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INHIBITION EFFECT THE EXTRACT OF OILCAKE RAPE SEEDS / MAJOR COMPONENTS AND ACETOPHENONE ON THE CORROSION OF STEEL

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Abstract: *It was investigated the corrosion behavior of steel in the protection against atmospheric corrosion VCI based on the isopropanol extract, as well as ketone. Their inhibition action was evaluated on corrosion of mild steel under a thin-film electrolyte consisting of simulated water using the weight loss method installed a synergistic increase in the inhibitory activity of a plant extract when administered Acetophenone compounds. The obtained results improve the scientific basis for selection the synergistic components in plant extracts.*

Анотація: *Прискореними гравіметричним методом корозійних випробувань в умовах періодичної конденсації вологи встановлено синергетичне підвищення інгібуючої ефективності рослинного екстракту при введенні кетону (ацетофенону). Отримані результати поглиблюють наукові основи підбору синергетичних компонентів до рослинних екстрактів.*

Temporary corrosion protection prevents the metal surfaces corrosion during transport and storage of equipment. Volatile corrosion inhibitors (VCIs) have been used for years to temporarily protect metals from corrosion in extreme conditions A vapour phase corrosion inhibitor (VPI) is a compound that has the ability to vaporize and condense on a metallic surface to make it less susceptible to corrosion. The main advantage of VPIs compared with conventional corrosion control methods stems from their gas-phase transport. A VPI reaches the metallic surfaces without contacting the surface directly. The efficacy, convenience, and cost effectiveness of VPIs made their application for rust control almost universal in automotive-manufacturing, steel-making, ship-building, power generation, and defence production. It was found that certain specific VPI formulations can in fact be toxic [1]. For example, dicyclohexyl ammonium nitrite (DICHAN) has been found to be most effective for inhibiting the atmospheric corrosion of steel, and gained industrial application for several decades. Research confirmed that some N-nitrosoamines, including those generated by DICHAN, were not only carcinogenic, but also hemotoxic as well. Most of the volatile corrosion inhibitors are synthetic chemicals, expensive, and very hazardous to environments. Thus, alternative of environmental-friendly VPIs is under consideration [1–3]. Among them, the use of volatile corrosion inhibitors (VCIs) is an effective and convenient means. Most of the volatile corrosion inhibitors are synthetic chemicals, expensive, and very hazardous to environments. Thus, alternative of environmental-friendly. Plant extract is low-cost and eco-friendly, and can be obtained through simple extraction process as well as biodegradable. The main advantage of using plant extract as the corrosion inhibitor is due to both economic and environmental benefits.

Through these studies, it is agreed that the inhibition performance of plant extract is normally ascribed to the presence in their composition of complex organic species such as tannins, alkaloids and nitrogen bases, carbohydrates, amino acids and proteins as well as hydrolysis products. These

organic compounds contain polar functions with N, S, O atoms as well as conjugated double bonds or aromatic rings, which are the major adsorption centers. Noticeably, the plant extract is a mixture of various components, which results in the complex inhibitive mechanism. It is rather difficult to determine what components present in plant extract create their relatively high ability to inhibit corrosion. A better way is to isolate the components and investigate the inhibition of each single component, but it is still difficult to isolate all the components. In addition, it takes long time to isolate the components. Thus, testing the inhibition potential of major components using available pure compounds could be an alternative choice to study the corrosion inhibition of plant extract. In our laboratory, much work has been conducted to study the inhibition by the extract of oilcake rape seeds (Brassicaceae) the corrosion of metals in different media. The main reason for the choice of oilcake rape seeds is that rape seeds are abundant resources with fast renewal and continual.

The extract of oilcake rape seeds (Brassicaceae), which contains many chemicals compounds, may be used as VCIs [1–3]. The extract of oilcake rape seeds is rich in Guanosine (about 10%), Xanthosine (8%), Dimethoxyacetophenone (12 %), Benzaldehyde, 4-hydroxy-3,5-dimethoxy (11.5%) and Oleic, Linoleic and Palmitic acid (about 32%) and the major compounds are Dimethoxyacetophenone, Benzaldehyde, 4-hydroxy-3,5-dimethoxy. However, in the earlier work [3], the effect of major components on inhibitive performance was still uncertain, and the further detailed studies are very necessary.

The present work first reports the synergistic inhibition effect the extract of oilcake rape seeds including two major compounds (Dimethoxyacetophenone, Benzaldehyde, 4-hydroxy-3,5-dimethoxy) and Acetophenone on the corrosion of mild steel in conditions of periodic condensation.

Experimental. The corrosion test and electrochemical measurements were carried out using mild steel strips. The composition of the mild steel is given in %: C 60.15; Mn 0.20–0.45; P 60.03; S 60.035 and Al, P 0.02. Steel specimens (50 mm × 20 mm × 1.5 mm) were used for volatile inhibiting sieve test (VIS). The strips were polished by emery paper of 1/0, 2/0 and 3/0 rinsed with double distilled water, degreased and dried at room temperature.

Extracts of the oilcake rape seeds was prepared by macerating in the 2-propanol alcohol for 48 hours and filtered through ordinary filter paper. Volatile inhibiting sieve test were applied to evaluate the inhibition effect of the VCIs. To obtain reproducible results three samples were used in each test simultaneously. There was a hole in each plate drilled to suspend the sample by a nylon thread. The samples were grinded with SiC paper to 1000 mesh and were then cleaned in alcohol and rinsed before drying at room temperature. The final geometrical area was 25 cm2. The gravimetric measurement was conducted by suspending the samples in a 250 cm3 conical flask with a tight-fitting rubber cork containing a small dish. The VCIs were dispersed in the dish. The samples with freshly prepared surface were mounted on the flask with and without 1.0 g inhibitor, respectively. After inhibitor film-forming period of 3 days, 15 cm^3 deionized water was added. The test process included cyclic warming and cooling of the samples in a corrosion testing chamber of varying humidity. One cycle included an 8 h exposure in the thermostat (50 ± 1°C), and 16 h exposure at room temperature.

Electrochemical measurements were carried out in stimulated atmospheric corrosion solution in a three-electrode cell, consisting of a mild steel rod working electrode (WE), a platinum foil counter electrode (CE), and a saturated calomel electrode (SCE) as reference electrode. Polarization electrochemical studies were performed at the facility, which includes a potentiostat PI-50-1, programmer P-8. Since it is known that the cathodic process of atmospheric corrosion occurring mainly with oxygen depolarization, and with great speed, then the uniform flow of oxygen to the metal surface electrode electrochemical study conducted with stirring. We use the mixer MM-5. The WE was mechanically polished on wet silicon carbide (SiC) paper (grades 120, 600, and 1200), rinsed with double-distilled water, degreased with acetone and ethanol, and dried at room temperature. The WE was embedded into an epoxy resin holder exposing a1 cm2 surface to the solution.

The potential values reported here were versus SCE. The cell was open to the laboratory air and the measurement was conducted without agitation at room temperature (25°C). The solution

was prepared by using double-distilled water containing 71 g Na2SO4. For the potentiodynamic polarization curve test, the potential changed from - 1100 mV to 500 mV around open circuit potential at a speed of 1 mV/s. All the experiments were carried out in 1N Na_2SO_4 solution as electrolyte.

Results and discussion.

It was found that the crude extract of oilcake rape seeds exhibits better inhibition performance than its major components. Weight loss, polarization curves methods were employed to evaluate corrosion rate and inhibition efficiency. The inhibition efficiency follow the order: extract of oilcake rape seeds > Benzaldehyde, 4-hydroxy-3,5-dimethoxy> Dimethoxyacetophenone. Similar comparative results between plant ex-tract and its major component have also been reported for the coffee extract and Artemisia pallens.

The presence of extract of oilcake rape seeds, Benzaldehyde, 4-hydroxy-3,5-dimethoxy or Dimethoxyacetophenone causes the decrease in the corrosion rate i.e. shifts the cathodic curves to positive potentials.

Quantum chemical calculation of density function theory (DFT) is applied to elucidate the relationship between the inhibitor molecule of major component and inhibition efficiency. Meanwhile, the difference in inhibition performance among extract of oilcake rape seeds, Dimethoxyacetophenone and Benzaldehyde, 4-hydroxy-3,5-dimethoxy orientin is discussed to gain some insight into the contribution of major components to the corrosion inhibition, and then discuss the inhibitive mechanism. It is expected to provide useful information on the link between the inhibition effect of the extract and that of its main constituents, and synergism between the extract of oilcake rape seeds including main constituents and triethylamine on the corrosion of steel. Explanation for inhibition and synergism. Noticeably, a number of compounds have similar chemical molecular skeleton structure of Benzaldehyde, 4-hydroxy-3,5-dimethoxy or Dimethoxyacetophenone could be seemed as the potential contributor for the inhibition performance. However, the inhibitory value of either Benzaldehyde, 4-hydroxy-3,5-dimethoxy or Dimethoxyacetophenone is lower than the crude extract to some extent, which may suggest that other composition compound have additional contribution to the corrosion inhibition effects.

CONCLUSIONS

A novel volatile corrosion inhibitor (VCI), composition extract of oilcake rape seeds and Acetophenone, was developed for temporary protection of carbon steel and the maximum inhibition efficiency is about 98,0%.

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