Identifying, Predicting and Preventing Localized Corrosion in Kr-85 Storage Canisters

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ABSTRACT:

During the reprocessing of used nuclear fuel, Kr-85 (half-life 10.75 years) is released into off-gas streams and must be recovered for safe storage. In the United States, the collected Kr-85 off-gas has been stored in steel canisters under low pressure (50 atm) or high pressure (~160 atm) with a zeolite Kr-getter which in some cases had been processed by hot isostatic pressing (HIPing). The Kr canisters must retain their integrity for a 100 year lifespan. However, recent investigations of legacy Kr storage canisters, made of carbon steel with stainless steels welds, have shown extensive corrosion, well before the required 100 year service lifetime. It has been suggested that Rb, the product of the decay of the Kr-85, is responsible for the corrosion of the canisters. However, the small literature section available on Rb interactions with steel is contradictory as to whether Rb drives corrosion processes or has no negative impact on the corrosion resistance of steel. Along with Rb, several other risk factors likely to influence the corrosion resistance of the canister materials may also be present (water, chloride, oxygen, hydrogen, the zeolite getter, metal heterogeneity, contaminants, radiation).

The proposed research effort will deliver information regarding the influence of Rb on steel corrosion rates, of relevance to the integrity and corrosion resistance of Kr-85 storage canisters, by leveraging collaborative expertise in corrosion and materials science. As well, the impact of Rb on the corrosion resistance of steel will be weighed against the other corrosion risk factors present to determine the root cause and mitigation strategies for the corrosion of the canisters. A combination of corrosion techniques, electrochemical analyses, spectroscopy, zeolite studies, and microscopy will be utilized to study this complex corrosion issue.