Designation: F2474 – 17 (Reapproved 2022)

An American National Standard

Standard Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems[1]

This standard is issued under the fixed designation F2474; 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 determination of appliance heat gain to space derived from the measurement and calculation of appliance energy consumption, energy exhausted, and energy to food, based on a system energy balance, parametric evaluation of operational or design variations in appliances, hoods, or replacement air configurations.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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.*

1.4 *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]

F1704 Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems

2.2 *ASHRAE Standard:*[3]

ASHRAE Guideline 2-1986 (RA96) Engineering Analysis of Experimental Data

ASHRAE Terminology of Heating, Ventilation, Air-Conditioning, and Refrigeration

2.3 *ANSI Standards:*[4]

ANSI/ASHRAE 51 and ANSI/AMCA 210 Laboratory Method of Testing Fans for Rating

NOTE 1—The replacement air and exhaust system terms and their definitions are consistent with terminology used by the American Society of Heating, Refrigeration, and Air Conditioning Engineers.[5] Where there are references to cooking appliances, an attempt has been made to be consistent with terminology used in the test methods for commercial cooking appliances. For each energy rate defined as follows, there is a corresponding energy consumption that is equal to the average energy rate multiplied by elapsed time. Electric energy and rates are expressed in W, kW, and kWh. Gas energy consumption quantities and rates are expressed in Btu, kBtu, and kBtu/h. Energy rates for natural gas-fueled appliances are based on the higher heating value of natural gas.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *energy rate, n*—average rate at which an appliance consumes energy during a specified condition (for example, idle or cooking).

3.1.2 *appliance/hood energy balance, n*—mathematical expression of appliance, exhaust system, and food energy relationship.

[actual appliance energy consumption]
= [heat gain to space from appliance(s)] + [energy exhausted] + [energy-to-food, if any]

3.1.3 *cold start, n*—condition in which appliances are energized with all components being at nominal room temperature.

3.1.4 *cooking energy consumption rate, n*—average rate of energy consumed by the appliance(s) during cooking specified in appliance test methods.

3.1.4.1 *Discussion*—In this test method, this rate is measured for heavy-load cooking in accordance with the applicable test method.

3.1.5 *exhaust energy rate, n*—average rate at which energy is removed from the test system.

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.07 on Commercial Kitchen Ventilation.

Current edition approved July 1, 2022. Published August 2022. Originally approved in 2005. Last previous edition approved in 2017 as F2474 – 17. DOI: 10.1520/F2474-17R22.

[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

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[5] The boldface numbers in parentheses refer to the list of references at the end of these test methods.

3.1.6 *exhaust flow rate, n*—volumetric flow of air (plus other gases and particulates) through the exhaust hood, measured in standard cubic feet per minute, scfm (standard litre per second, sL/s). This also shall be expressed as scfm per linear foot (sL/s per linear metre) of active exhaust hood length.

3.1.7 *energy-to-food rate, n*—average rate at which energy is transferred from the appliance to the food being cooked, using the cooking conditions specified in the applicable test methods.

3.1.8 *fan and control energy rate, n*—average rate of energy consumed by fans, controls, or other accessories associated with cooking appliance(s). This energy rate is measured during preheat, idle, and cooking tests.

3.1.9 *heat gain energy rate from appliance(s), n*—average rate at which energy is transferred from appliance(s) to the test space around the appliance(s), exclusive of the energy exhausted from the hood and the energy consumed by the food, if any.

3.1.9.1 *Discussion*—This gain includes conductive, convective, and radiant components. In conditions of complete capture, the predominant mechanism of heat gain consists of radiation from the appliance(s) and radiation from hood. In the condition of hood spillage, heat is gained additionally by convection.

3.1.10 *hood capture and containment, n*—ability of the hood to capture and contain grease-laden cooking vapors, convective heat, and other products of cooking processes. Hood capture refers to the products getting into the hood reservoir from the area under the hood while containment refers to the products staying in the hood reservoir.

3.1.11 *idle energy consumption rate, n*—average rate at which an appliance consumes energy while it is idling, holding, or ready-to-cook, at a temperature specified in the applicable test method.

3.1.12 *latent heat gain, n*—energy added to the test system by the vaporization of liquids that remain in the vapor phase prior to being exhausted, for example, by vapor emitted by products of combustion and cooking processes.

3.1.13 *makeup air handling hardware:—*

3.1.13.1 *diffuser, n*—outlet discharging supply air in various directions and planes.

3.1.13.2 *grille, n*—covering for any opening through which air passes.

3.1.13.3 *register, n*— grille equipped with a damper.

3.1.13.4 *throw, n*—horizontal or vertical axial distance an air stream travels after leaving an air outlet before maximum stream velocity is reduced to a specified terminal velocity, for example, 100, 150, or 200 ft/min (0.51, 0.76, or 1.02 m/s).

3.1.14 *measured energy input rate, n*—maximum or peak rate at which an appliance consumes energy measured during appliance preheat, that is, measured during the period of operation when all gas burners or electric heating elements are set to the highest setting.

3.1.15 *radiant heat gain, n*—fraction of the space energy gain provided by radiation.

3.1.15.1 *Discussion*—Radiant heat gain is not immediately converted into cooling load. Radiant energy must first be absorbed by surfaces that enclose the space and objects in the space. As soon as these surfaces and objects become warmer than the space air, some of their heat is transferred to the air in the space by convection. The composite heat storage capacity of these surfaces and objects determines the rate at which their respective surface temperatures increase for a given radiant input and thus governs the relationship between the radiant portion of heat gain and its corresponding part of the cooling load. The thermal storage effect is critically important in differentiating between instantaneous heat gain for a given space and its cooling load for that moment.

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

3.1.17 *replacement air, n*—air deliberately supplied into the space (test room), and to the exhaust hood to compensate for the air, vapor, and contaminants being expelled (typically referred to as makeup air).

3.1.18 *supply flow rate, n*—volumetric flow of air supplied to the exhaust hood in an airtight room, measured in standard cubic feet per minute, scfm (standard litre per second, sL/s). This also shall be expressed as scfm per linear foot (sL/s per linear metre) of active exhaust hood length.

3.1.19 *threshold of capture and containment, n*—conditions of hood operation in which minimum flow rates are just sufficient to capture and contain the products generated by the appliance(s). In this context, two minimum capture and containment points are determined, one for appliance idle condition, and the other for heavy-load cooking condition.

3.1.20 *uncertainty, n*—measure of the precision errors in specified instrumentation or the measure of the repeatability of a reported result.

3.1.21 *ventilation, n*—that portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

4. Summary of Test Method

4.1 This test method is used to characterize the performance of commercial kitchen ventilation systems. Such systems include one or more exhaust-only hoods, one or more cooking appliances under the hood(s), and a means of providing replacement (makeup) air. Ventilation system performance includes the evaluation of the rate at which heat is transferred to the space.

4.1.1 The heat gain from appliance(s) hood system is measured through energy balance measurements and calculations determined at specified hood exhaust flow rate(s). When heat gain is measured over a range of exhaust flow rates, the curve of energy gain to the test space versus exhaust rate reflects kitchen ventilation system performance, in terms of heat gain associated with the tested appliance(s).

4.1.2 In the simplest case, under idle mode, energy exhausted from the test system is measured and subtracted from the energy into the appliance(s) under the hood. The remainder is heat gain to the test space. In the cooking mode, energy to