Advanced chemistry and corrosion studies under hot water conditions relevant to LWR coolant

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Understanding the corrosion processes in light water reactors (LWR) is required as the UK moves away from its current gas cooled nuclear reactors towards water-cooled nuclear reactors more commonly employed in other countries. The new generation of reactors, starting with Hinckley Point C, will have significantly different components and require operating procedures and methodologies. These new LWR reactors will have vastly different corrosion, stress, and fatigue properties to the gas reactors undergoing shut down and decommissioning. The processes investigated in these water-cooled systems could also be applied to fusion reactor projects such as ITER and DEMO that will make use of similar pressurised water-cooling systems.

This presentation will explore the effects of different water chemistry regimes such noble metal chemical addition (NMCA) and zinc water chemistry in the mitigation of early-stage oxidation in steel water pipes. Conditions relevant to BWRs can be replicated to study their historical issues with SCC resulting from corrosion combined with mechanical stress. The USA combats this with a water chemistry change via hydrogen injection, zinc, and platinum added to the coolant. This is known to reduce corrosive activity and SCC crack growth during the operation of the reactor, however there as been little investigation how this regime behaves during the commissioning of new reactors in terms of initial pitting and cracking.

In order to investigate this further, autoclave experiments are performed to simulate various LWR conditions under differing chemistry regimes. The development of an autoclave flow loop facility to simulate the flowing of a cooling system will be described, to investigate the effects of flow assisted corrosion. Characterisation of samples exposed to reactor conditions will be presented through techniques including electron-microscopy, electron backscatter diffraction, X-ray diffraction, focused ion beam milling and high-speed atomic force microscopy.