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2022 American Nuclear Society Student Conference

The Benefits of Chromium-Coated Zircaloy as Accident Tolerant Nuclear Fuel Cladding: An Overview

Sparked by the reactor meltdown of Fukushima Daiichi in 2011, research of new technologies known as accident-tolerant fuels (ATFs) has increased rapidly. The Nuclear Regulatory Commission states that an ATF makes existing commercial reactors more resistant to nuclear accidents and lowers the cost of electricity over the reactor's lifetime. In other words, ATFs make a reactor safer and potentially even more efficient. ATFs can be categorized into two main segments, cladding and fuel. New types of nuclear fuel are being developed using materials other than uranium dioxide to make reactors safer in normal conditions and beyond design basis accident scenarios. The other significant segment of ATFs is fuel cladding. Nuclear fuel cladding is a layer of material around the fuel to contain the fuel and fission fragments. New ATF cladding materials are designed to perform just as well as the current cladding during normal operating conditions but perform much better during accident scenarios. This is achieved by using materials with superior properties, notably better resistance to oxidation and lower hydrogen generation. This will allow the reactor to maintain fuel integrity for a longer time in a nuclear accident by increasing the temperature at which the fuel will oxidize, thereby allowing the reactor to still perform well under higher temperatures.This paper is designed to outline the potential gaps in the literature about near-term ATFs cladding concept as these prove their potential for rapid implementation in commercial nuclear reactors. Topics covered include the two most common application technologies of chromium cladding, the effectiveness of chromium claddings, and future work conducted at Virginia Commonwealth University to identify the more relevant characteristics impacting the behavior of these future cladding designs.