수소유기 균열된 APi-X80 강재의 파면 분석

Analysis of Fracture Surface of API-X-80 Steel Failed by Hydrogen Induced Cracking

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Abstract : Acoustic microscopy and scanning electron microscopy were applied to non-destructively evaluate the hydrogen-induced cracking of API X-80 steels and to find the initiation time of the crack. The API X-80 steel had the average grain size of about 4-10 ㎛. The hardness was reduced from 240 to 202 [Hv] after exposing in HIC environment for 2-days. Friction coefficient and wear loss were 0.745 and 0.392 mm, respectively. Empirical equation of corrosion potential and corrosion rate of the steel with HIC time in 5%NaCl-0.5%CH_3COOH at 25°C were Eh (up)= 0.06*t [day]+0.2951, Eh(down) = 0.376*t[day]+0.5938, respectively. HIC grew with micro-size after 1-day exposure. The HIC tended to propagate on the surface with Al, Si, Ti, and Mn.

1. Introduction

Since hydrogen-induced cracking (HIC) is one of the main reasons for failure in line pipe steels, it is important for metallurgical engineers and materials scientists to understand the HIC mechanism to develop high-performance steels [1]. In this study, HiC surface of X-80 steel with micro-sized cracks was observed by Acoustic microscopy and scanning electron microscopy to find the initiation time to make a critical size of crack formed by hydrogen-induced cracking environments.

2. Experimental Method

API X-80 steel sheet (POSCO, Korea) was used for hydrogen-induced cracking (HIC) tests. Micro-hardness was measured with micro-Vickers hardness tester (HUATEC, DHV-100, China). The specimens for the HIC tests were mechanically sectioned along the rolling direction (100x20x50 [mm]). The specimens were kept in a standard HIC solution (NACE TM 0284-2003 solution-A) to produce hydrogen-induced cracks and to determine the initial time of critical crack formation in the specimen. Microstructure and micro-sized cracks were observed by scanning electron microscopy (Jeol JSM 6400, Japan) and scanning acoustic microscopy (Acoulab, ALMDU-3DDA, Korea). Cyclic corrosion test was carried out in artificial sea water and the wear resistance were determined by potentio-dynamic method (Gamry, Gamry-100, USA) and pin-on-disk type wear tester (R&B, Triboss PD-102, Korea), respectively.

3. Conclusions

(1) Average grain size of as-received X-80 steels was about 4-10 ㎛. The hardness was reduced from 240 to 202 [Hv] after exposing in HIC environment for 2-days. Friction coefficient and wear loss were 0.745 and 0.392 mm, respectively.
(2) The X-80 steels showed no-passivity for I-day exposure in 5%NaCl-0.5%CH_3COOH at 25°C. Empirical equation of corrosion potential and corrosion rate of the steel with HIC time were Eh (up)= 0.06*t [day]+0.2951, Eh(down) = 0.376*t[day]+0.5938, respectively.
(3) HIC grew with micro-size after 1-day exposure. The HIC tended to propagate on the surface with Al, Si, Ti, and Mn.

References

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