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An American National Standard

Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines[1]

This standard is issued under the fixed designation F1696; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the evaluation of the energy and water consumption of single-rack, door-type commercial dishwashers (hereafter referred to as dishwashers). Dishwashers may have a remote or self-contained booster heater. This test method does not address cleaning or sanitizing performance.

1.2 This test method is applicable to both hot water sanitizing and chemical sanitizing stationary rack machines, which includes undercounter single rack machines, upright door-type machines, pot, pan and utensil machines, fresh water rinse machines and fill-and-dump machines. Dishwasher tank heaters are evaluated separately from the booster heater. Machines designed to be interchangeable in the field from high temp and low temp (that is, Dual Sanitizing Machines) and vice versa, shall be tested at both settings. Machines should be set for factory settings. If a dishwasher includes a booster heater as an option, energy should be sub metered separately for the booster heater. When the test method specifies to use the data plate or manufacturer's recommendations, instructions, specifications, or requirements, the information source shall be used in the following order of preference and documented in the test report: data plate, user manual, communication with manufacturer.

1.3 The following procedures are included in this test method:

1.3.1 *Procedures to Confirm Dishwasher is Operating Properly Prior to Performance Testing:*

1.3.1.1 Maximum energy input rate of the tank heaters (see 10.3).

1.3.1.2 Maximum energy input rate of the booster heater, if applicable (see 10.4).

1.3.1.3 Water consumption calibration (see 10.5).

1.3.1.4 Booster temperature calibration, if applicable (see 10.2).

1.3.1.5 Tank temperature calibration (see 10.7.7.1 and 10.7.7.2).

1.3.2 *Energy Usage and Cycle Rate Performance Tests:*

1.3.2.1 Washing energy test (see 10.7).

1.3.2.2 Idle energy rate (door(s) open and door(s) closed) (see 10.8).

1.4 The values stated in inch-pound units are to be regarded as standard. The SI units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

F857 Specification for Hot Water and Chemical Sanitizing Commercial Dishwashing Machines, Stationary Rack Type

F861 Specification for Commercial Dishwashing Racks

F953 Specification for Commercial Dishwashing Machines (Stationary Rack, Dump Type) Chemical Sanitizing

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *NSF Standards:*[3]
NSF/ANSI 3 Commercial Warewashing Equipment
NSF/ANSI 170 Glossary of Foodservice Terms
2.3 *ASHRAE Document:*[4]
ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data

3. Terminology

3.1 *Definitions:*

3.1.1 *ambient temperature, n*—defined in NSF/ANSI 170-2014; Section 3.3.

3.1.2 *auxiliary rinse, n*—defined in NSF/ANSI 170-2014; Section 3.5.

3.1.3 *average tank temperature, n*—temperature of the wash tank measured within ½ in. of the factory installed thermostat bulb. The temperature is measured and averaged during the 10 rack (6 racks for pot and pan or for undercounter) loaded room temperature washing test. The time interval for averaging includes washing, rinsing, dwell, energy recovery (for heat recovery dishwashers), wash tank temperature recovery and loading. For upright machines, the temperature averaged over the entire period starting with the first loaded dish rack and ending with the elapsed interval period after the last rack is washed. For undercounter machines, the measurement period ends when both wash tank and booster elements have cycled off after the last load is washed. Stabilization loads should not be included in the average wash tank temperature.

3.1.4 *booster heater, n*—water heater for taking supply hot water (typically 140°F (60°C) up to 180°F (82°C)) for sanitizing rinse; the booster heater may be separate from dishwasher or integral. Booster heater is defined in NSF/ANSI 170-2014; Section 3.224.1.

3.1.5 *chemical dump type machine, n*—a low temp, stationary rack machine with a pumped recirculated sanitizing rinse.

3.1.6 *chemical sanitizing (low temp) machine, n*—a machine that applies a chemical sanitizing solution to the surfaces of dishes to achieve sanitization.

3.1.7 *chemical sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.170.

3.1.8 *cycle rate, n*—the number of loaded dishracks washed per hour during the Washing Energy Performance test.

3.1.9 *dishwasher, n*—a machine that uniformly washes, rinses, and sanitizes eating and drinking utensils and cookware.

3.1.10 *dual sanitizing machine, n*—a machine designed to operate as either a high temp or low temp machine.

3.1.11 *dwell mode, n*—for stationary rack machines, the dishwasher is in dwell mode when it is actively running a cycle but is not in wash or rinse modes.

3.1.12 *energy saver mode, n*—operational setting that is designed to reduce energy during idle mode through temporary shut-down of certain machine components (pumps or belt motors) or reduction of certain temperature set points.

3.1.13 *factory settings, n*—a setting that has been programmed or adjusted at the factory and is representative of the way that model is set up initially. These settings are the default settings for the machine and may or may not be user adjustable.

3.1.14 *flow pressure, n*—defined in NSF/ANSI 170-2014; Section 3.76.

3.1.15 *fresh water, n*—defined in NSF/ANSI 170-2014; Section 3.85.

3.1.16 *glasswashing, n*—a stationary rack, under counter machine specifically designed to clean and sanitize glasses.

3.1.17 *heat recovery dishwasher, n*—warewashing equipment with heat recovery systems; a heat exchanger that recovers energy from other sources for the purpose of heating potable water. This includes but is not limited to drain water heat exchangers, wash compartment heat exchangers, exhaust heat exchangers, and supplemental heat pumps.

3.1.18 *hot water sanitizing (high temp) machine, n*—a machine that applies hot water to the surfaces of dishes to achieve sanitization.

3.1.19 *hot water sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.171.

3.1.20 *idle mode, n*—for all dishwasher types, the dishwasher is in idle mode when it is not actively running but is still powered on and ready to wash dishes while maintaining the tank or tanks at the required temperature.

3.1.21 *idle rate, n*—rate of energy consumed by the dishwasher while "holding" or maintaining the heated tank water at the thermostat(s) set point during the time period specified.

3.1.22 *line pressure, n*—defined in NSF/ANSI 170-2014; Section 3.115.

3.1.23 *loads:*

3.1.23.1 *dishload, n*—a peg type, polypropylene dishrack of a specified weight, loaded with ten 9-in. plates of a specified weight, used to put a thermal load on the dishwasher during the washing energy performance test.

3.1.23.2 *glassload, n*—6 glasses by 6 glasses, polypropylene glass rack of a specified weight, loaded with eighteen 8-fl oz (237 ml) glasses, used to put a thermal load on the dishwasher during the washing energy performance test.

3.1.24 *non-recirculating pumped sanitizing rinse, n*—defined in NSF/ANSI 170-2014; Section 3.131.

3.1.25 *post-sanitizing rinse, n*—defined in NSF/ANSI 170-2014; Section 3.174.

3.1.26 *pot, pan, and utensil, n*—a stationary rack, door type machine designed to clean and sanitize pots, pans, and kitchen utensils.

3.1.27 *prewashing unit, n*—defined in NSF/ANSI 170-2014; Section 3.150.

3.1.28 *pumped rinse, n*—defined in NSF/ANSI 170-2014; Section 3.154.

3.1.29 *rack, n*—defined in NSF/ANSI 170-2014; Section 3.157.

[3] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

3.1.30 *rated temperature, n*—dishwasher's rated data plate minimum operating tank temperature as determined by NSF/ANSI 3.

3.1.31 *recirculating final sanitizing rinse, n*—defined in NSF/ANSI 170- 2014; Section 3.162.

3.1.32 *rinse mode, n*—for stationary rack machines, the dishwasher is in rinse mode when it is at the end of the actively running cycle and is spraying hot water or chemical sanitizing rinse water or a post-sanitizing rinse. If there is a post-sanitizing rinse, it shall be included in rinse mode.

3.1.33 *sanitization, n*—defined in NSF/ANSI 170-2014; Section 3.178.

3.1.34 *sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.173.

3.1.35 *sanitizing solution, n*—defined in NSF/ANSI 170-2014; Section 3.179.

3.1.36 *stationary rack machine, n*—a dishwashing machine in which a rack of dishes remains stationary within the machine while subjected to sequential wash and rinse sprays. This definition also applies to machines in which the rack revolves on an axis during the wash and rinse cycles.

3.1.37 *tank heater idle energy rate, n*—rate of energy consumed by the dishwasher while "holding" or maintaining the heated tank water at the thermostat(s) set point during the time period specified.

3.1.38 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

3.1.39 *undercounter dishwasher, n*—Specification F953 Type III machines, a stationary rack machine with an overall height of 38 inches or less, designed to be installed under food preparation workspaces. Under counter dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

3.1.40 *upright door-type dishwasher, n*—Specification F857 Type I (straight through model) and Type II (corner model) and F953 Type I (straight through model) and Type II (corner model) machines, stationary rack machine designed to accept a standard 20 by 20 in. (51 by 51 cm) dish rack, which requires the raising of a door to place the rack into the wash/rinse chamber. Closing of the door typically initiates the wash cycle. Subcategories of single tank, stationary door type machines include: single rack, double rack, pot, pan and utensil washers, chemical dump type and hooded wash compartment ("hood type"). Single tank, door type models can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

3.1.41 *user adjustable, n*—a setting that can be changed by an end user without having access to features reserved for appliance technicians. A password usually separates user adjustable and technician adjustable features in digital appliance controls. Nonuser adjustable manual controls require a panel to be removed to access that feature.

3.1.42 *washing, n*—defined in NSF/ANSI 170-2014; Section 3.222.

3.1.43 *wash mode, n*—for stationary rack machines, the dishwasher is in wash mode when it is actively running a cycle and is spraying wash water (that is, water that is neither part of the sanitizing rinse, nor post sanitizing rinse).

3.1.44 *water heater, n*—defined in NSF International/American National Standards Institute (NSF/ANSI) 170-2014: Glossary of Food Equipment Terminology; Section 3.224.

4. Summary of Test Method

4.1 The booster temperature (for high temperature machines) and wash tank temperature are calibrated and verified.

4.2 The maximum energy input rate of the tank heater and the booster heater is determined to check whether the dishwasher is operating at the manufacturer's rated input. If the measured input rate is not within 5 % of the rated input or the rating printed on the heating element, all further testing ceases.

NOTE 1—It is the intent of the testing procedure herein to evaluate the performance of a dishwasher at its rated gas pressure or electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 208 or 240 volts (V) with no change in components), the voltage selected by the manufacturer or tester, or both, shall be reported. If a dishwasher is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, recovery time) may differ at the two voltages. Therefore the tests may be performed at both voltages and results reported accordingly.

4.3 The water consumption is adjusted to the manufacturer's rated water consumption per NSF/ANSI Standard 3. Report the measured consumption and confirm that it is within 5 % of the NSF rating. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the dishwasher or provide another unit for testing.

4.4 The dishwasher energy rate is determined at idle, that is, when the tank temperature(s) is being maintained, but no washing is taking place. This test is run with the door(s) closed (see 10.8).

4.5 The booster heater idle energy rate is determined (see 10.9).

4.6 The dishwasher and booster energy consumption per rack of dishes or glasses is determined by washing racks loaded with a specified quantity of dishes or glasses (see 10.7).

4.7 Water consumption is monitored during testing to determine the rate of water usage.

5. Significance and Use

5.1 The maximum energy input rate test is used to confirm that the dishwasher is operating at the manufacturer's rated input prior to further testing. This test would also indicate any problems with the electric power supply, gas service pressure, or steam supply flow or pressure.

5.2 The tank and booster temperature are verified and water consumption is adjusted to NSF specifications to ensure that the test is applied to a properly functioning dishwasher.

5.3 Because much of a dishwasher's operating period is spent in the idle condition, tank heater and booster idle energy consumption rate is an important part of predicting an end user's energy consumption. The test is run with the door(s)