Simulation of Flow in a Rectangular Channel of a PEM Fuel Cell

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Introduction: This work presents the results of the simulation of a PEM fuel cell, focusing on the description of flow inside the gas channel. High flow rate is desirable to improve water management and avoid channel clogging, because it helps carrying water droplets downstream.

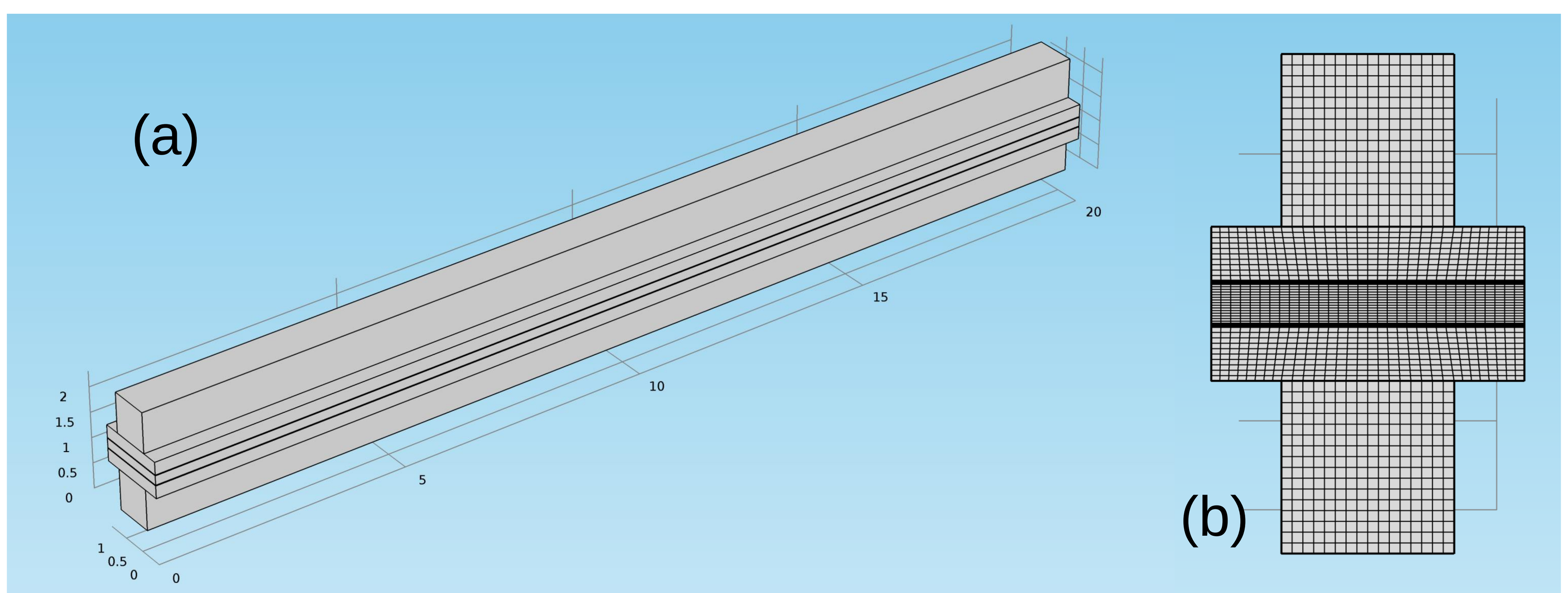

Figure 1. Geometric model (a) and Mesh (b)

Computational Methods: The geometric model used in this study comprises a fuel cell with a single rectangular channel (Figure 1). The physics interfaces used in this model were: Secondary Current Distribution, Free and Porous Media Flow, and Transport of Concentrated Species. The system is considered to be isothermal, steady state, and laminar flow. Hydrogen and oxygen, both humidified, are fed into the cell. In laminar flow, flow rate can be calculated with the following equation:

$$Q = \frac{V_{max}}{2} \cdot A_{cs}$$

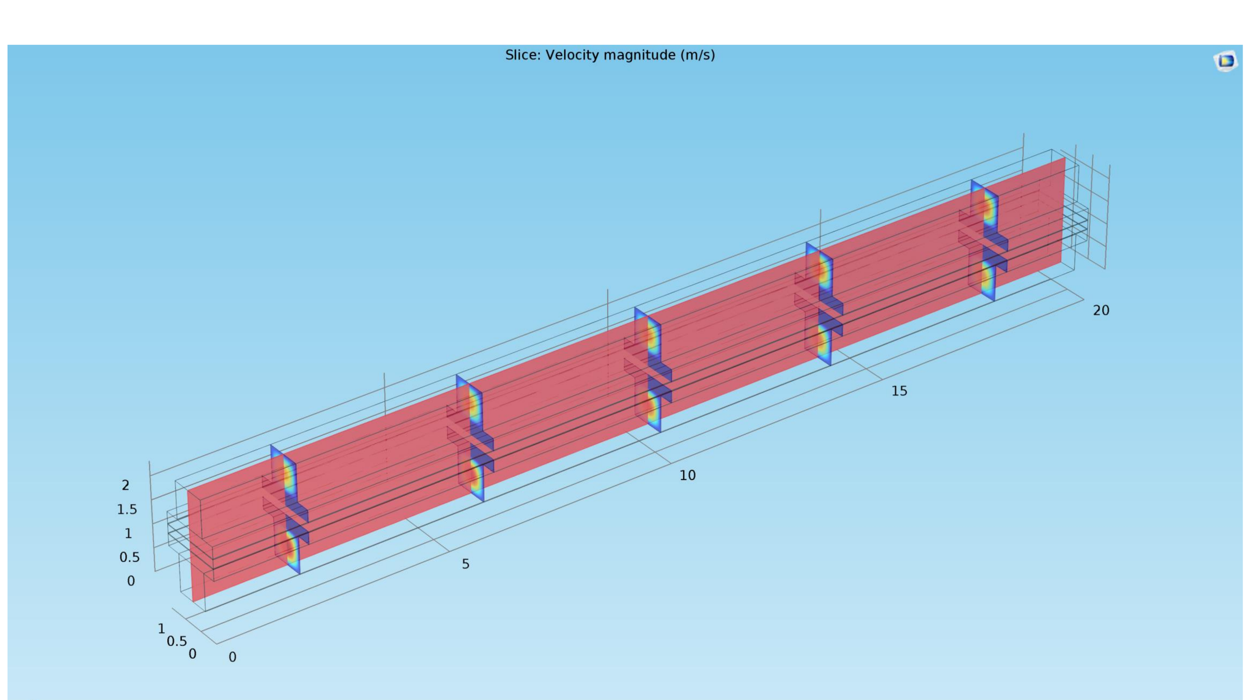

Figure 2. Midsection zx (red) and flow velocity

Results: The main variable evaluated in the channels was flow velocity. Flow rate was calculated from velocity and cross-section area (Figure 3). As expected in laminar flow, the velocity profile is parabolic (Figure 4). Flow rates change as the reactants are consumed and water is produced (Figure 5).

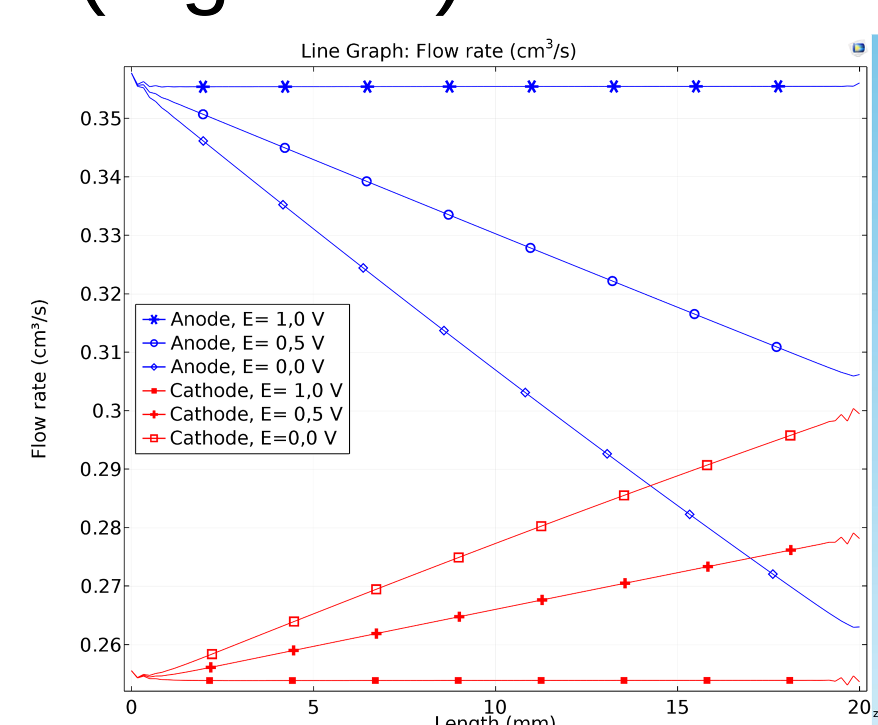

Figure 3. Flow rates

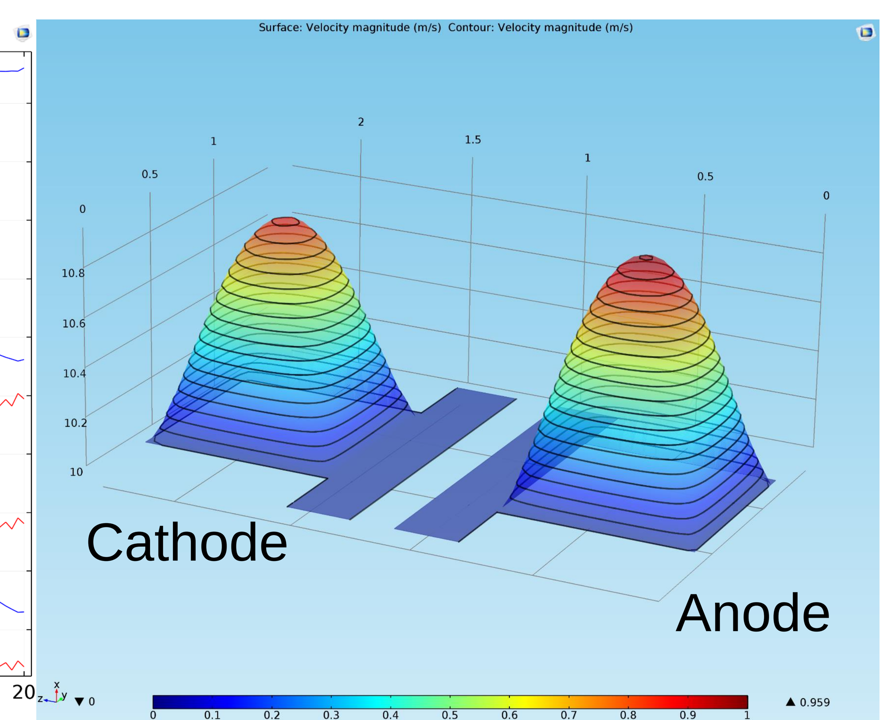

Figure 4. Velocity profile

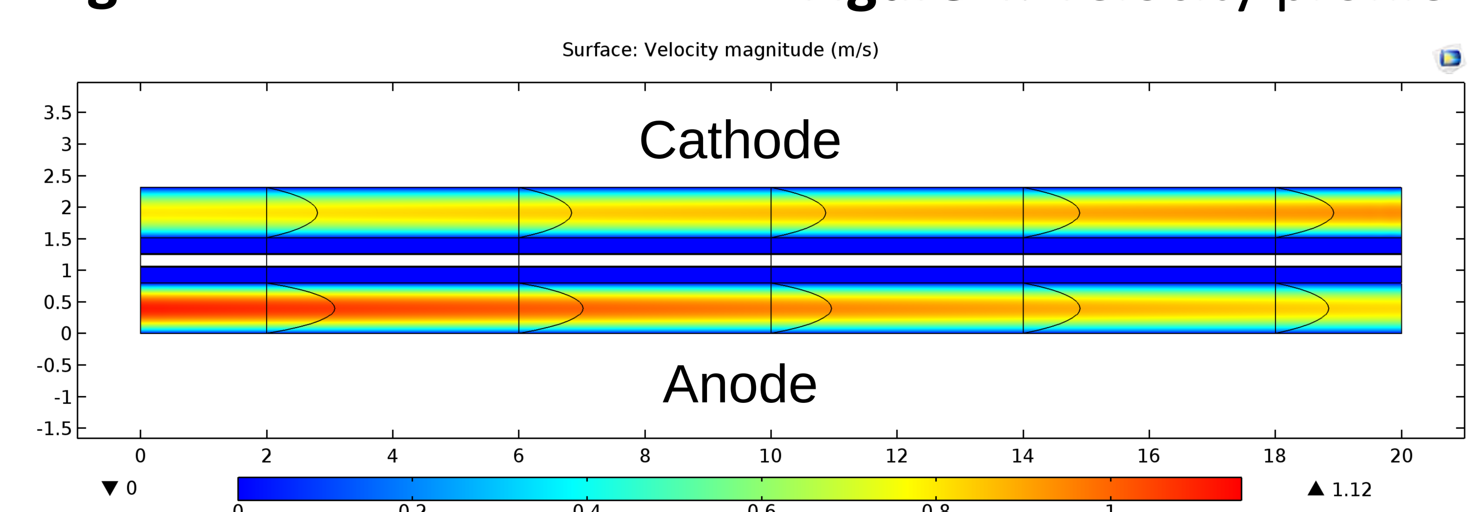

Figure 5. Velocity in the midsection zx

Conclusions: It was noted that flow rate increases along the cathode, mainly due to water production. This is interesting because, even though water concentration increases, it can be better removed from the cell, preventing channel clogging.

References:

1. X.-D. Wang et al., Numerical analysis on performances of polymer electrolyte membrane fuel cells with various cathode flow channel geometries, Int. J. Hydrogen Energy, v. 37, p. 15778-15786 (2012)
2. G. Doubek et al., Application of CFD techniques in the modelling and simulation of PBI PEMFC, Fuel Cells, v. 11, p. 764-774 (2011)

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