

Tritium aging effects on hydrogen permeation through Pd8.5Y0.19Ru alloy membrane

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Palladium alloy membranes have been widely used as permeator to produce pure tritium from impurities and tritide gas mixture in fusion reactor. But long term continuous operation will lead to accumulation of ^3He in alloy, resulting in tritium aging effects. Reports have primarily focused on the influence of tritium aging effects on mechanical properties, lattice parameters, growth of He bubble in the metal, and so on. In the present work, the effects on hydrogen isotopic permeation behaviors have been investigated.

To enlarge tritium aging effect, the atomic ratio of ^3He to metal in Pd8.5Y0.19Ru (at.%) alloy membrane reaches to 0.042, which is far more than the ^3He accumulation in practical operation. And then protium/deuterium permeation experiments were carried out with temperature varying from 573 to 723K, and pressure varying from 10^4 to 10^5 Pa. The results show that effects of radiogenic He in Pd8.5Y0.19Ru alloy membrane on hydrogen permeation behaviors are serious, not only decreasing the permeability, but also increasing the permeation separation factor α .

Fig.1 shows the protium and deuterium permeability of Pd8.5Y0.19Ru alloy membrane. The relationship between protium/deuterium permeability(Φ) and temperature(T) can be described as: $\Phi_H = 2.566 \times 10^{-6} \exp(-3542.45/T)$ mol/m.s.Pa^{0.5}, $\Phi_D = 1.398 \times 10^{-6} \exp(-3443.72/T)$ mol/m.s.Pa^{0.5}. Whereas the permeability expression for aged membrane is: $\Phi_H = 3.314 \times 10^{-7} \exp(-2918.32/T)$ mol/m.s.Pa^{0.5}, $\Phi_D = 2.053 \times 10^{-7} \exp(-2796.18/T)$ mol/m.s.Pa^{0.5}. Change in H-D permeation separation factor of Pd8.5Y0.19Ru alloy membrane is given in Fig.2.

^3He accumulation extremely decreases the strength of Pd8.5Y0.19Ru alloy membrane. The membrane containing ^3He using in the experiments is easy to be broken, which is unfit for practical operation.

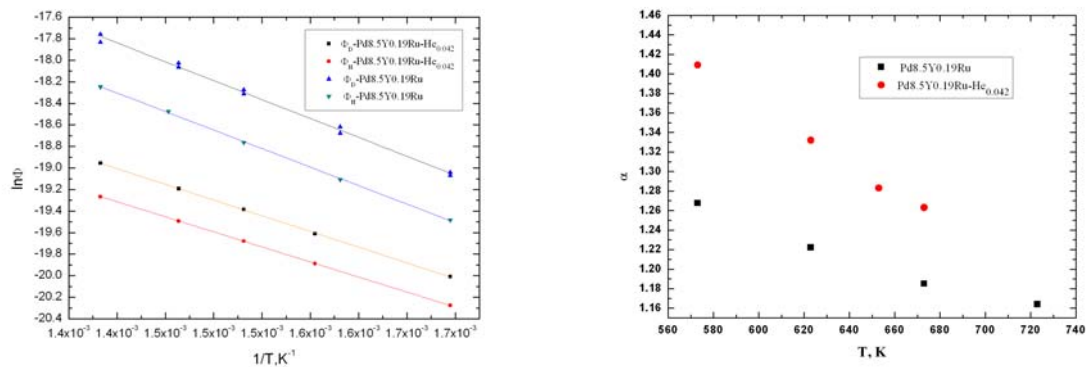


Figure 1 : Comprison of H_2 and D_2 permeability of original and aged Pd alloy membrane

Figure 2: Comprison of H-D permeation separation factor of original and aged Pd alloy membrane