



Designation: F3216 – 16 (Reapproved 2021)

Standard Test Method for Performance of Retherm Ovens¹

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1. Scope

1.1 This test method evaluates the energy consumption and cooking performance of retherm ovens. The food service operator can use this evaluation to select a retherm oven and understand its energy consumption.

1.2 This test method is applicable to gas and electric retherm ovens.

1.3 The retherm oven can be evaluated with respect to the following (where applicable):

- 1.3.1 Energy input rate (10.2),
- 1.3.2 Preheat energy consumption and time (10.3),
- 1.3.3 Idle energy rate (10.4),
- 1.3.4 Pilot energy rate (if applicable) (10.5), and
- 1.3.5 Cooking Energy Rate, Production Capacity, Cooking Energy Efficiency (10.7).

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

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 the Annual Book of ASTM standards volume information, refer the standard's Document Summary page on the ASTM website.

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

2.2 ASHRAE Documents:³

ASHRAE Handbook of Refrigeration “Thermal Properties of Food,” Chapter 19, Table 3, 2014.

3. Terminology

3.1 Definitions:

3.1.1 *cooking energy efficiency, n*—the ratio of the quantity of energy absorbed by the food product to the quantity of energy input to the oven during a cooking energy efficiency test expressed as a percent.

3.1.2 *cooking energy rate, n*—the average rate of energy consumption (Btu/h or kW) during the cooking energy efficiency tests.

3.1.3 *energy input rate, n*—the peak rate at which a retherm oven consumes energy (Btu/h or kW).

3.1.4 *idle energy rate* (ready-to-cook condition), *n*—the retherm oven's rate of energy consumption (Btu/h or kW), when empty, required to maintain its cavity temperature at the specified thermostat set point or to otherwise maintain the oven in a ready-to-cook condition.

3.1.5 *oven cavity, n*—the portion of the retherm oven in which food products are heated.

3.1.6 *pilot energy rate, n*—the rate of energy consumed (Btu/h) by a retherm oven's continuous pilot (if applicable).

3.1.7 *preheat energy, n*—the amount of energy consumed (Btu or kWh), by the retherm oven while preheating its cavity from ambient temperature to the specified thermostat set point or while preheating any other component of the oven, for example an integral heat exchanger, to a ready-to-cook condition.

3.1.8 *preheat time, n*—the time (min) required for the retherm oven cavity to preheat from ambient temperature to the specified thermostat set point or for the retherm oven to achieve a ready-to-cook condition.

³ Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

3.1.9 *production capacity, n*—the maximum rate (lb/h or kg/h) at which a retherm oven can bring the specified food product to a specified “cooked” condition.

3.1.10 *retherm oven, n*—an appliance with a closed, heated cavity, designed specifically for low-temperature reheating.

3.1.11 *uncertainty, n*—the 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 *Thermostat Calibration*—Accuracy of the retherm oven thermostat is checked at a setting of 250°F (121°C). This is accomplished by comparing the oven’s temperature control setting with the temperature at the center of the oven’s cavity. If necessary, the control is adjusted so that the maximum difference between its reading and the temperature at the center of the cavity is no more than $\pm 5^\circ\text{F}$ (3°C).

4.2 *Energy Input Rate*—The input rate of the oven is determined to check whether the retherm oven is operating within 5 % of its nameplate energy input rate. For gas combination ovens, the pilot energy rate and the fan and control energy rates are also determined.

4.3 *Preheat Energy Consumption and Time*—The time and energy required to preheat the oven from room temperature ($75 \pm 5^\circ\text{F}$ or $24 \pm 3^\circ\text{C}$) to a ready-to-cook condition (for example, $250 \pm 5^\circ\text{F}$ or $121 \pm 3^\circ\text{C}$).

4.4 *Idle Energy Rate*—Idle energy rate is determined with the retherm oven set to maintain a ready-to-cook condition (for example, $250 \pm 5^\circ\text{F}$ or $121 \pm 3^\circ\text{C}$).

4.5 *Cooking Energy Efficiency and Production Capacity*—The cooking energy efficiency and production rate are determined during heavy-load cooking tests.

5. Significance and Use

5.1 *Energy Input Rate*—Energy input rate is used to confirm that the retherm oven is operating properly prior to further testing.

5.2 *Preheat Energy Consumption and Time*—Preheat energy and time can be useful to food service operators to manage power demands and to know how quickly the retherm oven can be ready for operation.

5.3 *Idle Energy Rate*—Idle energy rate and pilot energy rate can be used to estimate energy consumption during non-cooking periods.

5.4 *Production Capacity*—Production capacity information can help an end user to better understand the production capabilities of a retherm oven as it is used to cook a typical food product and this could help in specifying the proper size and quantity of equipment. If production information is desired using a food product other than the specified test food, the test method could be adapted and applied.

5.5 *Cooking Energy Efficiency*—This test provides a measure of the oven’s energy efficiency while heavy loads are being cooked.

6. Apparatus

6.1 *Analytical Balance Scale*, for measuring weights up to 20 lb (9.1 kg), with a resolution of 0.01 lb (4 g) and an uncertainty of 0.01 lb (4 g).

6.2 *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 and an uncertainty of 0.2 in. Hg.

6.3 *Flow Meter*, for measuring total water consumption of the appliance (if applicable). The meter shall have a resolution of 0.01 gal (0.03 L), and an uncertainty of 0.01 gal (0.03 L), at flow rate as low as 0.2 gpm (0.76 L/min).

6.4 *Gas Meter*, for measuring the gas consumption of a retherm oven, shall be a positive displacement type with a resolution of at least 0.01 ft³ and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft³/h. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.01 ft³ and a maximum uncertainty no greater than 2 % of the measured value.

6.5 *Pressure Gauge*, for monitoring natural gas pressure. Shall have a range of zero to 10 in. H₂O, a resolution of 0.5 in. H₂O, and a maximum uncertainty of 1 % of the measured value.

6.6 *Stop Watch*, with a 1-s resolution.

6.7 *Temperature Sensor*, for measuring natural gas temperature in the range from 50 to 100°F (10 to 38°C), with an uncertainty of $\pm 1^\circ\text{F}$ (0.6°C).

6.8 *Thermocouple Probes*, Type K stainless steel-sheathed exposed junction with a range from -20 to 400°F (-29 to 204°C), with a resolution of 0.2°F (0.1°C), and an uncertainty of 0.5°F (0.3°C), for measuring oven cavity and food product temperatures.

NOTE 1—To facilitate monitoring food temperatures, it is recommended that only stainless-steel sheathed thermocouple probes be used.

6.9 *Watt-Hour Meter*, for measuring the electrical energy consumption of a retherm oven, shall have a resolution of 10 Wh or better 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 %.

7. Reagents and Materials

7.1 *Mashed Potato Packages*, for the cooking energy efficiency test, mashed potatoes shall be lightly seasoned, pre-cooked, unfrozen ($37 \pm 3^\circ\text{F}$ or $3 \pm 1^\circ\text{C}$), in sealed packages, and 4 ± 0.1 lb (1.8 ± 0.05 kg) per package. The mashed potatoes shall be stabilized in a refrigerator at $37 \pm 3^\circ\text{F}$ ($2.8 \pm 1.7^\circ\text{C}$).

7.2 *Steam Pans*, for cooking energy efficiency test, pans shall be perforated 12 by 20 by $2\frac{1}{2}$ in. (305 by 508 by 64 mm) stainless steel weighing 2.5 ± 0.5 lb (1.1 ± 0.2 kg).

7.3 *Baskets*, for cooking energy efficiency test, baskets shall be open-wired $13\frac{3}{8}$ by $25\frac{7}{8}$ by $2\frac{5}{8}$ in. (340 by 657 by 67 mm) stainless steel weighing 3.4 ± 0.3 lb (1.5 ± 0.1 kg).