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Recent achievements of the Pd-Ag membrane technologies in tritium extraction system applications

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The main expertise of the Membrane Laboratory of ENEA Frascati is related to the study and development of Pd-based membrane technologies (both permeators and catalytic reactors), which are one of the reference processes in the fuel cycle of nuclear fusion reactors. Principal characteristics of Pd-based membranes are infinite hydrogen selectivity, elevated hydrogen permeability, modularity, reduced cost and low energy consumption.

In the last few years, the ENEA laboratory has realized two experimental facilities for testing single and multi-tube Pd-Ag membrane modules. Several experimental and simulation activities have been carried out to evaluate the application of these technologies in the tritium extraction system of the solid blanket concept. In addition an important work has been done to optimize the membrane modules design.

This paper presents most significant results obtained in the two facilities during the He-H₂ permeation and heavy water decontamination tests under several operating conditions. During the permeation tests, many He-H₂ feed flow ratios have been investigated giving the possibility to experimentally describe the behavior of the Pd-Ag membrane module under DEMO-relevant conditions. Water decontamination tests have been performed by exploring the effect of different catalysts and reactions (i.e. isotopic swamping and water gas shift). All the results are discussed to define the scenario in which Pd-Ag membrane technologies can be considered an effective solution for the tritium extraction system. For the identified scenario a preliminary dimensioning of the system is also presented.

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