TRITIATED STAINLESS STEEL SURFACES

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Stainless steel is widely used in the fabrication of tritium gas handling systems. Its popularity as a construction material resides in part with the good mechanical properties stainless steel possesses in the presence of hydrogen and in part with the availability of an established industrial base to build components for high pressure and/or ultrahigh vacuum applications. In fact, it is quite common in tritium gas handling applications to design components to meet design criteria which satisfy both hard vacuum and high pressure requirements simultaneously. While the influence of hydrogen on stainless steel has been studied in detail, the impact of tritium with the metal surface is limited. This review paper summarizes studies which have been underway at Ontario Hydro Technologies for several years.

Surfaces exposed to tritium gas release tritium labeled species continuously for prolonged periods. While the release of these gases depends on several factors including surface condition and exposure conditions, the make up of the outgassed species changes with time. Shortly after an exposure T_2 and HTO dominate the outgassing spectrum. However as time passes, that is to say, as the tritiated surface ages, tritium labeled organics contribute significantly to the spectrum. Compounds such as formaldehyde have been observed in the outgassing spectrum. These compounds tend to be water soluble, rapidly contaminate downstream surfaces in a flowing system and deliver doses to personnel which appear to differ from HTO vapour exposures.

Decontamination is used to mitigate the spread of activity within a facility and to permit safe handling of items which have seen tritium service. Several techniques are available to reduce tritium contamination on surfaces. These include washing with a solution comprising water and a surfactant with or without the aid of an ultrasonic bath, thermal desorption, purging with a humid stream and exposure to room temperature plasmas. The effectiveness of each of these techniques has been compared using coupons which have been identically treated during the manufacturing, exposure to tritium and storage phases. Washing is convenient however the approach produces low level mixed waste. In addition, the decontamination is temporary; the surface activity returns within a few days as tritium in the subsurface diffuse to the surface. Thermal desorption permits removal approximately 95% of the tritium inventory on a surface provide the metal can be heated to 350 °C. Plasma decontamination, where applicable, is the most effective technique achieving nearly complete removal of tritium from a surface within a few minutes with negligible 're-growth' of surface activity in the following weeks. Items in many cases can be decontaminated to background levels.

This paper will characterize emission species from stainless steel surfaces outgassing at room temperature and at elevated temperatures, in dry and humid streams, demonstrate that the emission spectrum changes with time, and compare the effectiveness of several decontamination techniques.