Designation: E2024/E2024M – 11

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

This standard is issued under the fixed designation E2024/E2024M; 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 practice covers procedures for detecting the sources of gas leaking at the rate of 1×10^{-5} Pa m^3/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 *Units*—The values stated in either SI or std-cc/sec units are to be regarded separately as standard. The values stated in each system may not be exact equivalents: therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

2.2 *ASNT Documents:*[3]

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

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

2.3 *AIA Standard:*

NAS-410 Certification and Qualification of Nondestructive Test Personnel[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, see Terminology E1316, Section E.

4. Summary of Practice

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 The following items are subject to contractual agreement between the parties using or referencing these test methods:

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.08 on Leak Testing Method.

Current edition approved July 1, 2011. Published July 2011. Originally approved in 1999. Last previous edition approved in 1999 as E2024 - 05. DOI: 10.1520/E2024_E2024M-11.

[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 for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

[4] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.

***A Summary of Changes section appears at the end of this standard**

6.2 *Personnel Qualification*

6.2.1 If specified in the contractual agreement. Personnel performing examinations to these test methods shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, or 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.

6.3 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E543. The applicable edition of Practice E543 shall be specified in the contractual agreement.

6.4 *Re-examination of Repaired/Reworked Items*—Re-examination of repaired/reworked items is not addressed in these test methods, they shall be specified in the contractual agreement

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 1×10^{-5} Pa m^3/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 (CL) used for the system calibration shall be equal to the acceptance level (maximum permissible leakage rate). The leak rate of the standard leak will be less than the acceptance level when the system tracer concentration is less than 100 % for testing. value of the standard leak to be used is determined by the following formula:

$$CL = LR_{acc} \times \%C/100 \quad (1)$$

where:

CL = leakage rate of standard leak (Pa m^3/s or std cm^3/s),
LR_{acc} = acceptance level (maximum permissible leakage rate), and
$\%C$ = percentage concentration of tracer gas.

8.3 *Test Component/System Enclosure,* either a rigid structure or heavy plastic cover, to contain partially or totally surround the test part to accumulate the escaping 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. Stratification of the tracer gas shall also be taken into consideration.

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 CL leakage rate shall be determined in accordance with 8.2.

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. Keywords

11.1 conductivity leak test; leak testing; sensitive leak test; thermal conductivity leak test

SUMMARY OF CHANGES

Committee E07 has identified the location of selected changes to this standard since the last issue (E2024 - 05) that may impact the use of this standard. (July 1, 2011)

(1) Changed standard from Test Method to Practice.
(2) Added combined units statement as 1.2.
(3) Changed SI units of mol/s to Pa m^3/s in 1.1 and 8.1.
(4) Added formula to 8.2 to clarify relationship of CL, LR_{acc}, and %C.
(5) Added caution about stratification of tracer gas to 9.4.
(6) Added reference to 8.2 formula in 10.1.
(7) Deleted Precision and Bias section; and renumbered Keywords section.