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HOGNOSE: A New Model for Corrosion in PWRs

One of the main threats to fuel rod integrity in pressurized water reactors (PWRs) is corrosion, specifically CRUD induced localized corrosion (CILC) accelerated by the buildup of porous corrosion deposits (CRUD), which can impede heat transfer and exaggerate water chemistry effects. The authors have developed a more science-based, mechanistic, multi-scale finite-element model of Zircaloy corrosion by investigating the corrosion of various Zircaloys under a range of applicable conditions and accidents. Written using the MOOSE framework, HOGNOSE simulates the microstructural evolution of the oxide by differentiating between both protective and transparent oxides, including the transition from one to the other, by treating the corrosion process as an oxygen diffusion problem with varying oxygen diffusivity. Connection between oxide and alloy microstructural characteristics and oxygen diffusivity has led to accurate simulations for Zircaloy-4 under simulated PWR chemistries. Additionally, focus areas for experimental work have been identified.