동적 나노압침법을 이용한 수소유기균열분위기에서 생성된 X65-석유수소용 강관의 산화막 분석

Analysis of Oxide Film on X65-Line Pile Steel Formed in Hydrogen Induced Cracking Environment by Dynamic Nano-indentation Method

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Abstract : The oxide film was formed in hydrogen induced cracking (HIC) environment by potentio-dynamic method. Corrosion potentials and rates of the X-65 and X-80 line pipe steels were -0.3495 V_{SHE}, 2.833x10^{-3}A/cm^2 and 0.2716 V_{SHE} and 2.533x10^{-3}A/cm^2, respectively. Surface composition analysis of the oxide film contained sulfur. Thermodynamic analysis of the HIC solution chemistry suggested that the oxide phase consisted of iron sulfate. Dynamic nano-indentation method applied to determine nano-hardnesses of the oxide film and base metal hardness.

1. Introduction

Since line pile steels were exposed in hydrogen induced cracking (HIC) environment, their surface should be corroded during service. Several types of iron oxide phases have been reported by nano-technology [1, 2]. Since a predominant phase of the oxide film significantly depended on the composition of base alloy and corrosive condition, the oxide film formed by corrosion in the HIC environment was analyzed in this study to more precisely understand the formation mechanism of oxide layer.

2. Experimental Method

Line pile steels for this study were made by POSCO. The steel plates were kept in HIC condition (NACE-TM 0284-2003). Potentio-dynamic corrosion test was carried out in the HIC solution by (Gamry-100, USA). Surface analysis was performed by Auger electron spectroscopy (Perkin-Elmer 100, USA). Microstructure was observed by scanning electron microscopy (Jeol JSM 6400, Japan). The mechanical properties of the oxide layer was determined by nano-indentation (Hysitron 400, USA). Thermodynamic phase stability was numerically evaluated.

3. Results

Corrosion potentials and rates of the X-65 and X-80 line pipe steel were -0.3495 V_{SHE}, 2.833 I_{corr}[10^{-3}A/cm^2] and 0.2716 V_{SHE} and 2.533 I_{corr}[10^{-3}A/cm^2], respectively. The oxide layer contained iron, sulfur and oxygen. Thermodynamic analysis of the hydrogen induced cracking condition revealed that the pre-dominant oxide phase was iron sulfate.

Reference

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