Enhanced corrosion resistance of oil & gas materials through the surface-modification homogenization method

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Abstract: The corrosion issue of metal materials employed in oil and gas fields is becoming more and more prominent. Based on the detailed analysis of the corrosion mechanism of metal materials, an idea of surface homogenization was proposed to improve the corrosion resistance of pipes, i.e., homogeneous corrosion coating fabricated by using the surface technology. In the term of the stress corrosion cracking of martensitic stainless steel induced by the pitting corrosion, the surface active inclusions of super 13Cr martensitic stainless steel (S13CrMSS) were eliminated, the high energy area was significantly reduced by changing the compositions of the passivation solution and improving the pre-passivation process. Accordingly, a nano-scale amorphous film was preformed on S13CrMSS surface, which improved the pitting potential of S13CrMSS by about 100%. In the term of the carbon steel, corrosion resistant homogeneous coatings were prepared on its surface by thermal spraying and laser cladding. Plasma spraying coating significantly improved the corrosion resistance of the metal pipes, but the issue of connectivity porosity leaded to the corrosive medium easy to penetrate into the surface of the matrix, inducing the matrix corrosion. The porosity of coating fabricated by the high velocity oxygen flame spraying (HVOF) and laser cladding was significantly lower than that of the plasma-sprayed coating. There was commonly no connectivity pore in the coatings, which effectively controlled the active corrosion area on the surface of the metal pipes. Therefore, based on the idea of surface homogenization, the corrosion resistance of metal materials can be significantly improved.

Keywords: Corrosion, Surface homogenization, Oil & gas field, Surface modification