Compare between Two Type of Eco-friendly Corrosion Inhibitors by Studying Corrosion Resistance of Carbon Steel

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***Abstract*—**Carbon steel, the most widely used engineering material, despite its relatively limited corrosion resistance used in large tonnages in marine applications, nuclear power transportation, chemical processing , petroleum production and refining, pipelines, mining, construction and metal-processing equipment.

The main objective of the present work involved the study of the inhibitive properties of natural product as Celery and Spearmint plant extract as a safety and an environmentally friendly corrosion inhibitor for low carbon steel in (3.5% NaCl) solution. Results showed when the immersion model in (3.5% NaCl) solution that contains the inhibitor with concentration of (15% in volume), it's getting decrease in lost weight , indicating a layer of adequate oxide on the surface of steel, indicating that the amount of loss weight decrease with increasing concentration of inhibitor and this shows the damper on his ability to form a protective layer.

***Keywords*—**Corrosion inhibitor, Low carbon steel, Aqueous media.

I. Introduction

The corrosion of metals remains a world –wide scientific problem as it affects the metallurgical, chemical and oil-industries.[1]

Corrosion is a surface phenomenon known as the attack of metals or alloys by their environment as air, water or soil in chemical or electrochemical reaction to form more stable compounds.[2, 3, 4]

Carbon steel, the most widely used engineering material, accounts for approximately 85% of the annual steel production worldwide. Despite its relatively limited corrosion resistance. Carbon steel has been commonly selected as building material for oil and gas transportation pipelines. Internal corrosion has been encountered with carbon steel for many years in oil and gas production. Carbon steel is used in large tonnages in marine applications, nuclear power transportation, chemical processing , petroleum production and refining, pipelines, mining, construction and metal-processing equipment. The cost of metallic corrosion to the total economy must be measured in hardness of millions of dollars per year. Because carbon steels represent the largest single class of alloys in use, both in terms of tonnage and total cost, it is easy to understand that the corrosion of carbon steels is a problem of enormous practical importance. This is the reason for the existence of entire industries devoted to providing protective systems for irons and steel.[5, 6]

Corrosion of materials usually takes place in the presence of oxygen and moisture and involves two electrochemical reactions, oxidation occurs at anodic site and reduction occurs at cathodic site. [7]

There are various methods for prevention of corrosion which basically comprises those protective measures providing separation of metal surfaces from corrosive environments or those which cater for adjustment or altering the environment. These various methods of corrosion prevention include cathodic protection, anodic protection , coating and the use of corrosion inhibitor. [8]

Inhibitors are chemicals when added in small portions into a system can protect metals from corroding. Inhibitors usually protect metals by adsorbing themselves to the substrate and thus provide protection through the formation of a passive layer. [9, 10, 11]

The use of inhibitors is a practical technique to secure metals and alloys from aggressive environment. Large numbers of organic compounds revealed that N, S and O containing organic compounds may be efficient inhibitors. However, most of these compounds are not only expensive, but also toxic to living beings. It is needless to point out the importance of cheap and safe inhibitors of corrosion. So, considerable efforts are made to find corrosion inhibitors which are environmentally safe, ready available and of relatively low cost. Literature shows a growing trend in the use of natural products known as non-toxic compounds, called also green inhibitors, as corrosion inhibitors. [12, 13]

Corrosion inhibitor is chemical compound that when added to a liquid or gas, the corrosion rate of metals and alloys in contact with aggressive environments. The effectiveness, or corrosion inhibition efficiency of a corrosion inhibitors is a function of many factors including but not

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limited to: fluid composition, quantity of water, and flow regime. If the correct inhibitor and quantity is selected then it is possible to achieve high (90-99%) efficiency. Some of the mechanisms of effect are formation of a passivation layer, that is a thin film on the surface of the material that stops access of the corrosive substance to the metal, inhibiting either the oxidation or reduction part of the redo corrosion system (anodic and cathodic inhibitors).[14]

Several inhibitors have been synthesized and used successfully to inhibit corrosion of metals in acid media. However, the major problem associated with most of synthetic compounds is that they are highly toxic to both human beings and cause severe environmental hazards. The toxic effects of most synthetic corrosion inhibitors have led to use of natural products which are eco-friendly and harmless. [15]

In the present work involved the study behavior of natural product as Celery and Spearmint plant extract as a safety and an environmentally friendly corrosion inhibitor for low carbon steel in aqueous media at various concentrations of extract by using simple immersion technique.

II. Experimental Work

A. Chemical Composition of The Alloys

Sample used in this research a low carbon steel set out in its chemical composition in Table (1). Where chemical analysis was performed using a spectral analysis of metals in the General Company for Mechanical Industries in Alexandria. The sample was prepared in the form of thick disks (1mm) and diameter (10mm).

TABLE I
ILLUSTRATES THE PERCENTAGES OF THE CHEMICAL COMPOSITION OF THE CARBON STEEL MODELS USED IN RESEARCH

Fe %	**Mn** %	**Ni** %	**V** %	**C** %
97.17	1.45	0.19	0.25	Rem.

B. Sample Preparation

Specimens were prepared as follows:

1- Sample Preparation.
2- Drying and washing sample .
3- Mechanical preparation of sample (polishing, grinding and cutting)..

C. Corrosion Testing

Simple Immersion Method

This method to expose the samples to the electrolyte solutions [(5, 10 and 15 %celery and Spearmint), , (3%NaCl)] on a regular basis and for periods of time equal about (24 hr.) for each cycle. Where the weight was recorded before and after each cycle, after it washed and dried completely.

D. Analysis of the Powder Plant

Make detection of active compounds in powder plant extracts using the test of Spectroscope (FTIR) appears in Fig. 1 and 2.

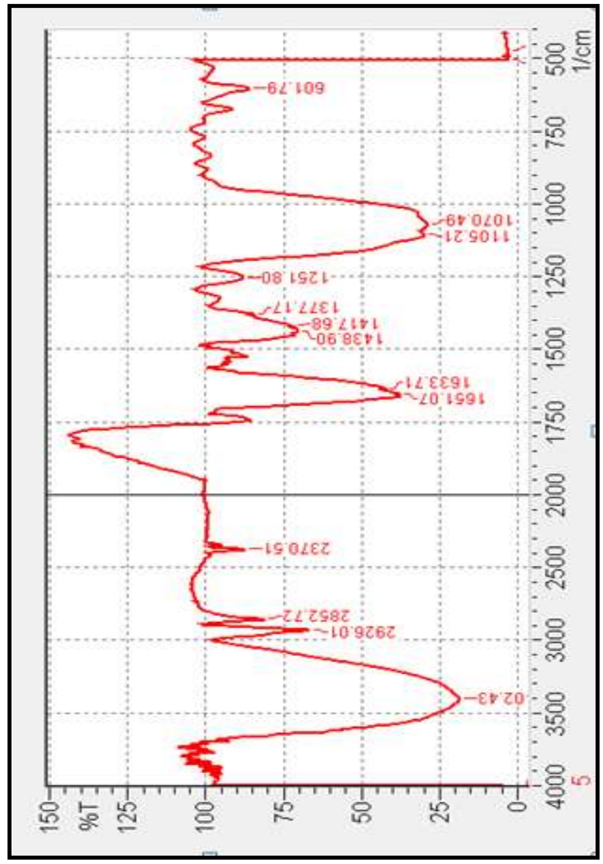

Fig.1 Test of spectroscope (FTIR) for celery powder plant.

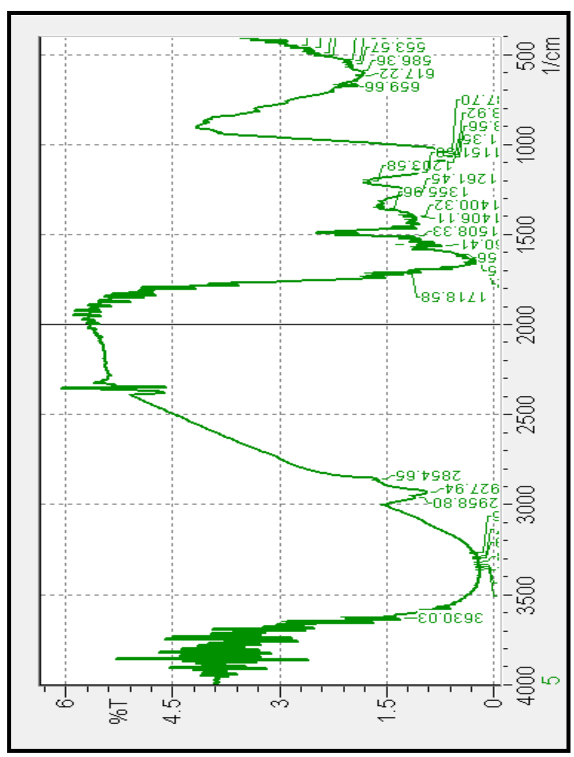

Fig.2 Test of spectroscope (FTIR) for Spearmint powder plant.

E. Disclosure of Effective Groups in the Powder Plant

Analysis of chemical conducted on the powder plant of the inhibitor the new proved to fit on many of the groups active, which are often vehicles aldehydes, ketone, amines, polyamides and alcohols or compounds of aromatic or phenolic. All of these compounds have properties of inhibition and this is consistent with the findings of other researchers. The presence of bounds double and ties triple and aromatic rings in inhibiting the new system will improve the act inhibitory to this inhibitor and Tables (2 and 3) identifies the groups and numbers of wavelengths corresponding.

TABLE II
THE ACTIVE GROUP AND POSITIVE NUMBER FOR CELERY INHIBITOR

Positive Number	Active Group
(3107.32 – 2850.79) cm^{-1}	C – H aromatic
(1616.36 – 1521.84) cm^{-1}	C = C
(2621.26 – 1942.32) cm^{-1}	C ≡ C or C ≡ N
(1734.01) cm^{-1}	C = 0 (keton, ester)
(1419.16) cm^{-1}	CH2
(2866.22) cm^{-1}	C – O

TABLE III
THE ACTIVE GROUP AND POSITIVE NUMBER FOR SPEARMINT

Positive Number	Active Group
(2854-2960) cm^{-1}	C – H aromatic
(1508.33-1580) cm^{-1}	C = C
(1203.58-1261.45) cm^{-1}	CHOH
(1718.58-1720) cm^{-1}	C = O (keton, ester)
(1400.139-1461) cm^{-1}	CH2, CH3
(1150-1151.45) cm^{-1}	C – O
(3610-2670) cm^{-1}	– OH
(1037.7-1101.35) cm^{-1}	Si-O-Si
(469-800) cm^{-1}	Si-H

III. RESULTS AND DISCUSSION

A. The Results of a Simple Immersion Test

The results are presented and discussed under various aspects difference between expose the samples to the electrolyte solutions [(5%, 10% and 15% celery and Spearmint), (3%NaCl)] on a regular basis and for periods of time equal about (24 hr.) for each cycle.

Simple Immersion Test in (3.5%NaCl) Solution Without Inhibitor

The relationship between weight loss and immersion time in (3.5% NaCl) Solution without inhibitor appears in Fig. 3 .

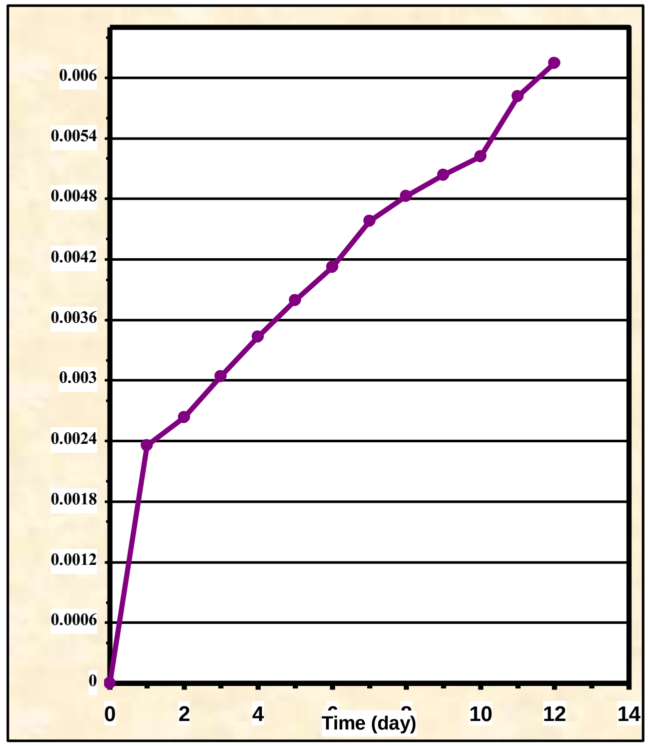

Fig.3 Illustrates the sample immersion of carbon steel in (3.5%NaCl) solution without inhibitor

Fig .3 appears when you immerse the sample in (3.5%NaCl) we note a continuous decrease weight with increased period of stay in solution, due to the nature of oxides formed as it is porous and weak adhesion (i.e., oxides, non-exhaustive) so they do provide a suitable protection of the metal. Also the large weight loss was due mainly to the presence of ions (Cl).

Simple Immersion Test in (3.5%NaCl) Solution With Inhibitor

The relationship between weight loss and immersion time in (3.5% NaCl) Solution with inhibitor appears in Figs. (4,5 and 6).

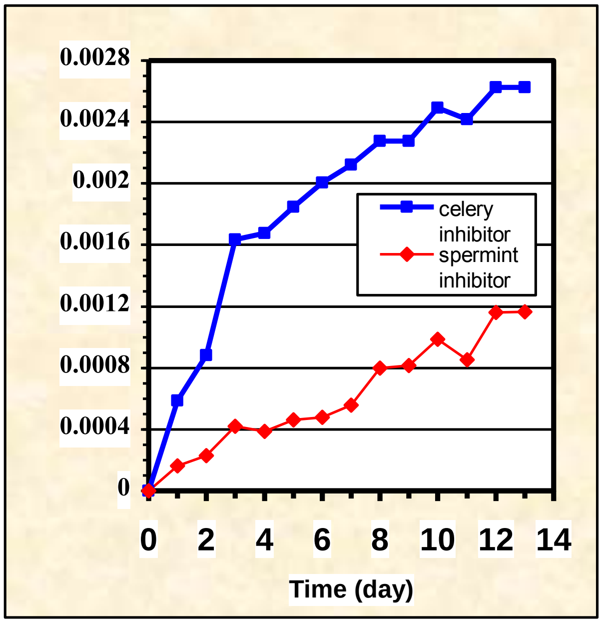

Fig.4 Illustrates the sample immersion of carbon steel in (3.5%NaCl) solution with (5%) concentration of celery and Spearmint inhibitor

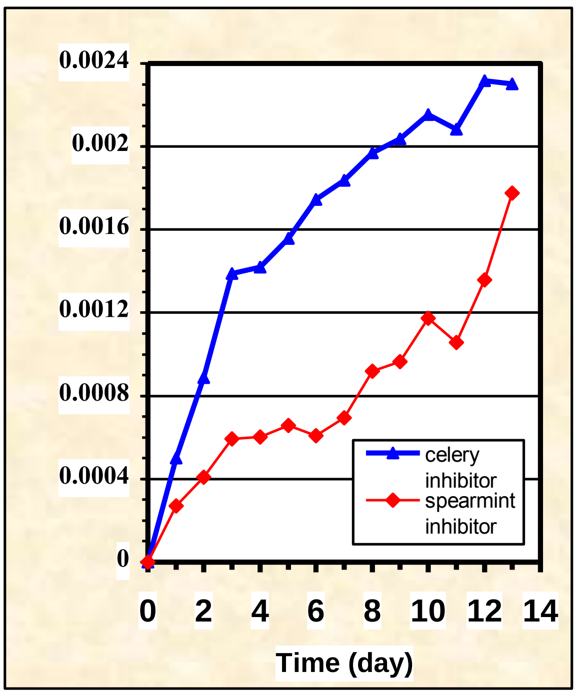

Fig.5 Illustrates the sample immersion of carbon steel in (3.5%NaCl) solution with (10%) concentration of celery and Spearmint inhibitor

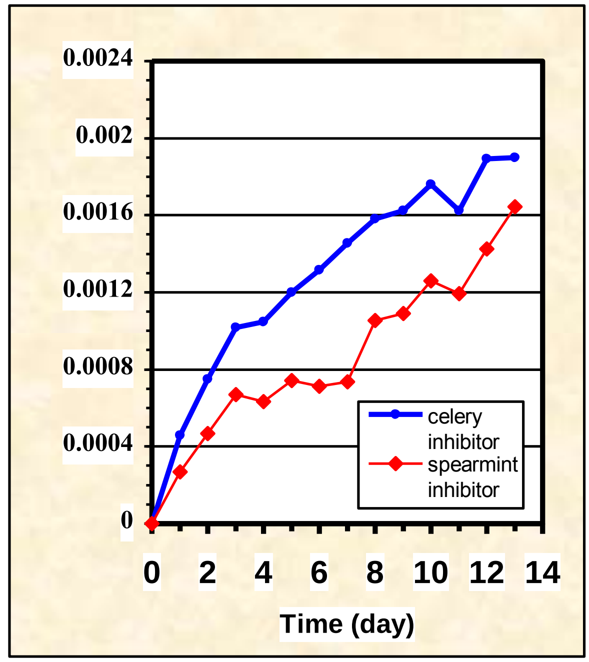

Fig.6 Illustrates the sample immersion of carbon steel in (3.5%NaCl) solution with (15%) concentration of celery and Spearmint inhibitor

Figs .4, appears when you immerse the sample in (3.5%NaCl), which contains the inhibitory concentration of (5% in volume) and a larger weight loss is very small compared with the normal form underwater (without the presence of inhibitor) and the result will be when you use the approach very soaked celery and spearmint, where a small weight loss.

Either when the immersion the sample in (3.5%NaCl) that contains the inhibitor with concentration of (10 and 15 % in volume), as shown in Figs (5 and 6) it's not getting lost weight only after (7 days), indicating a layer of adequate oxide on the surface of steel, and indicating that the amount of loss weight decrease with increasing concentration of inhibitor and this shows the damper on his ability to form a protective layer.

From compare all figures up we note the sample have high resistance corrosion with spearmint inhibiter then celery inhibitor.

IV. Conclusion

According to results of present work, the following can be concluded :

1- High resistance corrosion for sample with spearmint inhibitor then celery inhibitor.

2- Natural product as celery plant extract as a safety and an environmentally friendly corrosion inhibitor for low carbon steel in aqueous media.

3- The weight loss of low carbon steel in (3.5%NaCl) decreases with the inhibitor concentration increases.

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