A comparison study between water decomposition and high temperature electrolysis systems for tritium recovery

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In a deuterium-tritium (D-T) nuclear fusion plant, the development of highly tritiated water (HTW) processing systems for the tritium recovery is an important issue from both a tritium self-sufficiency and a safety points of view. HTW forms in various processes such as breeding blankets, recovery processes of tritium leakages from the primary enclosure, and fuel clean-up systems where plasma exhausts are treated. As a general strategy, it is desirable to decompose this tritiated water to recover tritium.

Regarding the potential technologies for the HTW processes, they are mainly based on chemical reaction and isotopic exchange reactions in the liquid phase or in the vapour phase. In this work two chemical reaction based systems for processing HTW have been studied: water decomposition by water gas shift reaction (WGSR) and high temperature electrolysis.

The WGSR takes place into a Pd-based membrane reactor which consists of Pd/Ag membranes coupled with a catalyst bed. Pd/Ag membranes are selectively permeable to hydrogen isotopes which are continuously removed from the gas stream. In this way, the reaction equilibrium can be shifted beyond the thermodynamic limit so that high reaction conversion (i.e. high water decomposition) is attained.

High temperature electrolysis (HTE) has the potential for higher efficiency than conventional electrolysis and can be accomplished using similar materials and technology to those used in solid oxide fuel cells.

Particularly, the processing of the materials used in such devices has been studied, those materials have been fully characterized and a comparison between these two tritium recovering systems has been performed.