Asian Journal of Chemistry; Vol. 23, No. 8 (2011), 3417-3419

ASIAN JOURNAL OF CHEMISTRY

www.asianjournalofchemistry.co.in

Effect of Benzotriazole and Tolytriazole on the Corrosion of Pure Zinc in 1M NaCl Solution

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(*Received*: 23 August 2010; *Accepted*: 18 April 2011) AJC-9815

In this study, the effect of benzotriazole (BTA) and tolytriazole (TTA) as inhibitors on the corrosion of pure zinc metal was investigated by electrochemical potential-time, current-potential and AC-impedance methods in 1M NaCl solution. Corrosion rates of metal in the studied solutions were obtained by extrapolation of Tafel zones of current-potential curves to the corrosion potential and inhibition effects were calculated from corrosion rates obtained in studied corrosive media. Inhibition effects of benzotriazole and tolytriazole are dependent to the concentration of the these triazolic compounds in the studied solutions. Inhibition effect as percentage is higer than 90.

Key Words: Zinc, Inhibition, Triazole.

INTRODUCTION

Zinc used as alloying element and cathodic protection of metals, but its corrosion resistance is not good. Because, its standard electrode potential is sufficiently negative[1]. For this reason, its corrosion resistance must be improve. It can be improve with surface pretreatments, coatings and addition inhibitors in the corrosive media[2-8].

Surface coatings protect the zinc against corrosion by preventing either by the release of metal ions to the solution or oxygen and hydrogen reduction on the cathodic zone[9]. Zinc oxide and hydroxide were performed on the metal surface as corrosion products. The organic compounds are added in the corrosive media for improving corrosion resistance of zinc oxide and hydroxide performed on the metal surface. These organic compounds are decreased the porosity of the corrosion products performed on the metal surface in the corrosive media.

In this sdudy,the inhibition effect of triazolic compounds benzotriazole (BTA) and tolytriazole (TTA) on the corrosion of pure zinc metal in NaCl solution were investigated as additives. These compounds are widely used as corrosion inhibitors for copper and ferrous alloys[10-13]. Benzotriazole and tolytriazole were used as inhibitor corrosion inhibition of carbon steel in zinc phosphating bath[14]. Tolytriazole and carboxylates coatings on zinc was decreased the corrosion of metal in atmospheric conditions[15]. These protective layers are very thin, insoluable and as an efficient barrier layer against corrosion of zinc in atmosphere.

EXPERIMENTAL

Zinc wire (Aldrich, 99.99 % purity, 2 mm diameter) was fixed in the Teflon tube with adhesive. Zinc electrode was polished with 1200 grid emery paper and was immersed in an aqueous solution of 0.15M HCl solution 20 s before immersion in studied corrosive media for obtaining better electrode surface.

Merk grade reagents of NaCl, benzotriazole and tolytriazolel were used for experiments and aqueous solutions were prepared with double distilled water. The potential-time (20 min), current-potential (1 mV/s) and AC-impedance curves were performed by constitued CH-Instruments 660B Potentiostat, electrochemical work station of computer programme, BAS disc electrode and Polyscience model 9106 thermostat system using a satureted Ag/AgCl as referance and a platinium wire as counter electrode. All measurements were carried out in aerated solutions at the 25 ºC. The impedance measurements were performed at the open circuit potential of working electrode with voltage perturbation amplitute of 5 mV in a frequency range between 10^5-1 Hz.

RESULTS AND DISCUSSION

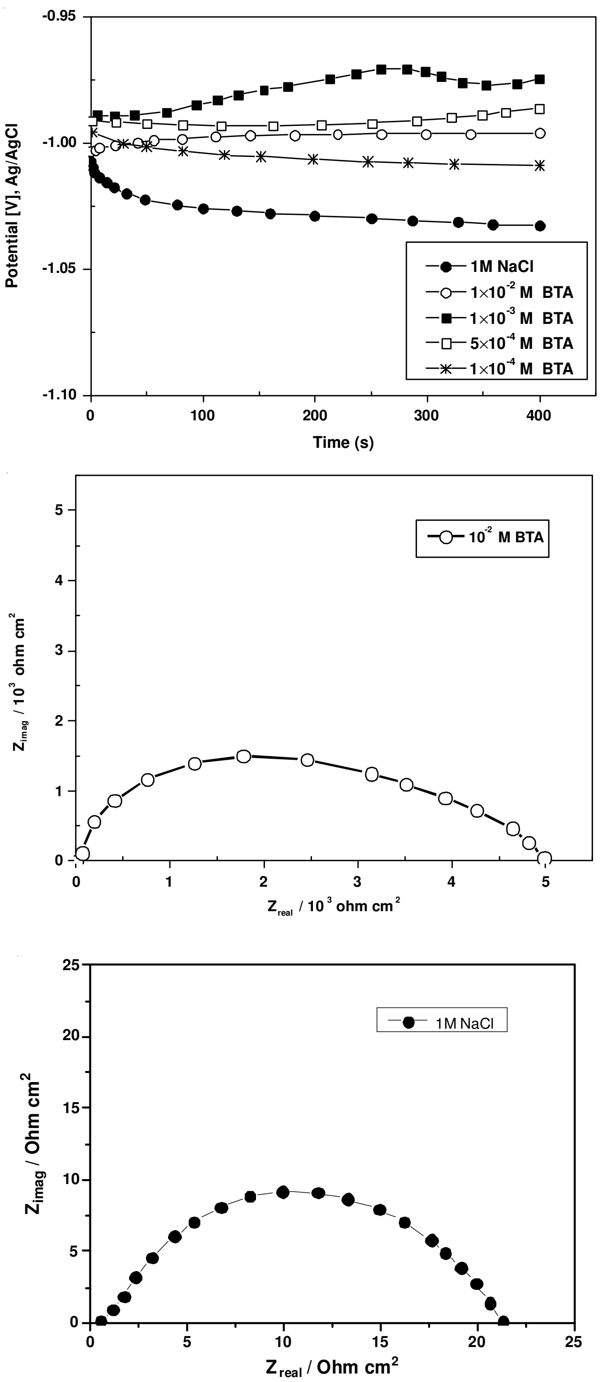
The potential-time, current-potential and Nyquist curves of zinc electrode obtained in 1M NaCl + xM BTA and 1M NaCl + xM TTA solutions are given Figs. 1 and 2. Calculated and measured corrosion characteristics of pure zinc electrode in the studied corrosion solutions are also given in Tables 1-2. Figs. 1-2 and data in Tables 1 and 2 show that the electrode potential chages to the negative direction in NaCl and NaCl

TABLE-1
CORROSION CHARACTERISTICS OF ZINC IN 1M NaCl + xM BTA SOLUTIONS AT 25 ºC

Media	E_{cor} (V)	$-b_c$ (mV)	b_a (mV)	i_{cor} (μA/cm²)	R (ohm cm²)	η (%)
1 M NaCl	-1.227	192	193	50.0	210	–
1×10^{-4} M BTA	-1.239	108	511	33.6	290	33
5×10^{-4} M BTA	-1.121	180	86	3.80	1600	92
1×10^{-3} M BTA	-1.047	219	230	0.58	3900	99
1×10^{-2} M BTA	-1.011	206	26	0.51	5000	99

TABLE-2
CORROSION CHARACTERISTICS OF ZINC IN 1M NaCl + xM TTA SOLUTIONS AT 25 ºC

Media	E_{cor} (V)	$-b_c$ (mV)	b_a (mV)	i_{cor} (μA/cm²)	R (ohm cm²)	η (%)
1 M NaCl	-1.227	192	193	50.000	210	–
1×10^{-4} M TTA	-1.190	180	242	9.960	1130	80
5×10^{-4} M TTA	-1.160	210	57	0.870	5600	98
1×10^{-3} M TTA	-1.019	242	24	0.565	4200	99



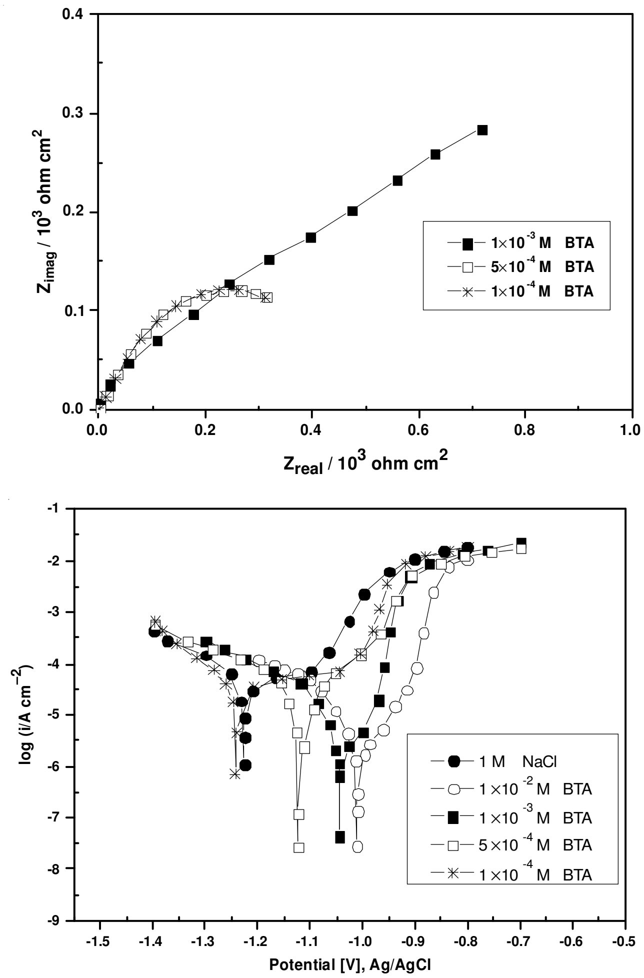


Fig. 1. Potential-time, Nyquist and current-potential curves obtained by zinc electrode in 1M NaCl + xmM BTA solutions [x: 0.0 (●), 0.1(×), 0.5 (□), 1(■), 10(o)]

containing small BTA or TTA solutions. But, it change to the positive direction with increasing BTA or TTA concentrations. These show that BTA and TTA are decreased corrosion of pure zinc metal as anodic inhibitor in the NaCl solution.

Inhibition effect of BTA and TTA as additives is *ca.* 99 %, if the additives concentration much more than 1×10^{-3} M. Nyquist diagrams obtained in NaCl and NaCl solutions containing very small or high concentration of BTA or TTA are semicircle. But, BTA or TTA concentrations are *ca.* 1 ×

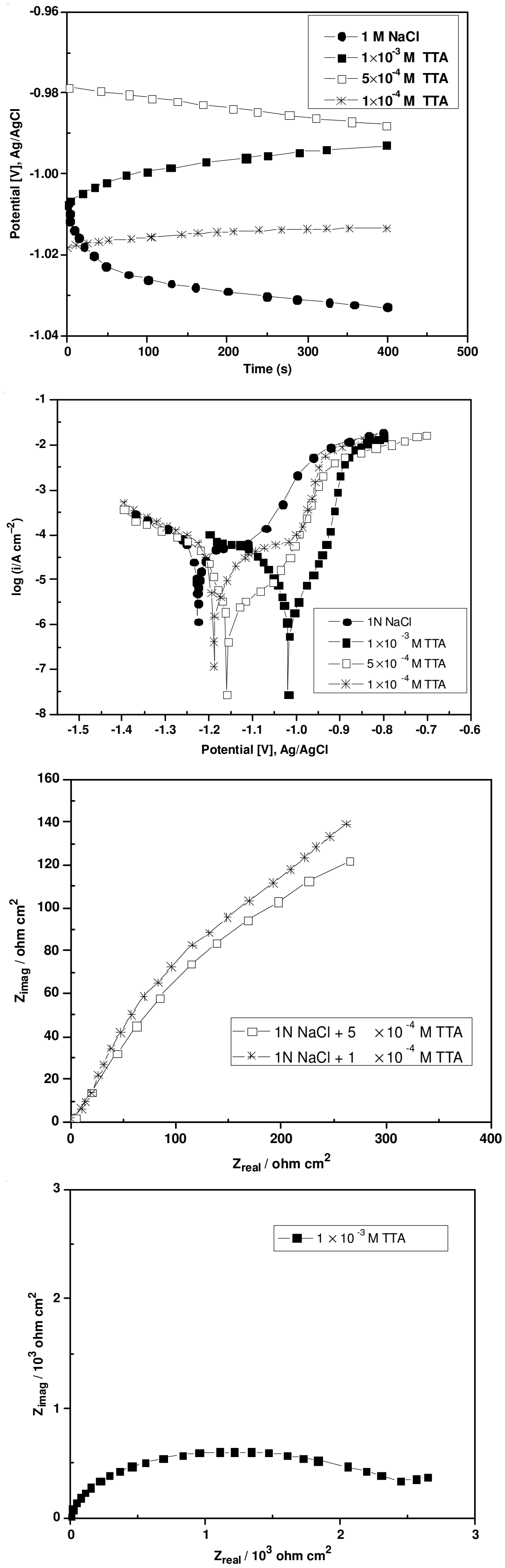


Fig. 2. Potential-time, Nyquist and current-potential curves obtained by zinc electrode in 1M NaCl + xmM TTA solutions [x: 0.0 (●) 0.1(×), 0.5 (□), 10(■)]

10^{-4} M, Nyquist diagrams are not semicircle. These diagrams show that the reaction on the pure zinc surface is charge transfer control, if the BTA or TTA concentrations in NaCl solutions are much small or high. In this conditions, one surface layer has at the metal/solution interface.

Surface coatings performed with zinc phosphate on the carbon steel is highly porous[16,17]. They included oxides, hydroxide and phosphate. Benzotriazole was decreased the porosity of phosphate layer performed on the carbon steel. Calculated corrosion rates of pure zinc were dramatically decreased and polarization resistances were also dramaticly increased in NaCl solution containing BTA or TTA. A high corrosion resistance shows that BTA or TTA must be decrease the porosity of surface coatings or polimerize on the metal surface[18].

These results show that BTA and TTA were decreased the porosity of surface coatings performed on the pure zinc electrode. Increasing electrode potential at the positive direction also shows this effect. If the metal surface was coated with passive layer, Nyquist diagram consisted semicirecle[19,20]. If the NaCl solution do not contain BTA and TTA or contain these additives much, Nyquist diagrams of pure zinc metal are semicircle similar to report of Lin *et al.*[20] for aluminium. The shape of the Nyquist diagram is dependent pretreated of metal surface[20].

ACKNOWLEDGEMENTS

The authors acknowledged the financial support from Ankara University (Project No: 2004-07-05-088).

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