed.
- If the dishwasher has a sensor to ensure water flow stops when dishes aren't present, periodically ensure the sensor is properly operating so that water isn't running all the time.

Retrofit Options

Efficient retrofit options are available for conveyor-type or flight-type dishwasher units. When retrofitting an existing conveyor- or flight-type dishwasher, consider installing rack sensors that allow water flow only when dishes are present, saving water by initiating cleaning cycle less frequently.

Replacement Options

When purchasing or leasing a new dishwasher or replacing an existing dishwasher, look for ENERGY STAR certified models by using ENERGY STAR's Product Finder at www.energystar.gov/productfinder/. ENERGY STAR certified dishwashers save water, conserve energy, and reduce overall operating costs.

Be sure to consider the typical kitchen throughput to select an appropriately sized dishwasher. A dishwasher that is larger than necessary will waste water if the machine is not loaded to capacity.

Savings Potential

ENERGY STAR certified commercial dishwashers use 50 percent less water than standard models, and ENERGY STAR certified residential dishwashers use 30 percent less water than standard models, on average. Use ENERGY STAR's Commercial Food Service (CFS) Equipment Calculator at www.energystar.gov/partner-resources/energy-star-training-center/commercial-food-service to estimate facility-specific water, energy, and cost savings for replacing an existing commercial dishwasher with an ENERGY STAR certified model. California Energy Wise has calculators at www.caenergywise.com/calculators/ that can be used to calculate the energy and cost savings potential from replacing many types of commercial kitchen equipment, including commercial door-type dishwashers.

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

Current Water Use

To estimate the water use of an undercounter; stationary door-type; pot, pan, and utensil; or conveyor-type commercial dishwasher, identify the following information and use Equation 1:

- Water use per rack washed. Look for this information on product specification sheets, the manufacturer's website, or other manufacturer literature.
- Average estimate of racks washed per day.
- Days of operation per year.

Equation 1. Water Use of Undercounter; Stationary Door-Type; Pot, Pan, Utensil; or Conveyor-Type Commercial Dishwasher (gallons or liters per year)

= Water Use per Rack x Racks Washed per Day x Days of Operation per Year

Where:

- Water Use per Rack: Gallons or liters per rack
 - Racks Washed per Day: Racks per day
 - Days of Operation: Days per year
-

To estimate the water use of a flight-type commercial dishwasher, identify the following information and use Equation 2 on the next page:

- Water use per hour. Look for this information on product specification sheets, the manufacturer's website, or other manufacturer literature.

- Hours of use per day.
 - Days of facility operation per year.
-

Equation 2. Water Use of Flight-Type Commercial Dishwasher (gallons or liters per year)

$$= \text{Water Use per Hour} \times \text{Hours of Operation per Day} \times \text{Days of Operation per Year}$$

Where:

- Water Use per Hour: Gallons or liters per hour
 - Hours of Operation per Day: Hours per day
 - Days of Operation per Year: Days per year
-

To estimate the water use of a residential dishwasher, identify the following information and use Equation 3.

- Water use per dishwashing cycle. Look for this information on product specification sheets, the manufacturer's website, or other manufacturer literature.
 - Number of dishwashing cycles per day.
 - Days of operation per year.
-

Equation 3. Water Use of Residential Dishwasher (gallons or liters per year)

$$= \text{Water Use per Dishwashing Cycle} \times \text{Number of Cycles per Day} \times \text{Days of Operation per Year}$$

Where:

- Water Use per Dishwashing Cycle: Gallons or liters per cycle
 - Number of Cycles per Day: Cycles per day
 - Days of Operation per Year: Days per year
-

Water Use After Replacement

To estimate the water use after replacing an existing dishwasher with an ENERGY STAR certified dishwasher, use Equation 1, Equation 2, or Equation 3 depending on the dishwasher type, substituting the water use per rack washed, per hour, or per cycle, as applicable, of the new machine. ENERGY STAR specifies maximum water consumption rates in gallons per rack for undercounter; stationary door-type; pot, pan, and utensil; and

conveyor-type machines. ENERGY STAR maximums are in gallons per hour for flight-type machines and in gallons per cycle for residential machines. This information is listed for most certified models on ENERGY STAR's Product Finder at www.energystar.gov/productfinder/. General ENERGY STAR water use maximums by equipment type can be found at www.energystar.gov/products/commercial_food_service_equipment/commercial_dishwashers/key_product_criteria and www.energystar.gov/products/dishwashers/key_product_criteria.

Water Savings

To calculate water savings that can be achieved from replacing an existing dishwasher, identify the following and use Equation 4:

- Current water use as calculated using Equation 1, Equation 2, or Equation 3.
- Water use after replacement as calculated using Equation 1, Equation 2, or Equation 3.

Equation 4. Water Savings From Dishwasher Replacement (gallons or liters per year)

$$\text{= Current Water Use of Dishwasher – Water Use of Dishwasher After Replacement}$$

Where:

- Current Water Use of Dishwasher: Gallons or liters per year
- Water Use of Dishwasher After Replacement: Gallons or liters per year

Energy Savings

Dishwashers exclusively use hot water; therefore, a reduction in water use will also result in energy savings. The energy required to heat water depends on the fuel used for water heating (e.g., electricity, natural gas), the efficiency of the water heater, and water heater temperature set points. High-temperature dishwashers require additional water heating, provided using a booster water heater, to reach higher water temperatures, and therefore consume more energy.

Since this information is not always readily available, energy savings that can be achieved from replacing existing dishwashers can be estimated using the water savings calculated in Equation 4 and the assumptions presented in Equation 5 on the next page.

Payback

To calculate the simple payback from the water use associated with replacing an existing dishwasher, consider the equipment and installation cost of the ENERGY STAR certified dishwasher, the water and energy savings as calculated in Equation 4 and Equation 5, respectively, and the facility-specific cost of water, wastewater, and energy.

ENERGY STAR certified dishwashers can also use less energy due to lower idle energy rates and inclusion of other energy-efficient features. This energy savings will further reduce the payback period and increase replacement cost-effectiveness.

Equation 5. Energy Savings From Dishwasher Replacement (kWh of electricity or Mcf of natural gas per year)

$$= \text{Water Savings} \times (\text{Energy per Gallon Heated} \div \text{Water Heater Efficiency})$$

Where:

- Water Savings: gallons (or liters) per year
 - Energy per Gallon or Liter Heated:
 - Assuming a 75°F (42°C) water temperature increase for a low-temperature dishwasher, 0.183 kilowatt hours (kWh) of electricity per gallon (0.048 kWh per liter); or
 - Assuming a 75°F (42°C) water temperature increase for a low-temperature dishwasher, 0.0006 thousand cubic feet (Mcf) of natural gas per gallon (0.00016 Mcf per liter); or
 - Assuming a 115°F (64°C) water temperature increase for a high-temperature dishwasher, 0.281 kWh of electricity per gallon (0.074 kWh per liter); or
 - Assuming a 115°F (64°C) water temperature increase for a high-temperature dishwasher, 0.0009 Mcf of natural gas per gallon (0.00025 Mcf per liter)
 - Water Heater Efficiency (unless otherwise known by the facility):
 - 1.00 for an electric hot water heater; or
 - 0.75 for a natural gas hot water heater
-

Additional Resources

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U.S. Department of Energy Federal Energy Management Program. Best Management Practice #11: Commercial Kitchen Equipment. www.energy.gov/femp/best-management-practice-11-commercial-kitchen-equipment.

U.S. Department of Energy. Dishwashers. www.energy.gov/energysaver/dishwashers

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