IMPACT BEHAVIOR OF REDUCED-ACTIVATION STEELS IRRADIATED TO 24 DPA -- R. L. Klueh and D. J. Alexander (Oak Ridge National Laboratory)

Journal of Nuclear Materials

Publication: Summer, 1996

EXTENDED ABSTRACT

Charpy impact properties of eight reduced-activation Cr-W ferritic steels were determined after irradiation to ≈21-24 dpa in the Fast Flux Test Facility (FFTF) at 365°C. Chromium concentrations in the eight steels ranged from 2.25 to 12wt% Cr (steels contained ≈0.1% C). The 2 1/4Cr steels contained variations of tungsten and vanadium, and the steels with 5, 9, and 12% Cr, contained a combination of 2% W and 0.25% V. A 9Cr steel with 2% W, 0.25% V, and 0.07% Ta was also irradiated. The steels had previously been irradiated at 365°C in FFTF to ≈6-8 and ≈15-17 dpa. Irradiation caused an increase in the DBTT and decrease in the USE, but there was little further change in the DBTT from that observed after the 15-17 dpa irradiation, indicating that the shift had essentially saturated with fluence.

The microstructures of the 2 1/4Cr steels were bainite with various amounts of polygonal ferrite, depending on the tungsten present in the steel. The two 9Cr steels and the 5Cr steel were 100% martensite, and the 12Cr-2WV steel was martensite with ≈25% δ-ferrite. The properties of the steels with 100% martensite were superior to those of the steels with the duplex structures of bainite and ferrite or martensite and ferrite. Indications are that the properties of the 2 1/4Cr bainitic steel with tungsten and vanadium, which is the 2 1/4Cr steel with the most irradiation resistance, would be improved if it were 100% bainite.

The 9Cr steels were least affected by irradiation, with the 9Cr-2WVTa showing only a 21°C increase in DBTT after ≈22.5 dpa. The 9Cr-2WVTa steel was the only steel that showed a slight increase in the shift with increasing fluence. This 21°C shift was an increase from shifts of 4 and 14°C in previous irradiations at 365°C to ≈6.4 and ≈15.4 dpa, respectively. Despite the slight increase over the previous irradiations, 21°C is one of the lowest shifts in DBTT for this type of steel irradiated to these conditions, and it compares with a 52°C shift for the 9Cr-2WV, which had the second lowest shift. The advantage for the 9Cr-2WVTa over the 9Cr-2WV is further enhanced by the much lower DBTT of the 9Cr-2WVTa before irradiation.

The results are encouraging because they indicate that the effect of irradiation on toughness can be favorably affected by changing composition and microstructure.