Electrochemical Corrosion Study of SA-516 GR 70 Carbon Steel, SA-240 TP 317 L Stainless Steel and Roll-Bonded Clad (SA-516 GR70 + SA-240 TP 317L) in H_2SO_4

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Abstract

Pressure vessels are containers destined to store fluids under internal or external pressure used in the chemical, petrochemical, paper and cellulose industries, among others. In general, pressure vessels are made of carbon steel although roll-bonded or explosion clad stainless steels are also used. Material selection is based on several parameters such as work fluid, pressure, temperature and resistance to the corrosive environment to which the material will be exposed, e. g. $H_2S_{(g)}$, $H_2SO_{4(aq)}$, $H_{2(g)}$ or $CO_{2(g)}$. The objective of the present work is to evaluate the corrosion resistance of SA-516 Gr.70 carbon steel and SA-240 TP 317L austenitic stainless steel and roll-bonded clad SA-516 Gr.70 + SA-240 TP 317L steels in H_2SO_4 0.5 mol/L containing naturally dissolved oxygen. Testes for determination of the corrosion potential evolution, potentiodynamic polarization and electrochemical impedance spectroscopy were carried out. The experimental results obtained from electrochemical impedance spectroscopy revealed a kinetic of electron transfer control in two stages as the mechanism for the electrochemical reaction for the SA-240 TP 317L stainless steel. The corrosive process of SA-516 Gr.70 carbon steel is controlled by electron transfer, but occurs in a single stage. Behaviour of the clad sheet was similar to that of the carbon steel. However, the surface adsorption mechanism, which reduces corrosion resistance, was observed. The polarization resistance (R_p), corrosion potential (E_{corr}) and corrosion rate (R_{corr}) were obtained for the studied materials. The SA-240 TP 317L stainless steel was found to be resistant to the selected corrosive medium, exhibiting passivity (from 0 to 950mV) throughout entire the corrosion process. The clad steel presented inferior passivity (450 to 950mV) when compared to the stainless steel, while the SA-516 Gr.70 carbon steel was found to undergo continuous corrosion in the H_2SO_4 0.5 mol/L environment. It was possible to conclude that the SA-516 Gr. 70 + SA-240 TP 317L clad steel can be used as a substitute for carbon steel due to its corrosion resistance evaluated. This mechanism was found to be affected by the ratio of anodic and cathodic area.

Keywords: Electrochemical corrosion, austenitic stainless steel, carbon steel, clad steel, electrochemical techniques.