

عنوان مقاله:

Investigation into Mechanism of Hydrogen Induced Cracking Failure in Carbon Steel: A Case Study of Oil and Gas Industry

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خلاصه مقاله:

Abstract Although the hydrogen induced cracking (HIC) is recognized as one of the destructive modes for pipeline and component steels serving in sour environments, the behavior of the HIC is still not fully understood. On the other hand, although many efforts have been made to identify the effects of hydrogen on laboratory steel specimens, the study of actual industrial samples has received less attention. In this paper, we have studied the mechanism of the HIC in a damaged pipe of a real case study of the oil and gas industry (finger type slug catcher) using detection, characterization, and microstructural investigation methods. The detection of the HIC in the specimens by advanced ultrasonic techniques, failure analysis using tensile tests, chemical composition analysis, optical microscopy (OM), field emission scanning electron microscopy (FE-SEM), and energy-dispersive spectroscopy (EDS) techniques and their correlation with the microstructure, type, and morphology of the inclusions were conducted. The results indicated that the value of elements, especially carbon (۰.۱۳ wt %) and manganese (۱.۴۴ wt %), satisfies the requirement of API 5L specification. Furthermore, the inclusions, such as elongated manganese sulfide and spherical aluminum oxide, and the pearlite grains or the interfaces of the ferrite–pearlite phases played an essential role in the HIC phenomenon as nucleation and propagation places of cracks. It was also observed that HIC cracks were mostly initiated and propagated through the center or near the center of a cross-section of specimens. This region was a segregated zone where the center segregation of elements has occurred. Finally, we recognized a linear correlation between the HIC susceptibility and hardness value in steel, where by moving away from the cracks (۱۸۰۰ μm) to the crack edges, the hardness value increased significantly (۱۷۹–۲۰۳ HV), confirming the diffusion of hydrogen into hydrogen traps

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