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Flow, Heat and Mass Transfer in Fuel Cells and Hydrogen Systems

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Abstract

Hydrogen and fuel cell systems have been the focus of sustained research and development to provide a pathway to decarbonize the energy system. Fuel cell technology involves a range of materials and transport processes that allow direct and high efficiency conversion of chemical energy to electricity. Fluid flow, heat and mass transport processes play a critical role in all operating aspects and in every component of a fuel cell and span from multiphysics transport in nanostructured electrodes, to turbulent flow in manifolds. The distribution and storage of compressed hydrogen —a key energy carrier for industry, fuel cells and emerging power-to-gas systems— presents several interesting turbulent mass transfer problems involving buoyancy effects and a range of venting/leak geometries and environmental conditions such as cross winds. Understanding of turbulent mixing under various scenarios is critical to the formulation of safety standards. This paper provides an overview of some of the experimental and modelling challenges and progress related to this rich array of flow, heat and mass transport problems.