Contribution ID: **475** Type: **Poster**

Tritium speciation in nuclear site metals: An aid to decommissioning

Monday, 14 May 2018 18:00 (15 minutes)

Insights into the manner in which tritium is associated and retained in metals can be gained by studying total tritium and its progressive loss with incremental heating from 20-900℃. A range of metals from two nuclear sites and one non-nuclear site has been investigated for their tritium content and associated thermal desorption profiles. These metals have had different exposure histories to tritiated water or neutrons and these variations have led to their different tritium content. Irradiated and non-irradiated metals show different tritium thermal desorption profiles and this reflects the relative ease of thermally decomposing hydrated oxides trapped along grain boundaries or the greater difficulty in mobilizing tritium trapped in the metal lattice. Significant 3H was observed in non-irradiated metals (e.g. stainless steel and copper) which implies that exposure of the metal to tritiated water vapour or gases near the nuclear facilities is a significant source of tritium contamination. Tritium contamination into the metals via atmospheric absorption is mainly confined to the surface layer or paint layer. Tritium penetrates into the metal surface by diffusion with a rate controlled by the metal types and the surface condition of the metal (painted, unpainted).

Tritium contamination of metals via neutron activation is not mainly confined to the surface layer. It will be affected by the distribution of some elements (e.g. 6Li or 10B) presented in the metal. Tritium of metal mainly presented two different forms including a weakly bound 3H (inferred to be an HTO form) and a strongly bound form (inferred to be a non-HTO form) that required a high temperature to liberate it. However, the HTO form of the metal has different thermal decomposition behaviour indicating a slow desorption rate at low temperature (~120 ℃). This is significantly different thermal decomposition behavior of HTO isolated rapidly at low temperature (~100 ℃). Therefore, the effective and quantitative extraction of 3H from metals requires prolonged heating at a high temperature (900 ℃ for 4-5 hours).

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Session Classification: Poster NAM

Track Classification: Nuclear Analytical Methods