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ENVIRONMENTAL FRIENDLY CORROSION INHIBITORS: A SUSTAINABLE SOLUTION FOR CORROSION CONTROL IN INDUSTRIAL APPLICATIONS

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Introduction

The use of environmental friendly corrosion inhibitors is among the most important fields in the corrosion control of metals due to their low impact on the environment and their inhibiting efficiency.

Materials and methods

The *Allium cepa L.* leaves extracts were prepared in a 99.6% ethanol solution (ChimReactiv, Romania) and in a 50%:50% (v:v) ethanol:water solution. To obtain the natural extracts, onion leaves and solvent were used in a 1:5 ratio. The mixtures obtained were kept at 40^{o}C for 7 days and then filtered. The extracts thus prepared, onion leaf extract in alcoholic solution (FC-Alc) and the extract in a 50%:50% (v:v) ethanol:water = (FC-Alc-A) and *Citrus aurantium dulcis (CAD)* oil, commercially available, were studied as inhibitor on the corrosion control of carbon steel and aluminium. All tests were performed in 3.5% NaCl solution with and without inhibitors. The electrochemical cell consists of a three electrode setup: a working electrode (steel or aluminium), a Pt mesh counter electrode and an Ag, $AgCl/KCl_{sat}$ reference electrode. All the electrochemical experiments (open circuit potential – OCP, potentiodynamic polarization and electrochemical impedance spectroscopy – EIS tests) were performed at room temperature 25±1°C.

Results and conclusions

One has achieved the best results for CAD for aluminium and for the onion extract for carbon steel corrosion. OCP showed for both aluminum and steel tested samples that they are stable in all tested solutions. For carbon steel sample, the electrochemical impedance spectroscopy (EIS) results are presented as Nyquist diagram (Figure 1) and in Table 1 are presented the results from the potentiodynamic polarisation. For the tested samples, one has calculated the inhibiting efficiency (IE%) from EIS by taking into account the values of the polarisation resistance (R_{ct}-R_s; R_{ct} and R_s are charge transfer resistance and solution resistance respectively, Ω).

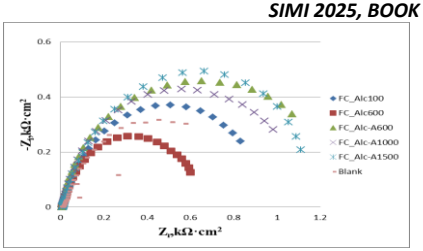

Figure 1. Nyquist diagram for carbon steel tested samples in 3.5%NaCl modified solutions.

The EIS results showed that the *Citrus aurantium dulcis* oil could act as an inhibitor of aluminium corrosion, regardless of the tested oil concentration. For the carbon steel, *Allium cepa L.* leaves alcoholic extracts may act as an inhibitor of corrosion, but the concentration of the extract is important. In the case of FC_Alc600 sample, the opposite effect was observed, it acted as an accelerator instead of an inhibitor.

Table 1. The results from EIS for the Al samples tested in the modified solutions.

CAD conc., mL/L	R_s, Ω·cm²	R_{ct}, kΩ·cm²	IE, %
0	2.33	4.226	-
0.67	5.33	4.395	3.86
2.00	5.31	11.939	64.60
3.33	9.95	47.988	91.19
6.67	10.09	36.105	88.29
20.00	16.69	19.345	78.15
26.67	8.30	18.112	76.67

The potentiodynamic polarisation results achieved are presented in Table 2 and Figure 2. The potentiodynamic polarisation results confirm that both tested inhibitors have an inhibiting effect on the corrosion of carbon steel in the case of *Allium cepa L.* and aluminium, in the case of *Citrus aurantium dulcis*.

Table 2. The values of i_{cor} (corrosion current density), v_{cor} (corrosion rate) and IE for the carbon steel samples

Sample	i_{cor}, µA/cm²	v_{cor}, µm/year	IE,%
Blank	3.4693	40.18	-
FC_Alc100	3.1874	36.93	8.13
FC_Alc600	4.3234	50.09	-24.62
FC_Alc-A600	1.7465	20.23	49.66
FC_Alc-A1000	1.8778	21.75	45.87

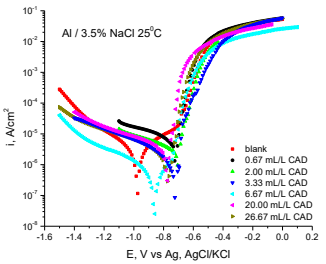

Figure 2. Tafel plots for aluminium samples tested in the modified solution.

One has achieved IE ranging from 8% up to 92%, for different amounts of inhibitors used.

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