

反应堆工程

聚变堆交叉冷却固态包层中子学设计优化

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摘要 针对聚变堆固态包层设计路线, 提出了一个交叉排列氦冷固态包层概念。设计采用Be、Li<sub>2</sub>TiO<sub>3</sub>分层球床。两种尺寸的氦气冷却管道交叉排列, 分两个回路同时冷却, 以增加系统安全可靠性。分析比较了4种<sup>6</sup>Li富集度布置方案。结果表明: 径向远离第一壁降低<sup>6</sup>Li富集度较为合理, 靠近第一壁的增殖层<sup>6</sup>Li富集度不能过低, 以减少长期运行中Li的消耗对氦增殖性能的影响。借助蒙特卡罗程序MCNP建立11.25°对称模型, 全堆包层氦增殖率为1.176, 包层寿命期内产氦性能稳定, 在包层寿命运行时间内的燃耗分布相对均匀。

关键词 [氦冷固态包层](#) [<sup>6</sup>Li富集度](#) [氦增殖率](#)

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Neutronics Design Optimization on Cross Cooled Solid Blanket of Fusion Reactor

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**Abstract** Aiming at the outline of fusion reactor solid blanket design, the crossed helium cooling channel solid blanket concept was developed. It adopted separated Be and Li<sub>2</sub>TiO<sub>3</sub> pebble bed as neutron multiplier and tritium breeder. Two kinds of cooling tubes were cross arranged, and the blanket was cooled by two loops of helium channels at the same time in order to increase the blanket availability. The 11.25° symmetric model was set up by using MCNP. After preliminary estimation, 4 cases of <sup>6</sup>Li enrichment arrangement were compared. The results show that lower <sup>6</sup>Li enrichment away from first wall in poloidal would be appropriate, and the <sup>6</sup>Li enrichment in the breeder zone near to the first wall should be high enough to reduce the effect of Li depletion on the tritium breeding performance during long time operation. Global tritium breeding ratio (TBR) reaches 1.176, and it obtains a relative steady tritium breeding performance over whole operation time. The burn up of Li is relatively uniform during blanket lifetime.

**Key words** [helium](#) [cooled](#) [solid](#) [blanket](#) [-<sup>6</sup>Li](#) [enrichment](#) [-](#) [tritium](#) [breeding](#) [ratio](#)

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