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Sulfide and Chloride Stress Corrosion Cracking Mitigation Using Low Plasticity Burnishing (LPB)

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Technical Abstract

Stress corrosion cracking (SCC) and sulfide stress corrosion cracking (SSC) prevent the use of less expensive carbon steel alloys in the recovery of fossil fuels in corrosive environments commonly seen in offshore and deep well recovery efforts. Tensile residual stresses generated from welding and fit-up along with high temperature and high pressure environments are significant contributors to SSC, SCC and fatigue failure. Because these alloys are not suited for sulfide or chloride environments, the current solution is to use or create much more expensive alloys with increased corrosion resistance to mitigate the problems.

Introducing compressive residual stresses into less expensive carbon steel alloys can dramatically reduce the risk of failure, mitigate SCC and SSC, and improve fatigue strength. This would allow use of the less expensive alloys in environments where they currently are unable to be used. Low plasticity burnishing (LPB) is a reliable and reproducible method of producing deep compressive residual stresses in complex geometric components. LPB is a closed loop feedback surface enhancement method capable of introducing a customized compressive residual stress field. Furthermore, LPB produces a very smooth surface finish, which aids in nondestructive inspection and examination. LPB tooling can be integrated with existing delivery platforms used for manufacture and repair of fossil fuel recovery components.

SSC and SCC of high strength API P110 grade tubular products and duplex stainless steel Alloy 2205 prevent their use in either sulfide or chloride containing environments at all temperatures. As more deep wells and offshore resources are probed and recovered it is imperative to mitigate the problem of SCC and SSC in a cost effective manner. By using LPB to improve the corrosion resistance of less expensive alloys they can then be used in more aggressive environments without failure, eliminating the need for expensive corrosion resistant alloys. The LPB process can be employed to treat components to provide a substantial increase in service life, and SCC / SSC mitigation. The LPB technology can play a pivotal role in creating more reliable and efficient fossil fuel recovery systems that are capable of safely and reliably operating in aggressive environments while being economical and environmental friendly compared to current practices.

The benefit of LPB is currently being evaluated on full size sections of uniaxial hoop stress loaded coupling stock as well as NACE A tensile and C-ring specimens of quench and tempered API P110 grade. Specimens are exposed to NACE A solution per NACE TM0177 in both the LPB treated and untreated condition. The time to crack initiation is documented along with the increase in life resulting from LPB treatment.

Key Words: low plasticity burnishing, sulfide stress cracking, stress corrosion cracking, fatigue, residual stress