CHROMIUM CARBIDE COATINGS FOR INNER-SIDE FUEL CLADDING PROTECTION: A REACTOR PHYSICS - BASED PERFORMANCE ANALYSIS

R.H. KHLIFA, N.N.NIKITENKOV
National Research Tomsk polytechnic University

The tragic events at Fukushima Daiichi nuclear power plants complex in 2011 have triggered a worldwide effort to implement numerous measures aimed at improving the safety of nuclear power plants. Protective coatings on Zr-based claddings were proposed within the frame of Accident Tolerant Fuel (ATF), a post Fukushima concept with the primary goal of improving nuclear fuel's tolerance for severe accident events. These coatings are being considered as short-term concepts to improve corrosion and high-temperature oxidation resistance, and reduce hydrogen absorption of Zr-based alloys, without introducing significant design modifications. Protective coatings were primarily evaluated as external coatings, however, the fact that inner-side of fuel cladding will remain un-protected is highlighted as a concern for the coatings approach. Hence, inner-side coatings as a complement to external coatings on nuclear fuel claddings were proposed. A numerical study (computer simulation) of the effect of the use of chromium carbide coatings was carried out to protect the inner shell on the characteristics of the reactor. Different thicknesses of these coatings were applied on the inner walls of nuclear fuel claddings using a single fuel assembly as a model. The impact of these coatings is evaluated through its induced effects on some reactor physics parameters such as the infinite multiplication factor, the flux, and the operating lifetime. Results were also compared with the case of using chromium coatings. Results showed that chromium carbide coatings will induce relatively small impacts on the studied parameters, when compared with the case of using pure metallic chromium coatings, however, many other factors need to be further studied, since chromium carbide coatings have a ceramic nature, therefore possible impacts on conductivity, adhesion, etc. would be expected.