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An American National Standard

Standard Test Method for Performance of Conveyor Broilers[1]

This standard is issued under the fixed designation F2239; 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 conveyor broilers. The food service operator can use this evaluation to select a conveyor broiler and understand its energy consumption.

1.2 This test method is applicable to gas, electric, and hybrid gas/electric conveyorized broilers. This test method covers both units with continuously operating conveyors and batch-style units with intermittently operating conveyors.

1.3 The conveyor broiler 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 and temperature uniformity (see 10.4),

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

1.3.5 Cooking energy efficiency, cooking uniformity and production capacity (see 10.8 and 10.9).

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 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]

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

2.2 *ANSI Standard:*[3]

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

2.3 *AOAC Documents:*[4]

AOAC Official Action 950.46 Air Drying to Determine Moisture Content of Meat and Meat Products

AOAC Official Action 960.39 Fat (Crude) or Ether Extract in Meat

2.4 *ASHRAE Standard:*[5]

ASHRAE Handbook of Fundamentals "Thermal and Related Properties of Food and Food Materials," Chapter 30, Table 1, 1989

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *broiler cavity, n*—that portion of the conveyor broiler in which food products are heated or cooked.

3.1.2 *continuous conveyor, n*—broiler with a belt or chain that moves constantly through the broiler cavity and does not halt during the cooking process.

3.1.3 *conveyor broiler, n*—device, with a continuous belt and a heat source above and below the belt, for cooking food by high heat, usually by direct or radiant heat. Conveyor broilers are used primarily, but not exclusively, for cooking meats.

[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 American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from Association of Official Analytical Chemists, 1111 N. 19th Street, Arlington, VA 22209.

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

3.1.4 *cooking energy efficiency, n*—quantity of energy imparted to the specified food product, expressed as a percentage of energy consumed by the conveyor broiler during the cooking event.

3.1.5 *cooking energy rate, n*—average rate of energy consumption (Btu/h or kW) during the cooking energy efficiency tests. Refers to both loading scenarios (heavy, light).

3.1.6 *cooking lane, n*—segment of broiler that food product passed through as it cooks. Each position on the conveyor where food product is placed represents a cooking lane.

3.1.7 *cooking uniformity, n*—calculated variation in cooked food product.

3.1.8 *energy input rate, n*—peak rate at which a conveyor broiler consumes energy (Btu/h or kW).

3.1.9 *idle energy rate, n*—conveyor broiler's rate of energy consumption (kW or Btu/h), when empty, required to maintain the broiler's temperature at the specified thermostat set point.

3.1.10 *intermittent conveyor, n*—broiler that operates the belt or chain only at the beginning or conclusion of a cooking cycle to move a batch of product through the broiler cavity.

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

3.1.12 *preheat energy, n*—amount of energy consumed (Btu or kWh), by the conveyor broiler while preheating its cavity from ambient temperature to the specified thermostat set point.

3.1.13 *preheat time, n*—time (min.) required for the conveyor broiler cavity to preheat from ambient temperature to the specified thermostat set point.

3.1.14 *production capacity, n*—maximum rate (lb/h) at which a conveyor broiler can bring the specified food product to a specified "cooked" condition.

3.1.15 *production rate, n*—rate (lb/h) at which a conveyor broiler brings the specified food product to a specified "cooked" condition. It does not necessarily refer to maximum rate. Production rate varies with the amount of food being cooked.

3.1.16 *temperature uniformity, n*—measured variation in broiler cavity temperature.

3.1.17 *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 conveyor broiler is operating within 5 % of the nameplate energy input rate. For gas and hybrid gas/electric conveyor broilers, the pilot energy rate and control energy rates are also determined (if applicable).

4.2 Preheat energy and time are determined.

4.3 Idle energy rate and temperature uniformity of each broiler cavity is determined while operating at manufacturer's recommended temperature setting.

4.4 Cooking energy efficiency is determined during light-load cooking tests using prefrozen hamburger patties as a food product.

4.5 Cooking energy efficiency, cooking uniformity, and production rate are determined during heavy-load cooking tests using prefrozen hamburger patties as a food product.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the conveyor broiler 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 conveyor broiler 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 Temperature uniformity of the broiler cavity may be used by food service operators to understand the heat distribution throughout the broiler cavity and select a conveyor broiler that matches their required temperature characteristics.

5.5 Cooking energy efficiency is a precise indicator of conveyor broiler energy performance while cooking a typical food product under various loading conditions. 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 conveyor broiler.

5.6 Cooking uniformity of the broiler may be used by food service operates to select a conveyor broiler that provides a uniformly cooked product.

5.7 Production capacity information can help an end user to better understand the production capabilities of a conveyor broiler 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, 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 natural gas volume to standard conditions. It shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

6.3 *Canopy Exhaust Hood,* 4 ft in depth, wall-mounted with the lower edge of the hood 6 ft, 6 in. from the floor and with the capacity to operate at a nominal exhaust ventilation rate of 300 cfm per linear foot of active hood length. This hood shall extend a minimum of 6 in. past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions.

6.4 *Convection Drying Oven,* temperature controlled at 215 to 220°F (101 to 104°C), used to determine moisture content of both the raw and the cooked food product.

6.5 *Data Acquisition System,* for measuring energy and temperatures, capable of multiple channel displays updating at least every 5 s.

6.6 *Gas Meter,* for measuring the gas consumption of a conveyor broiler, 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.

6.7 *Pressure Gage,* for monitoring natural gas pressure. It shall have a range of 0 to 10 in. water, a resolution of 0.5 in. water, and a maximum uncertainty of 1 % of the measured value.

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

6.9 *Temperature Sensor,* for measuring natural gas temperature in the range of 50 to 100°F with an uncertainty of ±1°F.

6.10 *Thermocouple(s),* high temperature (>1200°F) fiberglass insulated, 24 gage, type K thermocouple wire, welded and calibrated.

6.11 *Watt-Hour Meter,* for measuring the electrical energy consumption of a conveyor broiler, 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 *Drip Rack,* large enough to hold a full load of hamburger patties in a single layer (25 patties for a 30 in. nominal width broiler), for dripping hamburger patties.

7.2 *Freezer Paper,* waxed commercial grade, 18 in. (460 mm) wide, for use in packaging hamburger patties.

7.3 *Half-Size Sheet Pans,* measuring 18 by 13 by 1 in. (460 by 130 by 25 mm), for use in packaging hamburger patties.

7.4 *Hamburger Patties* shall be prefrozen, four per pound, 20 ± 2 % fat (by weight), finished grind, pure beef patties with a moisture content between 58 and 62 % of the total hamburger weight. The patties shall be machine prepared to produce ⅜-in. (9.5 mm) thick patties with a nominal diameter of 5 in. (127 mm).

NOTE 1—It is important to confirm by laboratory tests that the hamburger patties are within the above specifications because these specifications impact directly on cook time and cooking energy consumption.

7.5 *Permanent Marker,* felt-tip, for labeling plastic bags.

7.6 *Plastic Bags,* self-sealing, 1 gal (3.79 L) size, for collecting cooked hamburger patties.

7.7 *Plastic Wrap,* commercial grade, 18 in. (460 mm) wide, for use in packaging hamburger patties.

7.8 *Tongs,* commercial grade, metal construction, for handling hot hamburger patties.

8. Sampling and Test Units

8.1 *Conveyor Broiler*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the appliance according to the manufacturer's instructions under a canopy exhaust hood. Position the conveyor broiler so that a minimum of 6 in. is maintained between the edge of the hood and the vertical plane of the front and sides of the appliance. In addition, both sides of the conveyor broiler shall be a minimum of 3 ft from any side wall, side partition, or other operating appliance. The exhaust ventilation rate shall be 300 cfm per linear foot of active hood length. 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 operating.

NOTE 2—The ambient temperature requirements are designed to simulate real world kitchen temperatures and are meant to provide a reasonable guideline for the temperature requirements during testing. If a facility is not able to maintain the required temperatures, then it is reasonable to expect that the application of the procedure may deviate from the specified requirements (if it cannot be avoided) as long as those deviations are noted on the Results Reporting Sheets.

NOTE 3—It is acknowledged that custom hood and catalyst configurations exist for some conveyor broilers. This test method may still be applied when the chain broiler is used with a custom hood configuration or a catalyst, or both, as long as the configuration is noted on the Results Reporting Sheets.

9.2 Connect the conveyor broiler to a calibrated energy test meter. For gas installations, install a pressure regulator downstream from the meter to maintain a constant pressure of gas for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the conveyor broiler and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's nameplate voltage.

9.3 For an electric or hybrid gas/electric conveyor broiler, confirm (while the conveyor broiler elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 4—It is the intent of the test procedure within this test method to evaluate the performance of a conveyor broiler at its rated gas pressure or electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 208 or 240 V with no change in components), the voltage selected by the manufacturer or tester, or both, shall be reported. If a conveyor broiler is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, the preheat time) may differ at the two voltages.

9.4 For a gas or hybrid gas/electric conveyor broiler, adjust (during maximum energy input) 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 appliance following the manufacturer's recommendations for optimizing combustion. Proper combustion may be verified by measuring air-free CO in accordance with ANSI Z83.11.

10. Procedure

10.1 *General:*

10.1.1 For gas or hybrid gas/electric conveyor broilers, record the following for each test run:

10.1.1.1 Higher heating value,

10.1.1.2 Standard gas pressure and temperature used to correct measured gas volume to standard conditions,

10.1.1.3 Measured gas temperature,

10.1.1.4 Measured gas pressure,

10.1.1.5 Barometric pressure,

10.1.1.6 Energy input rate during or immediately prior to test (for example, during the preheat for that day's testing), and

10.1.1.7 Ambient temperature.

NOTE 5—Using a calorimeter or gas chromatograph in accordance with accepted laboratory procedures is the preferred method for determining the higher heating value of gas supplied to the conveyor broiler under test. It is recommended that all testing be performed with gas having a higher heating value of 1000 to 1075 Btu/ft^3.

10.1.2 For gas or hybrid gas/electric conveyor broilers, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (see 10.2).

10.1.3 For electric or hybrid gas/electric conveyor broilers, record the following for each test run:

10.1.3.1 Voltage while elements are energized,

10.1.3.2 Energy input rate during or immediately prior to test (for example, during the preheat for that day's testing), and

10.1.3.3 Ambient temperature.

10.1.4 For each test run, confirm that the peak input rate is within ±5 % of the rated nameplate input. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the conveyor broiler.

10.2 *Energy Input Rate:*

10.2.1 Install a thermocouple 1 in. above the conveyor, at the center of the broiler cavity (side to side and front to back). For broilers with multiple cooking cavities, install a thermocouple 1 in. above the conveyor, at the center of each additional broiler cavity.

NOTE 6—The number of cooking cavities is equal to the number of chambers separated by a solid wall or partition within the broiler. Each chamber typically uses a separate conveyor.

10.2.2 Set the temperature control for each cooking cavity to the manufacturer's recommended temperature setting and turn all cavities of the conveyor broiler on. Record the time and energy consumption from the time when the unit is turned on for a period of at least 10 min, or until any of the elements first cycle off.

10.2.3 Calculate and record the conveyor broiler's energy input rate and compare the result to the rated nameplate input. For gas conveyor broilers, only the burner energy consumption is used to compare the calculated energy input rate with the rated gas input. Any electrical energy use shall be calculated and recorded separately as the control energy rate.

10.2.4 In accordance with 11.4, calculate and report the conveyor broiler energy input rate, control energy rate where applicable, and rated nameplate input.

10.3 *Preheat Energy Consumption and Time:*

10.3.1 Verify that the cavity temperature is 75 ± 5°F. Set the temperature control to the manufacturer's recommended temperature setting for each broiler cavity and turn all cavities of the conveyor broiler on. Record the thermostat setting(s) for all thermostats.

10.3.2 Record the time, temperature and energy consumption until the temperature at the center of each cavity stabilizes and the unit is thoroughly heated. Record the stabilization temperature of each cavity. Stop monitoring time and energy. The preheat time is determined as the time for each cavity to reach 25°F of the stabilized operating temperature using the temperature reading of the cavity that took the longest amount of time to reach its maximum temperature. The preheat time for the broiler is the amount of time the slowest cavity took to reach 25°F below the stabilized operating temperature, as measured by its respective thermocouple. Preheat energy consumption is the total energy consumed by the broiler during the preheat time.

NOTE 7—Individual cavities in a multiple cavity broiler may preheat at different rates and stabilize at different temperatures. It is the intent of this test to judge preheat complete when the slowest preheating cavity is within 25°F of the maximum temperature measured by the thermocouple in that particular cavity.

NOTE 8—Preheat time includes any delay between the time the unit is turned on and the time the burners actually ignite.

10.3.3 In accordance with 11.5, calculate and report the conveyor broiler preheat energy consumption and time, the thermostat setting(s), and generate a preheat temperature versus time graph.

10.4 *Idle Energy Rate:*

10.4.1 Set the temperature control(s) to the manufacturer's recommended temperature setting(s) and preheat the conveyor broiler. Allow the conveyor broiler to stabilize for 60 min after the last broiler cavity reaches its thermostat set point.

10.4.2 At the end of 60 min, begin recording the conveyor broiler's idle energy consumption and the elapsed time for a minimum of 2 h. Record the length of the idle period.

10.4.3 In accordance with 11.6, calculate and report the conveyor broiler idle energy rate.

10.5 *Pilot Energy Rate:*

10.5.1 For a gas conveyor broiler with a continuous standing pilot, set the gas valve at the "pilot" position and set the conveyor broiler's temperature control to the "off" position.

10.5.2 Light and adjust the pilot according to the manufacturer's instructions.

10.5.3 Monitor gas consumption for a minimum of 8 h of pilot operation.

10.5.4 In accordance with 11.8, calculate and report the conveyor broiler pilot energy rate.

10.6 *Hamburger Patty Preparation:*

10.6.1 Note the nominal width of each conveyor and nominal cavity length of the broiler under test. The nominal length of the broiler cavity, in conjunction with the nominal width of the conveyor(s), represents how many hamburger patties can fit completely within the broiler cavity(ies) at a spacing of one patty per 6 in. For instance, a broiler with a nominal conveyor

TABLE 1 Total Number of Hamburger Patties Required for Each Run of a Light Load Test

Nominal Width, in.	Nominal Length, in.			
	12	18	24	30
12	8	8	8	8
18	12	12	12	12
24	16	16	16	16
30	20	20	20	20

TABLE 2 Total Number of Hamburger Patties Required for Each Run of a Heavy Load Test

Nominal Width, in.	Nominal Length, in.			
	12	18	24	30
12	20	30	40	50
18	30	45	60	75
24	40	60	80	100
30	50	75	100	125

TABLE 3 Total Number of Hamburger Patties Required for a Complete Broiler Test

Nominal Width, in.	Nominal Length, in.			
	12	18	24	30
12	84	114	144	174
18	126	171	216	261
24	168	228	288	348
30	210	285	360	435

width of 18 in. and a nominal cavity length of 30 in. can hold 15 hamburger patties at once (five patties in each of three lanes).

10.6.2 Based on the nominal conveyor width(s) and nominal cavity length, prepare enough hamburger patties for a light load test and a heavy load test. Each test will consist of a minimum of three runs. Table 1 lists how many hamburger patties are required for each run of a light load test, and Table 2 lists how many hamburger patties are required for each run of a heavy load test. Table 3 lists how many hamburger patties are required for a complete broiler test—three runs of a light load test plus three runs of a heavy load test.

NOTE 9—A minimum of three test runs is specified, however, more test runs may be necessary if the results do not meet the uncertainty criteria specified in Annex A1.

NOTE 10—Tables 1-3 are meant to help the tester prepare the right number of total hamburger patties needed to perform the Cooking Energy Efficiency and Production Capacity (see 10.8 and 10.9) test procedure. As part of that procedure, the patties required for each run of a light load test and each run of a heavy load test are divided into two equal groups and referred to as "stabilization" patties and "test" patties. The quantities specified in Tables 1-3 include the total number of required patties, that is, "stabilization" plus "test."

10.6.3 Verify the fat and moisture content of the hamburger patties in accordance with recognized laboratory procedures (AOAC Official Action 960.39 and Official Action 950.46B). Select hamburger patties (1 for every 15) randomly, and weigh them. Record the average weight of these samples to enable later determination of the total raw weight of each load.

10.6.4 Prepare patties for the test by loading them onto half-size 18 by 13 by 1-in. (46 by 33 by 2.5-cm) sheet pans (Fig. 1). Package 24 patties per sheet pan (six patties per level by four levels), separating each level by a double sheet of waxed freezer paper (Fig. 2). To facilitate verification that the patties are at the required temperature for the beginning of the test, implant a thermocouple horizontally into at least one hamburger patty on a sheet pan. Cover the entire package with a commercial-grade plastic wrap. Place the sheet pans in a freezer near the broiler test area until the temperature of the patties has stabilized at the freezer temperature.

10.6.5 Monitor the temperature of the frozen patty with a thermocouple. Its internal temperature must reach 0 ± 5°F (-17.8 ± 2.8°C) before the hamburger patties can be removed from the freezer and loaded onto the broiler. Adjust the freezer temperature to achieve this required internal temperature (the typical freezer setting is -5°F) if necessary.

10.6.6 Prepare a minimum of 24 additional hamburger patties for use in cook time determination. The actual number of patties needed for the cook time determination will vary with the width of the conveyor and the number of trials needed

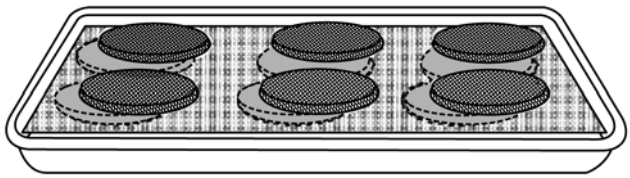

FIG. 1 Sample of Hamburger Patty Packaging

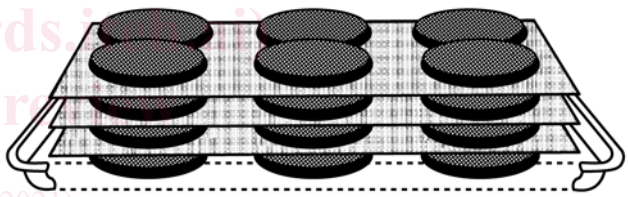

FIG. 2 Cutaway of Packaged Hamburger Patties

to establish a cooking time that demonstrates a 165°F final patty temperature after cooking.

10.7 *Cook Time Determination:*

10.7.1 Set the calibrated temperature control for each cooking cavity to the manufacturer's recommended setting, preheat all cavities of the conveyor broiler and allow it to idle for 60 min. Estimate a cook time for a hamburger patty. For broilers with multiple conveyors, set the cook time to the same value for each conveyor. The cook time is the time that it takes the entire patty to pass completely though the broiler cavity, starting from the point where the leading edge of the patty enters the broiler cavity until the point where the trailing edge of the patty exits the broiler cavity. The cook time will be different from the conveyor speed, which is the time it takes for a single point on the conveyor to pass through the broiler cavity. The broiler controls will most likely be based on the conveyor speed.

NOTE 11—It is the intent of this test method to have all broiler cavities cook hamburger patties using the same conveyor speed to allow reasonable implementation of the test procedure. Any variation in cooked food product between the different cooking lanes will be averaged in the final weighing.

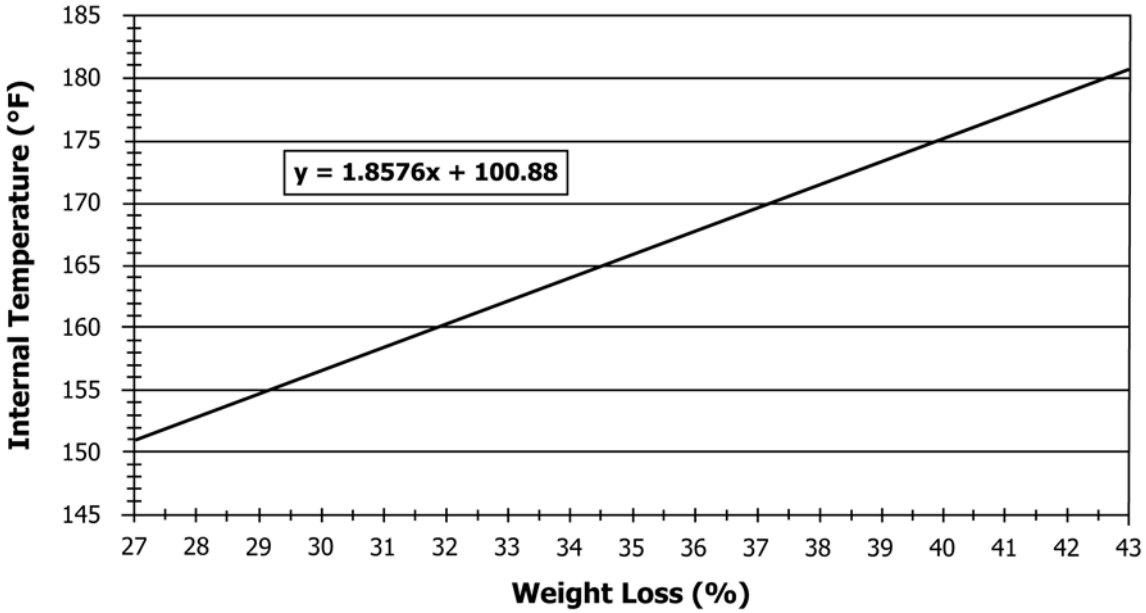

FIG. 3 Relationship Between Bulk Internal Temperature and the Weight Loss of Hamburger Patties Cooked on a Continuous Conveyor Broiler

10.7.2 Remove enough frozen hamburger patties from the freezer to fill the width of the conveyor(s) with patties (three patties for a conveyor broiler with a nominal conveyor width of 18 in.). Place the patties directly onto the conveyor(s) so that the leading edge of each patty is adjacent to the entrance of the broiler cavity, and spaced with equal distance between each patty from side to side. Do not allow more than 30 s to elapse from the time the patties are removed from the freezer until they are placed on the conveyor(s).

10.7.3 Allow the patties to pass through the broiler cavity and cook.

10.7.4 Hamburger patties shall be cooked to an internal temperature of 165 ± 5°F (74°C) which results in a medium-done condition. For continuous conveyors, this can be accomplished by cooking the patties to a 35 ± 2 % weight loss. For intermittent conveyors, this can be accomplished by cooking the patties to a 30 ± 2 % weight loss (see Fig. 3 and Fig. 4).

NOTE 12—Research conducted by PG&E has determined that the final internal temperature of cooked hamburger patties may be approximated by the percent weight loss incurred during cooking. The two are connected by a linear relationship (see Fig. 3 and Fig. 4), as long as the hamburger patties are within the specifications described in 7.4.

10.7.5 After removing the patties from the broiler, place them on a wire drip rack, drip for 2 min (1 min per side) and then weigh. Calculate the weight loss using the average initial patty weight determined in 10.6.3. The percent weight loss shall be as specified in 10.7.4 for an internal patty temperature of 165 ± 5°F.

10.7.6 If the percent weight loss is not 35 ± 2 % for continuous conveyors or 30 ± 2 % for intermittent conveyors, repeat the steps given in 10.7.2 – 10.7.5, adjusting the cook time (for example, speed of the conveyor(s) on continuous conveyors) to attain the appropriate weight loss for a 165 ± 5°F internal temperature. Be sure to keep all conveyor speeds in all cavities equal when making changes.

10.7.7 Record the determined conveyor speed and cook time for use during the cooking energy efficiency and production tests.

10.8 *Light-Load Cooking Energy Efficiency:*

10.8.1 The light-load cooking energy efficiency test is to be run a minimum of three times. Additional test runs may be necessary to obtain the required precision for the reported test results (see Annex A1).

10.8.2 Set the temperature control for each cooking cavity to the manufacturer's recommended operating temperature, preheat the broiler, and allow it to idle for 60 min. Set the cook times or conveyor speed to achieve the cook time for the hamburger patties determined in 10.7.7. Record the conveyor speed (continuous conveyors) and cook time (both continuous conveyors and intermittent conveyors).

10.8.3 Each light-load test run uses the number of hamburger patties detailed in Table 1, and is performed in two steps, or halves. The patties included in the first half of the test run are used to stabilize the broiler and are referred to as the "stabilization" patties. The patties included in the second half of the test run are used for energy efficiency determination and are referred to as the "test" patties. For example, a broiler with a nominal 18 in. conveyor width and a 24 in. nominal cavity length will require twelve patties for a light load—six stabilization patties and six test patties.

10.8.4 Remove the first row of patties from the freezer. Place the patties directly on the conveyor(s) so that the leading edge of each patty is adjacent to the entrance of the broiler cavity, and spaced with equal distance between each patty from side to side. Do not allow more than 30 s to elapse from the time the patties are removed from the freezer until they are placed on the conveyor(s). The example in Fig. 5 details the light loading scenario for a broiler with a 12 in. nominal conveyor width and an 18 in. nominal cavity length.

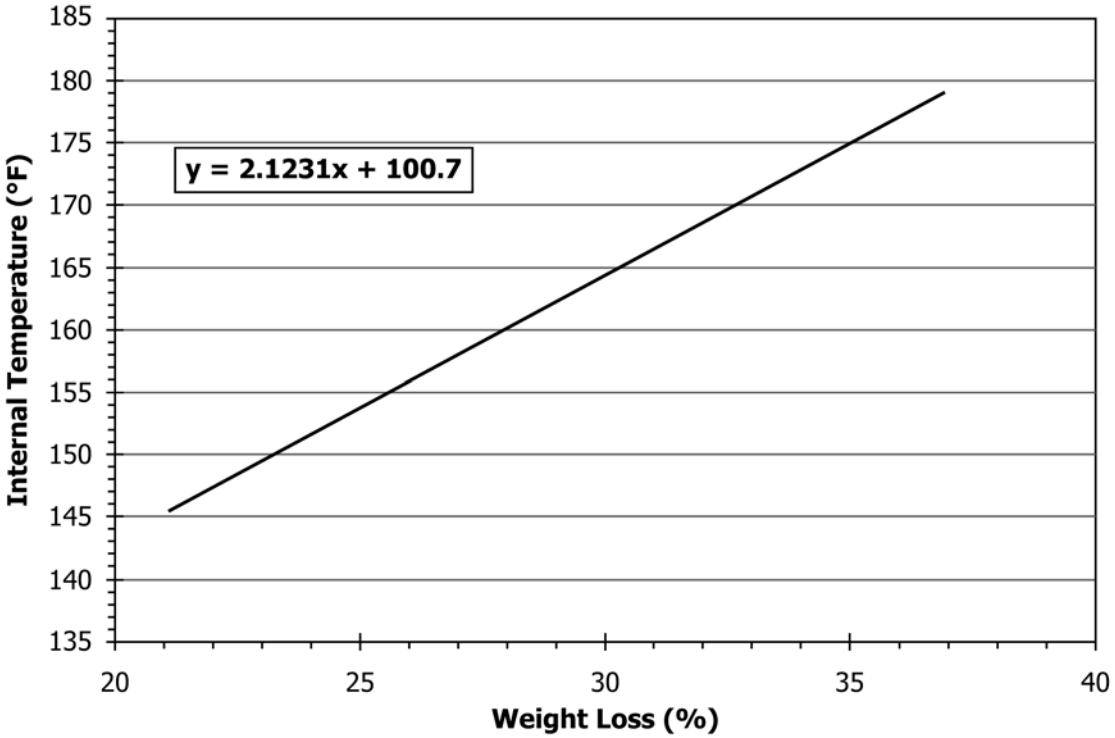

FIG. 4 Relationship Between Bulk Internal Temperature and the Weight Loss of Hamburger Patties Cooked on a Intermittent Conveyor Broiler

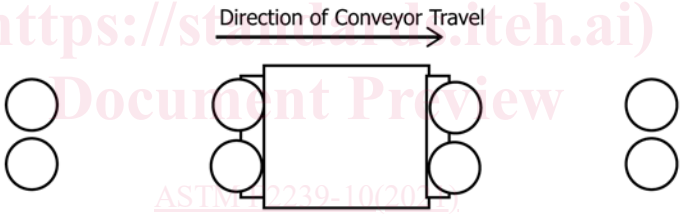

FIG. 5 Example of Light Loading Scenario for a Broiler With a 12 in. Conveyor Width and an 18 in. Cavity Length

10.8.4.1 For continuous conveyors, place the second row of patties on the conveyor(s) as soon as the first row of patties has passed completely through the broiler cavity and continue this loading pattern for subsequent rows.

10.8.4.2 For intermittent conveyors, place the second row of patties onto the conveyor 30 s after the first load has passed outside the broiler cavity.

10.8.5 After the second row of stabilization patties has passed through the broiler, load the first row of test patties on the conveyor(s). Start monitoring time and energy immediately upon placing the first row of test patties on the conveyor(s). Allow the patties to pass through the broiler cavity and cook.

10.8.6 As soon as each row of test patties has passed completely through the broiler, immediately remove the patties from each conveyor and place on a wire rack. Drip the patties for 2 min (1 min per side), then weigh.

10.8.7 Stop monitoring time and energy as soon as the second row of test patties has moved completely out of the broiler. The example in Fig. 6 details the start and stop timing for monitoring time and energy during light load testing of a broiler with a 12 in. nominal conveyor width and an 18 in. nominal cavity length. Drip and weigh the second row in the same manner as the first. Record the test time and energy.

10.8.8 Calculate the weight loss of the hamburger patties and verify that it meets the criteria in 10.7.4 for a 165 ± 5°F internal temperature. Record the final patty weight loss. If the weight loss is not within the range specified in 10.7.4, then repeat steps 10.8.3 – 10.8.7, adjusting the cook time until the specified weight loss is achieved. Record the adjusted conveyor speed and resulting cook time.

10.8.9 Perform run numbers 2 and 3 by repeating 10.8.3 – 10.8.8. Follow the procedure in Annex A1 to determine whether more than three test runs are required.

10.8.10 In accordance with 11.9, calculate and report the cooking energy efficiency, cooking energy rate, electric energy rate (if applicable for gas conveyor broilers), and production rate.

10.9 *Heavy-Load Cooking Energy Efficiency, Cooking Uniformity and Production Capacity:*

10.9.1 The heavy-load cooking energy efficiency test is to be run a minimum of three times. Additional test runs may be