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EVALUATION OF VARIOUS PLANT EXTRACTS AS VAPOR PHASE CORROSION INHIBITOR FOR MILD STEEL

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Abstract:

Abstract: Extract of various plants was developed as novel volatile corrosion inhibitors (VCIs). Vapour corrosion inhibition property was evaluated by volatile inhibiting sieve test (VIS) and potentiodynamic polarization. The volatiles of ethanol extract of various plants were analysed by gas chromatography–mass spectrometry GC–MS.

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

Atmospheric corrosion of metals in closed spaces, such as in parcels, and during storage and shipment, can be temporarily prevented by the use of certain substances called vapour space corrosion inhibitors (VPCI) [1-6]. 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. It was found that certain specific VPI formulations can in fact be toxic. Most of the volatile corrosion inhibitors are synthetic chemicals, expensive, and very hazardous to environments. The use of such green compounds will add to the efforts which recently activated to protect our planet from the used harmful chemicals. Thus, alternative of environmental-friendly VPIs is under consideration.

In this work, the extract of oilcake rape seeds (*Brassicaceae*), hop cones (*Húmulus*), brushes and skins of grapes (*Vítis*) and *Lavanda, Artemisia* extracts was tested as volatile corrosion inhibitor.

The corrosion rate and inhibition efficiency mild steel in environment at 100% RH in the absence and presence extract of plats materials are given in Table 1. Visual inspection is the criterion for the vapor phase corrosion inhibition test. After sieve test, both the specimens treated by volatile compounds of the oilcake rapeseeds, hop cones, brushes and skins of grapes 2-propanol extracts were bright in almost all areas. Only for Lavanda and Artemisia 2-propanol extracts, there were some small rusts in the edge of steel specimen. At equal concentrations (2 ml/on 250 cm^3) VPIs, the degree of corrosion inhibition is of the order of oilcake rapeseeds (*Brássica nápus*) = brushes < skins of grapes (*Vítis*) < hop cones (*Húmulus*), < Lavanda extracts (*Lavanda*) < *Artemisia* (genus) for both mild steel in environment at 100% R. H. This shows that plants extracts can volatilize and adsorb on the mild steel surface to protect the steel. In order to test the stability of the inhibitors over a period of time, the inhibition efficiencies of the inhibitor were calculated after every 24…48 h of immersion in vapour phase plants extracts.

All the VCI's have shown good inhibition efficiencies which may be attributed to the formation of barrier between metal and corrosive environment by the interaction of metal and inhibitor molecule. However, the difference in their inhibiting action can be explained on the basis of the various volatile compounds of extracts which differ in their molecular structure and inhibitory potency.

However, the difference in their inhibiting action can be explained on the basis of the various volatile compounds of extracts which differ in their molecular structure and inhibitory potency. The results of weight loss studies clearly demonstrate the superior performance (> 75…80 % percent inhibition efficiency) of rapeseeds (*Brássica nápus*) and brushes < skins of grapes (*Vítis*).

Table 1

Calculated corrosion rates (g m^{-2} h^{-1}) and inhibition efficiency (%) for volatile corrosion inhibition test

Samples (Treated by vapour phase plants extracts)	Corrosion rate / g m^{-2} h^{-1}	IE/%	The inhibition coefficient of metal dissolution γ
Control	0,2481	-	-
rapeseed extract	0,0186	90,1	10,1
hop cones extract	0,0552	70,6	3,4
brushes of grapes	0,0465	75,2	4,0
skins of grapes	0,0189	89,9	9,9
Lavanda	0,1092	41,8	1,7
Artemisia	0,1115	40,6	1,6

The polarization behavior of steel in 1 N Na_2SO_4 and after 48 h exposure to the volatile compounds of the various extracts shows that the all inhibitors causes a decrease in the corrosion rate, i.e. shifts the anodic curves to positive potentials. This may be ascribed to adsorption of inhibitor over the corroded surface.

The results could indicate that both cathodic and anodic reactions of steel electrode corrosion are inhibited by 2-propanol extracts of plant raw materials in 1.0 N Na_2SO_4. The results show that the after 48 h exposure to the volatile compounds of the extract of oilcake rape seeds, a brushes of grapes and skins of grapes effect as a mixed-type inhibitor.Clearly, both anodic and cathodic reactions are drastically inhibited. The anodic curves slopes do not change remarkably, which indicates that the mechanism of the corrosion reaction does not change and the corrosion reaction is inhibited by simple adsorption mode. Good agreement between weight loss and polarization curve is obtained. Both anodic and cathodic polarization curves after 48 h exposure to the volatile compounds of the Lavanda extract and Artemisia extract are shown in Fig. 1.

It is clear that the inhibitor causes a decrease in the corrosion rate, i.e. shifts the anodic curves to positive potentials. On the other hand, the inhibitor has slight effect on the cathodic curves.

One of such ways can involve the after effect of VCI (i.e., its ability to protect steel on by a protective film even after the inhibitor has been removed from the corrosive medium). The after effect can be provided by both relatively thick (“phase”) which often form when metal is kept in the vapour phase containing a VCI. This effect is based on the irreversible inhibitor adsorption, which depends on the chemical structure of the inhibitor. We studied the after effects of films obtained on still samples by immersing them in the vapour phase containing this inhibitor (Table 2).

This result in considerable aftereffect, i.e., the retention of the state of protection after the inhibitor has been removed from the corrosive environment.

The results could indicate that the adsorption of extracts on steel surface is typical chemisorption.

Analysis of volatile components of plants extracts that showed a higher degree of protection was studied by gas chromatography-mass spectrometry. The volatile chemical composition the extract of cake oil rape seeds is highly complex containing glycosides, nucleosides, ketone, aldehyde, saturated and unsaturated fatty acids, sterols and alkaloids. The most important compounds in rapeseed cake are Guanosine (about 10%), Sucrose (6%), Xanthosine (8%), 3',5'-Dimethoxyacetophenone (12 %) Benzaldehyde, 4-hydroxy-3,5-dimethoxy (12%), Acetic, Oleic, Linoleic and Palmitic acid (about 32%),and Sterols (about 11%).

Table 2

Aftereffect of VCI on mild steel in the vapour phase (Test duration 504 h, time τ of the film formation, 120 h)

Samples (Treated by vapour phase plants extracts)	IE/%	
	3 % NaCl	1 N Na_2SO_4
vapour phase of rapeseed extract	69,4	72,3
hop cones extract	50,5	57,3
brushes of grapes	64,6	55,2
skins of grapes	60,1	49,6
Lavanda	23,2	11,8
Artemisia	24,7	10,6

The volatile chemical composition the extract of skins of grapes containing ketones: 1-Hexanol, (E)-2-Hexen-1-ol; trans-Linalool oxide furan, cis-Linalool oxide furan, Benzaldehyde, Linalool, -Terpineol, trans-Linalool oxide pyran, cis-Linalool oxide pyran, Citronellol, Nerol, Geraniol, Benzylalcohol, 2-Phenylethanol. The major compounds were linalool (11%), geraniol (7%), and nerol (13%) and Benzaldehyde (8%). Compounds responsible for this aroma (terpenes, C_{13}-norisoprenoids, benzene derivatives, and aliphatic alcohols) are presents in grapes, mainly in the skin.

The inhibition of mild steel corrosion by rapeseed cake extract is probably attributed to the presence of keton and aldehyde and glycosides, since these compounds contain such centers of adsorption as oxygen atoms. All individual chemical compounds are known as inhibitors for several metals. These compounds have extended π-electron systems and functional groups.

CONCLUSIONS

A novel volatile corrosion inhibitor (VCI), extract of oilcake rape seeds (*Brassicaceae*), hop cones (*Húmulus*), brushes and skins of grapes (*Vítis*) was developed for temporary protection of carbon steel and the maximum inhibition efficiency is about 90%. Extract of plants material probably capable of rather irreversibly adsorbing. This result in considerable after effect, i.e., the retention of the state of protection after the inhibitor has been removed from the corrosive environment. Extract of rapeseed cake, grapes brushes, skins of grapes suppressed the anodic and cathodic reaction of steel electrode and renders the corrosion potential to more noble direction.

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