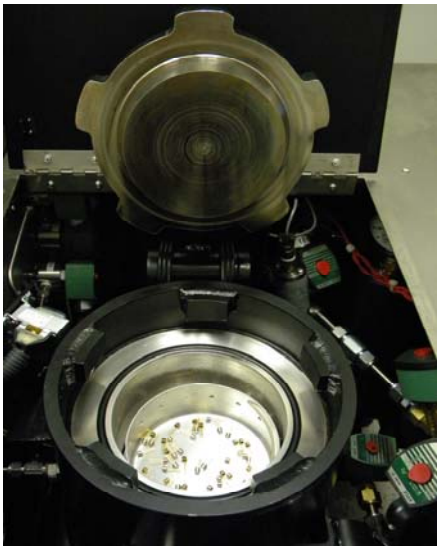
ONEIDA RESEARCH SERVICES, INC.

Krypton-85 Hermeticity Test Sequence

The Krypton-85 Leak Testing method is a highly sensitive technique used to measure fine and gross leak rates in high reliability devices. It is the preferred method to characterize small leak rates in critical components. The advantages of Krypton-85 over other methods include extremely fast test times, lower overall testing cost, lower leak rate detection ($<10^{-12}$ atm cc/sec Air limits), minimal absorption to glass and other materials (as with Helium), leak site identification and the ability to test in ambient conditions. Use of a radioisotope tracer gas in leak detection allows for minute quantities of the tracer to be measured without the need for extracting the tracer gas under high vacuum.

Krypton-85, used as a tracer gas, is mixed with Air thereby increasing the quantity of gas for pressurization while creating a viscosity equivalent to that of air. The minimum amount of test gas that can be measured is dependent upon the concentration of Krypton-85 being used and the number of Krypton-85 disintegrations that can be detected. The number of disintegrations per second occurring in one atm-cc of Krypton-85 is related to its half-life and to the number of Krypton-85 molecules. The half life of Krypton-85 is 10.76 years. Over 99% of the disintegrations involve the emission of beta particles with 0.5% of the disintegrations leading to gamma emission. It is the gamma photon, combined with the release of low energy x-rays that are able to penetrate the walls of the component to be measured and converted to a leak rate.



Kr-85 Pressurization Tank

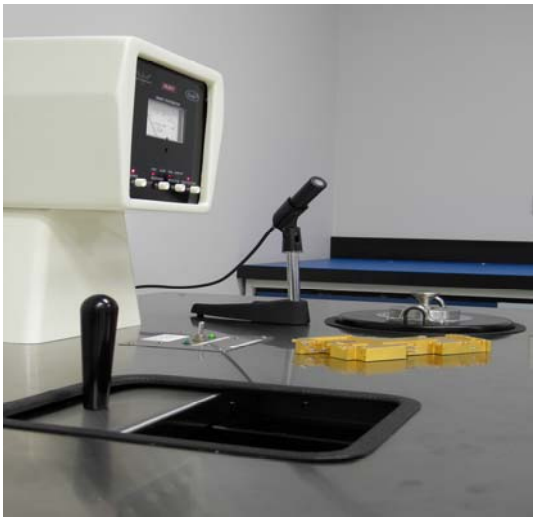
Low leak rate sensitivity is based on the time of exposure and external tank pressure. The equation used to relate the gamma count rate to the leak rate can be found in Military Standard 883, method 1014 and Military Standard 750, method 1071 as follows:

$$Q_s = \frac{R}{(S)(K)(P)(T)(t)}$$

Where:
Q_s = reject leak rate (atm cc/sec Kr-85)
R = detector reject level (cpm)
S = specific activity (uCi/atm cc)
K = counting efficiency (cpm/uCi)
$P = (P_e^2 - P_i^2)$
P_e^2 = external bomb pressure (atm)
P_i^2 = internal pressure of part (atm)
T = bomb time (hours)
t = 3600 (sec/hr)

The Krypton-85 leak rate equation determines the pressure and duration of the test based on a reject leak rate value (Q_s). These calculated conditions are then used in the device pressurization cycle. Test samples are placed in a sealed vessel, evacuated to 0.5 torr to remove moisture and Air and then pressurized per the specified value. Once the pressurization cycle is complete, the gas is recovered. A vacuum is pulled on the sealed vessel to 0.5 torr for fine leak testing or 2.0 torr for gross leak testing. The tank is then backfilled with air and devices are removed immediately for screening.

Packages are screened using a calibrated X-ray scintillation crystal. A flat crystal or a well type crystal is utilized depending on the package size and quantity being tested. The well crystal is able to detect up to 15,000 cpm/uCi of residual Krypton-85. The count rate measured is a direct measurement of the disintegration rate of Krypton 85 molecules. Each Krypton 85 molecule emits a 0.51 MeV Gamma ray. The total number of molecules that entered the package can be calculated, and hence, the total leak rate of the package. In addition, the detection process is performed at ambient conditions and thus the packages are not exposed to vacuum. Testing at ambient conditions mitigates or eliminates the problems encountered with helium based leak testing. A major concern of helium based testing is the issue of de-adsorption. Krypton-85 gives off both gamma rays and beta particles making it detectable both internally and externally. Beta radiation is stopped by the walls of the package and therefore not detectable on the scintillation crystal. Beta particles can, however, be detected with the use of a Geiger-Mueller counter, or GM tube. This GM tube is used to measure any Krypton-85 gas that may be trapped on the external package surface or possibly being emitted from a gross leak site.



Krypton-85 Counting Station

This type of ultra sensitive detection capability allows for the measurement of extremely small quantities of Krypton-85 gas that may have entered the package. Due to the sensitivity of the crystal and the speed at which results can be read, the Krypton-85 system is ideal for production quantity batch testing, device failure analysis and low level, small cavity leak detection.

If you have any questions or would like additional information regarding services offered at Oneida Research Services, Inc. please contact Mrs. Deborah Delluomo by telephone at (315)736-5480 or by email at dadelluomo@ors-labs.com.

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