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质子交换膜燃料电池的建模与仿真分析

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摘要: 针对当前燃料电池模型复杂、准确度不高、不利于控制策略研究等问题, 对质子交换膜燃料电池工作原理进行研究, 对燃料电池进行数学描述。通过分析电池工作过程中影响输出的几个主要因素即电化电动势、活化极化过电压、欧姆极化过电压、浓度极化过电压与双层电荷层作用, 建立燃料电池数学模型。用实验测试数据和参数优化方法确定模型参数, 并利用Matlab/Simulink仿真平台对质子交换膜燃料电池模型进行仿真分析。仿真结果表明: 模型输出结果与实验结果相吻合, 模型具有良好的稳态性能; 模型输出能快速响应负载变化, 其动态性能良好; 此模型能真实反映质子交换膜燃料电池工作特性, 能有效地用于燃料电池控制策略研究。

关键字: 燃料电池; 建模; 仿真; 参数优化

Modeling and simulation analysis of proton exchange membrane fuel cell

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Abstract: Based on the current problems in the complex fuel cell model, for example, the accuracy is not high and it is not easy to control strategy, the principle of proton exchange membrane fuel cell was introduced and taken as the foundation to describe the fuel cell mathematically. By analyzing some primary factors, such as electromotive force of cells, activation voltage drop, ohmic voltage drop, concentration voltage drop, double-layer charging effect and affected output in the battery work process, the fuel cell mathematical model was established. The model parameters were determined with the testing data and the parameter optimization method, and the model was emulated on the platform of Matlab/Simulink. The simulation results show that the model output and the empirical datum can totally reflect the operational factor of proton exchange membrane fuel cell accurately, and there is a good agreement between the model outputs and experimental results, and the steady-state and transient state characteristics of PEMFC can be reflected accurately. Therefore, this model may be applied effectively in the PEMFC (proton exchange membrane fuel cell) control strategy research.

Key words: fuel cell; modeling; simulation; parameter optimization

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