PLATE-LIKE HEAT EXCHANGERS RESISTANCE MADE OF ALLOY 06KhN28MDT (SIMILAR TO AISI904L STEEL) TO CREVICE CORROSION

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Plate-like heat exchangers made of the 06KhN28MDT alloy (similar to AISI904L steel) in the production of different acids are used. It can be exposed to crevice corrosion between the corrugations of adjacent heat transfer plates of plate-like heat exchangers. In the article, the resistance of the alloy to crevice corrosion in model circulating waters has been investigated. For production melts of the 06KhN28MDT alloy with a minimum content of C and a maximum of Cr, Mo, Ti and Cu with a mean austenite grain diameter of up to 15 μm are recommended to choose.

Keywords: crevice corrosion, plate-like heat exchanger, model circulating water, chloride-containing media, resistance of 06KhN28MDT alloy to crevice corrosion

Introduction. The 06KhN28MDT alloy (similar to AISI904L stainless steel) is used in the production of plate-like heat exchangers, which are used in the production of sulfuric, orthophosphoric, hydrofluoric acid, etc. [1]. After all, they have high corrosion resistance to intercrystalline corrosion in these media [2]. But the circulating water, which is used to cool the technological product during the production of acids, contains chlorides and other anions [3], which can be the cause of pitting or crevice corrosion of heat exchangers [4–6].

Crevice and pitting corrosion of steels and alloys have many common features [10], in particular, pitting corrosion of heat exchanger plates under sediment from circulating water on their surface can turn into crevice corrosion when the chloride-containing media in the gap between them is acidified or alkalized with a simultaneous increase in chloride content [3]. Under such conditions, pitting on the surface of the heat exchange plates from the circulating water side grows intensively and turns into corrosion ulcers. At the same time, the intensity of their growth no longer depends on the parameters of the chloride-containing media (pH, chloride concentration). Therefore, the article investigated the influence of the parameters of the 06KhN28MDT alloy on its resistance to crevice corrosion in circulating water during the operation of plate-like heat exchangers.

Results. In the article, the resistance of the alloy to crevice corrosion in model circulating water of 3% NaCl by electrochemical methods has been

investigated. For five industrial melts of the alloy, anodic potentiodynamic curves of forward and reverse move have been constructed (Fig.1) and potentials E_r, E_{cor}, E_{crew} have been determined. The resistance of the 06KhN28MDT alloy to crevice corrosion by the E_{crew} potential and the basis of the resistance of the alloy to this corrosion in the crevice ΔE has been estimated, which simulated a gap between adjacent plates of plate-like heat exchangers of 0.3 mm.

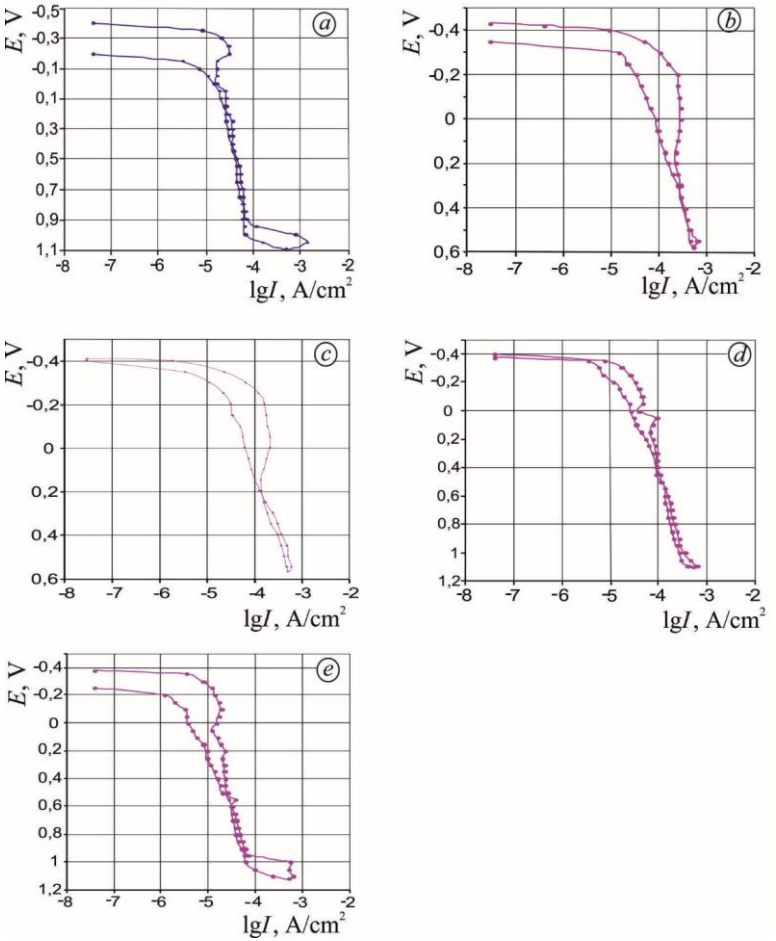

Fig. 1. Anodic potentiodynamic curves of forward and reverse move of 06KhN28MDT alloy: a – melt 1, b – melt 2, c – melt 3, d – melt 4, e – melt 5.

According to the results of corrosion studies of the alloy 06KhN28MDT (similar to AISI904L steel) in model circulating water, it has been established

that its potentials E_{crew} are the most positive (1.10 and 1.13V) in melts of alloy 1, 5, and in melts 2, 3 – the most negative value (0.58V) has been established. This is due to the fact that they have the highest content of Cr (24.29 and 23.44 wt %) and the total content of Mo, Ti and Cu (6.41 and 6.19 wt %), and in melts 2, 3 – the smallest Cr (22.69 and 21.82 wt. %) and the total content of Mo, Ti, Cu (6.05 and 5.75 wt. %). Taking into account the literature data, it is assumed that this trend is related to the formation of mixed Cr, Mo, Ti oxide films enriched in Cr on the surface of the alloy, since Cu promotes its diffusion to the oxide film. Melts 1, 4, 5 with the lowest C content (0.050; 0.048; 0.050) have the most positive values of this potential (1.10; 1.10; 1.13V), and No 2, 3 are the most negative (0.58V) has been found, which may be due to the carbon content greater than its solubility in the solid solution of austenite (0.067 and 0.068 mass .%). No correlation between the E_{crew} potential of the alloy and the volume of titanium nitrides in it has been found, but it that the potentials E_r, E_{cor}, E_{crew} significantly depend on the volume of titanium sulfides in the melt 1 (0.0091 vol. %), which is more than twice as high as in melts 2, 5 has been established. Evaluation of the resistance of the alloy to crevice corrosion in circulating water by ΔE, which was determined by the difference in the potentials of E_r and E_{cor}, showed similar results, in particular melts 1, 4, 5 are the most resistant to this local corrosion (ΔE = 1.2; 0.95; 0.98V), and No 2, 3 (ΔE = 0.93; 0.64V) are the least resistance. This is due to the influence of C, Cr, Mo, Ti and Cu, as well as the volume of titanium sulfides on the E_r and E_{cor} potentials, similar to their influence on E_{crew}. It is shown that pl. 1, 5, which are the most resistant to this local corrosion, have the minimum values of the mean diameter of the austenite grain (11 and 15 μm), and No 2, 3, which are most prone to it - 24 and 29 μm. But in melt 4, which occupies an intermediate place, this indicator is 31 μm. This is most likely due to the low probability of crossing titanium carbonitrides with austenite grain boundaries, where local corrosion damage originates. Melts 1, 5, which are the most resistant to crevice corrosion in circulating water, have the largest area of local damage has been established. This is due to the redistribution of currents between a smaller number of local damages due to the repassivation of a larger part of them. Manufacturers of plate-like heat exchangers to choose melts of the 06KhN28MDT alloy with a minimum content of C and a maximum of Cr, Mo, Ti and Cu with a mean austenite grain diameter of up to 15 μm are recommended.

Conclusions. According to the results of corrosion studies of the alloy 06KhN28MDT (similar to AISI904L steel) in model circulating water, it has been established that its potential E_{crew} shifts in a more positive direction from 0.58 (melts 2, 3) to 1.10 and 1.13 V melts 1, 5 with an increase in its Cr content from 21.82 and 22.69 (melts 2, 3) to 24.29 and 23.44 wt.% (melts 1, 5), the total content of Mo, Ti and Cu from 6.05 and 5.75 melts 2, 3 to 6.41 and 6.19 wt. % melts 1, 5 and a decrease in the C content from 0.067 and 0.068 melts 2, 3 to

0.05 wt. % melts 1, 5. This helps to increase the resistance of the oxide film on the surface of the alloy to crevice corrosion due to the formation of mixed Cr, Mo, Ti oxide films enriched in Cr due to the activating effect of Cu. Reducing the content of C in the alloy to its solubility in the solid austenite solution prevents the precipitation of Cr, Ti, and Mo carbides in the vicinity of titanium nitrides, which has a positive effect on the resistance of the oxide film to "breakdown" by chlorides in the gap near these inclusions. These chemical elements also contribute to the growth of the basis of the resistance of the alloy to crevice corrosion ΔE from 0.64 and 0.93 melts 3, 4 to 1.2 and 0.98 V melts 1, 5 with a change in their content in the mentioned interval has been established. This is due to the fact that the potential E_r of the alloy shifts to a more positive side, and E_{cor} to a more negative side with an increase in the content of Cr, Mo, Ti, Cu and a decrease in C. It is shown that the specific magnetic susceptibility of the alloy χ_0 is an integral characteristic that characterizes the atomic-magnetic state and depends on the content of these chemical elements. It is assumed that Ti sulfides can determine the potentials of the alloy 06KhN28MDT E_r, E_{cor}, E_{crew}, affecting the protective properties of mixed Cr, Mo, Ti oxide films.

The melts 1.5 of the 06KhN28MDT alloy, which are the most resistant to crevice corrosion, experienced the greatest corrosion damage has been established. This is caused by the process of redistribution of current density between local corrosion damages due to repassivation of most metastable, due to the formation of mixed Cr, Mo, Ti oxide films, since these melts contain the largest amount of these alloying elements.

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