



## Standard Test Method for Performance of Rack Ovens<sup>1</sup>

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### 1. Scope

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

1.2 This test method is applicable to thermostatically controlled, gas and electric rack ovens.

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

- 1.3.1 Energy input rate (10.2),
- 1.3.2 Thermostat calibration (10.3),
- 1.3.3 Preheat energy and time (10.4),
- 1.3.4 Idle energy rate (10.5),
- 1.3.5 Pilot energy rate, if applicable (10.6),
- 1.3.6 White sheet cake browning (10.7), and
- 1.3.7 Steam performance (10.8), and
- 1.3.8 Baking energy efficiency and production capacity (10.9).

1.4 The values stated in inch-pound units are to be regarded as standard.

1.5 *This test method may involve hazardous materials, operations, and equipment. 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.*

<sup>1</sup> 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. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels  
F1496 Test Method for Performance of Convection Ovens

#### 2.2 ANSI Document:<sup>3</sup>

ANSI Z83.11 American National Standard for Gas Food Service Equipment

#### 2.3 ASHRAE Documents:<sup>4</sup>

ASHRAE Fundamentals 1997  
ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bake time, n*—time required to bake the frozen pies specified in 7.3.

3.1.2 *baking cavity, n*—that portion of the appliance in which food products are heated or cooked.

3.1.3 *baking energy, n*—energy consumed by the rack oven as it is used to bake frozen pies under full-load conditions.

3.1.4 *baking energy efficiency, n*—quantity of energy imparted to the pies, expressed as a percentage of energy consumed by the rack oven during the baking event.

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

3.1.6 *duty cycle, n*—defined as percent (%) of burner time on divided by a complete on/off cycle during idle energy mode at 400°F.

3.1.7 *idle energy rate, n*—the rate of energy consumed (Btu/h or kW) by the rack oven while “holding” or “idling” the baking cavity at the thermostat set point.

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

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

3.1.8 *measured energy input rate, n*—peak rate at which a rack oven consumes energy (Btu/h or kW), typically reflected during preheat.

3.1.9 *mini-rack oven, n*—an appliance that bakes by forcing air within a closed cavity, either fitted with a mechanism for rotating an internal rack which accommodates 8 pans at 4 in. spacing or a fixed 8 pans at 4 in. spacing within the cavity.

3.1.10 *nameplate energy input rate, n*—the maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

3.1.11 *pilot energy rate, n*—average rate of energy consumption (Btu/h) by a rack oven's continuous pilot (if applicable).

3.1.12 *preheat energy, n*—amount of energy consumed by the rack oven while preheating the baking cavity from ambient room temperature ( $75 \pm 5^\circ\text{F}$ ) to the thermostat set point.

3.1.13 *preheat rate, n*—average rate ( $^\circ\text{F}/\text{min}$ ) at which the rack oven's baking cavity is heated from ambient temperature ( $75 \pm 5^\circ\text{F}$ ) to the thermostat set point: defined as the set temperature minus ambient temperature divided by the preheat time.

3.1.14 *preheat time, n*—time required for the rack oven to preheat from ambient room temperature ( $75 \pm 5^\circ\text{F}$ ) to the thermostat set point.

3.1.15 *production capacity, n*—maximum rate (lb/h) at which the rack oven can bake frozen pies as specified in 7.3.

3.1.16 *rack, n*—a device which is used to hold pans within a rack oven.

3.1.17 *rack oven, n*—an appliance that bakes by forcing hot air over the food within a closed cavity, either fitted with a mechanism for rotating one or more racks, or one or more non-rotating racks within the cavity.

3.1.18 *steam injection cycle, n*—a period whereby steam is introduced into the baking cavity during baking.

3.1.19 *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 rack oven is connected to the appropriate metered energy source, and energy input rate is determined to confirm that the appliance is operating within 5 % of the nameplate energy input rate.

4.2 The accuracy of the oven's thermostat is checked at 400°F and adjusted as necessary.

4.3 The amount of energy and time required to preheat the rack oven to 400°F is determined.

4.4 The idle energy rate is determined with the rack oven set to maintain 400°F in the baking cavity.

4.5 Pilot energy rate is determined, when applicable, for gas rack ovens.

4.6 The rack oven is used to bake a full-load of white sheet cakes (8 cakes in a mini-rack, 15 cakes in a single-rack oven,

and 30 cakes in a double-rack oven, for example) to assess the browning uniformity of the oven.

4.7 The rack oven's steam performance is characterized by assessing the amount of steam produced on repeated bake cycles.

4.8 The rack oven is used to bake a full-load of frozen pies. Baking energy efficiency, baking energy rate, and production rate are determined from these tests.

## 5. Significance and Use

5.1 The energy input rate and thermostat calibration tests are used to confirm that the rack oven is operating properly prior to further testing.

5.2 Preheat energy and time can be useful to food service operators to manage energy demands and to know how quickly the rack oven can be ready for operation.

5.3 Idle energy rate and pilot energy rate can be used by the food service operator to estimate energy consumption during non-baking periods.

5.4 The oven's browning and baking uniformity can be used by an operator to select an oven that bakes a variety of products evenly.

5.5 Steam performance can be useful for a food service operator interested in the oven's ability to consistently create steam during a baking cycle.

5.6 Baking energy efficiency is a precise indicator of rack oven energy performance under various loading conditions. This information enables the food service operator to consider energy performance when selecting a rack oven.

5.7 Production capacity is used by food service operators to choose a rack oven that matches their food output requirements.

## 6. Apparatus

6.1 *Analytical Balance Scale*, for measuring weights up to 25 lb, with a resolution of 0.01 lb and an uncertainty of 0.01 lb.

6.2 *Barometer*, for measuring absolute atmospheric pressure, to be used for adjustment of measured gas volume to standard conditions. Shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

6.3 *Data Acquisition System*, for measuring energy and temperatures, capable of multiple channel displays updating at least every 2 s.

6.4 *Freezer*, sized large enough to hold a full-load of frozen pies (24 pies for a mini-rack oven, 45 pies for a single rack oven, and 90 pies for a double rack oven) and capable of maintaining the frozen product at  $0 \pm 5^\circ\text{F}$ .

6.5 *Flow Meter*, for measuring total water consumption of the oven, having a resolution of 0.01 gal and an uncertainty of 0.01 gal for flows of 0.2 gpm and higher.

6.6 *Gas Meter*, for measuring the gas consumption of a rack oven, shall be a positive displacement type with a resolution of at least 0.1 ft<sup>3</sup> and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft<sup>3</sup>/h. If