Capsaicin Extract ss Corrosion Inhibitor for Carbon Steel in Sodium Chloride Aqueous Solution

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Abstract

In this paper are presented preliminary results obtained using capsaicin extract as corrosion inhibitor for carbon steel in sodium chloride aqueous solution. Capsaicin is a chili pepper extract with analgesic properties. The electrochemical behavior of capsaicin in sodium chloride solution was examined by cyclic voltammetry Further, the inhibitory effect was studied by linear polarization and Tafel method in order to determin the kinetic parameters, providing informations about the the mechanism of inhibitory effect. The diminution of corrosion rate of carbon steel in the presence of capsaicin can be attributed to the inhibitor molecules adsorbtion on the sample surface and blocking the active sites, or depositing corrosion products on the metal surface.

Introduction

Steel is a proven durable and efficient building material. It is cost effective, aesthetically pleasing, sustainable, and strong. However, like all metals, steel corrodes when exposed to the atmosphere. Therefore, it is important to consider corrosion protection methods in constructing projects with exposed steel. Approximately 85% of all steel produced is carbon steel and therefore susceptible to natural oxidation and galvanic corrosion [1]. Corrosion control of steel is an expensive process and industries spend huge amounts to control this problem.

Protection by corrosion inhibitors is one of the well known methods of corrosion protection and one of the most useful in the industry. This method is following stand up due to low cost and practice method [2]. Throughout the ages, plants have been used by human beings for their basic needs such as production of food-stuffs, shelters, clothing, fertilizers, flavors and fragrances, medicines and last but not least, as corrosion inhibitors. The use of natural products as corrosion inhibitors can be traced back to the 1930's when plant extracts of Chelidonium majus were used for the first time in H_2SO_4 pickling baths [2-5].

The active ingredient capsaicin (oleoresin of Capsicum) is generally obtained by grinding dried ripe fruits of Capsicum frutescens L. (chili peppers) into a fine powder. The extract may be obtained by distillation of the powder in an appropriate solvent, and evaporation of the solvent to yield the liquid oleoresin and associated fatty matter. The fatty matter is removed by decanting or filtration [6].

The diminution of thr corrosion rate of carbon steel in the presence of capsaicin or active ingredient of capsaicin can be attributed to the adsorption of inhibitor molecules on the methal surface blocking the active sites or depositing corrosion products.

Experimental

Electrochemical measurements were conducted using BioLogic SP150 potentiostat/ galvanostat in a conventional three-electrode cell systems. The working electrode was carbon steel, the counter electrode was graphite, and a Ag/AgCl acted as the reference electrode. Experiments were performed in 3.5% NaCl solution, to determine the corrosion potential and

corrosion current.

To determine the inhibitor effect of capsaicin on the corrosion rate of carbon steel in sodium chloride aqueous solution in preliminary studies a 4 mg L^{-1} concentration has been used. The chemical structures of capsaicin ($C_{18}H_{27}NO_3$) is presented in figure 1 [7].

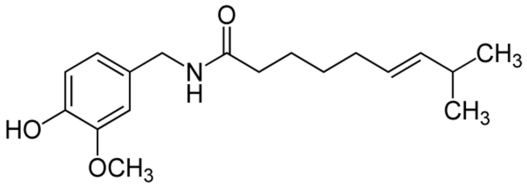

Fig.1. Chemical structures of capsaicin [7].

Results and discussion

Preliminary information about how capsaicin extract can influence the corrosion process of carbon steel are pointed by its electrochemical behavior on platinum electrode in sodium chloride media emphasised by cyclic voltammetry.

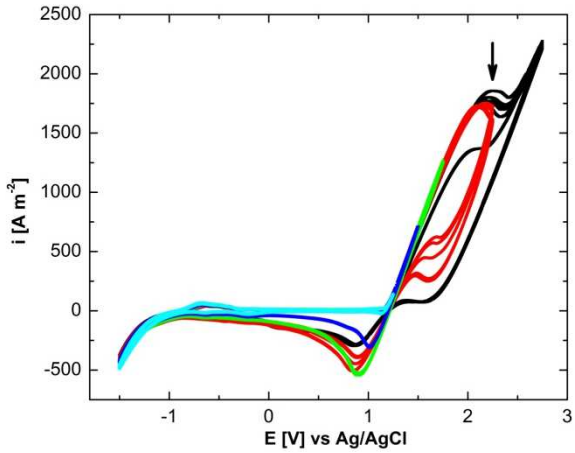

Figure 1. Cyclic voltammograms (5 cycles) on Pt electrode in 3.5% NaCl in different fields of potential.

In figure 1 cyclic voltammograms recorded on Pt as working electrode in 3.5% NaCl solution without capsaicin are presented. The base curve obtained in a blank solution presents the characteristics of polarization curves drawn in sodium chloride solutions.

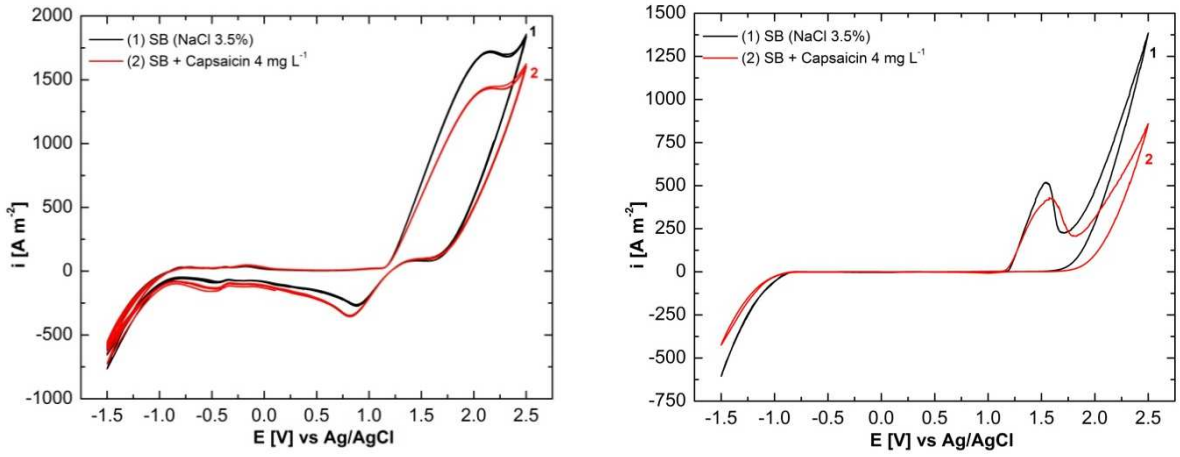

Figure 2. Cyclic voltammograms (5 cycles) on Pt electrode in 3.5% NaCl in the absence/presence of 4 mg L^{-1} capsaicin, scan rate: a) 500 mV s^{-1} and b) 5 mV s^{-1}.

In figure 2a (dE/dt = 500 mV s^{-1}) and 2b (dE/dt = 5 mV s^{-1}) there are showen cyclic voltammograms recorded on Pt as working electrode, in 3.5% NaCl solutions without and with 4 mg L^{-1} capsaicin used in preliminary corrosion tests.

In order to identify how capsaicin extract influences the electrode processes, polarization curves where recorded separately at 5 mV s^{-1}, in cathodic domain as well as in anodic one. The obtained voltamograms are presented in figure 3a-b.

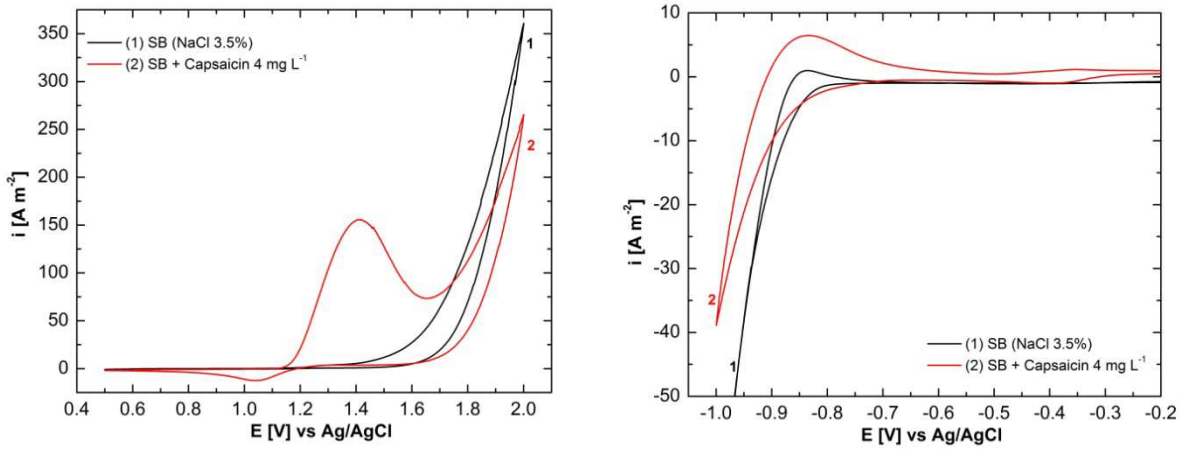

Figure 3. Cyclic voltammograms on Pt electrode for anodic (a) and athodic (b) polarization in 3.5% NaCl in the absence/presence of 4 mg L^{-1} capsaicin, scan rate 5 mV s^{-1}

The manner in which capsaicin acts as corrosion inhibitor for carbon steel in sodium chloride solution and its effect on the corrosion rate can be estimated by Tafel polarization method. The potentiodynamic polarization curves recorded without and with 4 mg L^{-1} capsaicin are shown in figure 4.

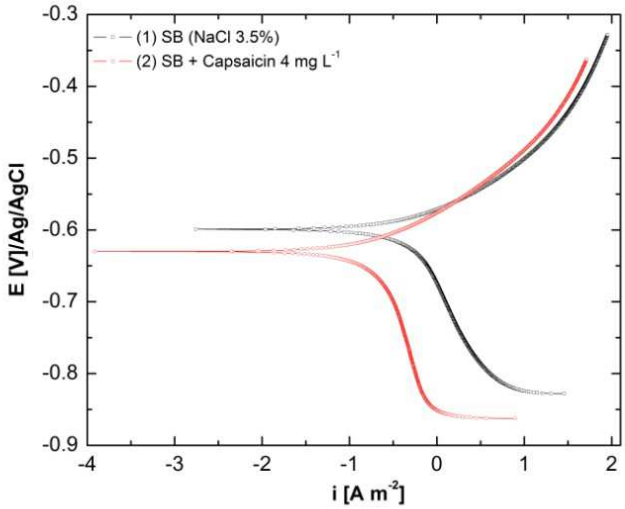

Figure 4. Linear polarization curves on carbon steel electrode in 3.5% NaCl in the absence/presence of 4 mg L^{-1} capsaicin, scan rate 1 mV s^{-1}.

Numerical values of the corrosion current density (i_{corr}) variation, corrosion potential (E_{cor}), anodic Tafel slope (b_a), cathodic Tafel slope (b_c) and polarization resistance (R_p) were obtained from polarization profiles by extrapolating potentiodynamic curves from figure 4 using BioLogics software and showed in table 1.

Tabel 1. Polarization parameters for the corrosion of carbon steel in 3.5% NaCl in the absence and presence of 4 mg L^{-1} capsaicin:

Electrolit	T [K]	i_{cor} [μA cm^{-2}]	E_{cor} [mV]	$-b_c$ [mV dec^{-1}]	b_a [mV dec^{-1}]	R_p [Ω]	v_{cor} [mm an^{-1}]	*IE* [%]
SB (NaCl 3.5%)	298	39.14	-601.1	294.0	77.1	276	1.15	-
SB + 4 mg L^{-1} Capsaicin		10.74	-630.0	272.5	74.4	573	0.433	62.94

Conclusion

Preliminary studies confirm that capsaicin has promising corrosion inhibition properties for carbon steel in aqueous sodium chloride solutions. Capsaicin extract can be added to the list of non-toxic, cheap and effective green corrosion inhibitors from renewable sources.

Acknowledgements

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