Effect of thermal ageing on high temperature tensile and creep properties of JLF-1 and CLAM steels

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Several types of reduced activation ferritic / martensitic steels (RAFMs) have been considered as promising candidates for blanket structural material in ITER-TBM and DEMO fusion reactors. The continuous development and qualification of these steels for fusion applications require an exhaustive understanding of their microstructure and mechanical properties. Of special relevance is ageing resistance behavior of these steels during long-term thermal load at high temperature. In this work, the effect of thermal ageing of the Japanese candidate RAFM JLF-1 (JOYO-II-HEAT) and Chinese candidate RAFM CLAM (HEAT 0603A) on high temperature mechanical properties was investigated with focused attention on their tensile and creep properties.

The JLF-1 steel used in the experiment was a 25 mm-thick plate, fabricated from a 100 kg-ingot. The CLAM steel was melted in a vacuum induction furnace into a 300 kg ingot, then was hot-forged and rolled into a 15 mm-thick plate. The samples of JLF-1 steel were normalized at 1323 K for 60 minutes and then tempered at 1053 K for 60 minutes. While, the samples of CLAM steel were normalized at 1253 K for 30 minutes and then tempered at 1033 K for 90 minutes. The ageing was carried out at 773-873 K up to 2000 h to simulate inservice condition and 973 K for 100 h as accelerated conditions. The Vickers hardness was measured at room temperature. The tensile properties were conducted at room temperature and 773-873 K at an initial strain rate of $6.67 \times 10^{-4}$ s$^{-1}$. The uniaxial creep tests were also performed at 773-873 K and stresses in the range of 100-250 MPa in a vacuum of $< 1 \times 10^{-4}$ Pa with the same specimen type as for the tensile tests. Microstructures of the samples were examined before and after the ageing and after the testing by SEM and TEM.

The hardness value did not change significantly with ageing time at 773-873 K, however decreased after ageing at 973 K for 100 h. The relation of the hardness change to tensile and creep properties and microstructure will be introduced and analyzed.

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