Designation: F2238 – 20

An American National Standard

Standard Test Method for Performance of Rapid Cook Ovens[1]

This standard is issued under the fixed designation F2238; 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 evaluates the energy consumption and cooking performance of rapid cook ovens. The food service operator can use this evaluation to select a rapid cook oven and understand its energy consumption.

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

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

1.3.1 Energy input rate (see 10.2),

1.3.2 Preheat energy consumption and time (see 10.3),

1.3.3 Idle energy rate (see 10.4),

1.3.4 Pilot energy rate (if applicable) (see 10.5), and

1.3.5 Cooking-energy efficiency, cooking energy rate, and production capacity (see 10.6).

1.4 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

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

2.2 *ASHRAE Documents:*[3]

2013 ASHRAE Handbook of Fundamentals Chapter 1, Psychrometrics

2014 ASHRAE Handbook—Refrigeration Chapter 19, Thermal Properties of Foods

ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data[3]

2.3 *AOAC Document:*[4]

AOAC Procedure 984.25 Moisture (Loss of Mass on Drying) in Frozen French Fried Potatoes

3. Terminology

3.1 *Definitions:*

3.1.1 *cooking-energy efficiency, n*—quantity of energy imparted to the specified food product, expressed as a percentage of energy consumed by the rapid cook oven during the cooking event.

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

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

3.1.4 *idle energy rate, n*—the rapid cook oven's rate of energy consumption (Btu/h or kW), when empty, required to

[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 Sept. 1, 2020. Published October 2020. Originally approved in 2003. Last previous edition approved in 2016 as F2238 – 16. DOI: 10.1520/F2238-20.

[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, http://www.ashrae.org.

[4] Available from AOAC International, 2275 Research Blvd., Suite 300, Rockville, MD 20850-3250, http://www.aoac.org.

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*—that portion of the rapid cook oven in which food products are heated or cooked.

3.1.5.1 *Discussion*—Cavity ≥ 12-½ in. test product 12 in. diameter nominal pizza. Cavity ≤ 12 in. test product 8 in. diameter pizza product.

3.1.6 *pilot energy rate, n*—rate of energy consumption (Btu/h) by a rapid cook oven's continuous pilot (if applicable).

3.1.7 *preheat energy, n*—amount of energy consumed (Btu or kWh), by the rapid cook 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*—time (min.) required for the rapid cook oven cavity to preheat from ambient temperature to the specified thermostat set point or for the rapid cook oven to achieve a ready-to-cook condition.

3.1.9 *production capacity, n*—maximum rate (lb/h) at which an rapid cook oven can bring the specified food product to a specified "cooked" condition.

3.1.10 *production rate, n*—rate (lb/h) at which a rapid cook oven brings the specified food product to a specified "cooked" condition. Does not necessarily refer to maximum rate. Production rate varies with the amount of food being cooked.

3.1.11 *rapid cook oven, n*—a cooking appliance that utilizes one or more heat transfer technologies to cook food product within a chamber and which is capable of cooking the food product significantly faster than is possible using solely radiant oven or convection oven technologies. Heat transfer technologies which may be employed include microwave, quartz halogen and high velocity or impingement convection, both gas and electric.

3.1.12 *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 Energy input rate is determined to confirm that the rapid cook oven is operating within 5 % of the nameplate energy input rate. For a gas rapid cook oven, the pilot energy rate and the fan and control energy rates are also determined.

4.2 Preheat energy and time are determined.

4.3 Idle energy rate is determined.

4.4 Cooking-energy efficiency and production capacity are determined during barreling-run cooking tests using pizza as the food product.

4.4.1 Cooked product photo documented. Photos of cooked product for visual comparison.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the rapid cook oven is operating properly prior to further testing.

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

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

5.4 Cooking-energy efficiency is a precise indicator of a rapid cook oven's energy performance while cooking a typical food product. If energy performance information is desired using a food product other than the specified test food, the test method could be adapted and applied. Energy performance information allows an end user to better understand the operating characteristics of a rapid cook oven.

5.5 Production capacity information can help an end user to better understand the production capabilities of a rapid cook 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.

6. Apparatus

6.1 *Analytical Balance Scale,* for measuring weights up to 20 lb (9.1 kg), with a resolution of 0.01 lb (0.005 kg) and an uncertainty of 0.01 lb (0.005 kg).

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 (670 Pa) and an uncertainty of 0.2 in. Hg (670 Pa).

6.3 *Canopy Exhaust Hood,* 4 ft (1.2 m) in depth, wall-mounted with the lower edge of the hood 6 ft, 6 in. (1.98 m) from the floor and with the capacity to operate at a nominal exhaust ventilation rate of 200 cfm per linear foot (94.4 L/s per linear meter) of active hood length. This hood shall extend a minimum of 6 in. (150 mm) past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions.

6.4 *Convection Drying Oven,* with temperature controlled at 220 ± 5°F (100 ± 3°C), to be used to determine moisture content of pizza crust, pizza sauce and pizza cheese.

6.5 *Gas Meter,* for measuring the gas consumption of a rapid cook oven, shall be a positive displacement type with a resolution of at least 0.01 ft^3 and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3/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 ft^3 and a maximum uncertainty no greater than 2 % of the measured value.

6.6 *Pressure Gage,* for monitoring natural gas pressure. Shall have a range of 0 to 15 in. H_2O (0 to 3.7 kPa), a resolution of 0.5 in. H_2O (125 Pa), and a maximum uncertainty of 1 % of the measured value.

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

6.8 *Temperature Sensor,* for measuring natural gas temperature in the range of 50 to 100°F (10 to 93°C) with an uncertainty of ± 2°F.

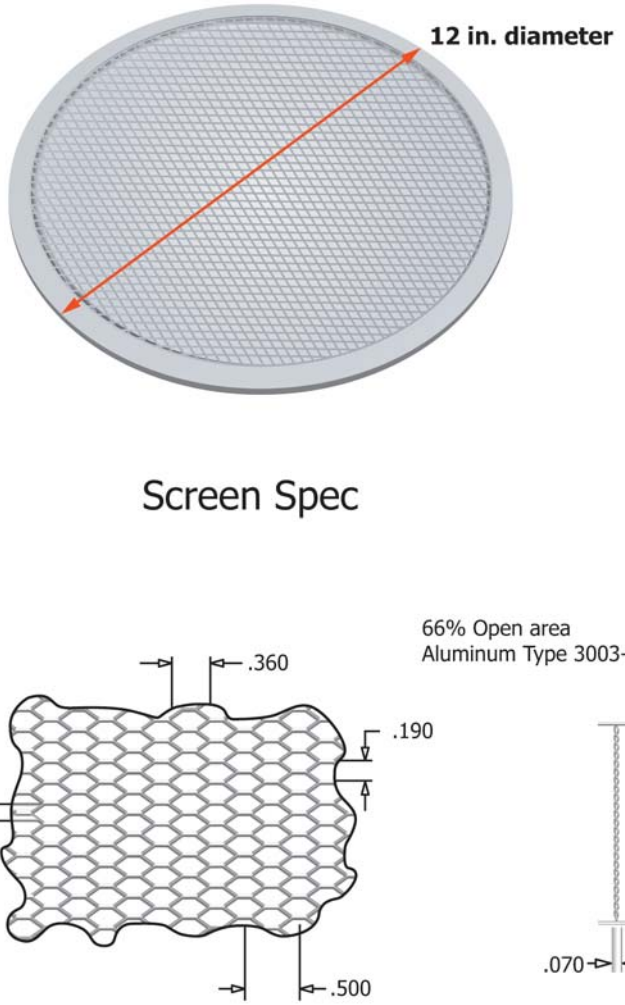

FIG. 1 Pizza Screen

6.9 *Thermocouple,* industry-standard, insulated, 24 gage, type T or Type K thermocouple wire, welded and calibrated, with an uncertainty of ±1°F.

6.10 *Thermocouple Probe,* Type T or Type K, micro needle, product probe with a response time from ambient to 200°F (93.3°C) of less than 20 s, and an uncertainty of ±2°F.

6.11 *Watt-Hour Meter,* for measuring the electrical energy consumption of a rapid cook oven, 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 %.

7. Reagents and Materials

7.1 *Pizza Crust*—Shall be a nominal 11.5 ± 0.5 in. (292 ± 13 mm) diameter, prebaked or parbaked (self-rising) crust, enriched flour (wheat flour, malted barley flour, niacin, reduced iron, thiamine mononitrated riboflavin, rolic acid). Refrigerate to 38 ± 2°F (3.3 ± 1°C).

7.1.1 *Pizza Fully Prepared*—Frozen[5] nominal 12 in. (305 mm) diameter product for oven cavities 12 ½ in. (317.5 mm) wide/depth or greater. Use nominal 8 in. (203 mm) diameter product for cavities less than 12 in. (305 mm) wide/depth.

7.2 *Pizza Sauce*—Shall be a simple, tomato based sauce with tomatoes, water, tomato paste. A moisture content of 90 ± 2 % by weight, based on a gravimetric moisture analysis. Refrigerate to 38 ± 2°F (3.3 ± 1°C).

7.3 *Pizza Cheese*—Shall be a part skim, low moisture, shredded mozzarella cheese, parmesan cheese (pasteurized cultured part-skim milk, salt, enzymes), provolone cheese

[5] The Food Service Technology Center has found that Freschetta – Frozen (25.85 oz), 4 Cheese Pizza, Item # 73184 – complies with the 12 in. diameter pizza specification requirements for this test method. The sole source of supply of the pizza known to the committee at this time is Schwan's Food Company Inc., Marshall, MN, 56258. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.