Water Vapor Oxidation Behavior of Nitrided Alloys under High-Temperature and Pressure

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Introduction

A steam turbine valve [1] for the generator is critical parts to control high–temperature and steam pressure and cause a high generation capacity. Therefore, mechanical durability is seriously required in a generating condition. ASTM 1355 and 12Cr-Mo-W-V (SUS422) [2] alloy have been used in a nuclear [1] and thermal power [3] generation. A plasma nitriding [4] has many merits such as short process-time, high surface performance and environment-friendly.

In this study, nitriding behaviors and surface properties of ASTM 355 and SUS 422 steels were investigated with various nitriding parameters in the plasma nitriding. Their mechanical and corrosion properties such as hardness at high temperature and polarization curves were also evaluated after nitriding.

Experimental

ASTM A355 and SUS422 were used and their size was an outer diameter of 10 mm, an inner diameter of 2 mm, and a thickness of 3 mm. The specimens were treated a gas and a plasma nitriding. The thickness of the nitrided layer of ASTM A355 and SUS422 was 360 and 200 μm, respectively. The oxidation test was conducted at 283℃ and 10 MPa for 500 ~ 2500 h.

The high-temperature hardness test for the gas and plasma nitrided specimen was conducted at a load of 200 g for 10 sec. The specimen was kept at a vacuum of 1.0 x 10^{-5} torr in order to prevent an oxidation at high temperature.

Polarization curves were measured using a three-electrode system in 60% $N_2H_4 \cdot H_2O$ solution (pH 9.5). Ag/AgCl and graphite were used as a reference and a counter electrode, respectively. All specimens were masked using a lacquer and their electrode areas were 1.13 cm^2. The potential was swept at a scan rate of 1.0 x 10^{-3} V/sec.

Results and discussion

Hardness of the nitrided layer for the ASTM A355 alloy is shown in Fig. 1. Vickers hardness for the gas nitrided specimen was 1,150 at room temperature and decreased to 590 at 283℃, whereas the value for the plasma nitrided layer was 1,070 and decreased to 520 at 283℃. In SUS422 alloy, Vickers hardness for the gas nitrided layer was 1,070 at room temperature and decreased to 495 at 283℃, whereas the value for the plasma nitrided layer was 1,110 and decreased to 530 at 283℃.

Polarization curves of the nitrided ASTM A355 alloy are shown in Fig. 2. The plasma nitrided specimen was more corrosion resistant than in the gas nitrided. The non-nitrided specimen was rapidly corroded. Corrosion potential was much noble in the nitrided specimen and corrosion current was also much lower than that in the non-treated specimen. It is due to a passivation film formed on the surface of the nitrided specimen.

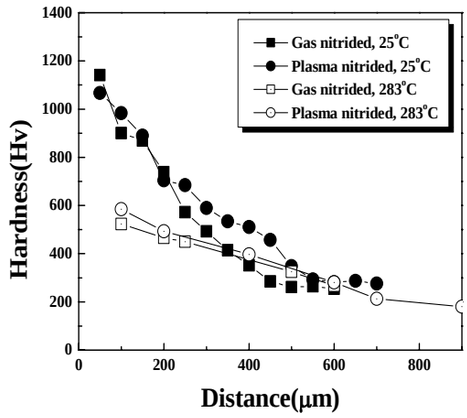

Fig. 1 Micro-hardness of ASTM A355 obtained at various temperatures.

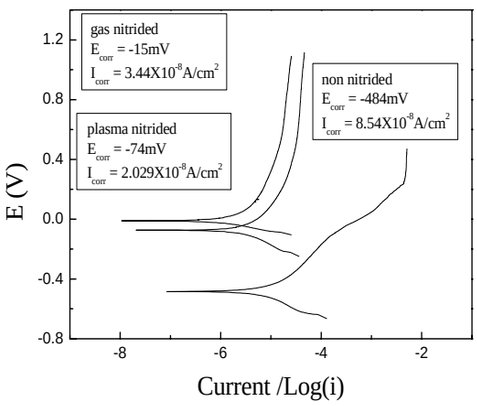

Fig. 2 Polarization curves of ASTM A355 in hydrazine solution (pH 9.5) at 25℃.

Acknowledgments

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References

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