Designation: E 408 – 71 (Reapproved 1996)$^{\epsilon 1}$

Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques[1]

This standard is issued under the fixed designation E 408; 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.

ϵ^1 NOTE—Section 6 was added editorially in May 1996.

1. Scope

1.1 These test methods cover determination of the total normal emittance (Note) of surfaces by means of portable, inspection-meter instruments.

NOTE 1—Total normal emittance (ϵ_N) is defined as the ratio of the normal radiance of a specimen to that of a blackbody radiator at the same temperature. The equation relating ϵ_N to wavelength and spectral normal emittance [$\epsilon_N(\lambda)$] is

$$\epsilon_N = \int_0^\infty L_b(\lambda,T)\epsilon_N(\lambda)d\lambda / \int_0^\infty L_b(\lambda, T)d\lambda \quad (1)$$

where:

$L_b(\lambda, T)$ = Planck's blackbody radiation function $= c_1\pi^{-1}\lambda^{-5}(e^{c_2/\lambda T} - 1)^{-1}$,
c_1 = 3.7415×10^{-16} W·m^2,
c_2 = 1.4388×10^{-2} m·K,
T = absolute temperature, K,
λ = wavelength, m,
$\int_0^\infty L_b(\lambda, T)d\lambda$ = $\Delta\pi^{-1}T^4$, and
Δ = Stefan-Boltzmann constant = 5.66961×10^{-8} W·m^2·K^{-4}

1.2 These test methods are intended for measurements on large surfaces when rapid measurements must be made and where a nondestructive test is desired. They are particularly useful for production control tests.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Summary of Test Methods

2.1 At least two different types of instruments are commercially available for performing this measurement. One type measures radiant energy reflected from the specimen (Test Method A),[2] and the other type measures radiant energy emitted from the specimen (Test Method B).[3] A brief description of the principles of operation of each test method follows.

2.1.1 *Test Method A*—The theory employed in Test Method A has been described in detail by Nelson et al[4] and therefore is only briefly reviewed herein. The surface to be measured is placed against an opening (or aperture) on the portable sensing component. Inside the sensing component are two semi-cylindrical cavities that are maintained at different temperatures, one at near ambient and the other at a slightly elevated temperature. A suitable drive mechanism is employed to rotate the cavities alternately across the aperture. As the cavities rotate past the specimen aperture, the specimen is alternately irradiated with infrared radiation from the two cavities. The cavity radiation reflected from the specimen is detected with a vacuum thermocouple. The vacuum thermocouple views the specimen at near normal incidence through an optical system that transmits radiation through slits in the ends of the cavities. The thermocouple receives both radiation emitted from the specimen and other surfaces, and cavity radiation which is reflected from the specimen. Only the reflected energy varies with this alternate irradiation by the two rotating cavities, and the detection-amplifying system is made to respond only to the alternating signal. This is accomplished by rotating the cavities at the frequency to which the amplifier is tuned. Rectifying contacts coupled to this rotation convert the amplifier output to a d-c signal, and this signal is read with a millivoltmeter. The meter reading must be suitably calibrated with known reflectance standards to obtain reflectance values on the test surface. The resulting data can be converted to total normal emittance by subtracting the measured reflectance from unity.

2.1.2 *Test Method B*—The theory of operation of Test Method B has been described in detail by Gaumer et al[5] and is

[1] These test methods are under the jurisdiction of ASTM Committee E-21 on Space Simulation and Applications of Space Technology and are the direct responsibility of Subcommittee E21.04 on Space Simulation Test Methods.

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[2] A satisfactory instrument for this type of measurement is the Infrared Reflectometer Model DB 100, manufactured by Gier-Dunkle Instruments, Inc., Torrance, CA.

[3] A satisfactory instrument for this type of measurement is the Model 25A Emissometer, manufactured by the Lion Research Corp., Cambridge, MA.

[4] Nelson, K. E., Leudke, E. E., and Bevans, J. T., *Journal of Spacecraft and Rockets*, Vol 3, No. 5, 1966, p. 758.

[5] Gaumer, R. E., Hohnstreiter, G. F., and Vanderschmidt, G. F., "Measurement of Thermal Radiation Properties of Solids," *NASA SP-31*, 1963, p. 117.