Effect of Initial Heat Treatment on DBTT of F82H Steel Irradiated by Neutrons

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Reduced-activation ferritic/martensitic steels are candidate materials for the blanket structure of fusion reactors. Radiation-hardening of 8-9%Cr martensitic steels irradiated by neutrons occurrs mainly at irradiation temperatures lower than about 400^{o}C, and it increases with decreasing irradiation temperature down to 250^{o}C. The shift of DBTT (ductile-brittle transition temperature) also increases with decreasing irradiation temperature, and the shift increases largely for irradiation at 250^{o}C. Several researchers reported that the increase of yield strength and the shift of DBTT were different in several martensitic steels, such as F82H, JLF-1, JLF-1B, ORNL 9Cr-2WVTa, OPTIFER Ia, II, MANET II and Mod.9Cr-1Mo, which had different concentrations in some elements and were tempered at different temperatures. The effects of the normalizing and tempering of heat treatment on tensile and impact behavior in martensitic steels before irradiation were reported by L. Schafer and P. Gondi. However, the mechanisms of the changes of yield strength and DBTT due to irradiation in these martensitic steels are not clear, and it is necessary to reveal the effects of heat treatment and impurities on them. The optimum heat treatment will be required to improve resistances to radiation hardening and embrittlement. In this study, the dependence of impact properties on tempering time and temperature has been examined for martensitic steel F82H (Fe-8Cr-2W-0.2V-0.04Ta-0.1C) irradiated by neutrons.

The dependence of DBTT on tempering time and temperature was examined for a martensitic steel F82H irradiated at 150 and 250^{o}C to a neutron dose of 1.9 dpa in the Japan Materials Testing Reactor. Miniaturized Charpy V-notched (CVN) impact (3.3 mm x 3.3 mm x 23.6 mm) specimens were fabricated. The heat treatment was performed at 750 and 780^{o}C for 0.5 h after the normalizing at 1040^{o}C for 0.5 h. The tempering time at 750^{o}C was varied from 0.5 to 10 h. Charpy impact testing was carried out in the hot cell of the JMTR of JAERI, and the absorbed energy was measured as a function of temperature. After the testing, the fracture surfaces were observed. The DBTT of F82H steels heat-treated with different tempering conditions depended on the tempering conditions before the irradiation. After irradiation, the DBTT of F82H steels irradiated at 250^{o}C to 1.9 dpa was ranged from –23 to 25^{o}C, and the DBTT of F82H steels irradiated at 150^{o}C to 1.9 dpa was ranged from 0 to 15^{o}C. The DBTT of the F82H steel depended on temperature and time of tempering. In this study, the DBTT of pure iron and F82H+2Ni steel irradiated by neutrons was also examined.