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能源和环境工程

管式固体氧化物燃料电池机理模型与性能分析

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摘要 针对Siemens-Westinghouse公司阴极支撑型(AES)管式固体氧化物燃料电池，耦合电极内部离子传导、电子传导、气体扩散、热量传递及电化学反应过程，建立了全面考虑活化极化、欧姆极化与浓差极化损失的管式SOFC横截面方向二维微观机理模型。模型计算结果与文献中实验数据吻合较好，模拟结果表明：电池横截面方向的组分浓度和电流密度的分布与SOFC的运行工况密切相关。连接器的存在和尺寸对电池工作性能均有较强影响。对于所研究的阴极支撑型SOFC，电池性能会受到氧气在多孔阴极中扩散过程的限制，改善多孔电极的微观结构可有效提高电池运行性能。

关键词 管式固体氧化物燃料电池；阴极支撑；机理模型；极化；传递

分类号

Mechanistic model development and performance study of cathode-supported tubular solid oxide fuel cell

Abstract

A cross-section direction two-dimensional mechanistic model of the Siemens-Westinghouse Power Corporation’s (SWPCs) cathode-supported tubular solid oxide fuel cell(SOFC) was developed.The model coupled the intricate interdependency among the ionic conduction, electronic conduction, gas transport, heat transfer and electrochemical processes.Three forms of polarization (activation polarization, Ohmic polarization, concentration polarization) were considered.Result validation showed good agreement with the published experimental data.The simulation results predicted that the species concentration and current density distributions were related to SOFC operating conditions.The size of current collector would affect the cell performance and should be carefully chosen.Gas diffusion through a thick and porous cathode was proven to be one of the performance-limiting factors and better cell performance could be achieved through the optimization of electrode microstructure.

Key words tubular SOFC cathode-supported mechanistic model polarization transport

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