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Study Corrosion Inhibitor for Carbon Steel Alloy in Salt Environment by Using Natural Compound Extracted from Bell Green Peppers

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Abstract

. In the presence study,the 2-methoxy-3- isobutylpyrazine (bell pepper pyrazine) was extracted from Bell green pepper. The structure of bell pepper pyrazine was characterized by FTIR spectroscopy technique. Subsequntly, the extract was evaluated as corrosion inhibitor for carbon steel alloy by using "Tafel plots" method at 25 °C for different concentrations include (5,10,15,20,25,and 30) ppm . The results indicated that the bell pepper pyrazine depict a higher inhibition efficiencies 97.6% at concentration 20 ppm table(3) . The effect of temperature on the inhibition efficiency for the optimal concentration of pyrazine extract (20) ppm was studied at (35, 45 and 55 °C), the results revealed that the efficiency was reduced as temperature increased. From this resultes,the bell pepper pyrazine extracts from Bell green pepper can be used as green inhibitor for corrosion.

Key words: Bell pepper pyrazine , Extracted, corrosion inhibitors.

1. Introduction

Corrosion is the destructive attack of a material by reaction with its Environment. Corrosion is a chemical or electrochemical oxidation process, in which the metal transfer electrons to the environment and undergoes a valance change from zero to a positive value. The serious consequences of the corrosion process have become a problem of worldwide significance. Corrosion control is achieved by recognizing and understanding corrosion mechanisms, using corrosion-resistant materials and altering designs, also by using protective systems, devices, and treatments[1-9]. Corrosion inhibitors are chemical compounds that, when added in small concentration to a corrosive environment, effectively decreases the corrosion rate. These inhibitors will reduce the corrosion rate of either anodic oxidation or cathodic reduction, or both. The inhibitors themselves form a protective film on the surface of the metal[10-13]. Organic inhibitor are applied extensively to protect metals from corrosion in many aggressive acidic media (e.g., in the acid pickling and cleaning process of metals). Different kinds of organic compounds are used as corrosion inhibitors for iron alloys in various acid media such as aromatic compounds with positively charged amine groups, Sodium sulfonates, phosphonates, or mercaptobenzotriazole (MBT) are used commonly in cooling waters and antifreeze solution. The bell pepper(alsoknown as sweet pepper, pepper or capsicum) is a cultivar group of the species Capsicum annuum.Cultivars of the plant produce fruits in different colours, including red, yellow, orange, green, white, and purple. Bell green pepper contain organic chemical (2-methoxy-3- isobutylpyrazine ("bell pepper pyrazine"))[14-17].

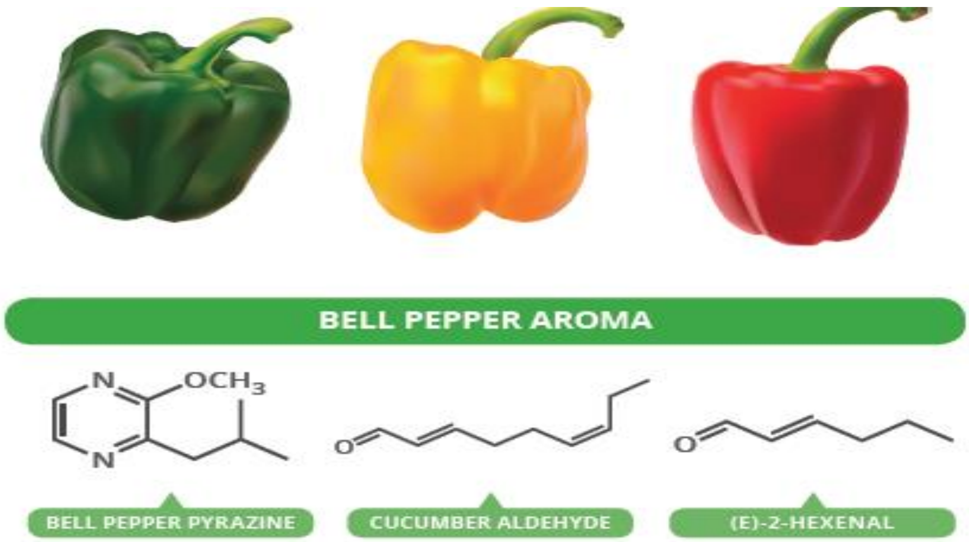

Figure (1) : Bell pepper chemistry

In green peppers, a single chemical, 2-methoxy-3- isobutylpyrazine ("bell pepper pyrazine"). Other minor contributors include (E,Z)-2,6-nonadienal ("cucumber aldehyde"). The concentrations of most volatile compounds drop during ripening, with the exception of (E)-2-hexenal and (E)-2-hexenol, lending a sweeter, fruitier note to the aroma[18-20]. In the present study used extracted organic compound (2-methoxy-3-isobutylpyrazine ("bell pepper pyrazine")) from Bell green pepper as corrosion inhibitor for carbon steel in formation water.

2. **Experimental techniques**

2.1. Extraction of 2-methoxy-3- isobutylpyrazine (bell pepper pyrazine)

The extracted 2-methoxy-3-isobutylpyrazine(bell pepper pyrezine) from bell green peppers was carried out by cutting green pepper into chipds and washed with water. And then dissolved it in the ethanol with shaking for eight hours. After that the solution was filtred. The filterate solution was dried by oven to evaporate the solvent(ethanol)and to obtained 2-methoxy-3- isobutylpyrazine (bell pepper pyrazine) .

3. Characterization of the Extracted compound

The new compound was characterized by FTIR spectroscopy technique, as a sold disc by using KBr powder for sold sample. FTIR spectra [21,22] was shown in figure (2) . From figure (2) and table (1), the FT-IR spectra of pyrazine gave peaks at 2866 cm^{-1} and 1446$cm^{-1}$for asymmetric stretching and symmetric bending ofCH_3 groups respectively. The C-H of methylene group gave three peaks, the asymmetric stretching peak at 2973 $cm^{-1}$and others scissoring at 1409 cm^{-1} and roking at 724 cm^{-1}. The C-O-C group gave a peak at 1051 cm^{-1} and the C-N group gave a peak at 1073 cm^{-1}. The C=C of aromatic ring gave a peak at 1588 cm^{-1}.

The peak at 3435cm^{-1} may be back to N-H group dueto the compound pyrezine can be absorb the Moisture and formation hydrogen bonding therefore gave a peak at 3435cm^{-1}.

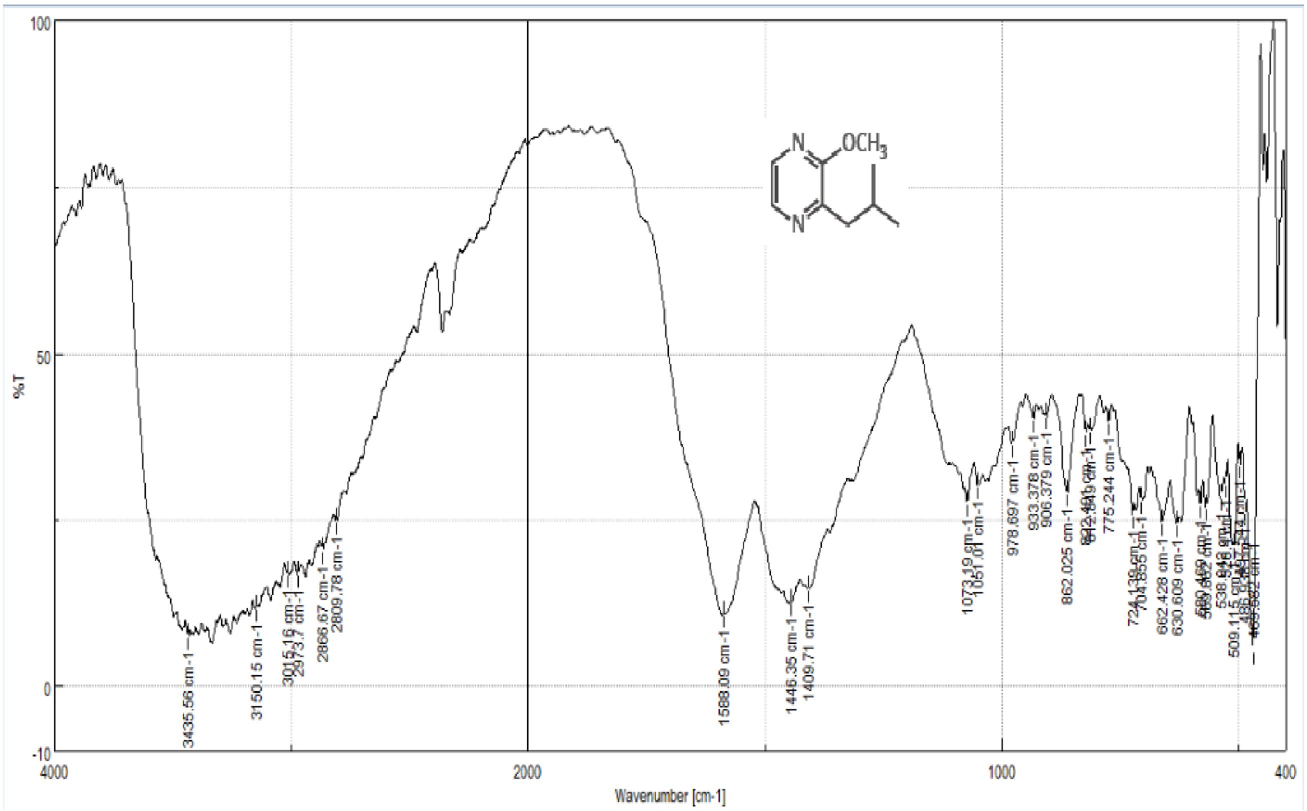

Figure (2) FTIR spectrum of 2-methoxy-3- isobutyl pyrazine

Table (1) The important characteristics FTIR bands and their location for 2-methoxy-3- isobutyl pyrazine (Bell pepper pyrazin

4. **The Composition of alloy**

Comp	ArC-N Stre (cm^{-1})	ArC=C Stre (cm^{-1})	C-O-C Str (cm^{-1})	CH3 As-Stre (cm^{-1})	CH3 S-ben (cm^{-1})	CH2 As-Stre (cm^{-1})	CH2 Sciss (cm^{-1})	CH2 Rok (cm^{-1})
Bell pepper pyrazine	1073	1588	1051	2866	1446	2973	1409	724

The type of alloy used in this study was carbon steel (C1010) standard strips obtained from Alabama company. The composition of these alloy was illustrated in Table (2).

Table (2) Chemical composition of carbon steel alloy

Alloy	Composition % w/w									
Carbon steel (C1010)	C	Mn	P	S	Si	Ni	Cr	Cu	As	Fe
	0.08-0.13	0.3-0.5	0.04	0.05	0.17-0.37	0.3	0.1	0.3	0.08	Residue

5. **Preparing the metal specimen for test**

A standard strips of carbon steel (C1010) with dimensions of 3cm length, 1.24cm widths and 0.14 cm thicknesses. The total area of immersed strip is 8.45cm^2. Carbon steel strips were used to evaluate the prepared compound as corrosion inhibitors. The faces of each specimen were grind and polished by emery cloth paper to 400 micron. Then specimens degreased with acetone, and washed with distilled water and ethanol. Hot air were used to dry the sample and stored in a desiccators containing silica gel during the period in between polishing and Tafel measurements.

6. **The Corrosive Environments**

The in present study, using formation water as salt corrosive environment that supplied by Iraqi Southern Oil Company.

7. Experimental procedure for Tafel Plot method

Tafel experiment set up is shown in Figure (3). A potentiostat was used to measure current density vs. electric potential in order to calculate the corrosion rates. The instrument performs different techniques such as potentio dynamic polarization scan, Tafel plots, linear polarization scan and other specialized measurements techniques.

Figure (3): Corrosion measurements Instrumentation set up

8. **Corrosion rate of carbon steel in Formation water without inhibitor at constant temperature.**

The "Tafel plots" experiment used to measure the corrosion rates of formation water by determined the open Circuit Potential (OCP) value and then determined Linear Sweep Voltammetry (LSV) by added ±0.5V to OCP value and then recording potential vs. log current functional at stagnant condition. Corrosion cell kept at constant temperature (room Temp). by placing it in a thermostatic water bath. The Tafel plots choose for evaluation of inhibitors because they quickly present corrosion rate information. The linear portion of anodic or cathodic polarization log current vs. potential plot is extrapolated to linear sector of the corrosion potential line. From table (3) and figure (4) ,the formation water causing corrosive of carbon steel due to contained the ions, this ions made the formation water behaves as a saline electrolyte causing corrosion of carbon steel alloy with corrosion rate 9.5078 mpy.

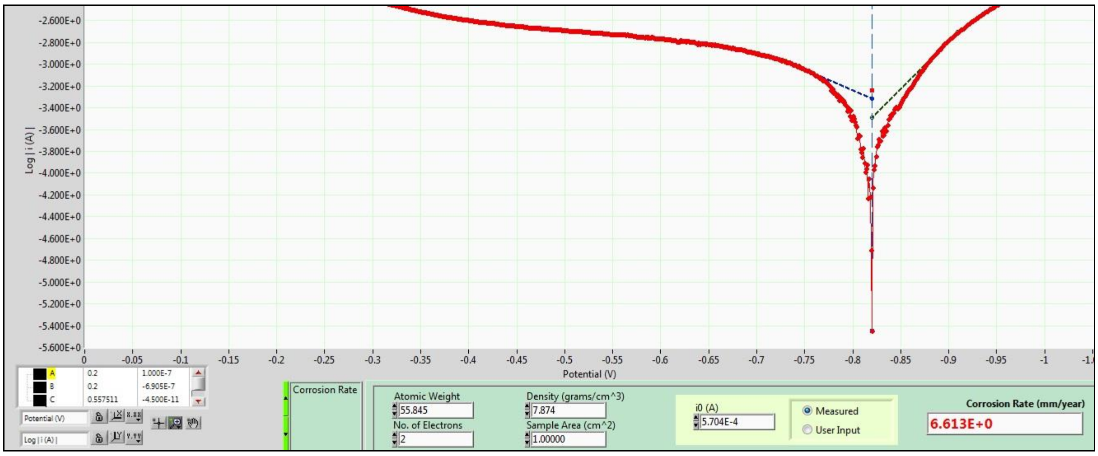

Figure (4): Tafel plot of formation water without inhibitor

9- Corrosion rates of carbon steel in formation water with differente concentrations of inhibitor (bell pepper pyrazine) at constant temperature.

The electrochemical results obtained from polarization experiments through "Tafel plots" performed in corrosive environment (formation water) in the absence and presence of different concentration of bell pyrazine (from 5ppm to 30ppm) are showed in Table (3) .The corrosion rate of formation water with adding different concentrations of pyrazine compound had been measured at the same method in section (8) at constant temperature 26^0C. Corrosion rate (CR) was measured in (mm/y) units, and to convert corrosion rate (CR) from (mmy) to (mpy), equation (1) were used [22,23]:

CR/ mpy = 0.0254 mm/y …………1

Table (3) Corrosion Inhibiter for2-methoxy-3- isobutyl pyrazine (bell pepper pyrezine)

Conc. (ppm)	Ecorr (V)	Icorr (A) E-6	CR (mm/year)	CR (mpy)	IE (%)
0	-0.82	5.704E-4	6.613	260.354	-
5	-0.75	4.870E-5	5.646E-1	22.228	91.4
10	-0.65	8.416E-4	9.076E-1	35.732	86.3
15	-0.64	5.406E-4	5.830E-1	22.952	91.1
20	-0.62	1.476E-4	1.591E-1	6.263	97.6
25	-0.72	3.804E-5	4.068E-2	16.015	93.8
30	-0.59	1.880E-5	2.043E-2	8.043	96.9

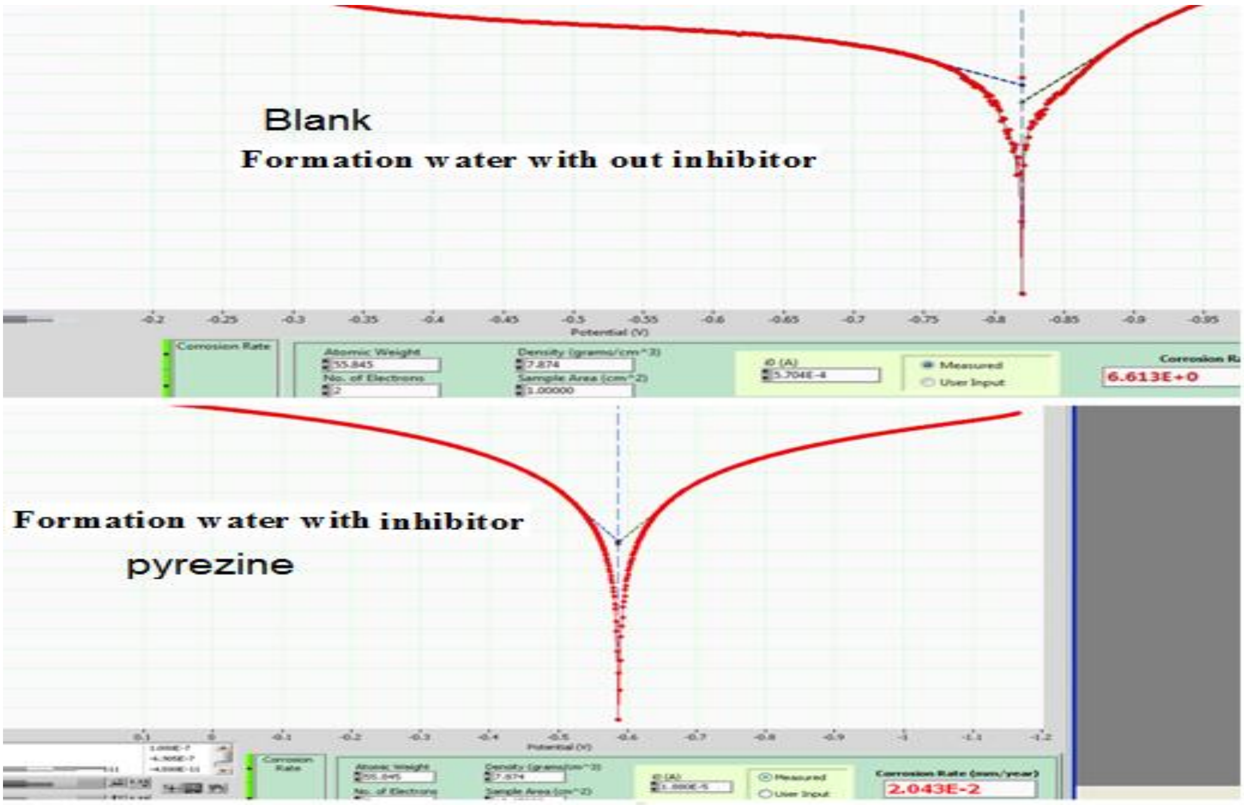

Fig (5) Tafel plot with Optimum Value (20ppm) of Inhibiter 2-methoxy-3- isobutyl pyrazine (bell pepper pyreazine) with Blank.

10- Results and discussions

Tafel plots employed for rapid evaluation inhibitors in order to determine their effectiveness on the corrosion rates of carbon steel.From Table (3) and figure (5) the prepared compound (bell pepper pyrazine) shown high inhibition efficiency for corrosion rate, ***Ecorr*** and ***Icorr*** of carbon steel in formation water after added various concentrations. From this results, the inhibition efficiency was different due to different in the concentrations.

10.1- The Effect of Inhibitors Concentrations on Corrosion Rate

The corrosion rates of carbon steel(CS) studied as a function of concentrations by using different concentrations of inhibitor (5ppm- 30ppm) as shown in tables (3). From these results, the optimum inhibition concentration is 20 ppm with efficiency 97.6% as in Table (3), whereas at lower concentration a decrease in efficiency can be observed due to its chemical structure, in 5-15 ppm. In high concentration (20ppm) the increasing of molecules which leads to increasing nitrogen atoms that adsorping on metal surface which lead to reduce I_{corr} and $_{Ecorr}$ then increasing its inhibition efficiency. The efficiency of an inhibitor can be expressed by the following equation.

Inhibitor Efficiency (%) = $100 \cdot (CR_{uninhibited} - CR_{inhibited}) / CR_{uninhibited}$

10.2- Effect Increasing Temperature on Corrosion Rat

In present study the effect of temperature on inhibitor properties and corrosion inhibitor for CS and alloy was studied at range (30-50ºC) as shown in tables (4) .This table show that this inhibitor have some effects on both, the cathodic and anodic processes. This indicates a modification of the mechanism of cathodic hydrogen evolution as well as anodic dissolution of iron, which suggests that the above inhibitors can be, inhibited the corrosion process of CS, and their suppression of cathodic process by the covering of CS surface with monolayer due to the adsorbent of inhibitors molecules. It can also be that anodic Tafel constant (βa) slopes has variation values between increasing and decreasing values whereas the decreasing may be described to the changes in charge transfer resistance. From table(4), the compound(pyrazine) showed that the increasing corrosion rate with increasing the temperature as well as increasing in I_{corr} lead to decreasing Rct and decreasing inhibition efficiency and decreasing in both βa and βc with increasing temperature refers to increasing in both anodic and cathodic reactions respectively. The decreasing in inhibition efficiency as temperature decreased can be interpreted due to that desorption is aided by increasing the corrosion .Also decreasing in efficiencyas temperature increased result from decreasing in viscosity of the inhibitor solution then increasing the diffusion of ions in solutions and decrease the stability of protective film on metal surface that leads to decrease the activity of the inhibitor. Increasing temperature also increase the diffusion of ions in solutions and decrease the stability of protective film on metal surface which leads to decrease activity of the inhibitor[24,25].

Table (4) Effect Temperature on Corrosion Rate of bell pepper pyrazine at Optimum Value (20ppm)

Temp (C°)	E corr (V)	Icorr (A) E-5	CR (mm/year) E-1	CR (mpy)	βc (A/V) E+0	βa (A/V) E+0	Rct (ohm) E+3
30	-0.59	1.880	1.043	6.074	-6.356	4.016	2.800
35	-0.441	2.557	1.839	7.240	-5.888	5.515	1.013
40	-0.417	2.634	1.805	7.106	-5.832	5.486	0.986
45	-0.385	1.083	1.9531	7.688	-6.146	5.923	2.906
50	-0.419	2.138	2.282	8.984	-6.331	5.567	1.208

11- Conclusions

The main conclusions of the present study could be summarized in the following points:

1. The extraction of bell pepper pyrezine from green pepper plant was successful.

2. The new compoud (Bll pepper pyrezine) can be used as the corrosion inhibitor of carbon steel in formation water.

3- From table (3), the Optimum Value of inhibition efficiency was 20pmm.

4- The new inhibitor (Bll pepper pyrezin) has shown a strong inhibitive effect with different temperatures.

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