§11. Effect of Thermal Ageing on High Temperature Mechanical Properties of JLF-1 Steel

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Introduction

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 [1]. 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 [2]. In this work, the effect of thermal ageing of the Japanese candidate RAFM JLF-1 (JOYO-II-HEAT) on high temperature mechanical properties was investigated with focused attention on their tensile and creep properties.

Experimental procedures

The JLF-1 steel used in the experiment was a 25 mm-thick plate, fabricated from a 100 kg-ingot. The samples of JLF-1 steel were normalized at 1323 K for 60 minutes and then tempered at 1053 K for 60 minutes.

The ageing was carried out at 873 K for 100 h to simulate in- service condition and 973 K for 100 h as an accelerated conditions. The Vickers hardness was measured with a load of 300 g at room temperature. The gauge size of the tensile specimens was 5 x 1.2 x 0.25 mm^3. Tensile test was conducted at RT, 823 K and 873 K at an initial strain rate of 6.67 x 10^{-4} s^{-1}. The test at RT was conducted in the air, while the tests at elevated temperature were carried out in a vacuum of < 1 x 10^{-4} Pa. The 0.2% proof strength was measured as yield strength.

Results and discussions

The hardness value did not change significantly after ageing at 873 K for 100 h, but decreased after at 973 K for 100 h, as shown in Fig.1.

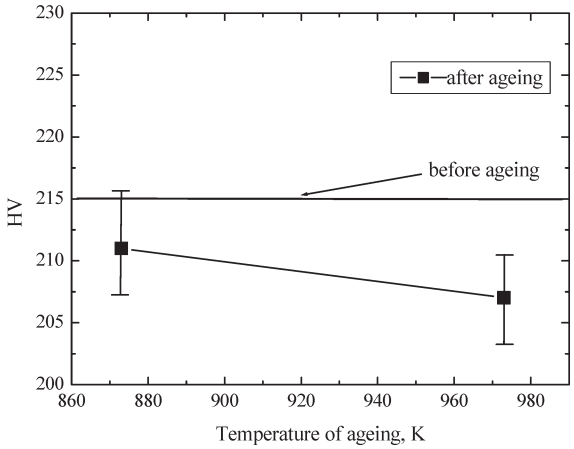

Fig.1 The effect of ageing on hardness of JLF-1 steel

The tensile results for JLF-1 steel are shown in Fig. 2.

The figure shows that the strength decreased with the increase in test temperature. Both ultimate strength (UTS) and yield strength (YS) were decreased at all test temperature after ageing at 973K for 100 h. The decrease was a little smaller at 823 K and 873 K.

The total elongation increased slightly after the ageing.

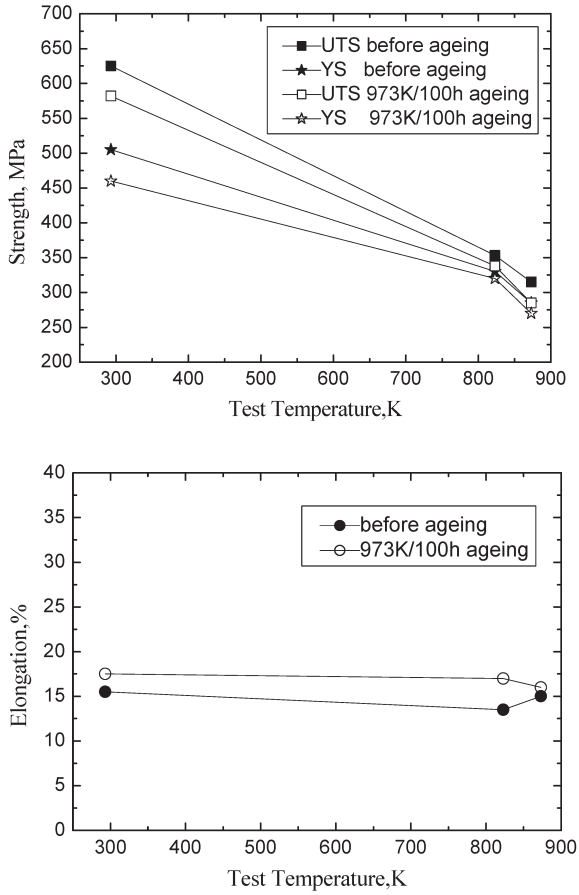

Fig. 2 The tensile properties of JLF-1 steel

Summery

The effects of ageing on the hardness and tensile properties for JLF-1 steel were examined.

The hardness value did not change significantly after ageing at 873 K for 100 h, however decreased after at 973 K for 100 h.

The UTS and YS decreased at all test temperature after ageing at 973K for 100 h. However, the total elongation was a little increased.

The ageing for longer time is ongoing. The uniaxial creep tests will also be performed and microstructures will be examined by SEM and TEM before and after the ageing.

Reference

1) T. Muroga, M. Gasparotto, S.J. Zinkle, Fus. Eng. & Des.61-62 (2002) 13-25.
2) M. Tamura, K. Shinozuka, etc.. J. Nucl. Mater. 283-287 (2000) 667-671.