Uptake and release of tritium by nickel

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To improve understanding of the mechanism of the chronic release of tritium from fusion reactor materials the uptake and release of tritium by nickel was compared with that of Type SS316 stainless steel. As known, the solubility of tritium in nickel is of the same order of magnitude as that in Type SS316 but the diffusivity is considerably higher. Thus, in accordance with expectations, loading nickel and Type 316 stainless steel with tritium-containing hydrogen under the same conditions gave rise to specimens of comparable tritium content. Depth profiles of loaded specimens were obtained by chemical etching with hydrogen peroxide. Tritium release rates were determined at temperatures in the range 288 – 308 K by placing specimens in a flow system with dry argon or ambient air as carrier gas and collecting liberated tritium in bubblers over extended periods of time. The liberation rate of tritium was also quantified under vacuum conditions. Runs in a flow apparatus that permitted distinction between HT and HTO showed that more than 99 % of the released tritium consists of water. The results revealed that at ambient temperature the chronic release rates of tritium from nickel are higher than those from Type 316 stainless steel. This can be rationalized by the higher diffusivity of tritium in nickel than in stainless steel and the assumption that on the metal surface isotopic exchange with ambient moisture is not rate determining. This assumption is supported by calculations.

A one-dimensional diffusion model was taken as a basis to evaluate release rates numerically. Best fit values of tritium diffusion coefficient across nickel were estimated by comparing results from calculation with experimental values at the selected experimental temperatures. The best fit diffusion coefficients were found to be in line with corresponding values given in the literature. From this it follows, that at ambient temperature the release of tritium from nickel is probably controlled by a simple diffusion mechanism.