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POLARIZATION STUDIES OF STEEL IN THE PRESENCE OF SYNERGETIC MIXTURES BASED ON INORGANIC OXIDIZERS AND MONOETHANOLAMINE IN SODIUM CHLORIDE SOLUTIONS

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Abstract: *Polarization studies have shown that the effect of inhibitors containing inorganic oxidants and monoethanolamine reduces the corrosion rate of steel in 3% NaCl. This decrease unambiguously indicates a simultaneous slowing down of the cathodic reduction of molecular oxygen and the anodic reaction of metal ionization. Based on the studies carried out, it was concluded that the developed mixtures function as mixed –type inhibitors.*
Keywords: *polarization, inhibitor, cathodic and anodic processes, ionization, synergetic effect.*
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Introduction

According to previously obtained data [1-5], it showed that the combined introduction of inorganic oxidizing agents and amines at the certain ratios into a corrosive medium leads to a noticeable decrease in the corrosion rate of carbon steel. In this regard, it is of scientific interest to study corrosion-electrochemical properties of St.3 in these mixtures and find out reasons of braking effect of the used inhibitors.

Previously, we obtained data on the effect of the concentration of inhibitors on electrode potentials under open circuit conditions, since these changes can be used to indirectly judge about possible effect of synergistic mixtures on the course of electrode reactions occurring on the steel surface.

Experimental part

Electrochemical measurements were carried out on a Pi-50-1 potentiostat with a separated anode and cathode space. As an electrode, a rotating disk electrode (970 rpm) was taken from steel gradest 3 with a working surface of 1 cm. Potentials were measured relative to the silver chloride electrode and recalculated to the normal hydrogen scale. The auxiliary electrode was platinum. Polarization curves were recorded in the potentiodynamic regime with a potential sweep rate of 12 mV per minute.

Results and discussion

The removal of polarization curves in the potentiodynamic regime for the tested metal in a given corrosive sphere without additives and in the presence of inhibitors allows us to find out which of the processes (anode or cathode) is mainly braked by the introduction of inhibitors, components and their mixtures.

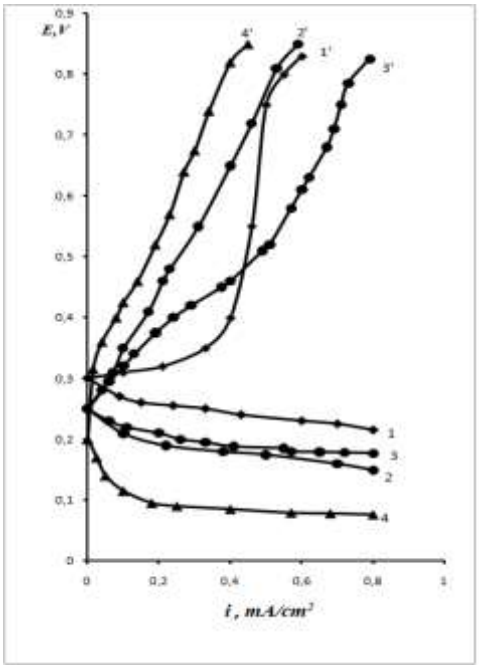

Fig. l. Cathode, anode polarization curves of St. 3 in a 3% NaCl solution with the addition of an inhibitor, mg/1: 1–1 '- without inhibitor; 2–2'–$NaNO_2$-100; 3-3'–MEA – 100; 4–4'– $NaNO_2$ –100 + MEA – 100

In Fig. 1 polarization curves taken in a 3% NaCl solution and in the presence of monoethanolamine (MEA) are presented, $NaNO_2$ individually and in their mixture. As can be seen from Fig. 1, with the addition of $NaNO_2$ (100 mg/1) in the background solution (3% solution of NaCl), the electrode potential is shifted to a positive direction at 80 mV. At the same time, both cathodic and anodic processes are simultaneously braked, and the inhibition of the latter is stronger. With the addition of monoethanolamine (100mg/g) to the background solution, the cathodic process is mainly inhibited. The addition of both $NaNO_2$ and monoethanolamine (100mg/g) to the solution simultaneously leads to stronger suppression of both cathodic and anodic processes (Fig. 1. curves 4-4'.)

As follows from Fig.1, both individually and jointly, $NaNO_2$ and MEA are able to change the kinetics of electrochemical processes on steel and lead to a noticeable decrease in the corrosion rate. The greatest effect is observed in the mixture of these inhibitors. In this work, along with the above mentioned inhibitor, we studied other mixtures of inhibitors as well, in particular, mixtures of potassium chromate and MEA. Polarization measurements showed that the combined presence of two components in the mixture (K_2CrO_4+MEA) leads to a noticeable braking of cathodic and anodic processes. Moreover, the inhibition of the anode process in this case is greater than in the presence of sodium nitrate (Fig. 2). A study into kinetics of the anodic ionization reaction of steel in the presence of a mixture of MEA with sodium molybdate revealed that although monoethanolamine and sodium molybdate contribute to some anodic polarization of the electrode, their mixture with a synergistic property, has the greatest influence on this process.

In our opinion, the mechanism of the protective effect of MRA mixture and $NaNO_2$ is that a chemisorbed layer of iron hydroxide which includes monoethanolamine is formed on the outer protective layer of iron oxide, and in the case of chromate with MEA, a complicated complex of chromium with iron of the chelated type is formed on the steel surface.

Thus, there is a definite correlation of the influence of studied inhibitors on the corrosion rate and the anodic reaction of steel ionization.

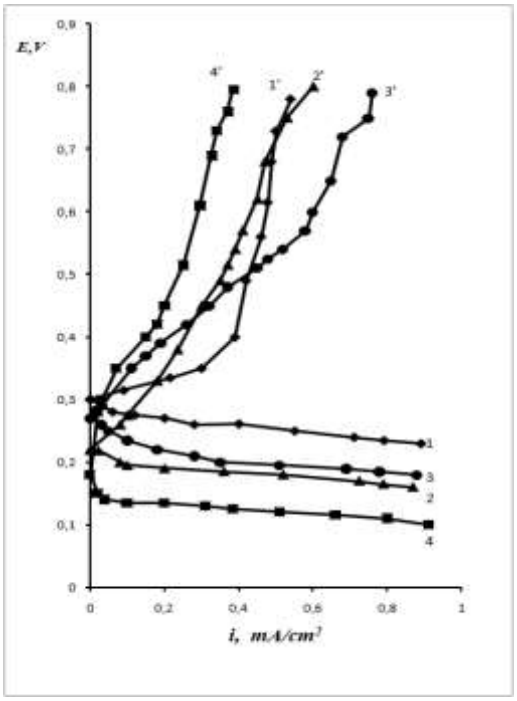

Fig. 2. Cathode and anode polarization curves of St. 3 in a 3% NaCl solution with the addition of an inhibitor, mg/1: 1–1'- without inhibitor; 2–2'– K_2Cr0_4 10; 3–3' – $H_2N – CH_2 – CH_2 – OH$ – 90; 4–4'– K_2Cr0_4–l 0 + $H_2N – CH_2 – CH_2$– OH– 90

Conclusion

Electrochemical studies show that in neutral electrolytes a synergistic effect of inhibiting the corrosion process is observed, with the combined presence of these oxidizing agents and MEA in a corrosive environment. These mixtures exert a braking effect both on cathodic and anodic processes.

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QEYRİ-ÜZVİ OKSİDLƏŞDİRİCİLƏRİN VƏ MONOETANOLAMİN ƏSASINDA HAZIRLANMIŞ İNHİBİTOR QARIŞIĞININ OLDUĞU NATRİUM XLORİD MƏHLULLARINDA POLYARLAŞMANIN TƏDQİQİ

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Polyarlaşma tədqiqatları nəticəsində məlum olmuşdur ki, tərkibində qeyri-üzvi oksidləşdiricilər və monoetanolaminin olduğu inhibitorlar poladın korroziya sürətini azaldır ki, bu da birqiymətli molekulyar oksigenin reduksiyası və anod reaksiyası olan metalın ionlaşma proseslərinin ləngiməsinə dəlalət edir. Hər iki prosesin ləngiməsi hazırlanmış inhibitor sistemlərin qarışıq tipli olduqlarını təsdiq edir.
Açar sözlər: *polyarlaşma, inhibitor, katod və anod prosesləri, ionlaşma, sinergetik effekt*

ПОЛЯРИЗАЦИОННЫЕ ИССЛЕДОВАНИЯ СТАЛИ В ПРИСУТСТВИИ СИНЕРГЕТИЧЕСКИХ СМЕСЕЙ НА ОСНОВЕ НЕОРГАНИЧЕСКИХ ОКИСЛИТЕЛЕЙ И МОНОЭТАНОЛАМИНА В РАСТВОРАХ ХЛОРИСТОГО НАТРИЯ

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Поляризационные исследования показали, что влияние ингибиторов, содержащие неорганические окислители и моноэтаноламин, уменьшают скорость коррозии стали в 3%-м растворе NaCl. Это уменьшение однозначно свидетельствует об одновременном замедлении катодного процесса восстановления молекулярного кислорода и анодной реакции ионизации металла. На основе проведенных исследований сделано заключение о том, что разработанные смеси функционируют как ингибиторы смешанного типа.
Ключевые слова: *поляризация, ингибитор, катодные и анодные процессы, ионизация, синергетический эффект.*