§2. Tensile Properties of Reduced Activation Ferritic/Martensitic Steel after Aging at 400 to 650°C for 100 Kh

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Reduced-activation ferritic/martensitic (RAFM) steels have been developed as the structural materials for fusion blanket. Precipitation during heat treatment and under operation condition affects the strength of RAFM steels. Effects of long-term aging for 1 to 100 kh on mechanical properties have been reported for a RAFM, F82H steel. Microstrucctural analyses have clarified that precipitation of Laves phase (Fe_2W) occurred during the aging at 550°C and above for 100 kh. These microstructural change can degrade tensile properties of RAFM steels. The purpose of the present study is to clarify tensile properties of F82H after aging at 400 to 650°C for 100 kh.

The materials used were 15 mm-thick plates of F82H-IEA heat with a composition of Fe- 7.71Cr- 1.95W- 0.091C -0.16V -0.02Ta -0.11Si -0.16Mn -0.002P -0.002S -0.006N in mass %. The final heat treatment conditions were normalizing at 1040°C for 40 min and tempering at 750°C for 1 h, which is designated as as-NT condition. The plates were aged from 400 to 650°C for 100 kh. Tensile tests at room temperature (RT) were conducted in the air, while high temperature (HT) tests were performed from 400 to 650°C in a vacuum better than 10^{-4} Pa. The initial strain rate in the tensile tests was 6.7×10^{-4} s^{-1}.

Figures 1 and 2 plot the tensile parameters, yield (0.2 %-proof) stress (YS), ultimate tensile strength (UTS), uniform elongation (UE), total elongation (TE), and reduction of area (RA). Fig. 1 shows the parameters from room temperature (RT) tests on as-NT specimens and the ones after the aging, while Fig. 2 shows the ones from high temperature (HT) tests at aging temperature. The data trends for the aged sample are indicated by thick solid lines. The horizontal and thin lines indicate the level for the tensile parameters of as-NT sample before aging. The previous data obtained with standard size specimens are also plotted for comparison. The data trends for the previous data are drawn with dashed lines. It was revealed that the degradation of YS and UTS was 50 MPa or less at 550°C and below at both RT and HT tests. Since 50 MPa is comparable to the variation observed among other heats of RAFM steels, the degradation would not be significant as structural materials if the variation is acceptable. Above 550°C, YS and UTS decreased with increasing aging temperature. On the other hand, TE and RA after the aging both at RT at HT were comparable to or higher than those before aging. While, no degradation of ductility was detected after the aging. Possible mechanisms for the degradation of tensile strength due to aging are loss of solid solution hardening by W due to precipitation of Laves phase (Fe_2W) and recovery of martensite structure, such as loss of hardening by interstitial C, coarsening of martensite structure, and recovery of dislocations.

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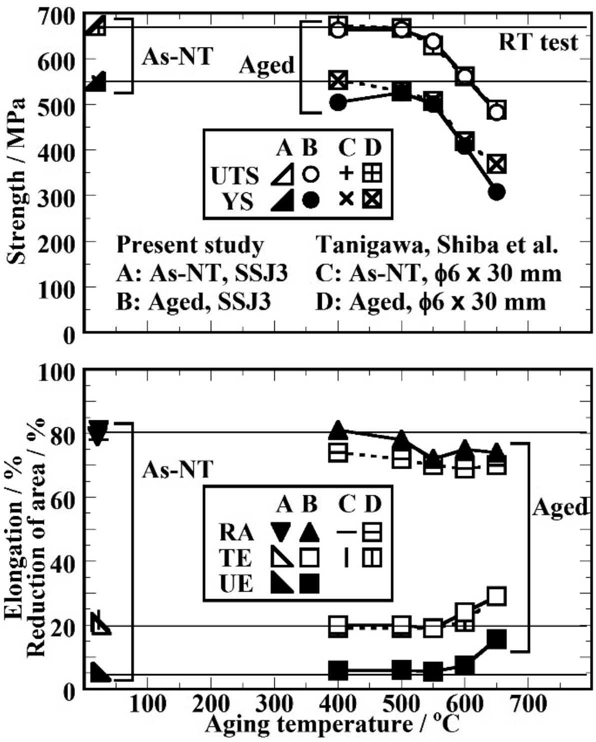

Fig. 1 Tensile parameters for F82H for as-NT and aged samples at RT.

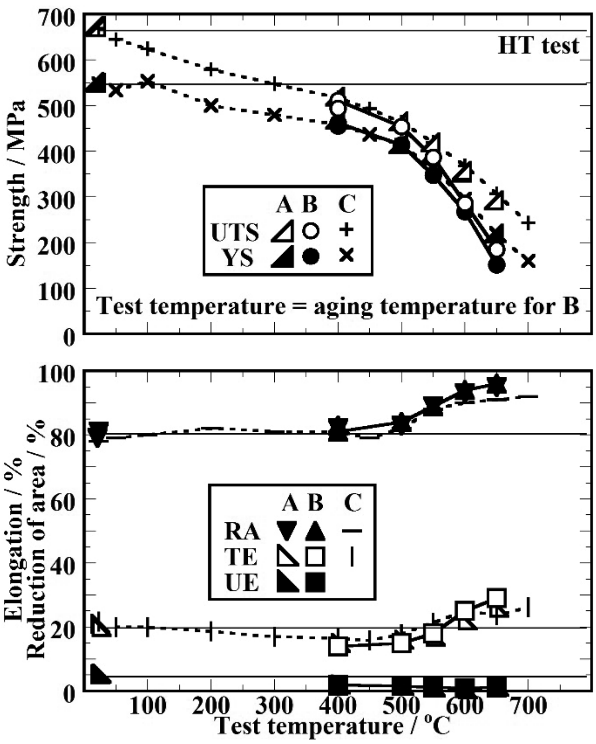

Fig. 2 Tensile parameters for F82H for as-NT and aged samples at aging temperature. See Fig. 1 for the test conditions A, B and C.