TRITIUM PERMEATION ISSUES FOR THE ITER TORUS CRYOPUMPS

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ITER is the first fusion device designed for equimolar deuterium / tritium operation. For this reason, the possibility that tritium could permeate through the stainless steel wall of the torus cryopumps' (CP) cryosorbing panels and the tubes carrying the cryogen to them has been considered. By its nature, hydrogen permeation rates strongly depend on the temperature at which it occurs, becoming very small as the temperature decreases. The present work is based on extensive search into the available literature on protium, deuterium and tritium permeation. According to literature, permeation involves adsorption, dissolution, diffusion, and desorption. Any tritiated gas specie (HT, DT, T_2) ultimately dissociates into atoms, which are then free to permeate inside all surfaces according to well documented temperature-dependent solubility, diffusivity and permeation rates. One difficulty is that most papers on hydrogenlike permeation deal with temperatures at or well above room temperature, while the torus CPs will be kept most of the time at cryogenic temperatures, for which permeation data are not available. In this case extrapolations have been made of data at room temperature.
The paper discusses the results of calculations carried out by considering the wall thickness of all cryogenically-cooled CP components --quilted cryopanels and tubes--, taking into account the duration and magnitude of the thermal cycles during the operation and regeneration of the torus CPs. These two factors, combined with the tritium decay half- life of 12.3 years, result in almost all of the tritium decaying before having permeated to a distance corresponding to the thickness of the cryopanels and tubes of the cryogenic system. This study has been compared to measurements made at JET during the 1997 D-T Phase on permeation through 2 mm-thick inconel bellows at a much higher temperature, and the agreement is good. As a result, the detailed design of the cryogenic system can be carried out without considering the additional engineering complexity of radiologically safe tritiated components.