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DEVELOPING A COUPLED THERMAL-MECHANICAL-POROUS MODEL FOR ELECTROLYTE FLOW IN A MOLTEN SALT BATTERY

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In this work, we present a coupled thermal-mechanical-porous model for electrolyte flow through a molten salt battery. A molten salt battery consists of a porous anode and cathode, which are separated by a porous separator saturated with a solid electrolyte. Upon activation of a heat source, the electrolyte in the porous separator melts and flows into the surrounding anode and cathode. At this point, the battery becomes electrochemically activated.

This work focuses on the evolution of the electrolyte, and not the electrochemical behavior. Since the molten salt battery is under mechanical load, the resultant change in void space caused by the electrolyte melting and then flowing out of the separator results in an axial deformation. Consequently, the initial migration of the electrolyte is a process influenced by capillary wicking as well and deformation-induced flow. Properly modeling this behavior requires considering the coupled thermal, mechanical, and porous behavior of the system. The system is modeled using a multiphysics finite element framework that includes a thermal conductive model for describing the heat activation, a nonlinear mechanical model for the deformation of the solid phase, and a two-phase partially saturated flow model for the electrolyte migration.

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