

反应堆工程

钯-银复合膜在高温气冷堆氦气净化中的应用初探

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摘要 针对金属钯-银合金复合膜分离氦气中杂质氢气的应用进行探索性研究。按照法国CEA一套小型氦气净化试验装置CIGNE的设计参数, 采用典型SSP设计, 应用有限单元法求解模型。膜组块长度采用限定值0.5 m, 膜高压侧压力为100 kPa, 跨膜压力差为80 kPa。计算结果表明, 一次通过即可使氢气浓度从1 000 $\mu\text{L/L}$ 降低到限定值5 $\mu\text{L/L}$, 在最优化吹扫气比例系数0.397 0情况下, 氦气产出率为96.18%, 满足系统设计要求。氢气浓度在膜组块内沿长度方向呈指数分布。对采用相同膜组块的另外两种典型设计TSSP和CMC也进行了初步计算和比较。

关键词 [钯复合膜](#) [氦气净化](#) [膜分离](#) [再循环单分离渗透器](#) [串联双分离渗透器](#) [连续薄膜塔](#)

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Preliminary Study on Application of Pd Composite Membrane in Helium Purification System of High-Temperature Gas-Cooled Reactor

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Abstract Helium purification system (HPS) is the main part of the helium auxiliary system of high-temperature gas-cooled reactors (HTGR), also in fusion reactors. Some exploratory work was carried out on the application of Pd composite membrane in the separation of He and H₂. A typical single stripper permeator with recycle (SSP) system was designed, based on the design parameters of a small scale He purification test system CIGNE in CADARACHE, CEA, France, and finite element analysis method was used to solve the model. The total length of membrane module is fixed to 0.5 m. The results show that the concentration of H₂ is found to reduce from 1 000 $\mu\text{L/L}$ in feed gas to 5 $\mu\text{L/L}$ in the product He (the upper limitation of HPS in HTGR). And the molar ratio of product He to feed gas is 96.18% with the optimized ratio of sweep gas to retentive gas 0.397 0. It's an exponential distribution of H₂ concentration along the membrane module. The results were also compared with the other two popular designs, two stripper in series permeator (TSSP) and continuous membrane column (CMC).

Key words [Pd composite membrane](#) [helium purification](#) [membrane separation](#) [single stripper permeator with recycle](#) [two stripper in series permeator](#) [continuous membrane column](#)

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