THE ANTICORROSION PERFORMANCES OF THE ION-MODIFIED ZEOLITES FOR

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Introduction

Aluminum alloys are commonly used as a construction material in different industries due to their high mechanical properties. They contain various intermetallics, that ensure strength and hardness. Though, the intermetallics increase alloys sensibility to corrosion due to the difference in potentials of alloying components and the aluminum matrix [1]. One of the common and effective methods used to protect aluminium alloys from corrosion destruction is application of paint coatings [2]. Anticorrosion paints contain inorganic pigments which inhibit corrosion by electrochemical and chemical reactions. Environmental friendly zeolites are promising inhibiting pigments for corrosion protection of the aluminum alloys [1]. Zeolites are nanocrystalline aluminosilicate with 3D porous structure, which use as containers in paint coating [3]. Corrosion protection performance zeolites increased by modification of metal cations.

The aims: The research aim is to evaluate the inhibitory effect of modified zeolites by calcium, zinc and manganese ions in 0.1% NaCl solution.

Methods

Synthetic zeolite was used in the study. The zeolite was milled by RetschPM high energy planetary ball mill 100 for 1 h. Rotation frequency of the grinding cylinder was 100 rpm. In result was obtained a powder a size of 2…4 µm with an increased specific surface area. The modification of zeolite was carried out by liquid-phase ion-exchange method with zinc, calcium and manganese cations, using $Ca(NO_3)_2{\cdot}4H_2O$, $Zn(NO_3)_2{\cdot}6H_2O$ and $Mn(NO_3)_2{\cdot}6H_2O$ salts. The salt concentration was 0.45 M. The synthesis was carried out at 70 °C under periodic mixing for 90 min.

The polarization characteristics were recorded by a Cor–500 potentiostat, using a saturated Ag/AgCl reference electrode and a counter platinum electrode. The potential scan rate during experiments was 2 mV/s. Aluminium alloy sample working area was 1 cm^2.

Table 1. The electrochemical characteristics of the aluminium alloy

Solution	Time exposure			
	24 h		96 h	
	E_{corr}, V	$i_{corr}{\cdot}10^3$, mAcm^{-2}	E_{corr}, V	$i_{corr}{\cdot}10^3$, mAcm^{-2}
0.1% NaCl	-0.64	1.8	-0.61	1.5
Adding 1 g·l^{-1} into 0.1% NaCl solution				
Zeolite	-0.62	1.6	-0.56	1.6
Ca-zeolite	-0.61	1.4	-0.56	1.4
Mn-zeolite	-0.64	1.6	-0.69	0.8
Zn-zeolite	-0.63	1.0	-0.67	0.4
Adding 2 g·l^{-1} into 0.1% NaCl solution				
Zeolite	-0.62	1.8	-0.61	1.5
Ca-zeolite	-0.56	0.8	-0.54	1.6
Mn-zeolite	-0.59	0.5	-0.64	0.5
Zn-zeolite	-0.72	0.2	-0.64	0.1

Results

In Fig. 1 shows the polarization curves of the aluminium alloy after exposure for 24 h in 0.1% NaCl solution and in solutions with the addition of pigments, according to the corrosion potential (E_{corr}) and current (i_{corr}) were determined (Table 1). Electrochemical corrosion of the aluminium alloy in sodium chloride with a concentration of modified zeolites of 1 g·l^{-1} occurs under mixed control. It was shown in [4] that the desorption properties of the studied zeolites increased in the series Ca^{2+}<Mn^{2+}<Zn^{2+}. Therefore, the presence of Ca^{2+} cations doesn't provide necessary improvement of corrosion resistance of the aluminium alloy. This is probably due to the insufficient amount of inhibiting components both in the modified zeolite and in the formed Ca-contained zeolite suspension. The concentration increment of modified zeolites to 2 g·l^{-1} improved corrosion protection of the aluminium alloy.

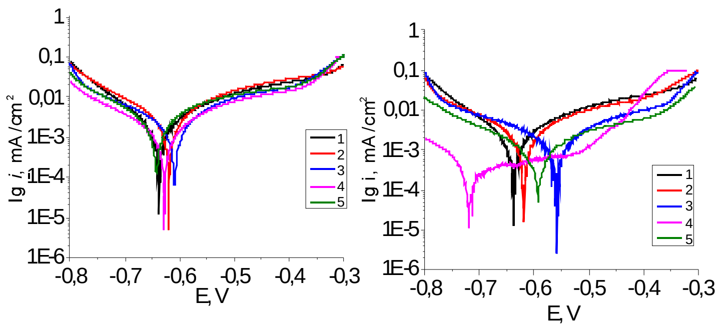

Fig. 1. The potentiodynamic polarization curves of the aluminium alloy after exposure for 24 h in 0,1% NaCl solution (*1*) and adding 1 g·l^{-1} (*a*) or 2 g·l^{-1} (*b*) into solution initial zeolite (*2*) or modified zeolite by Ca (*3*), Mn (*4*), Zn (*5*)

The protective effect of the studied pigments is also observed after 96 h exposure in the case of Mn and Zn-zeolites, since the Mn^{2+} and Zn^{2+} cations form insoluble hydroxides, in contrast to Ca^{2+} cations, which form poorly soluble hydroxides. At the same time, the greatest anticorrosive effect provided modified zeolite by Zn cations.

References

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Conclusion

Consequently, electrochemical measurements were shown that the corrosion resistance of the aluminum alloy in 0.1% NaCl solution is increased due to the modified zeolites obtained by liquid-phase ion exchange. The inhibitory effect of the studied zeolites is due to the formation of insoluble oxide-hydroxide layers and grows in the series

Ca-zeolite<Mn-zeolite<Zn-zeolite.

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