Synthesis, characterisation and evaluation of new amine adducts derived from paint stripper as corrosion inhibitors for industrial applications

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Abstract

The amine admixture was separated from the industrial waste paint removal (TURCO USA) which consist 60% ethanol amine and 40% n-methylpyrolidone, the admixture was separated purified then the condensation product of the amine admixture was evaluated as inhibitor for acid cleaning processes. On the otherhand the amine admixture was transferred to its benzoate salt. The product was purified,characterised by IR,NMR, and CHN analysis. The products were evaluated as corrosion inhibitors.

Several corrosion evaluation parameters were determined using advanced techniques. The parameters investigated were corrosion rate, polarization potential,% of inhibiting efficiency,…etc.

The obtained data showed that the separated amine admixture have great efficiency as corrosion inhibitor for acid cleaning , there is no indication for pitting corrosion were observed even in the presence of low concentrations from the amine admixture.

The amine benzoate salt showed remarkable efficiency as corrosion inhibitor as examined by potentiostat under statgnent conditions and at different concentrations representative cures are included.

تحضير وتشخيص وتقييم مانع تآكل جديد من مشتقات الامين المستخلصة من فضلات الاصباغ الصناعية

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الخلاصة

تم أستخلاص الامين الممزج بمخلفات الاصباغ الصناعية من نوع (TURCO USA) حيث وجد أنه يحتوي على 60% إيثانول أمين و 40% مثيل بايرولين.تم فصلها وتنقيتها وتشخيصها بألطرق الطيفية وتحليل العناصر CHN وبعد ذلك تم تحويل الامين المكثف الى ملح البنزوات وملح الكلوريد. لقد تم تقييم ملحي الامين كمادة مانعة للتآكل في عمليات التنضيف الحامضي وتم دراسة كفاءتها تحت ظروف ساكنة وتحت ظروف تشبه ظروف الاستخدام الصناعي وبتراكيز مختلفة. لقد أظهرت النتائج أن مشتق بنزوات الامين له كفاءة عالية . لقد أستخدم في تجارب تقيم هذه المواد جهاز قياس معدل سرعه التآكل potentiostat طراز EG&G 350A .

Introduction

The use of organic corrosion inhibitors involves considering both electronic and salvation effects , and further development occurs via complex formation concept . The corrosion inhibition is frequently the consequence of reactions of nucleophilic substitution of ligands in metal surface complexes. The action of most inhibitors except cathodic inhibitors is closely related to passivation of metals since they inhibit the anodic reaction and / or promotes the cathodic reactions. There is strong relationship between the chemical structure of the inhibitors and their effectiveness as corrosion inhibitors, therefore the inhibition mechanism differs from one class to another[(1)].

In the last few decades several classes of corrosion inhibitors have being developed and commercialized and being used in various industrial fields[(2)], i.e corrosion inhibitors volatile , for oil fields , for cooling water system(open and closed recycling) , for chemical cleaning applications , pitting inhibitors as oxygen scavengers and reinforced concrete corrosion inhibitors[(3)].

In previous research programme we developed and implemented industrially a new polymeric corrosion inhibitor for cooling water system based on quinoline polymers[4].

In the present work two types of corrosion inhibitors are prepared and evaluated as adsorbing corrosion inhibitors which are prepared from industrial paint stripper wastes.

Experimental

Materials

i- The paint stripper waste was obtained from TURCO- USA composed of N-methylpyrolidone and ethanol amine as mixture .

ii- Benzoic acid and hydrochloric acid were supplied by Fluka.

Instruments

i- Corrosion measuring system model 350 A (EG & G) with computarised system.

The set-up consist of two electrometer model 356 , electrochemical cell.

ii- The analysis of CHN , NMR , IR , were carried out at United Arab University Center Laboratory for duplicate samples.

Separation of the mixed amines from the waste

The waste paint stripper usually contains organic polymeric paint constituent dissolved in the paint stripper solvent admixture. The pure organic components were separated from the waste and purified as following:

The paint stripper waste was treated with equal volume of water with continuous mixing for 30 minutes, accordingly the solid constituents of the paints were precipitated and separated by filtration.

The mixed amines were separated from the aqueous filterate by distillation in the presence of azeotropic additives. The distillate was dried with molecular sieves and the pure amine mixture was used in the preparation of the corrosion inhibitor adducts.

preparation of the corrosion inhibitor adducts

The pure amine mixture separated in (2.3) was refluxed for one hour under nitrogen atmosphere.Its observed that the viscosity of the reaction mixture increased due to the formation the final product oligomer which characterized by various techniques; IR , NMR , and CHN .

Preparation of the amine adduct salts

Two types of amine adduct salts were prepared by neutralizing the amine adduct with hydrochloric acid or benzoic acid. The two amine salts were evaluated as corrosion inhibitors.

.Corrosion inhibition evaluation

Sample preparation

Mild steel standard discs 2-3mm thickness and 20mm diameter were used after being polished and cleaned before used adopting standard procedures(4).

Evaluation medium

The new inhibitors were evaluated for cooling water system and acid cleaning medium in the presence of inhibitors in different concentrations and as presented in Table-1.

Experimental procedure

The electrochemical cell consisting five necked round bottom flask filled with working electrode, calomel refrence electrode , platinum electrode , outlet for evolved gases at the electrodes and drain valve for the cell solution.

The microprocessor corrosion measuring system EG & G model 350A was used in the corrosion measurements evaluation which were performed according to reference[(4).]

Result and discussion

Several corrosion evaluation parameters were determined. Tafel plots were scanned at rate of 1min/s in the presence of inhibitors and for the non inhibited solutions while recording the potential vs. log current (I) at

stagnant conditions.Tafel plots were determined. Representative Tafel plots are shown in figures (1 & 2).

The obtained Tafel plots were used in the evaluation of the prepared inhibitors via determining the rate of corrosion in (mpy) at different inhibitor concentrations.

The corrosion inhibitor efficiency of the inhibitors was determined from corrosion rate measurements in the presence of inhibitors and without inhibitors from the following relationship :

$$\text{Inhibitor efficiency (\%)} = \frac{C_R - C_{R^*}}{C_{R^*}} \times 100$$

C_R and C_{R^*} are the corrosion rates in the presence of inhibitors and without inhibitor respectively. The obtained results showed that the inhibition efficiency depends greatly on the inhibitor concentrations, i.e. temperature , pH , pressure , static or dynamic conditions and presence of corrosion materials.

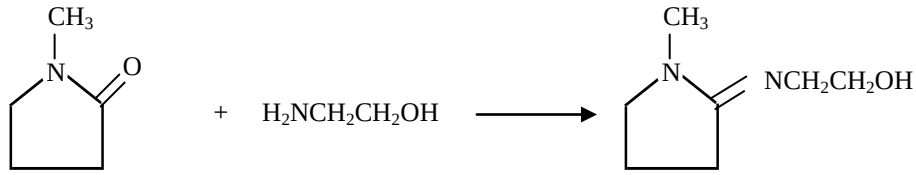
The amine inhibitor adducts showed lower efficiency (88%) than their benzoate salts (93%) as general corrosion inhibitors,while hydrochloride salt showed efficiency of (74%) when used at 20mg/l in 10% HCL cleaning solution.

On the other hand the polarization resistant R_p was determined as a function of inhibitor concentration (mg/l). Typical results are listed in Table (1).

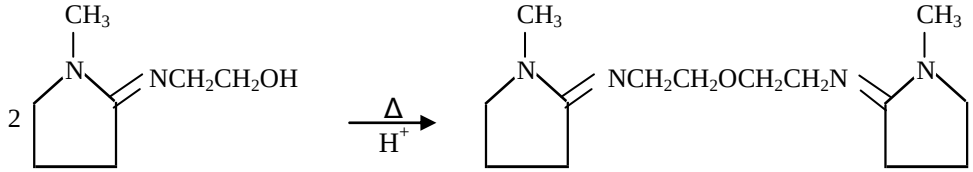
Table (1)Some corrosion parameters determined from the electrochemical measurements in cooling water system

Inhibitor	PH	Polarization,R_p resistant(ohm)	Current density Icorr.(nA/cm^2)	%Efficiency	Corrosion rate(mpy)
Ammine adduct 10mg/l	8.5	2.102 E_4	5.632 E_2	88	0.258
Benzoate salt of Ammine adduct (10mg/l)	7.0	2.913 E_4	5.204 E_2	93	0.175
Amine hydrochloride salt(acid cleaning) 20mg/l,10% HCL	4.0 - 5.0	1.723 E_4	1.389 E_3	74	0.685

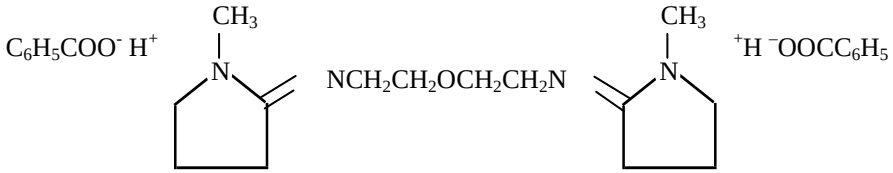
Regarding the expected chemical reactions of the amine adduct formed, it can be explained according to the following manner :



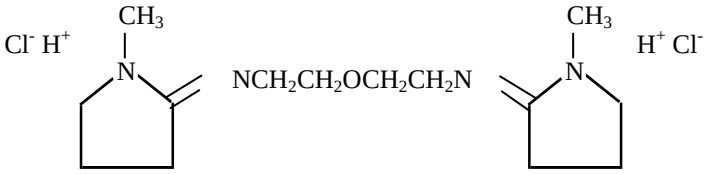
Upon heating and in the presence of acid when the salt adduct formed, further condensation might take place :



and the salt adduct will have the following structure



or as hydrochloride salt i.e.



The unreacted amine mixture also present, and the benzoate adduct salt of the mixture was confirmed by IR , NMR , and CHN . The CHN analysis were as follows:

Compound (I)

	%C	%H	%N
Calculated (%)	62.0	6.90	6.95
Found (%)	61.5	6.45	8.31
	59.9	6.40	6.54

The effect of the hydrochloride salt as acid cleaning inhibitors is in line with currently used amine inhibitors[5] but this inhibitor have further advantageous of being prepared and produced from industrial wastes as paint strippers.

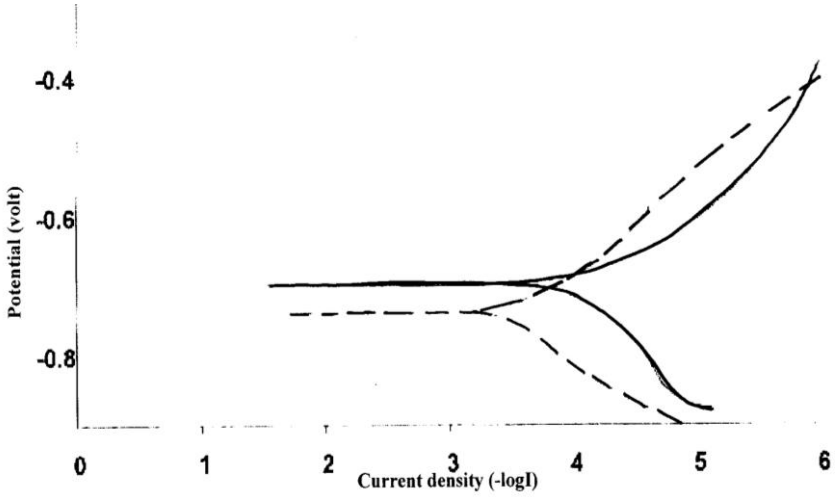


Figure (1) typical Tafel plot for amine adduct inhibitor (—) with out inhibitor (-----) with 10 mg/l at pH 8

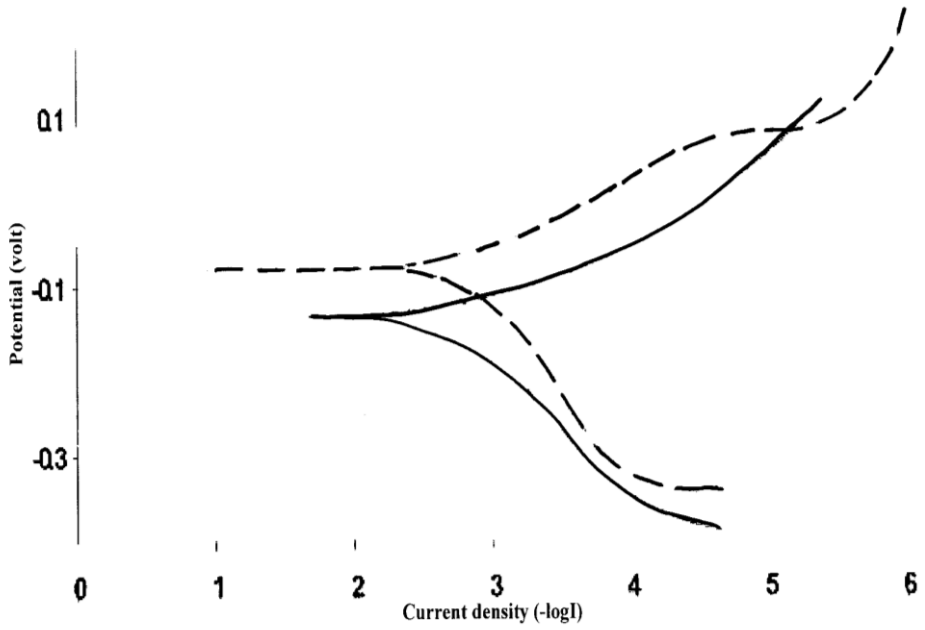


Figure (2) Typical Tafel plot graph for the benzoate salt adduct inhibitor (——) with out inhibitor (----) 5 mg/l inhibitor at pH 7

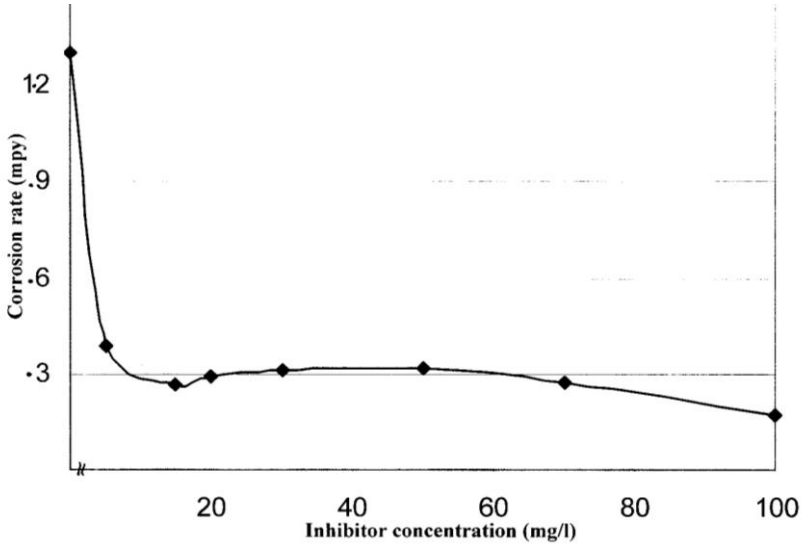


Figure (3) the representative relation ship showing the effect of amine adduct inhibitor concentration on the rate of corrosion

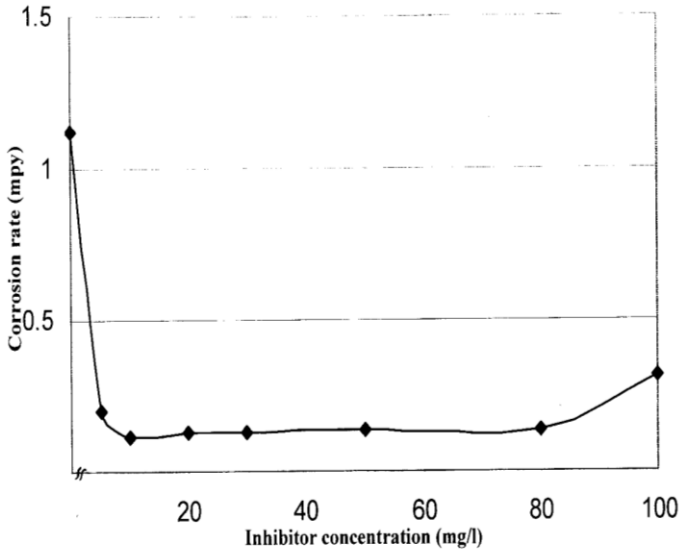


Figure (4) the representative relation ship showing the effect of benzoate salt of amine adduct inhibitor concentration on the corrosion rate

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