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MECHANISMS FOR PREVENTING DEUTERIUM INGRESS AT ROLLED JOINTS IN CANDU FUEL CHANNELS

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In CANDU fuel channels, Zr-2.5Nb pressure tubes are connected to out-of-core piping by rolling them into steel end fittings. A combination of residual tensile stresses from the rolling process and enhanced deuterium ingress makes pressure tubes susceptible to delayed hydride cracking (DHC) at the rolled joints. Improvements to fuel channel longevity are being sought by modifying the rolled joint to prevent hydride formation (a prerequisite for DHC) at the region of residual tensile stress in the pressure tube. One promising improvement is to chromium plate the end fitting where it contacts the pressure tube. Tests of full-size rolled-joint assemblies on an out-reactor, heavy water loop are showing that chromium plating reduces deuterium ingress at rolled joints by about 50%.

To refine our understanding of mechanisms for rolled-joint deuterium ingress and the role of chromium plating in preventing ingress, a set of modified rolled-joint assemblies was tested. The modifications included using end-fitting hubs that had either a single groove or no grooves, that were chromium plated or unplated, and using standard pressure tubes or tubes with the outer as-manufactured oxide ground off. After 219 days on the loop, the assemblies were destructively examined. We concluded that deuterium released in the crevice between the pressure tube and end fitting from corrosion reactions was a major contributor to ingress at rolled joints. Also, if the oxide on the pressure tube is kept intact, there is little deuterium ingress. As a result, chromium plating may reduce deuterium ingress in two ways: by oxidizing less than stainless steel and thereby reducing the amount of deuterium available to be picked up by the pressure tube; and by minimising the damage to the pressure tube oxide during the rolling process.

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