Probing into the controlling factors and mechanisms for stress corrosion cracking of austenitic alloys in nuclear power plant water coolants

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Abstract Improving the predictability and applicability of the models for stress corrosion cracking (SCC) of austenitic alloys in nuclear power plant water coolants requires the generation of reliable data, proper way of data mining and analysis, sorting and quantification of controlling factors, mechanistic understanding and suitable modeling strategy for resolving the synergism between crack tip mechanics and reaction kinetics. Systematic experiments have been designed and data are piled up for various combinations of material, high temperature water environments and loading conditions. Various models are reviewed and some details are discussed, including slip-dissolution/oxidation model(SDOM), film rupture model(FRM), tarnish rupture model(TRM), deformation/oxidation model(SOM), coupled environment fracture model(CEFM), (selective) internal oxidation model (s-IOM), Selective oxidation model(SOxM), preferential dissolution model(PDsM), active path model(APM), grain boundary migration model(GBMM), Surface mobility model(SMM), film-induced cleavage model(FICM), corrosion tunnel model(CTM), enhanced crack tip plasticity model(ECTPM), corrosion ECTPM (C-ECTPM), adsorption ETCMP (A-ECTPM), film ECTPM(F-ECTPM), stress enhanced crack tip dissolution(SECTD), stress enhanced crack tip oxidation(SECTO), etc. Some controlling factors for SCC of austenitic alloys in nuclear power plant water-coolants are quantified and analyzed through the treatment of coupling of the crack tip oxidation kinetics and the crack tip mechanics. Some examples are given to demonstrate the developed model.

Keywords Stress corrosion cracking, nuclear power plants, environmentally assisted cracking, mechanism, controlling factors, prediction models