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RESEARCH ARTICLE

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Effect of cyclic heat treatment process on the pitting corrosion resistance of EN-1.4405 martensitic, EN-1.4404 austenitic, and EN-1.4539 austenitic stainless steels in chloride-sulfate solution

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Abstract

The effect of high temperature variation on the corrosion resistance of EN-1.4405, EN-1.4404, and EN-1.4539 stainless steels in 2 M H_2SO_4/3.5% NaCl solution was studied. Untreated EN 1.4405 exhibited the highest corrosion rate at 4.775 mm/year compared to untreated EN 1.4539 with the lowest corrosion rate (1.043 mm/year). Repetitive heat treatment significantly decreased the corrosion rate of the steels by 54.61%, 27.83%, and 50.28% to 2.167, 1.396, and 0.519 mm/year. EN-1.4539 steel exhibited the shortest metastable pitting activity among the untreated steels due to higher resistance to transient pit formation while heat treated EN-1.4404 and EN-1.4539 steels exhibited double metastable pitting activity. Heat treated EN-1.4405 was unable to passivate after anodic polarization signifying weak corrosion resistance. Pitting current of heat-treated steels was generally higher than the untreated counterparts. Heat treatment extended the passivation range value of EN-1.4405 and EN-1.4539 steels compared to those of the untreated steels. The corrosion potential of heat-treated steels significantly shifted to electronegative values. The optical image of untreated and heat treated EN-1.4404 and EN-1.4539 steels were generally similar while the images for EN-1.4405 significantly contrast each other.

KEYWORDS

chloride, corrosion, passivation, pitting, steel

1 | INTRODUCTION

Stainless steels generally have extensive applications in most industries due to their superior physical, mechanical, economic, physico-chemical, and corrosion resistance properties compared to carbon steels.[1-4] Corrosion reaction mechanisms influence the chemical properties of stainless steels and subsequently cause significant alterations in their physical and mechanical properties. The corrosion resistance of stainless steels is due to the chemical reaction of Cr with adsorbed