Designation: E 2024 – 99

Standard Test Methods for Atmospheric Leaks Using a Thermal Conductivity Leak Detector[1]

This standard is issued under the fixed designation E 2024; 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 These test methods cover procedures for detecting the sources of gas leaking at the rate of 4.5×10^{-9} mol/s (1×10^{-4} standard cm^3/s) or greater. The tests may be conducted on any object that can be pressurized with a tracer gas that is detectable by a thermal conductivity detector. The test sensitivity will vary widely depending on the tracer gas used.

1.2 *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. Referenced Documents

2.1 *ASTM Standards:*

E 1316 Terminology for Nondestructive Examinations[2]

2.2 *ASNT Documents:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing[3]

ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel[3]

2.3 *Military Specification:*

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification[4]

2.4 *AIA Standard:*

NAS-410 Certification and Qualification of Nondestructive Test Personnel[5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, see Terminology E 1316, Section E.

4. Summary of Test Method

4.1 *Scanning Method*—This test method sets minimum requirements for a thermal conductivity leak detector. It provides for calibration of the detector and gives procedures for pressurizing the test object, locating leaks and estimating the leakage rate.

4.2 *Accumulation Method*—The accumulation method is sometimes the only practical method for accessing complex shaped flanges or sections of pressurized vessels to be leak tested. It may be achieved by entrapping or enclosing an area of a test component with a suitable covering and sampling the buildup of tracer gas concentration with the thermal conductivity leak detector. The acceptance criteria is based on the tracer gas concentration detected by the thermal conductivity detector after an accumulation time from leakage from the leak(s) into the known sample volume.

5. Significance and Use

5.1 These test methods are useful for locating and estimating the size of pressurized gas leaks, either as quality control tests or as field inspection procedures. Also, they are valuable as pretests before other more time consuming and more sensitive leak tests are employed. These test methods are semi-quantitative techniques used to locate leaks but cannot be used to quantify except for approximation. These test methods may be used in an accept-reject test mode.

6. Basis of Application

6.1 *Personnel Qualification*—If specified in the contractual agreement, personnel performing examinations to these test methods shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard, such as ASNT/CP-189, SNT-TC-1A, MIL-STD-410, NAS-410, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

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[1] These test methods are under the jurisdiction of ASTM Committee E-07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.08 on Leak Testing Method.

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[2] *Annual Book of ASTM Standards*, Vol 03.03.

[3] Available from the American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228–0518.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

[5] Available from the Aerospace Industries Association of America, Inc., 1250 Eye Street, N.W., Washington, DC 20005.

7. Interferences

7.1 *Background Gases*—Thermal conductivity detectors are sensitive to all gases that have a thermal conductivity value different from air and their sensitivity changes with the degree of difference. Background gases in the test area may significantly alter the test sensitivity to a particular tracer gas.

7.2 *Cleanliness of Test Surface*—The areas to be tested must be free of oil, grease, paint, water, and other contaminants that might mask a leak or be drawn into the leak detector and clog the probe.

7.3 *Pressurizing with Test Gas*—In order to evaluate leakage accurately, the test gas in all parts of the device or system must contain substantially the same concentration of tracer gas. When the device contains air prior to the introduction of test gas, or when an inert gas and a tracer gas are added separately, this may not be true. Devices in which the effective diameter and length are not greatly different, such as tanks, may be tested satisfactorily by simply adding tracer gas; however, when long or restricted systems (piping) are to be tested, more uniform tracer gas distribution will be obtained by first evacuating to less than 100 Pa (.75 torr), and then filling with the tracer gas or by employing proper purge technique.

7.4 *Unknown Tracer Gas Concentration*—When performing the calibration of the leak detector, a capillary standard leak generally is used that contains 100 % concentration of the tracer gas. Leak testing often is done on devices or systems that do not contain this same gas concentration as the standard leak. Doing so will cause the test sensitivity (detector response) to be less than that from the standard leak.

7.5 *Operator Scanning Variations*—The leak detector response will change when the test operator varies the scanning parameters because the scanning distance and speed determines the tracer gas concentration that the leak detector measured. Any change in scanning parameters from those used for calibration may cause a reduction in test sensitivity and instrument response.

7.6 *Gas Compatibility*—Some gases, such as hydrogen and ammonia, may permanently alter the instrument sensitivity and stability. Refer to the instrument manufacturer's manual.

8. Apparatus

8.1 *Thermal Conductivity Leak Detector*—This detector should have a minimum detectable leak rate of 4.5×10^{-9} mol/s (1×10^{-4} Std cm^3/s). To perform tests as specified in these test methods, the detector should have the following minimum features:

8.1.1 Thermal conductivity sensor.

8.1.2 Device to maintain a stable probe air velocity.

8.1.3 Controls to zero detector.

8.1.4 Battery status indicator for portable instruments. The instrument sensitivity for a portable detector shall not vary prior to a low battery indication.

8.2 *Standard Leaks of Both Fixed and Variable Type*—The leak rate of the standard leak used for the system calibration shall be equal to the acceptance level (maximum permissible leakage rate). The leak rate of the standard leak may be less than the acceptance level when the system tracer concentration is less than 100 % for testing.

8.3 *Test Component/System Enclosure*, either a rigid structure or heavy plastic cover, to contain partially or totally surround the test part with tracer gas. The enclosure must not restrict flow to the leak detector.

9. Calibration of Leak Detector

9.1 The detector shall be turned on and allowed to warm up and zeroed as specified by the manufacturer. The probe (sensor) then shall be moved across the standard leak at a distance of not more than 1 mm (0.04 in.) from the standard leak orifice and moved not faster than 20 mm/s (0.8 in./s), and the detector's response observed. The standard shall be scanned several times and the average indicated leakage rate is the test acceptance reading. The scanning speed and distance may have to be adjusted during calibration to improve the detector response. These scanning parameters established during calibration shall not be exceeded while scanning the test system.

9.2 The capsule leak should be stored with the shutoff valve, if present, closed, and the leak should be allowed to stabilize for approximately 5 min after opening.

9.3 Calibration shall be performed prior to, upon completion of, and during testing at intervals not to exceed 1 h. Failure of a calibration check to obtain the same or greater response as the previous check shall require that an evaluation or retest of all tested parts or areas examined be performed.

9.4 For the accumulation method, the thermal conductivity detector needs to be checked against a known standard concentration of the tracer gas in air into the test volume during the accumulation time. For volumes different from the test volume, a proportional adjustment shall be made.

10. Procedure

10.1 Evacuate the device or test system to remove air and pressurize with tracer gas to the specification test pressure. When the test system cannot be evacuated, either the system must be purged sufficiently with the tracer gas or the tracer gas concentration calculated. When testing is performed with a tracer gas concentration less than 100 %, then the output shall be scaled appropriately to correct the instrument response.

10.2 Calibrate the leak detector in accordance with 9.1. This calibration shall be performed in the test area to allow the probe to sample the background gases.

10.3 *Probe Areas Suspected of Leaking*—The thermal conductivity sensor shall be held not more than 1 mm (0.04 in.) from the test surface and moved not faster than 20 mm/s (0.8 in./s). The gases, scanning rate, and distance shall be equal to that used in the calibration performed in 9.1. Any detector response shall be verified by moving the probe away from the area and then rescanning the area. Any verified response less than the instrument response established from sampling the leak standard in accordance with 9.1 is acceptable, and leakage readings equal to or greater than that instrument response is unacceptable.

10.4 When surface scanning is hindered by adverse atmospheric or testing conditions, such as wind, drafts, or wet surfaces, an enclosure may be used to protect and accumulate the tracer gas. An exact quantitative measurement under these conditions usually is not possible.

10.5 Check calibration as specified in 9.1.

11. Precision and Bias

11.1 *Precision*—The uncertainties in these test methods that are measured statistically, are referred to as Type A uncertainties. These uncertainties can be evaluated by making repeated measurements. Typically, these values may be no better than 20 % of the leak rate. These uncertainties will be affected by the following:

11.1.1 The ability of the test technician to duplicate the test procedure (scanning rate, calibration, etc.);

11.1.2 The variability in interferences caused by air currents and the local air composition; and,

11.1.3 The stability of the sensing instrument.

11.2 *Bias*—The uncertainties in these test methods that are evaluated by nonstatistical means, are referred to as Type B uncertainties. The bias uncertainties will be composed of the uncertainties in the calibrated leak used for the instrument calibration, the uncertainties associated with the readability of the instrument, the test uncertainties concerned with the assumptions of the tracer gas concentration, uniformity, and effects due to test conditions including blockage of leaks with condensable gases or particles and air currents within the testing environments. Estimates of the bias uncertainties should be made at the time of testing.

12. Keywords

12.1 conductivity leak test; leak testing; sensitive leak test; thermal conductivity leak test