Comparison of steady and transient flow boiling critical heat flux (CHF) for FeCrAl accident tolerant fuel cladding alloy, Zircaloy, and Inconel

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Comparison of steady and transient flow boiling critical heat flux (CHF) for FeCrAl accident tolerant fuel cladding alloy, Zircaloy, and Inconel

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The nuclear reactor design focuses on building a system that is robust and reliable, is efficient and economical, and do not run into undesirable transient accident scenarios. The nuclear reactor safety focuses on ensuring the system operation under the safety margins and requirements provided by the regulatory agencies. Following the Fukushima nuclear reactor accident, the US Department of Energy Office of Nuclear Energy (DOE-NE) Advanced Fuels Campaign (AFC) is working to develop fuel and cladding candidates with potentially enhanced accident tolerance: ‘Advanced Tolerant Fuel’ (ATF). As a part of the AFC, this research focuses on gaining mechanistic understanding of the material performance of proposed candidate ATF claddings in a thermal-hydraulics stand point. Unexplored thermal-hydraulics behaviors and the critical heat flux (CHF) of ATF claddings are key as it is vital information to towards safety margins during reactor operation, to the progression of design basis accidents, and to nuclear reactor and fuel design. Once CHF is reached during either normal operation or accident scenarios, material cannot avoid catastrophic failure caused from current fuel cladding promoting excessive temperature increment. Experimental boiling and CHF data is implemented in the system codes to further estimate assessment of the potential impact of ATF cladding materials on the progression of key design basis accidents in light water reactors (LWRs), including impacts due to differences in heat transfer characteristics. Findings of this study will not only benefit the current nuclear reactor operation and the new fuel designs utilizing candidate ATF claddings in the interest of nuclear reactor safety and optimal operation, but also benefit mechanistical understanding on effects of material surface characteristics and material thermal properties.