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Seal Testing Devices

Prefilled with Helium

IsoVac Report R–4210

PURPOSE:
Evaluation of the abilities and shortcomings associated with the Helium Mass Spectrometer, (HMS), testing of electronics parts that are prefilled with some percentage of helium.

BACKGROUND:
The tightening of the Military Standard leak testing requirements has introduced some complications in the leak testing procedures. This is of particular importance with small cavity devices. Commonly, devices are either bombed in pure helium for intervals of time as required in the standards, or they are prefilled with helium at time of sealing. The percentages of helium are usually 10%, sometimes 15-20%, and less frequently with 100% helium. The major concern is with the filling with 10-20% He.

The devices may be filled with helium at time of manufacture, and then leak tested, usually within one hour. The concerns, (following 1071.8 para. 10.2.2 "Failure Criteria"), must be categorized as follows:

- Packages that are < 0.01 cm^3 and must pass a leak test to 1×10^{-9} atm cm^3/s (**air**).
- Packages that are > 0.01 and < 0.5 cm^3 are required to pass a 5×10^{-9} atm cm^3/s (**air**) leak test.
- Large packages > 0.5 cm^3 are required to be leak tested to a sensitivity of 1×10^{-8} atm cm^3/s (**air**).

1. A package with a cavity of < 0.01 cm^3 must be tested to 1×10^{-9} atm cm^3/s (**air**), which is equal to a helium leak rate of ~3×10^{-9} atm cm^3/s (He). If you have put 10% helium in the part and you are looking at a 3×10^{-9} helium leak, you will only see a helium reading of 3×10^{-10} atm cm^3/s (He) on the HMS. A 20% helium fill will only give you a reading of ~6×10^{-10} atm cm^3/s (He) on the HMS, (about an order of magnitude below the background reading of most production HMS).

2. A package with a cavity of > 0.01 and < 0.5 cm^3 must be tested to 5×10^{-9} atm cm^3/s (**air**), (which is equivalent to ~1.4×10^{-8} atm cm^3/s (He)). If you have filled the part with 10% helium and you are looking at a 1.4×10^{-8} atm cm^3/s (He) leak, you will only see a helium reading of 1.4×10^{-9} atm cm^3/s (He) on the HMS. (A reading below the normal background of the HMS).

3. A > 0.5 cm^3 package filled with 10% helium must be tested to 1×10^{-8} atm cm^3/s (**air**) which is equal to an equivalent ~3×10^{-8} atm cm^3/s (He). If you have only put 10% He in the part, a 3×10^{-8} (He) leak will be measured as ~3×10^{-9} atm cm^3/s helium on the HMS. That is at the very lower limit of the common measurability on the HMS in production environments.

It is easy to see that the readings achieved with the 10% helium fill are readings that are at or below the normal background readings of the common production mass spectrometers.

POST-QUAL TESTING:

The final, or "Pre-Shipping" HMS testing of prefilled parts becomes more questionable when the parts are subjected to a seal test using the HMS, following 'Temp-Cycling', 'Burn-in" and any other series of testing to which the parts must be subjected prior to a "pre-shipping", or "final" HMS test.

Interfering factors:

1. The loss of prefill if the parts have been through temperature cycling which has been confirmed to cause some parts to open during the temperature cycling. If a part opens, it will loose some of the prefilled helium from within the part. Without the remaining helium concentration being accurately known, The final HMS test in questionable

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2. If the parts were subjected to F/C fluid bubble testing during the initial test sequence, the validity of the 'pre-shipping' helium leak test is questionable, (and actually in violation of the MIL-STDs which do not accept 'Fine leak' testing following a F/C test), as it is known that fine leaks are masked by the F/C fluid. Data has shown that it is not uncommon to reduce an accurately determined fine leak rate by 2-3 orders of magnitude by subjecting the device to F/C fluid.

3. The small cavity devices are most susceptible to escape after qual testing as they can loose prefilled-helium tracer-gas in a very short time if they develop or increase their leak rate. The majority of parts that open during thermal cycling are found to open up with leak rates in the 10^{-6} range. That leakage may only be during the time the device is at a temperature of 50^{o} to65^{o}C, (as that is the temperature range where most thermal leakers are being detected). A 0.01 cm^3 cavity part will lose about 98% of its helium in about 10 hours with 1×10^{-6} leak rate. With a 1×10^{-7} leak rate the same part will loose about half of its gas overnight, and result in the measured leak rate being about an order of magnitude less than the true leak rate of the part.

4. A device that has been filled with 100% helium faces the same anomalies as are described in the paragraphs above. The absolute percentage of helium remaining within the package after it has been through one or two weeks of handling and testing, is always of concern.

5. "Back-Pressurization" of packages prior to 'pre-shipment' leak testing should assume there is no helium within the part and be pressurized in compliance with 1071.8 Failure Criteria. If the devices are not leaking, there is no excess yield loss. If they have leaks and have some of the original prefill helium within the parts and that is increased by the back-pressurization, the only consequence is that the part will reject with an indicated leak rate greater than the true leak rate of the part, <u>but it will not escape</u>. However, if the part has seen F/C fluid immersion, and then develops a leak during qual-testing, the back-pressurization step is not likely going to put in as much helium as predicted, and the measurement is thus questionable.