

**Study of stress corrosion mechanisms of supermartensitic stainless steels  
in H<sub>2</sub>S medium**

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**Abstract:** Super martensitic stainless steels are widely used in the oil and gas industry, but failures occurred in service under severe conditions. The aim of this study is to provide a better understanding of the stress corrosion mechanism in H<sub>2</sub>S medium. For this purpose, laboratory heats have been casted with different molybdenum contents, a component known to improve corrosion resistance. These additions of alloying elements then involve a fine characterization of the microstructure, in order to grasp the mechanisms of rupture. Particular attention has been paid to the evolution of the retained austenite and residual ferrite fraction with the heat treatments of quench and annealing which are commonly practiced on these grades. Then, by electrochemical measurements without mechanical stress, the addition of molybdenum was identified as beneficial for the passivity of the grade in the H<sub>2</sub>S medium. And for 2.25% molybdenum contents, corrosion products have been identified as mainly nickel sulfides, which are inhibitors of hydrogen recombination. Subsequently, corrosion tests under static and dynamic load coupled to electrochemical impedance measurements show a beneficial effect of molybdenum and residual austenite. In particular, molybdenum reduces the defects of the passive film. A finite elements model simulates the slow strain rate traction tests taking into account the hydrogen embrittlement. In order to use experimental parameters, an electrochemical permeation cell was implemented and used to measure the hydrogen diffusion coefficient within our different heats. A good match with the experimental results was obtained with this model and a parametric study was carried out on the diffusion coefficient and the hydrogen interfacial concentration. Finally, a synthesis provides the proposal of a stress corrosion mechanism divided in two steps: the passive film resistance to limit the hydrogen absorption in the matrix and the trapping of the hydrogen by the residual austenite in function deformation.