IRRADIATION CREEP AND SWELLING OF VARIOUS AUSTENITIC ALLOYS IRRADIATED IN PFR AND FFTF

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EXTENDED ABSTRACT

In order to use data from surrogate neutron spectra for fusion applications, it is necessary to analyze the impact of environmental differences on property development. This is of particular importance in the study of irradiation creep and its interactions with void swelling, especially with respect to the difficulty of separation of creep strains from various non-creep strains.

As part of an on-going creep data rescue and analysis effort, the current study focuses on comparative irradiations conducted on identical gas-pressurized tubes produced and constructed in the United States from austenitic steels (20% CW 316 and 20% CW D9), but irradiated in either the Prototype Fast Reactor (PFR) in the United Kingdom or the Fast Flux Test Facility in the United States. In PFR, Demountable Subassemblies (DMSA) serving as heat pipes were used without active temperature control. In FFTF the specimens were irradiated with active (±°5C) temperature control. Whereas the FFTF irradiations involved a series of successive side-by-side irradiation, measurement and reinsertion of the same series of tubes, the PFR experiment utilized simultaneous irradiation at two axial positions in the heat pipe to achieve different fluences at different flux levels. The smaller size of the DMSA also necessitated a separation of the tubes at a given flux level into two groups (low-stress and high-stress) at slightly different axial positions, where the flux between the two groups varied ≤ 10%. Of particular interest in this study was the potential impact of the two types of separation on the derivation of creep coefficients.

It was shown that when the axial separations in PFR were relatively small, there was no impact on the derived creep coefficients. Thus, for the low-stress and high-stress separations, the impact was negligible. For separations involving more significant flux-ratio separations (0.67 and 0.83) the impact was larger and necessitated treating the low-flux and high-flux sets as separate data sets. The influence of flux differences were expressed in the non-creep strains, specifically the carbide-related densification and the void swelling. The creep coefficients themselves were not affected, however. Thus the variations in behavior in PFR were only a reflection of the well-known history effect on void swelling. When comparing the results between PFR and FFTF, the non-creep strains again showed a sensitivity to the different temperature/stress/flux history of each reactor, but the creep coefficients were again found to be relatively insensitive. The results of both experiments validated the use of the $B_o + D\dot{S}$ creep model employed in all earlier studies.

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