Effect of stabilization treatment and Nb/C ratio on the intergranular corrosion susceptibility of Super304H austenitic heat-resistant steel

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Abstract: The newly developed Super304H austenitic stainless steel is being widely used in ultra supercritical fossil fired boilers because of its superior high temperature strength, good oxidation resistance and steam corrosion resistance. But some failures of Super304H tubes caused by intergranular corrosion (IGC) have occurred in some ultra supercritical boilers in China and the high intergranular corrosion susceptibility of the Super304H tubes was found to be induced by the unqualified match of carbon and niobium or the improper delivery heat treatment technology [1]. In this paper, the influence of stabilization treatment and Nb/C ratio on the intergranular corrosion resistance of Super304H austenitic heat-resistant steel was investigated deeply by optical microscope, scanning electron microscopy, electrolytic extraction and X-ray diffraction. Meanwhile, the intergranular corrosion degree was evaluated by oxalic acid electrolytic etching and double loop electrochemical potentiokinetic reactivation tests. The results show that, compared to the solution state, the amount of precipitates increas significantly after stabilization treatment. What is more, there were many $Cr_{23}C_6$ precipitates along grain boundaries when stabilized at 950 ℃, indicating that 950 ℃ was still in the range of sensitizing temperature for Super304H. When stabilizing temperature reaches 1100 ℃, Nb(C, N) precipitates are most and the IGC resistance is superior to the that of solution state. The 1100 ℃ is in the range of solution temperature（1050-1150℃）for Super304H, suggesting that the delivery state solution treatment of Super304H plays dual functions of solution and stabilization. Concerning the effect of Nb/C ratio on IGC susceptibility, it is found that IGC susceptibility of Super304H is high when Nb/C ratio is less than 4.8, and is low when Nb/C ratio is more than 8.2. However, IGC susceptibility fluctuates and has no clear trend when Nb/C ratio is between 4.8 and 8.2, which may be related to the insufficient dissolution of primary bulk Nb-rich phases into the matrix due to improper first stage heat treatment.

[1]Yan Gao [a,*], Chunlei Zhang [b], Xiahua Xiong [a], Zhijun Zheng [a] and Min Zhu [a], Intergranular corrosion susceptibility of a novel Super304H stainless steel, Engineering Failure Analysis，2012, 24(9): 26–32

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