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Standard Test Methods for Determining Hermeticity of Electron Devices with a Helium Mass Spectrometer Leak Detector[1]

This standard is issued under the fixed designation F 134; 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 leaks and measuring leak size in electron devices and associated parts with a helium mass spectrometer leak detector.

1.2 *Method A, Helium Leak Test,* may be conducted on parts with an internal cavity which either contains gas other than helium (such as air or nitrogen) or is evacuated.

1.2.1 The measured leak rate is a function of internal free volume, conditioning pressure and time, and the delay time between pressurizing and testing as well as the leak size. In general, if molecular flow is assumed, leak size can be calculated from the measured leak rate. Both the upper and lower limits of detectability depend on conditions of the measurement and so no single range of applicability can be specified for the method.

1.2.1.1 The smallest detectable leak size (see 5.7) depends primarily on the internal free volume, the product of conditioning pressure and time, and the sensitivity of the leak detector.

1.2.1.2 The largest detectable leak size (see 5.2) depends primarily on the internal free volume, and the delay time between conditioning and testing, and, to a lesser extent, on the conditioning pressure and the sensitivity of the leak detector.

1.2.1.3 The method may be applied to detect leaks with leak size between the smallest and the largest detectable leak size. In practice, a value of the maximum acceptable leak size (see 5.5) is agreed upon between the parties to the test and the conditions of the test are established by adjusting the product of conditioning pressure and time so that this leak size is greater than the smallest detectable leak size. Then leaks greater than this can be detected unless they exceed the largest detectable leak size. To detect leaks larger than the largest detectable leak size, other procedures must be employed (Note 1).

1.2.2 If a quantitative measure of leak rate is required parts must be tested singly. Batch testing for a leak is permissible (see 11.1.6).

1.2.3 For repetitive or routine testing of devices of a fixed volume under fixed conditions, a go, no-go test can be established based on the measured leak rate.

1.3 *Method B, Helium Tracer Probe Test,* is used to locate actual leakage sites. Leaks in the range 10^0 to 10^{-8} atm·cm³/s can be detected.

1.3.1 This method can be applied both to electron devices and to other parts such as terminals which can be attached to an evacuated chamber.

1.3.2 Under conditions in which the blanket of helium surrounding the leak approaches a pressure of 1 atm, the measured leak rate determined by this method approaches the leak size.

NOTE 1—Alternative methods for determining hermeticity of electron devices may be found in Practices F 97 and Practices F 98 (see 2.1).

1.4 These test methods are not appropriate for use on grease-filled devices.

1.5 Method A cannot be used on devices for which the specified conditioning pressure would exceed the component rating.

1.6 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

F 78 Method for Calibration of Helium Leak Detectors by Use of Secondary Standards[2]

F 97 Practices for Determining Hermeticity of Electronic Devices by Dye Penetration[2]

F 98 Practices for Determining Hermeticity of Electron Devices by a Bubble Test[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *internal free volume, V* [cm³]—within a device, the total volume that can contain a gas or vapor.

3.1.2 *largest detectable leak size, L_{max}* [atm·cm³/s]—the largest value of leak size in a package of a particular volume that gives a reading on a leak detector with a particular sensitivity when measured a particular time after the end of the conditioning period. An approximate relationship between the variables is as follows:

$$L_{max} \approx 0.0062\,(V/t_2)\ln(2.69\,L_{max}P_E/Q_{min}),$$

where:

P_E = conditioning pressure, atm,

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[2] *Annual Book of ASTM Standards*, Vol 10.04.

t_2 = delay time, min, between conditioning and measurement, and the other quantities are defined in this section (Fig. 1).

3.1.3 *leak detector sensitivity,* Q_{min} [atm·cm³/s]—the value of measured leak rate that is four times the background leak rate of the leak detector (see 10.2). This quantity is affected by the surface absorption characteristics of the devices being tested in addition to the characteristics of the leak detector.

3.1.4 *leak size, L* [atm·cm³/s]—the quantity of dry air (dew point less than −25 C) in cubic centimetres that flows through an aperture or porous wall at 23 ± 3 C in 1 s with a pressure differential of 1 atm across the aperture or wall.

3.1.5 *maximum acceptable leak size,* L_A [atm·cm³/s]—the largest value of leak size that can be tolerated in parts deemed acceptable with respect to hermeticity. This value must be mutually agreed upon by parties to the test.

3.1.6 *measured leak rate,* Q_m [atm·cm³/s]—the quantity of helium in cubic centimeters that flows through an aperture or porous wall in 1 s as determined under specified conditions. Usually, leak rates measured under different conditions or by different methods cannot be compared unless flow mechanisms are assumed and corresponding leak sizes calculated.

3.1.7 *smallest detectable leak size,* L_{min} [atm·cm³/s]—the smallest value of leak size in a package of a particular volume that gives a reading on a leak detector with a particular sensitivity after conditioning in helium at a particular pressure for a particular time. An approximate relationship between the variables is as follows:

$$L_{\text{min}} \approx 0.0062\ \sqrt{Q_{\text{min}}V/P_{\text{E}}t_1}$$

where:

P_E = conditioning pressure, atm,

t_1 = conditioning time, h, and

the other quantities are defined in this section (Fig. 2). Deviations from this relationship occur at large values of the ratio $P_E t_1/V$ as shown by the shaded areas in Fig. 2. The deviations are greatest for small values of P_E. To obtain a value for the minimum detectable leak rate in these areas, the full relationship between L and Q_m should be employed (see 12.1.4).

4. Summary of Test Methods

4.1 *Method A*—Helium gas is forced under pressure into the completed part. The part under test is then transferred to a chamber connected to a helium mass spectrometer leak detector, and the rate of leakage of helium from the part is measured.

4.2 *Method B*—The part under test is attached to a

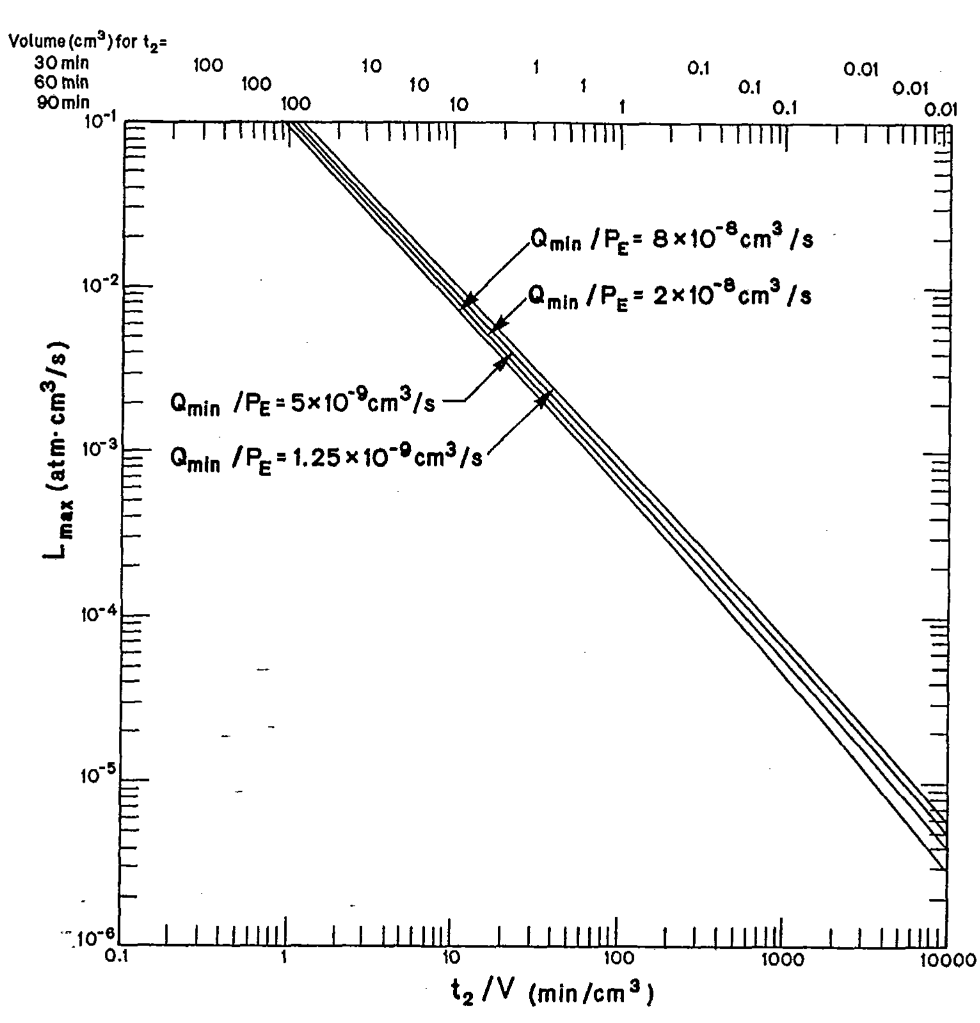

FIG. 1 Largest Detectable Leak