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Flow and Reaction in a Porous Rotating Disk Electrode BOMI NAM, NICOLAS MANO, ADAM HELLER, ROGER BONNECAZE, The University of Texas at Austin — We study experimentally and numerically the flow and reaction in a porous rotating disk electrode (PRDE). While the mass transport and electrochemical reaction rate on rotating disk electrodes are well defined by the Koutetskii-Levich theory, the PRDE exhibits much richer behavior controlled by the thickness, radius and permeability of the porous disk as well as the rotation rate. From experiments we find that the current generated in the PRDE generally exhibits three regimes separated by two sharp transitions, which are a function of these parameters. The fundamental cause of this behavior is hydrodynamic, and it is explored by numerically solving the flow and reaction in a PRDE. The model consists of the Navier-Stokes equation in the ambient fluid, a modified Darcy's law accounting for the rotation in the porous medium, and a convection-diffusion equation with a first order reaction all coupled through boundary conditions. A range of flow rates, geometries, porous medium and fluid properties, and reaction rates have been investigated. In general it is found that more fluid and reactant perfuse the porous disk as the rotation rate, thickness to radius ratio and permeability increase. The behavior of the current generated in the PRDE is explained through a ratio of the reaction time and the residence time. It is found that the appropriate dimensionless reaction time is sufficient to characterize the system. The simulation results agree very well with experimental data.

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