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一种模块化航空有源滤波器的研究

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Research on a Modular Aeronautical Active Power Filter

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摘要

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摘要

航空有源滤波器(AAPF)是解决飞机供电系统中电能质量问题的一种先进方案,而模块化设计对航空有源滤波器灵活性、可维护性和可靠性的提升作用巨大。首先提出并研究了一种新型模块化航空有源滤波器,分析了主电路数学模型及其混合载波PWM(CH-PWM)调制方式;其次基于损耗对比分析进行了主电路拓扑优化,推导了模块均压控制律并给出了系统控制策略;最后进行了仿真和实验验证。结果表明,模块化航空有源滤波器能够有效补偿航空电网中由典型非线性负载产生的谐波和无功电流分量,三相电网电流的总谐波畸变率(THD)均在5%以下,补偿效果显著。

关键词: 有源滤波器 飞机供电系统 模块化 数学模型 混合载波PWM调制 损耗

Abstract:

The aeronautical active power filter (AAPF) is an advanced solution in resolving the power quality problems of aircraft electrical power systems, and modular construction design plays an important role in improving the flexibility, maintainability and reliability of the aeronautical active power filter system. First, this paper studies a modular aeronautical active power filter which is based on the H-bridge modular circuit. The main circuit topology of the modular aeronautical active power filter is described in a physical structure and a mathematical model. A carrier hybrid pulse width modulation (CH-PWM) colligating the characteristics of carrier phase shift pulse width modulation and carrier disposition pulse width modulation is analyzed. Second, by comparing the power loss of the different main circuit solutions, a suitable topology is selected and its corresponding control strategy is given. Finally, simulation and experiment are performed to verify the theoretical analysis. The results show that the harmonic and reactive components produced by the typical nonlinear load can be compensated effectively by the modular aeronautical active power filter, and the total harmonic distortions (THD) of three-phase source currents are below 5%. Thus, a good compensation performance is achieved by the proposed scheme.

Keywords: active power filter aircraft electrical power systems modular construction mathematical model carrier hybrid PWM modulation loss

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