Influence of Mo content on susceptibility of medium carbon martensitic steels to hydrogen embrittlement

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High-strength martensitic steels are used in various industrial applications owing to good balance of mechanical properties. Nevertheless, exposure of high-strength steels to hydrogen containing environment can have detrimental influence on their properties as a consequence of elevated susceptibility to hydrogen embrittlement (HE). In previous studies, the effect of Mo content on resistance of martensitic steels to sulphide stress cracking was reported. During the sulphide stress cracking, formation of sulphide layer on material surface can govern hydrogen induced crack propagation. However, in case of sulphide-free conditions, there is limited understanding about the role of Mo in the commercially available martensitic steels and its effect on hydrogen embrittlement.

This research elucidates correlation between the content of Mo carbide and hydrogen uptake of two high-strength Cr-Mo martensitic steels with different chemical composition and heat treatment. Hydrogen trapping behaviour and permeation were investigated by means of electrochemical permeation test and thermal desorption spectroscopy. Electrochemically charged Cr-Mo steels were subjected to slow strain rate tests to elucidate mechanical performance. The carbide distribution and microstructure of Cr-Mo steels were observed using scanning electron microscopy, electron backscatter diffraction and x-ray diffraction.

The results showed the level of reversibility of trapped hydrogen in the microstructure of investigated Cr-Mo steels. Thermal desorption analysis indicated two low temperature peaks with similar activation energies in case of both alloys. Hydrogen related to these peaks referred to as diffusible hydrogen was responsible for the deterioration of mechanical properties. Electrochemical charging showed higher uptake of hydrogen for alloy with higher content of Mo. Higher content of Mo promoted better mechanical performance of this alloy and had influence on susceptibility to HE.