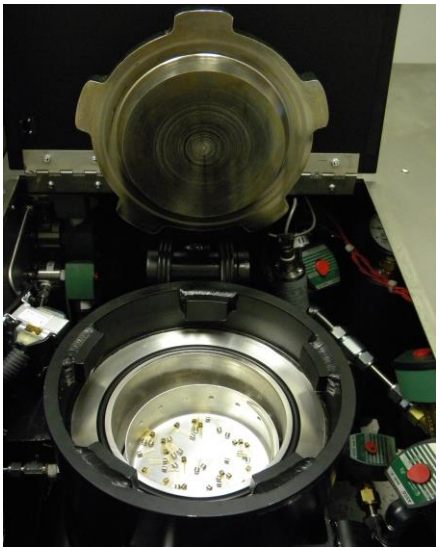
ONEIDA RESEARCH SERVICES, INC.

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 military 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, 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 extraction.

Krypton-85, used as a tracer gas, is mixed with Nitrogen increasing the quantity of test gas 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 atoms in one atm-cc. 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 and be measured as a leak rate.



Kr-85 Pressurization Tank

Low leak rate sensitivity is achieved based on the length of time and external pressure required to obtain the required quantity of gas. The equation used to relate the gamma count rate to the leak rate is:

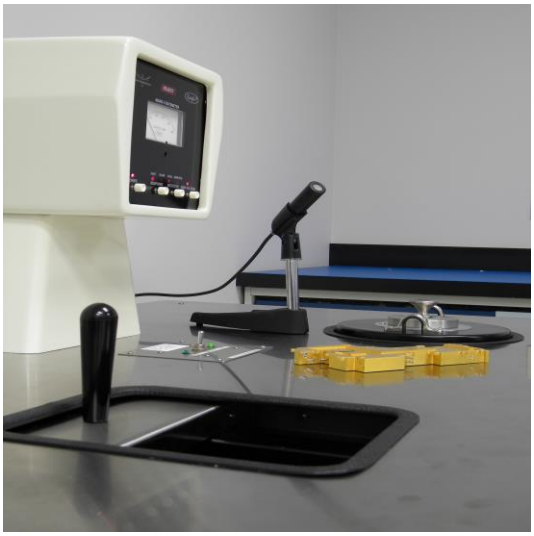
The Radiflo® Equation

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

Where:
Q = reject leak rate (atm cc/sec Kr)
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 (psia)
P_i^2 = internal pressure of part (psia)
T = bomb time (hours)
t = 3600 (sec/hr)

The Radiflo equation determines the pressure and duration of the test based on a reject leak rate value (Q). These calculated conditions are then used in the device pressurization cycle. Components are placed in a sealed tank which is evacuated to 0.5 torr and then pressurized per specification. Once the cycle is complete, the gas is recovered. This pump out cycle will go as low as 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 crystal is able to detect up to 15,000 cpm/uCi of residual Krypton 85. The count rate measured is the actual detection 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. Another concern of helium based testing is the issue of de-adsorption. Krypton 85 gives off both gamma and beta rays 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, but can be detected with the use of a Geiger Meuller Counter, or GM tube. This GM tube is used to measure any Krypton gas that may be trapped on the external package surface or possibly being emitted from a gross leak site.



Kr-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 further information regarding services offered at Oneida Research Services, Inc. please contact Ms. Krista Vivenzo by telephone at (315)736-5480 ext.2231 or by email at kvivenzo@ors-labs.com.

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