



Standard Test Method for Performance of Convection Ovens¹

This standard is issued under the fixed designation F1496; 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 energy consumption and cooking performance evaluation of convection ovens. The test method is also applicable to convection ovens with limited moisture injection. The results of applying it can be used by the food service operator to select a convection oven and to understand its energy consumption and performance.

1.2 This test method applies to general purpose, full-size, and half-size convection ovens and bakery ovens used primarily for baking food products. It is not applicable to ovens used primarily for slow cooking and holding food product, to large roll-in rack-type ovens, or to ovens that can operate in a steam-only mode (combination ovens).

1.3 This test method is intended to be applied to convection ovens that operate close to their rated input in the dry heating mode, with the circulating fan operating at its maximum speed.

NOTE 1—Ovens that can operate in steam-only mode should be evaluated using Test Method F2861.

1.4 The oven's energy consumption and cooking performance are evaluated in this test method specifically with respect to the following:

- 1.4.1 Thermostat calibration (10.2),
- 1.4.2 Energy input rate and preheat energy consumption and time (10.3),
- 1.4.3 Pilot energy rate (if applicable) (10.4),
- 1.4.4 Idle energy rate (10.5),
- 1.4.5 Cooking energy efficiency and production capacity (10.6),
- 1.4.6 Cooking uniformity (10.7),
- 1.4.7 White sheet cake browning (10.8), and
- 1.4.8 Bakery steam mode, if applicable (10.9).

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

1.6 *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.

1.7 *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
- F2092 Specification for Convection Oven Gas or Electric
- F2093 Test Method for Performance of Rack Ovens
- F2861 Test Method for Enhanced Performance of Combination Oven in Various Modes

2.2 ASHRAE Documents:³

- 1989 ASHRAE Handbook of Fundamentals, Chapter 6, Table 2—Thermodynamic Properties of Water at Saturation
- ASHRAE Guideline 2-1986 (RA90) “Engineering Analysis of Experimental Data”

3. Terminology

3.1 Definitions:

3.1.1 *average preheat rate*—rate ($^{\circ}\text{F}/\text{min}$) at which cavity temperature is heated from ambient temperature to the oven's thermostat set point.

3.1.2 *bakery steam mode*—a single injection of water/steam into the baking cavity at the start of a bake cycle. Injection time not to exceed 60 seconds per baking event.

3.1.3 *convection oven*—an appliance for cooking food by forcing hot air over the surface of the food using a fan in a closed cavity.

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.

Current edition approved May 1, 2019. Published June 2019. Originally approved in 1993. Last previous edition approved in 2013 as F1496 – 13. DOI: 10.1520/F1496-13R19.

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

3.1.4 *cook time*—time required to cook potatoes during a cooking energy efficiency test.

3.1.5 *cooking energy*—energy consumed (kBtu or kWh) by the oven as it cooks potatoes during the cooking energy efficiency tests.

3.1.6 *cooking energy efficiency*—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.

3.1.7 *cooking energy rate*—average rate of the oven’s energy consumption (kBtu/h or kW) during a cooking energy efficiency test.

3.1.8 *fan and control energy rate*—the rate of energy consumption (kW) by an oven’s controls and fan motor.

3.1.9 *heavy load*—the testing capacity of the convection oven based on a minimum spacing of 2.75-in. (70mm) between adjacent racks.

3.1.10 *idle energy rate*—oven’s rate of energy consumption (kBtu/h or kW), when empty, to maintain its cavity temperature at the thermostat set point.

3.1.11 *measured energy input rate*—peak rate (kBtu/h or kW) at which an oven will consume energy, measured during a period (typically, its preheat period) when it is known that the oven is operating at full input, including the fan at high speed.

3.1.12 *pilot energy rate*—rate of energy consumption (kBtu/h) by a gas oven’s standing pilot during non-cooking periods, if applicable.

3.1.13 *preheat energy*—amount of energy consumed (kBtu or kWh) by the oven while preheating its cavity from ambient temperature to the oven’s thermostat set point.

3.1.14 *preheat time*—time (min) required for the oven cavity to preheat from ambient temperature to the thermostat set point.

3.1.15 *production capacity*—maximum rate (lb/h (kg/h)) at which a convection oven can bring the specified food product to a specified “cooked” condition. May also be referred to as throughput.

3.1.16 *steam injection cycle*—a period whereby steam/water is introduced into the baking cavity during baking.

3.1.17 *uncertainty*—a measure of the combination of the bias and precision error in specified instrumentation or the measure of the repeatability of a reported test result.

4. Summary of Test Methods

4.1 *Thermostat Calibration*—The accuracy of the oven thermostat is checked at 350°F (177°C), the set point for all but the browning test, which is 300°F (149°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 $\pm 5^\circ\text{F}$ ($\pm 2.8^\circ\text{C}$).

4.2 *Preheat Energy Consumption and Time*—The time and energy required to preheat the oven from room temperature ($75 \pm 5^\circ\text{F}$) to 340°F is determined.

4.3 *Energy Input Rate*—The input rate of the oven is determined to check whether the oven is operating properly. If the measured input rate is not within 5 % of the rated input, all further testing ceases until the appliance can be made to operate within this specification. For gas ovens, the pilot energy rate and the fan and control energy rate are also determined.

4.4 *Idle Energy Rate*—The idle energy rate (kBtu/h or kW) is determined with the oven set to maintain $350 \pm 5^\circ\text{F}$ ($177 \pm 2.8^\circ\text{C}$).

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

4.6 *Cooking Uniformity*—The uniformity of heating within the oven’s cavity is determined and reported based on the average temperature on each rack during cooking tests.

4.7 *White Sheet Cake Browning*—The uniformity of browning from rack to rack is documented using white sheet cakes.

4.8 *Bakery Steam Mode*—The recovery performance convection oven’s baking steam delivery system is characterized by assessing the amount of steam produced on repeated bake cycles.

5. Significance and Use

5.1 *Thermostat Calibration*—This test is conducted to ensure that all test results are determined at the same bulk oven cavity air temperature.

5.1.1 The results of the following tests can be used by an operator to select a convection oven based on its energy consumption performance or its cooking performance. Also, the results allow an operator to understand an oven’s energy consumption.

5.2 *Energy Input Rate*—This test is used to confirm the test oven’s rated input and to ensure its proper operation during all testing.

5.3 *Fan and Control Energy Rate*—Information from this test can be used to estimate the cost of electricity required to operate a gas oven. This cost can be added to the cost of gas consumed to estimate the total cost of energy necessary to operate the oven.

5.4 *Pilot Energy Rate*—This test provides a measure of a gas oven’s energy consumption rate during periods when its burner is not on.

5.5 *Preheat Energy Consumption and Time*—This test provides a measure of time and energy required to preheat the oven cavity from ambient temperature to the thermostat set point temperature.

5.6 *Idle Energy Rate*—This test provides a measure of an empty oven’s energy consumption at a typical cooking temperature setting. It also provides an indicator of the combined effectiveness of components of the oven’s design (for example, insulation, door seals, and combustion efficiency) that influence its energy consumption.