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VUB Technology Offer – CHIS

Model for improved fuel cell process control

A control mechanism, of vital importance

Fuel cell systems are currently actively studied for commercial stationary power generation, residential applications and transportation technologies. To compete with the internal combustion engines (ICE), fuel cell systems must operate and function at least as well as the conventional engine. The transient behavior of a fuel cell system has an important influence on the operation and performance.
The viability, efficiency, and robustness of this technology depend on understanding, predicting and **controlling the unique transient behavior of the fuel cell system.** As power is generated by the fuel cell, heat and water or other products are generated, whereas fuel and oxidant are consumed. **To avoid membrane degradation and voltage loss during this transient, a control mechanism is of vital importance.**
The Chemical Engineering Department (CHIS) of the Vrije Universiteit Brussel (VUB) offers a new solution to answer this need.

Keywords

fuel cell
process control
transient behavior
multilayered model

Multilayered TSR Model

In the presented model, the fuel cell is described by a multilayered Tank in Series Reactor (TSR) model (Fig. 1). This **modified TSR model simulates the 2D behavior of a fuel cell**. The developed model accounts for component and energy balances in gas channels, electrolyte and catalyst layers together with charge balances at electrode/electrolyte interfaces. Hereby the partial pressures of oxidant and fuel, temperature and membrane hydration can be optimized and maintained during transient.
Polarization curves calculated with this improved model agree very well with experimental data (Fig. 2) and furthermore enable us to approximate parallel flow field design with co-current and counter-current operating modes for a planar fuel cell.

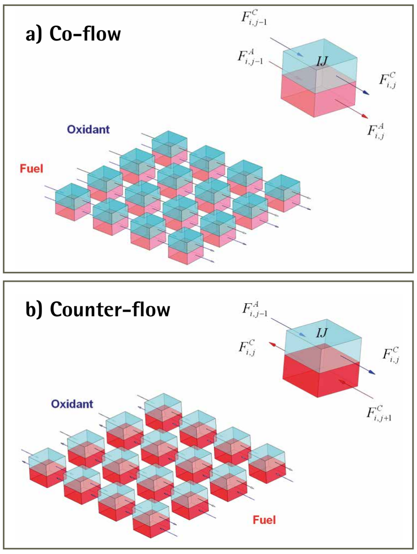

Figure 1:

Schematic presentation of the multilayered TSR model with (a) co-flow and (b) counter-flow of oxidant and fuel.

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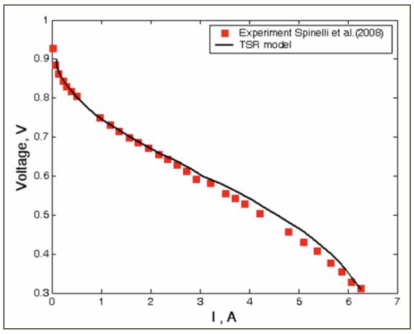

Figure 2:

The improved model predicts polarization curves in excellent agreement with experimental data from Spinelli P. et al. (J. Power Sources, 2008; 178, 517-524).

TSR Model Characteristics

- Potentiostatic and galvanostatic operation mode
- Simulation of 2D behavior (usually only 1D)
- Profound, stable and fast simulation
- Different set ups: co-flow, counter-flow (Fig. 1) and cross-flow

Advantages

- improved safety due to stable fuel cell operation
- improved efficiency due to optimal process control
- reduced membrane degradation

Market opportunities

Improved control of fuel cell processes is of concern to the **complete fuel cell value chain.** This model will aid fuel cell suppliers, process control engineers, and fuel cell users (chemicals and/or electricity producing companies) to improve the products and performances of **power generation fuel cells** and **fuel cells for chemical production** and electricity co-generation.

Commercialization phase

This know-how is available implemented in SIMULINK or another interface, and presents a **licensing opportunity.**

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