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反应堆工程

聚变裂变混合堆钍基增殖锕系元素嬗变包层中子学初步研究

马续波;陈义学;王悦;张斌;杨寿海;韩静茹;张普忠;石生春

华北电力大学 核科学与工程学院，北京102206

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摘要 聚变裂变混合堆比纯聚变堆在工程及技术方面要求低，且在产生核燃料、嬗变长寿命核废料以及固有安全性方面具有一定优势，因此，越来越受到人们的重视。增殖包层是混合堆系统的关键部件，已有的包层研究基本上是基于较成熟的铀 钚燃料循环技术。针对我国铀资源相对较少而钍资源较丰富的现状，本文就一种新型的钍基燃料增殖锕系元素嬗变包层进行了初步的中子学研究，利用一维离散纵标法燃耗程序BISONC以及Monte-Carlo粒子输运程序MCNP，对包层的关键核参数，诸如氚增殖比、少量锕系元素的嬗变质量、^{233}U产量以及热功率等，进行了较详细的计算分析。计算结果表明，生成的核燃料^{233}U的富集度可达到3.65%，从而满足压水堆燃料富集度要求。分析结果为下一步的包层优化设计提供了依据。

关键词 中子学 聚变裂变混合堆 钍包层 锕系元素

分类号

Preliminary Neutronics Calculation of Thorium-Based and MA Transmutation Breeding Blanket for Hybrid Fusion-Fission Reactor

MA Xu-bo;CHEN Yi-xue;WANG Yue;ZHANG Bin;YANG Shou-hai;HAN Jing-ru;ZHANG Pu-zhong;SHI Sheng-chun

School of Nuclear Science and Engineering, North China Electric Power University, Beijing 102206, China

Abstract Hybrid fusion-fission reactor has advantages of production of nuclear fuel and transmutation of long-life nuclear waste and having inherent safety, at the same time, demand is significantly reduced compare to the pure fusion reactor. Breeding blanket is the key part of the fusion-fission reactor and in the past, the uranium-plutonium blanket concept was widely investigated. Considering the problem of uranium-plutonium cycle and abundant in thorium in our country, in this work, a thorium-based breeding and MA (minor actinides) transmutation blanket concept was proposed and the preliminary neutronics calculation was discussed. One-dimensional transport and burnup calculation code BISONC and Monte-Carlo transport code MCNP were used to calculate the key parameters, such as tritium breeding ratio, production of ^{233}U mass and power density, and so on. The fuel of ^{233}U enrichment can be 3.65%. It is the foundation for optimization of the blanket.

Key words neutronics _ fusion-fission reactor _ thorium-based blanket _ minor actinides

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