RELATIONSHIP BETWEEN THE LIMIT POTENTIALS OF 06KHN28MDT ALLOY AND ITS CHARACTERISTICS IN A CHLORIDE-CONTAINING MEDIUM

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Mathematical models based on regression trees have been developed to establish the relationship between the repassivation potentials E_{rep} and free corrosion E_{cor} of 06KhN28MDT alloy in a gap with a chloride-containing medium and its chemical composition and structure. It was found that the E_{rep} potential shifts to the positive side by 192.4 mV with an increase in the Cr content from 23.12 up to 23.68 wt.%, and E_{cor} reaches the most negative value (-0.4557 V) with a decrease in the Cr and Mn content. Reducing the mean austenite grain diameter to 11 μm reduces E_{rep} to 0.287 V. Mathematical models allow us to select optimal melts to increase the resistance of heat exchangers to crevice corrosion.

Keywords: crevice corrosion of 06KhN28MDT alloy, prediction of crevice corrosion resistance of 06KhN28MDT alloy, repassivation and free corrosion potentials and their calculation

Introduction. The design features of plate heat exchangers can contribute to crevice corrosion during their operation in the circulating systems of enterprises. In particular, local corrosion damage has been recorded at the tops of corrugations between adjacent heat transfer plates, on their surfaces under the recycled water sediment, and at the ends of the groove for the rubber gasket [1, 2]. This paper establishes the dependence between the limit potentials of the 06KhN28MDT alloy and its indicators in a gap with a chloride-containing medium.

Results. Based on the results of the analysis of the mathematical model (Fig. 1), it has been found that the free corrosion potential E_{cor} of the alloy has the most negative value (-0.455714V) when the chromium content is less than 22.215 wt.% and the manganese content is less than 0.455 wt.%. Under such conditions, the resistance of this alloy to crevice corrosion increases, as its ΔE criterion increases [3]. This is due to the fact that the lower the alloy's E_{cor} potential, the easier it is to give up electrons, contributing the ionization of metals at the anode sites. The density of anode currents decreases due to their redistribution among a larger number of anode sites, which "slows down" the transformation of metastable local corrosion damage into stable damage [4, 5].

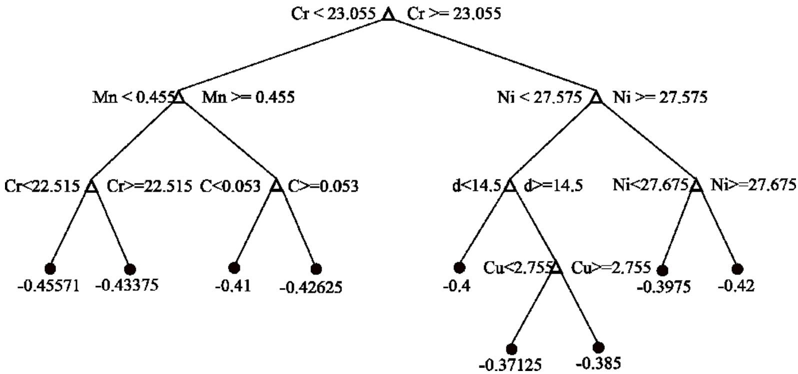

Fig. 1. Regression tree showing the relationship between the free corrosion potential E_{cor} of 06KhN28MDT alloy in a gap with a chloride-containing solution and its chemical composition and structural components.

Reducing the content of manganese, as a surface-active chemical element, most likely contributes to the depletion of the oxide film on the alloy surface by chromium, which leads to a shift in its potential E_{cor} in the negative direction [6].

It was found that the potential E_{cor} of the alloy shifts to -0.4126 V if the chromium content is greater than or equal to 23.055 wt.%. If the nickel content is less than 27.57 wt% and the mean austenite grain diameter is less than 14.5 μm, the E_{cor} potential is -0.4 V. These dependencies show that the smaller the austenite grain and the lower the nickel content, the more positive the corrosion potential. Under such conditions, the ionization of metals in contact with the media is more difficult.

The E_{cor} potential shifts to the negative side to -0.434615V with an increase in manganese content from 0.455 up to 0.57 wt%. When the carbon content is less than 0.053 wt.%, the E_{cor} potential is -0.41 V. Thus, the E_{cor} potential of the alloy shifts to the positive side by 0.0246 V, which reduces the rate of general corrosion but increases the probability of crevice corrosion.

The analysis of the model showed that the repassivation potential E_{rep} of the 06HN28MDT alloy depends on the content of chromium, copper, and the mean austenite grain diameter (Fig. 2). If the chromium content is less than 23.43 wt.%, as well as less than 22.315 wt.% and the mean austenite grain diameter is less than 22 μm, then the potential E_{rep} is 0.07875 V. If the chromium content is greater than or equal to 23.43 wt.%, then the potential shifts intensively towards the positive side to 0.5538 V. This contributes to an increase in the ΔE criterion of the alloy and its resistance to crevice corrosion [7–9].

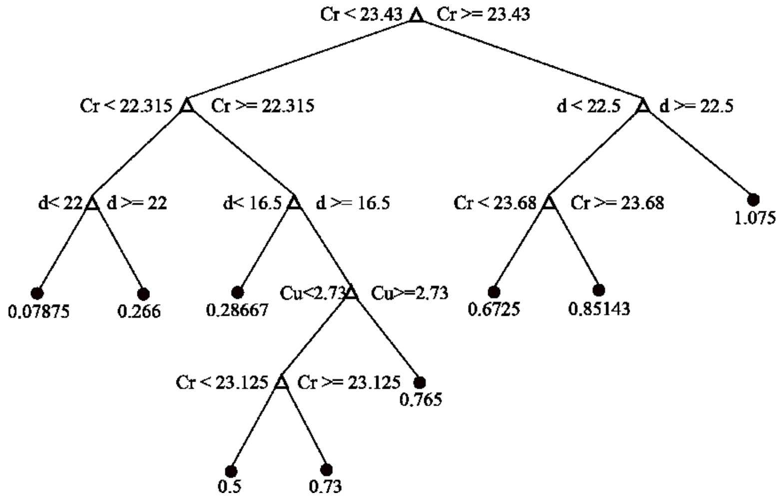

Fig. 2. Regression tree showing the relationship between the repassivation potential E_{rep} of 06KhN28MDT alloy in a gap with a chloride-containing solution and its chemical composition and structure components

It has been established that defects in the alloy structure at the austenite grain boundaries have a stronger effect on its E_{rep} potential in a chloride-containing medium than the ability of chromium to form passive films on the surface of local damage [10, 11]. When the mean austenite grain diameter is greater than or equal to 22.5 μm, the E_{rep} potential is 1.075V.

It was found that the potential E_{rep} of the alloy rapidly shifts to the positive side by 192.4 mV with an increase in chromium content from 23.125 up to 23.68 wt.%. This leads to an increase in the alloy's resistance to crevice corrosion in a chloride-containing media.

Conclusions. Analysis of regression tree-based mathematical models reveals that the repassivation potential (E_{rep}) of 06KhN28MDT alloy in chloride-containing media shifts positively by 192.4 mV with chromium content increase from 23.12 up to 23.68 wt%, significantly enhancing crevice corrosion resistance through formation of dense oxide films. Minimum E_{rep} values (0.287V) are observed at austenite grain diameters below 16.5μm, with progressive positive shifts to 0.5V when Cu<2.73% and Cr<23.125%, and further up to 0.765V and 0.73V respectively at higher concentrations, where copper demonstrates greater influence on electrochemical behavior. The corrosion potential (E_{cor}) reaches maximum negative values (-0.4557V) at reduced chromium (<22.215%) and manganese (<0.455%) concentrations, which decreases crevice corrosion susceptibility while accelerating general corrosion. Carbide precipitation occurring at carbon contents exceeding 0.053 wt% induces slight negative E_{cor} shifts, while larger grain diameters (>15.5μm) produce more positive values (-0.38V). Increased nickel content (>27.675%) shifts E_{cor} negatively by 0.17V, enhancing the alloy's resistance to local corrosion.

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