DESIGN OF PD-BASED MEMBRANE REACTOR FOR GAS DETRITIATION

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The development of a Pd-based membrane reactor to be applied in a process for tritium removal from various gaseous streams of tokamak systems has been carried out.
This membrane reactor consists of Pd-Ag permeator tube fixed in a finger-like mode into a stainless steel shell. The feed stream (gases to be detritiated) is fed inside the membrane lumen where the isotopic exchange takes place on to a catalyst bed while pure hydrogen is sent in countercurrent mode in the shell side. The feed stream is a low activity gas stream of flow rate in the range 10-20 L/h.
The membrane reactor design has been based on a simplified calculation model which takes into consideration the very low tritium content of the gas to be processed and a complete oxidation of the tritiated species in the feed stream. The model considers a tubular Pd-Ag membrane divided into finite elements where the mass balances are carried out according to both the thermodynamic equilibrium reactions and permeation rates through the membrane of the hydrogen isotopes.
The reactor modeling permitted to verify that a Pd-Ag membrane tube of diameter 10 mm, 500 mm of length and 150 μm of wall thickness is capable to attain a decontamination factor larger than 10.
A new mechanical design of the Pd membrane reactor has been also developed: especially, any mechanical stress of the long permeator tube consequent to the hydrogenation and thermal cycling has been avoided. Furthermore, an innovative effective heating system of the membrane has been also applied.