Progress of Fretting wear behaviour of Zr alloy cladding tube in simulated primary water of PWR

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Abstract Running condition fretting map (RCFM) and material response fretting map (MRFM) of Zr alloy tube under grid-to-rod (GTR) configuration in simulated primary water of PWR were established. RCFM shows three fretting regimes, namely, partial slip regime (PSR), mixed fretting regime (MFR) and gross slip regime (GSR). According to MRFM, the wear mechanism under partial slip regime is adhesive wear with the character of delamination of local regions, both adhesive wear and cracking are found for mixed fretting regime, while abrasive wear and severe delamination for gross slip regime. Compared with the results at room temperature, the mixed fretting regime range increases obviously at high temperature, while friction coefficient is lower. The fretting wear behaviour of Zr alloy cladding tubes under partial slip regime in simulated primary water of PWR was investigated. The fretting regime remains unchanged with the increasing fretting time and hence both the wear volume and depth of the worn areas formed on Zr cladding tubes change slightly. The wear mechanism is adhesive wear, and delamination occurs at some local regions, resulting in slight damage. Third-body layer, oxide layer, tribologically transformed structure layer, and general deformation layer are observed form the cross-section of the worn area and their formation mechanisms are analysed in detail. Moreover, from the metal/oxide interface to surface, the main oxides transition from tetragonal-ZrO_2 to monoclinic-ZrO_2. Finally, the partial slip regime process and the microstructural evolution during fretting wear are discussed.

Keywords Fretting wear, Running condition fretting map, wear mechanism, PWR

Reference

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