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Finite element modeling of fuel behavior based on the MOOSE framework

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Abstract: Fuel performance modeling and analysis plays an important role in fuel design and performance optimization, especially accurate fuel rod modeling and analysis in 3D. Fuel thermal behaviors are very complex and are strongly coupled with other factors. For example, with the increase of burnup, fuel thermal conductivity decreases which further increases the pellet central temperature, and gap distance becomes smaller during the swelling of the pellet, because of the accumulation of solid fission products, fission gas and pellet thermal expansion which decrease the pellet central temperature in turn. So fuel performance modeling is inherently a multiphysics problem. In this paper, we established a 1/4 pellet-cladding model containing modules for heat transfer, mechanical analysis, and fission gas release calculation, etc, based on the MOOSE finite-element framework. This paper demonstrates our current experiences in applying the MOOSE framework to PWR fuel behaviors simulations.

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