

Scope: Excerpted from ASTM E498/E498M-11

This practice covers procedures for testing and locating the sources of gas leaking at the rate of 1×10^{-8} Pa-m³/s (1×10^{-9} Std. cm³/s) or greater. The test may be conducted on any object to be tested that can be evacuated and to the other side of which helium or other tracer gas may be applied.

This test method is used to helium leak test objects that are capable of being evacuated to a reasonable test pressure by the leak detector pumps in an acceptable length of time. This requires that the object be clean and dry. Also, to cope with larger volumes or relatively “dirty” devices, auxiliary vacuum pumps having greater capacity than those in the mass spectrometer leak detector (MSLD) may be used in conjunction with the MSLD. The leak test sensitivity will be reduced under these conditions.

Significance and Use:

Test Method A is the most frequently used in leak testing components which are structurally capable of being evacuated to pressures of 0.1 Pa (approximately 10^{-3} torr). Testing of small components can be correlated to calibrated leaks, and the actual leak rate can be measured, or acceptance can be based on a maximum allowable leak. For most production needs acceptance is based on acceptance of parts leaking less than an established standard which will ensure safe performance over the projected life of the component. Care must be exercised to ensure that large systems are calibrated with reference leak at a representative place on the test volume. Leak rates are determined by calculating the net gain or loss through a leak in the test part that would cause failure during the expected life of the device.

Interferences:

Series leaks with an un-pumped volume between them present a difficult if not impossible problem in helium leak testing. Although the trace gas enters the first leak readily enough since the pressure difference of helium across the first leak is approximately one atmosphere, it may take many hours to build up the partial pressure of helium in the volume between the two leaks so that enough helium enters the vacuum system to be detected by the MSLD. This type of leak occurs frequently under the following conditions:

- Double-welded joints and lap welds.
- Double O-rings
- Threaded joints
- Ferrule and flange-type tubing fittings
- Casings with internal voids
- Flat polymer gaskets
- Unvented O-ring grooves

In general, the solution is in proper design to eliminate these conditions; however, when double seals must be used, an access port between them should be provided for attachment to the MSLD. Leaks may then be located from each side of the seal and after repair, the access port can be sealed or pumped continuously by a “holding” pump (large vacuum systems).

Temporarily plugged leaks often occur because of poor manufacturing techniques. Water, cleaning solvent, plating, flux, grease, paint, etc. are common problems. To a large extent, these problems can be eliminated by proper preparation of the parts before leak testing. Proper degreasing, vacuum baking, and testing before plating or painting are desirable.

In a device being tested, capillary tubing located between the leak and the leak detector can make leak testing extremely difficult as test sensitivity is drastically reduced and response time increased. If there is a volume at each end of the capillary, each such volume should be attached to the leak detector during testing. If this is impossible, the device should be surrounded with a helium atmosphere while attached to the leak detector for a long time to assure leak tightness. When unusually long pumping times are necessary, the connections to the leak detector (and all other auxiliary connections) that are exposed to the helium should be double-sealed and the space between the seals evacuated constantly by a small auxiliary roughing pump to avoid allowing helium to enter the system through seals that are not a part of the device to be tested.

Apparatus

- Helium Mass Spectrometer Leak Detector, having a minimum detectable leak rate as required by the test sensitivity.
- Auxiliary Pumps, capable of evacuating the object to be tested to a low enough pressure so that the MSLD may be connected.
- If the object under test is small and clean and the MSLD has a built-in roughing pump, the auxiliary pumps are not required.
- Suitable Connectors and Valves, to connect to the MSLD test port. Compression fittings and metal tubing should be used in preference to vacuum hose.
- Standard Leaks of Both Capsule Type (Containing its own Helium Supply) and Capillary Type (an Actual Leak which is Used to Simulate the Reaction of the Test System to Helium Spray)—The leak rate from the capsule-type leak should be adequate to demonstrate the minimum allowable sensitivity of the MSLD. The capillary type should be slightly smaller than the test requirement.
- Vacuum Gage, to read the pressure before the MSLD is connected.
- Helium Tank and Regulator, with attached helium probe hose and jet.

Calibration of MSLD

Attach the capsule leak to the MSLD and tune the MSLD to achieve maximum sensitivity in accordance with the manufacturer's instruction.

Allow sufficient time for the flow rate from the capsule leak to equilibrate. The capsule leak should be stored with the shutoff valve (if present) open and the leak should be allowed to equilibrate to ambient temperature for several hours.

MSLD calibration shall be performed prior to and upon completion of testing.

Procedure

Evacuate the device to be tested until near equilibrium pressure is reached on the rough vacuum gage.

Open the valve to the leak detector and close the valve to the roughing pumps.

This procedure will be automatic where the device is relatively small and clean and where an automatic MSLD is used without external pumps. Do not allow the pressure in the spectrometer tube to exceed the manufacturer's recommendation. This means in some cases that the MSLD inlet valve can only be partially opened. Maximum test sensitivity will be achieved with the inlet valve completely open and the auxiliary pump valve completely closed. However, testing at reduced sensitivity levels can be done as long as the inlet valve can be opened at all.

Adjust the helium probe jet so that a small flow of helium is coming from the tip.

Set the leak detector on the appropriate lowest range.

Pass the tip of the helium probe by the end of the standard capillary leak at a rate similar to the scan rate at which the object under test will subsequently be tested.

Note the deflection of the leak detector output meter. If the probing rate is increased, the test sensitivity will be decreased, and if the probing rate is decreased, the test sensitivity will be increased. Consequently, when a leak is indicated during leak testing, it will be necessary to move the probe slowly backward until a maximum signal occurs. (Continued...)

The approximate leak size can be determined by multiplying the size of the standard leak by the maximum reading obtained from the located leak and dividing by the maximum reading obtained when the helium was applied directly to the standard leak.

Starting at the most suspect part of the object to be tested, spray the smallest amount of helium on the part that will give a signal when sprayed on the capillary leak.

If there are drafts, work up opposite to the direction of air flow.

When a leak is pinpointed, it should be first evaluated if desired, then sealed either permanently (preferable) or temporarily in such a manner as to allow repair at a later time, before proceeding to look for additional leaks.

If the leak is so large that the MSLD output saturates (that is, goes to the top of the highest range), it can be evaluated by reducing the sensitivity of the test until the signal from the standard leak is barely readable. This can be done by opening the roughing valve and partially closing the MSLD inlet valve or by reducing the sensitivity of the leak detector itself if more convenient.

If the unknown leak still produces an off-scale signal, it will be necessary to use a larger standard leak and far less test sensitivity or to use a reduced percentage of helium in the probe. (For instance, a probe gas concentration of 1 % helium and 99 % nitrogen would reduce the apparent sensitivity by a factor of 100.)

After the first leak has been found and sealed, the same technique is continued until all leaks have been similarly treated.

After all leaks have been found and repaired, it is desirable to enclose the entire device in a helium envelope (which can be a plastic bag or a large bell jar) to determine the total device integrity. This step could also be done first and would eliminate the necessity for probing if no leakage is shown. However, if there are any materials in the device that are pervious to helium, doing this step first may build up the helium background to such a degree that subsequent probing would be insufficiently sensitive. Write a test report or otherwise indicate the test results as required.