Understanding the Effect of Strain on Microstructure Properties and Environmental Degradation of AGR Fuel Cladding

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Abstract

Prior to 2018, the UK had a closed nuclear fuel cycle meaning all advanced gas-cooled reactor (AGR) spent fuel was reprocessed. This is no longer the case, currently all AGR spent fuel is put into interim storage pending long term geological disposal [1]–[3]. Interim storage in the UK involves storing the spent fuel pins in large storage ponds filled with pH-moderated water. Here, pins are stored within slotted steel storage cans, which are then placed in skips inside the ponds [4]. The water acts as a coolant for the fuel, and combined with the cans, a barrier to radioactive product release.

During storage, the spent fuel is still contained within its original stainless steel cladding inside the cans. This is the first barrier to fission product release. Due to the presence of water, environmental degradation can occur in certain conditions [5]. The cladding material is highly corrosion resistant, however fuel pins are exposed to extreme conditions during their lifetime in the reactors, such as high temperature and irradiation. This can cause the fuel cladding to become vulnerable to environmental attack. This is believed to occur at certain locations on the fuel pin, where the material has been previously worked or deformed, which in turn impacts its microstructure. The reasoning for this is not currently well understood. This study aims to address this gap in knowledge by investigating how changes in microstructure strain of the fuel cladding can impact corrosion mechanisms and surface film passivity. The aim is to do this under conditions relevant to spent fuel storage, including increased pH and temperature. Research in this area is key for the UK nuclear industry, as the amount of fuel pending long-term disposal is increasing and storage must be carried out safely and effectively to protect the environment. This project will contribute towards challenging current conservatisms with the UK's current wet storage strategy for spent AGR fuels.

References

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