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Invited Talk

Finite volume methods for the simulation of PEM fuel cells

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In Proton exchange membrane (PEM) fuel cells, the transport of the fuel to the active zones, and the removal of the reaction products are realized using a combination of channels and porous diffusion layers. In order to improve existing mathematical and numerical models of PEM fuel cells, a deeper understanding of the coupling of the flow processes in the channels and diffusion layers is necessary. This is especially beneficial in order to optimize the important water management in PEM fuel cells.

After discussing different mathematical models for fluid-porous interfaces [1,2] (Navier-Stokes & Darcy/Brinkman) for PEM fuel cells, the talk addresses the discretization of the arising nonlinear partial differential equation (PDE) system by Voronoi-box based finite volume methods [3]. This approach is based on the generation of a boundary conforming Delaunay mesh [4] in two and three dimensions, being the dual of the Voronoi mesh.

The existence of two dual meshes allows for an appropriate discretization of differential operators like grad, div and curl, which transfers qualitative properties of the continuous differential operators to the discretized ones like the maximum principle for convection diffusion equations. Note that this desirable property even holds for some classes of nonlinear PDEs.

References

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