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高温气冷堆主氦风机无变压器逆变器仿真设计

摘要

摘要：针对高温气冷堆主氦风机传统 H 桥级联驱动方案依赖移相变压器、体积大成本高，以及三电平拓扑在 6kV 中压工况下存在超压击穿风险的问题，本文将 5L-ANPC 无变压器拓扑应用于 4.5MW 主氦风机驱动系统，完成调制策略适配与电容电压平衡控制参数整定，搭建仿真模型开展全工况验证。结果表明，系统输出线电压 THD 低至 0.39%，直流侧中点电压稳态波动收窄至 ±200V，负载阶跃下具备优异的动稳态性能。本文结合安全裕量给出 IGBT 选型参考，为该驱动高温气冷堆主氦风机系统无变压器化升级提供了工程可行方案。

关键词

高温气冷堆；主氦风机；5L-ANPC；零序电压；IGBT 选型

Abstract

To address the defects of the traditional H-bridge cascaded drive scheme for the main helium blower of High Temperature Gas-cooled Reactor (HTGR), including dependence on phase-shifting transformers, large volume and high cost, as well as the over-voltage breakdown risk of three-level topology under 6kV medium-voltage conditions, this paper applies the transformer-less five-level active neutral-point-clamped (5L-ANPC) topology to the 4.5MW main helium blower drive system. The modulation strategy adaptation and parameter tuning of capacitor voltage balance control are completed, and a simulation model is established for full-operating-condition verification. The results show that the THD of system output line voltage is as low as 0.39%, the steady-state fluctuation of DC-side neutral-point voltage is narrowed to ±200V, and the system presents excellent dynamic and steady-state performance under load steps. Combined with safety margin requirements, this paper provides IGBT selection reference, and offers an engineering feasible scheme for the transformer-less upgrade of the HTGR main helium blower drive system.

Keywords

HIGH TEMPERATURE GAS-COOLED REACTOR (HTGR); MAIN HELIUM BLOWER; FIVE-LEVEL ACTIVE NEUTRAL-POINT-CLAMPED (5L-ANPC); ZERO-SEQUENCE VOLTAGE; IGBT SELECTION

Author: 金, 俞熹 (清华大学核能与新能源技术研究院)

Co-authors: WANG, hong; WANG, kui; GENG, yinan

Presenter: 金, 俞熹 (清华大学核能与新能源技术研究院)

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