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An American National Standard

Standard Test Method for Performance of Rack Conveyor, Commercial Dishwashing Machines[1]

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1. Scope

1.1 This test method evaluates the energy and water consumption of rack conveyor, commercial dishwashing machines, hereafter referred to as dishwashers. Dishwashers may have remote or self-contained booster heater. This procedure does not address cleaning or sanitizing performance.

1.2 This test method is applicable to both hot water sanitizing and chemical sanitizing rack conveyor machines, which include both single tank and multiple tank machines. Dishwasher tank heaters are evaluated separately from the booster heater.

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 (10.2).

1.3.1.2 Maximum energy input rate of the booster heater, if applicable (10.3).

1.3.1.3 Final sanitizing rinse water consumption calibration (10.4).

1.3.1.4 Booster temperature calibration, if applicable (10.5).

1.3.1.5 Wash tank temperature calibration (10.6).

1.3.1.6 Wash tank pump and conveyor motor calibration (10.7).

1.3.2 *Energy Usage and Cycle Rate Performance Tests*:

1.3.2.1 Washing energy performance test (10.8).

1.3.2.2 Tank heater idle energy rate (10.9).

1.3.2.3 Booster idle energy rate, if provided (10.10).

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

F858 Specification for Hot Water Sanitizing Commercial Dishwashing Machines, Single Tank, Conveyor Rack Type

F861 Specification for Commercial Dishwashing Racks

2.2 *NSF Standards:*

NSF/ANSI 3 Commercial Warewashing Equipment[3]

NSF/ANSI 170 Glossary of Foodservice Terms[3]

2.3 *ASHRAE Standard:*

ASHRAE Guideline 2–1986 (RA90) Engineering Analysis of Experimental Data[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *booster heater*, *n*—water heater for taking supply hot water (typically 140°F) up to 180°F+ for sanitizing rinse; the booster heater may be separate from dishwasher or integral.

3.1.2 *batch*, *n*—a group of five dishloads as described in 3.1.4.

3.1.2.1 *Discussion*—The dishracks are grouped into batches to better simulate typical in-kitchen operation and facilitate consistent application of the washing energy use test.

3.1.3 *cycle rate*, *n*—maximum production rate of a dishwasher when washing dishloads in accordance with the Cycle Rate Performance test.

3.1.4 *dishload*, *n*—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 test.

[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.

[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.

3.1.5 *dishwasher*, *n—for this test method*, a machine that uniformly washes, rinses, and sanitizes eating and drinking utensils.

3.1.5.1 *Discussion*—The machine shall be capable of removing physical soil from properly racked and prescraped items, and sanitizing multiple-use eating and drinking utensils.

3.1.6 *empty dish rack*, *n*—dish rack without any dishware placed in the dish rack.

3.1.6.1 *Discussion*—Two empty dish racks are run through the dishwasher prior to washing the first dishload to condition the dishwasher for testing as specified in the Washing Energy Test (see 10.8).

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

3.1.8 *recovery time*, *n*—time from the end of washing a dishload to until the wash tank heaters have cycled off.

3.1.8.1 *Discussion*—All tank heaters must cycle off at least once for a multiple tank machine.

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

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

4. Summary of Test Method

4.1 The maximum energy input rate of the tank heater and the booster heater, if applicable, is measured to confirm that the dishwasher is operating at the manufacturer's rated input. If the measured input rate is not within 5 % of the rated input, all further testing ceases, and the manufacturer shall be contacted. The manufacturer may make appropriate changes or adjustments to the dishwasher.

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 electrical unit is rated dual voltage, that is, designed to operate at either 208 or 240 V with no change in component, the voltage selected by the manufacturer or the 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, cycle rate, may differ at the two voltages. Therefore the tests must be performed at both voltages and the results reported accordingly.

4.2 Wash tank and booster temperatures are retained at the manufacturer's factory settings.

4.3 Water consumption is adjusted in accordance with manufacturer's rated water consumption per NSF/ANSI 3. The pressure regulator valve is adjusted to 20 ± 1 psi and the water consumption measured. If this is not within ±0.15 GPM of the NSF rating or the manufacturer's rating if not listed to NSF standards, then the manufacturer shall be contacted.

4.4 The tank heater energy rate is determine at idle, that is, when the tank temperature is being maintained, but no washing is taking place.

4.5 Booster heater idle energy rate is determined.

4.6 Dishwasher and booster energy consumption per rack of dishes is determined during a heavy-use scenario by washing a total of 25 loaded dishracks.

4.7 Water consumption (gal/h (L/h)) 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 method also will indicate any problems with the electric power supply, gas service pressure, or steam supply flow or pressure.

5.2 Tank and booster temperatures, as well as water consumption, are adjusted to NSF specifications to insure 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(s) are important parts of predicting dishwasher's energy consumption.

5.4 The washing energy test determines energy usage per rack. This is useful both as a measure for comparing the energy performance of one dishwasher to another and as a predictor of the dishwashers energy consumption.

5.5 Water-consumption characterization is useful for estimating water and sewage costs associated with dishwashing machine operation.

6. Apparatus

6.1 *1 or 2 Wh Meters*, for measuring the electrical energy consumption of the tank heaters, pump motor, and booster heater, if applicable, shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 10 %.

6.2 *1 or 2 Gas Meters*, for measuring the gas consumption of tank heater, or booster heater, if applicable, or both, shall have a resolution of at least 0.01 ft^3 (0.0003 m^3), and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3/h (0.06 m^3/h). If the meter is used for measuring the gas consumed by pilot lights, it shall have a resolution of a least 0.01 ft^3 (0.0003 m^3) and have a maximum uncertainty of at least 0.01 ft^3 (0.0003 m^3) and have a maximum uncertainty no greater than 2 % of the measured value.

6.3 *1 or 2 Steam Flow Meters*, for measuring the flow of steam to tank heaters and or booster heater, if applicable, shall have a resolution of 0.01 ft^3 (0.0003 m^3), and a maximum uncertainty of 1 % of the measured value.

6.4 *Pressure Gage*, for measuring pressure of steam to steam coils and steam injector, shall have a resolution of 0.5 psig (3.4 kPa), and a maximum uncertainty of 1 % of the measured value.

6.5 *Canopy Exhaust Hood or Vent Cowl Exhaust Ducts*, measured in agreement with manufacturers requirements. Vent cowl exhaust ducts shall operate at a nominal 200 cfm (94.4 L/s) on entrance side of dishwasher and 400 cfm (188.8 L/s) on exit side or in accordance with manufacturer's recommendation, if applicable. Canopy exhaust hood shall use a 3-ft by 6-ft configuration operating at the dishwashing machine manufacturer's specified ventilation rate. Report the ventilation rate and ventilation exhaust type.

6.6 *Pressure Gage*, for monitoring natural gas pressure, shall have a range of 0 to 10 in. H_2O (zero to 2.5 kPa), a resolution of 0.1 in. H_2O (125 Pa), and a maximum uncertainty of 1 % of the measured value.

6.7 *Temperature Sensor*, for measuring natural gas temperature in the range of 50 to 100°F (10 to 40°C), with a resolution of 0.5°F (0.3°C) and an uncertainty of ±1 °F (0.5°C).

6.8 *Barometer*, for measuring absolute atmospheric pressure, to be used for adjustment of measured natural gas volume to standard conditions, shall have a resolution of 0.2 in. Hg (670 Pa), and an uncertainty of 0.2 in. Hg (670 Pa).

6.9 *Flow Meter*, for measuring water consumption of the dishwasher. Shall have a resolution of 0.01 gal (40 mL), and an uncertainty of 0.01 gal (40 mL), at flow rate as low as 0.2 gpm (13 mL/s).

6.10 *Stop Watch*, with a 0.1-s resolution.

6.11 *Analytical Balance Scale*, or equivalent, for measuring weight of dishes and dish racks used in the dishload energy test. It shall have a resolution of 0.01 lb (5 g) and an uncertainty of 0.01 lb (5 g).

6.12 *Calibrated Exposed Junction Thermocouple Probes*, with a range from -20 to 400°F (-30 to 200°C), with a resolution of 0.2°F (0.1°C) and an uncertainty of 1.0°F (0.5°C), for measuring tank temperature, booster and dishwater inlet temperatures. Calibrated K-type 24-GA thermocouple wire with stainless steel sheath and ceramic insulation is the recommended choice for measuring the booster and dishwater inlet temperatures. The thermocouple probe can be fed through a compression fitting so as to submerge exposed junction in booster and dishwasher inlets.

6.13 *Dishracks*, minimum of 12, Metro Mdl P2MO, 20-in. × 20-in., peg-type, commercial or acceptable equivalent. Each shall weigh 4.6 ± 0.1 lb, and be used in the Washing Energy Test (see 10.8).

6.14 *Plates*, minimum of 250, 9-in., ceramic glazed plates, weighing an average of 1.3 ± 0.05 lb each.

NOTE 2—Inter-American® mdl #132 are within the specified weight range and are inexpensive.

6.15 *Surface Temperature Thermocouple Probe*, for measuring dish plates and dishracks temperatures. Resolution and uncertainty shall be the same as in 6.12.

7. Sampling

7.1 *Dishwasher*—A representative production model shall be selected for performance testing.

8. Materials

8.1 As specified in 6.13, the dishracks must be made of polypropylene. This material is required because the test method assumes a specific heat of 0.39 Btu/lb × °F. One verification that a rack is polypropylene is if it has the recycling symbol No. 5 on it (and the letters "PP" below it).

9. Preparation of Apparatus

9.1 Install the dishwasher in accordance with the dishwasher manufacturer's instructions under a 3-ft by 6-ft canopy exhaust hood or connect to vent cowl exhaust ducts. Vent cowl exhaust ducts should operate at a nominal 200 cfm (94.4 L/s) on the entrance side of dishwasher and 400 cfm (188.8 L/s) on the discharge side or in accordance with manufacturer's recommendations, if applicable. Record the ventilation rate used for the testing. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F within the testing environment when the exhaust ventilation system is working and the appliance is being operated.

9.2 Install the booster heater, if it is not integral to the dishwasher, in accordance with the manufacturer's recommendations. The pipe from the booster outlet to the dishwasher inlet shall be minimized and shall be wrapped with ½-in. insulation along its entire length.

9.3 Connect the booster to a supply of water, which is within ±2°F of its input temperatures, not to exceed 140 ± 2°F.

9.4 Connect the dishwasher (including tank heater, motors and controls) and booster to calibrated energy test meters. The dishwasher and booster shall not be monitored as one energy load. Separate monitoring will broaden the usefulness of the data and enhance the accuracy of the results.

9.5 For gas installations, install a pressure regulator (downstream from the meter) to maintain a constant (manifold) pressure of gas supplied to the dishwasher and booster heater, if applicable, for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the dishwasher and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions.

9.6 For electric tank heaters and boosters, confirm, while the elements are energized, that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. If it is not, a voltage regulator may be required during the tests. Record the test voltage for each test.

9.7 For gas tank heaters and boosters, during maximum energy input, adjust the gas supply pressure downstream from the appliance's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the dishwasher following the manufacturer's recommendations for optimizing combustion, as applicable.

9.8 Install the flow meter (6.9), such that total water flow to the booster and dishwasher is measured.

9.9 Install a temperature sensor(s) (6.12) in the wash tank near the thermostat bulb.

9.10 Install a temperature sensor (6.12) at the inlet to the dishwasher's final rinse water manifold and in the inlet to the booster heater. The sensors should be installed with the probe immersed in the water.

NOTE 3—Install the thermocouple probes described in 6.12 into final rinse water manifold for the dishwasher and into the supply water inlet at the booster. The thermocouple probe must be installed so that the thermocouple probe is immersed in the incoming water. A compression fitting should be first installed into the plumbing for both inlets. A junction fitting may need to be installed in the plumbing line that would be compatible with the compression fitting.

9.11 Install dishwashing machine's strip (end) curtains in accordance to manufacturer's recommendations.

9.12 *Preparation of Dishloads*: