The Charcoal Gettering Technology

IsoVac Report R – 4150-A

The Radiflo® radioisotope leak test technology has been in practice for over forty years. Testing devices with cavities >0.02cc, the application is very reliable for both Gross & Fine leak detection, (without getters). However, with small cavity devices, the tracer-gas is lost too quickly for reliable detection of gross leaks. The same problem is even worse with helium and even with bubble tests.

The simplest description of the "Standard" Kr85 Gross-leak test procedure is to place devices in a pressurization chamber, evacuate out the air from the chamber, introduce a Kr85/air mixture to a pressure of 75-90 psia, for a period of 36 seconds, to several minutes, (depending on the sensitivity desired), and then return the Kr85 mixture back into a storage container. The objective in catching gross leaks is to 'out-pump' the leakage of the tracer-gas back out of the package through the leak. That is, to leave as much residual Kr85 tracer-gas in the package as possible. The advantage of the radioisotope test method is that the radiation is measured coming from the Kr85 tracer-gas that is left inside the part. It is not required to be sucked back out of the part as in the helium test. Also, the detectability of Kr85 gas is millions of times greater than the detection of helium in a mass spectrometer.

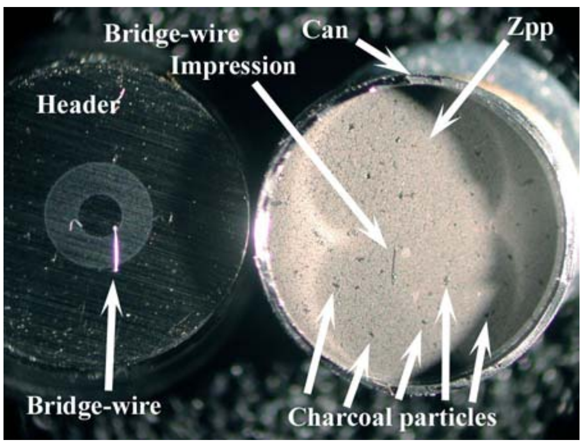
We are concerned with gross leaks in parts with < 0.01 cc cavities. Packages with such a small cavity and a 10^{-3} cc/sec gross leak will lose it's helium in a matter of seconds. If the cavity is smaller, or the leak is larger, neither a bubble test nor a helium test will reliably catch it. The Radiflo test is not absolute either, unless the part is bombed long enough to impregnate the internal materials, or there is a charcoal gettering material inside the part, which will hold the Kr85 gas long enough to assure detection. Unfortunately, there is no type of charcoal that will getter or hold helium.

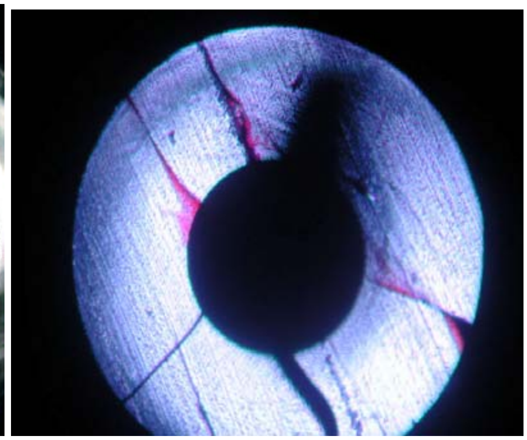
The ***new technology*** for applying the radioisotope leak test to detect gross leaks in small or even 'zero-cavity' devices, involves the use of a licensed patented process(1) that uses a unique gettering medium to collect and hold the Kr85 gas long enough to allow reliable detection, even in a wide-open package. The gettering medium is "Steam-Activated Coconut-Shell Charcoal". Charcoal is a form of "Carbon", a "non-metallic Element", atomic number 6, atomic weight 12. The activated charcoal form has an affinity for Kr85 gas. It will "a**d**sorb' and hold Kr85 gas for as long as 30 minutes after bombing the device in a Kr85-Nitrogen mixture. The scientific theory is a combination of physics and chemistry, where the van der Waals forces of bond between the charcoal and the Kr85 molecule are extremely strong. It is a well known art of using charcoal in breathing apparatus to allow the charcoal to collect and hold toxic gases away from the human wearing the apparatus. Charcoal also has a unique attraction for water vapor, and it will hold water up to 27% of the charcoal's weight. This unique feature is used by many companies to protect their product from damage to the circuit in application by eliminating water vapor from the package throughout the device life. Steam activated charcoal is essentially a molecular lattice. It has a surface area that is 500-1000 square meters per gram. A typical 100/300 mesh charcoal particle has a diameter of 0.003", a volume of ~ 4×10^{-7} cc, and weighs 0.243 µgm, and yet it provides 133 mm^2, (1.33 cm^2), of surface area. A typical 8 mg application of charcoal in a device will provide over 30,000 cm^2 of surface area. In a typical application, hundreds of 300 mesh particles are used, or, a few dozen to a few hundred larger particles are used. This new technology is being used commercially in over 75 million devices per year.

The ***application*** of this technology is varied. In some 'zero-cavity' applications, (such as explosives), the charcoal is mixed with the explosive, compressed at 20,000 psi and sealed in a can. In the electronics field, charcoal is bonded using various techniques, to the lid of a package, inside of a TO-type can, or to the inner walls of a package. With these techniques, devices that otherwise do not have enough cavity to hold a detectable amount of tracer-gas, the charcoal makes it easily detected, even with large gross leaks. Silver-epoxies are commonly being used to reliably bond the charcoal in a package.

Charcoal has been added to ordnance materials for over sixty years for various applications. The addition of a few milligrams of charcoal to modern day ordnance materials, specifically in initiators, gas generators, and other types of cartridges, has shown that there are no deleterious effects associated with the charcoal presence in the powder. The adsorption of water up to 27% by weight of the charcoal has been found to be an enhancement in the ordnance performance.

IsoVac Engineering has offered to work with the manufacturers of the very small packages in an effort to develop a reliable method of including charcoal within these packages, to provide a reliable means of detecting large gross leaks.





The left photo shows an initiator with the can separated from the header. The header was pressed so tightly against the highly compressed ordnance material that the bridge-wire left an impression in the ordnance, demonstrating that the device had a "Zero-Cavity". A few milligrams of charcoal are seen mixed into the ordnance. This "open-can" tested with the Radiflo system would be detected as a reject due to the charcoal, and would remain as a reject for twenty to thirty minutes. The same device tested with Helium mass spectrometry was not detectable. The right photo shows a header feed-through glass with multiple radial-cracks, which resulted in 'gross-leaks' into the bridge-wire area. Such leakage is undetectable by Helium or bubble testing, since there is no cavity to store the helium for detection, or provide gas for bubble detection.

(1) US Patents: 5,452,661 & 5,929,367