

反应堆工程

# 海基核动力装置自然循环数学模型的建立与运行特性研究

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**摘要** 建立了适用于海基核动力装置自然循环运行分析的理论模型, 主要包括两相不平衡态、五方程的漂移流模型;改进的混合物动量守恒方程来描述海洋条件引起的附加压降;采用多压力节点模型进行压力矩阵的求解;选择非等温模型计算两相摩擦因子, 并考虑摇摆对摩擦因子的影响;对低雷诺数自然循环工况下阻力件的能量损失因子进行了修正;考虑摇摆与浮沉对换热系数的影响;建立了两群三维时空中子动力学模型, 采用基于非线性迭代的半解析节块法来求解中子扩散方程。对海基核动力装置在横摇、纵摇、横倾、纵倾、浮沉、直线变速、回转等条件下的自然循环运行特性进行了研究。

关键词 [海基核动力装置](#) [自然循环](#) [数学模型](#)

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## Theoretical Model Research and Operating Characteristics Analysis of Natural Circulation for Nuclear Machinery Under Ocean Condition

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**Abstract** The natural circulation theoretical models of nuclear machinery under ocean condition were established, which mainly include two-phase, non-homogeneous, drift flux model with five equations. The additional pressure drop induced by ocean condition was illustrated by modifying the mixture momentum equation, the nodal pressure solution was used to solve the pressure matrix, the non-isothermal model was preferred to calculate the two-phase friction factor, and the influence of shaking motion to which was also taken into account. The local loss coefficient was calculated as a function of Reynolds number. The influence of shaking and heaving motion to heat transfer coefficient was also considered. The two-group, 3-D neutron kinetics model was established. A nonlinear iterative semi-analytical nodal method was used to solve diffusion equation. The natural circulation operational characteristics of nuclear machinery under rolling, pitching, heeling, heaving, linear acceleration and rotation motions were investigated.

**Key words** [marine](#) [nuclear](#) [machinery](#) [natural](#) [circulation](#) [theoretical](#) [model](#)

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