

Preparation of Chemical Inhibitors to Treat the Corrosion and Erosion of Machines

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Abstract- Inhibitors and Insulators are an important industrial chemicals used as an essential intermediates in the fertilizer industry, for element surface treatment in the metallurgical industry and as an additive in industry of the food. The inhibitors industry is spread out worldwide in America ,Europe and Asia involving countries that operate amines compounds , phenol compounds , pyridine compounds -based products. The present paper involved, preparation of three Chemical inhibitors. Effect of trust inhibition of Azo-anil compounds based on sulfuric acid has been tested on surface trust in 1 M sulfuric acid(H₂SO₄) solution via weight loss methods . The data of results appeared that the selected azo – anil compounds are good trust inhibitors. The efficiency of inhibition for the selected azo- anil compounds increases with increase in concentration, and decreases with high temperatures.

Keywords- Corrosion ,erosion , machine , corrosion inhibitors .

I. INTRODUCTION

Using chemical inhibitors to reduce the processes of trust rate is quite divers. In the extraction of oil and industries process, the inhibitors(1-3) are considered the first line anti-corrosion.



Corrosion inhibitors have been the focus of many researchers. Nevertheless, most of the results are obtained by experiments of trial and error in vitro and in vivo. Theories, equations and rules to highlight the inhibitor use or development are limited. Trust inhibitor is defined as a chemical substance(4-11) that reduces the corrosion rate effectively when added to an environment in sub amount concentration. Inhibitor efficiency could be revealed measuring this improvement. To prevent trust, inhibitors, which are chemical substances, are added to a chemical stream to lower corrosionrate(12-20) in order for the processing equipment to have good lifetime of service. Corrosion inhibitors are known to be the most cost-effective methods to control or prevent corrosion since they allow the use of less pricy metals for a corrosion environment.



Inhibitors of corrosion are literally in thousands. As a result, choosing one is often a challenge, especially when the task is assigned to select aninhibitor of corrosion (21-25) as a beginning.



Pliny stated corrosion occurring at the metal surfaces, as well as solutions to minimize the impact of corrosion.

II. EXPERIMENTAL PART

2.1 Corrosion Testson Machines

Corrosion Testson Machines are an important device for a diversity of industrial tasks which could greatly vary over the system life. A decision of making economic sense at design time probably would be meaningless when the same system had been operating for 20 years. In a number of applications (26-31), the chosen materials could be the best option for the initial conditions of operating.

III. PREPARATION OF CHEMICAL INHIBITORS

Amine solution of 0. 1M fromdiamine derivative has been dissolved in hydrochloric (HCl) acid ,then cooled at (ice) oC. A 0.01 M basic solution of (NaNO₂) sodium nitrite was added at (0- 5) oC. gradually with stirring and the temperature kept at (-5)oC., flowed by addition of cooled solution of coupling compound para-salicyldehyde (0.2 M) according to studies(14 ,15), the product was filtered , dried , then (0.01 M) refluxed with (amino- phenyl thiadiazole , aminophenyloxadiazole , amino phenyl triazole) for (4 hrs) with glacial acetic acid (drops) according to studies(25 ,26) to produce chemical inhibitors (1 , 2 , 3) respectively., their structural formula in Fig 1.

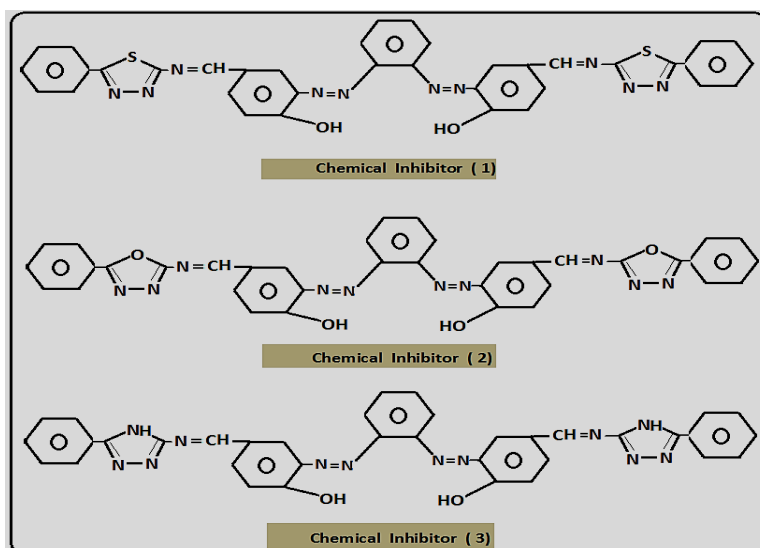


Fig (1): Organic structures of the formatted inhibitors

IV. PREPARATION OF AGGRESSIVE SOLUTION

Aggressive solution from (1M H₂SO₄) was prepared through dilution of concentrated acid (98% H₂SO₄) in distilled water. Gradually Inhibitor concentrations from (1x10⁻²to 1x10⁻⁵ M) were formatted insolution of(1M H₂SO₄) at 30oC.

V. WEIGHT LOSS MEASUREMENTS

The mild sheet was press-cut in a mechanic way into (2.5 cm)diameter shape disc. These shapediscs were emery polished ranging 110 - 410 grades for a smooth surface.

Mild steel surface treatments; however, involve absolute ethanol degreasing and acetone drying. The specimens treated were then kept in a non-moisture desiccator before use in the trust studies.

Initially, specimens of mild steel were weighed in an electronic scale. Then they were prepared and immersed completely in flask of (500 ml) volume involving (1M sulphuric acid) with or without the inhibitors for (10 hrs). The specimens were taken out after (10 hours) 30°C exposure period, washed with water out of corrosion results and eventually acetone -washed. Afterwards they were weighed again after being dried. Measurements of mass loss were conducted by method of ASTM explained previously (34, 35). The tests were conducted in duplicate in order to assure the results accuracy and the weight loss mean was reported. Weight loss permitted to calculate the rate of mean trust and corrosion in (mg cm⁻² h⁻¹). The mild steel corrosion rate was calculated by the relation (1):

$$\square = \Delta \square / \quad (1)$$

Where Δm is the mass loss (gm), s the area (cm²) and t is the immersion period (h). While the ratio of inhibition efficiency (E (%)) calculated via using the equation (2):

$$E\% = W_{\text{corr}} - W_{\text{corr}}(\text{inhib}) / W_{\text{corr}} \times 100 \quad (2)$$

The W_{corr} and $W_{\text{corr}}(\text{inhib})$ are the trust rates of mild with or without inhibitor, respectively.

VI. RESULTS AND DISCUSSION

Measurements of Weight loss: loss in the weight of surface in uninhibited acid solution and solutions involving various concentrations from the inhibitor was calculated and determined after hours:

Table (1): Corrosion or trust rate, efficiency of inhibition, surface coverage (θ) and free energy of adsorption for mild in 1M H₂SO₄ through using measurements of weight loss.

Acid (1M H ₂ SO ₄)		Concentration of Inhibitors (M)			
Goads (kJ/mol)	Θ	E%	Trust rate (mg cm ⁻² h ⁻¹)	M(g)	
	-	-	3.4871	0.313	Uninhibited
-30.20 (Y=0.8321)					
Inhibitor 1					
0.9412	74.21	0.6731	0.0117	1 X 10 ⁻²	
0.9323	71.16	0.6934	0.0128	1 X 10 ⁻³	
0.8901	64.12	1.1076	0.0294	1 X 10 ⁻⁴	
0.8804	52.14	1.4831	0.0539	1 X 10 ⁻⁵	
-32.43 (Y =0.8432)					
Inhibitor 2					
0.7745	50.10	1.4783	0.0328	1 X 10 ⁻²	
0.7518	48.82	1.5245	0.0515	1 X 10 ⁻³	
0.7555	48.51	1.5587	0.0589	1 X 10 ⁻⁴	
0.7286	45.15	1.9572	0.0761	1 X 10 ⁻⁵	
-337.21 (Y =0.8771)					
Inhibitor 3					
0.5735	47.11	1.9901	0.0886	1 X 10 ⁻²	
0.5483	45.41	2.0114	0.0795	1 X 10 ⁻³	
0.5194	42.19	2.1845	0.0839	1 X 10 ⁻⁴	
0.4979	39.62	2.3492	0.0948	1 X 10 ⁻⁵	

VII. RESULTS AND DISCUSSION

According to the results, inhibition efficiency and trust or corrosion rate as indicated by measurements of weight loss of suggested inhibitors at various concentrations (1, 2, and 3) after immersion for 8 hours at 30°C are summarized in Table (2) and illustrated in Fig. 6. These ratios reveal that the mild corrosion of steel is lessened because of the inhibitors suggested in 1M H₂SO₄ at all concentrations of the current study. However, there is notable decrement in the weight in the specimen of mild steel after 8 hours with no use of inhibitor. That could be

justified by organic compounds adsorption on the surface of mild steel that makes impairment to corrosion environment.

The increase of inhibition efficiency with concentration reveals that extra inhibitor molecules are being adsorbed at higher concentration on the metal surface, causing larger surface coverage.

A corrosion inhibitor is simply a substance that is applied to environment to significantly decrease the corrosion rate in especially metals in special and materials that are in exposure to that environment. It is labeled the first defense line against corrosion.

In some corrosion types, there is almost no noticeable change or reduction of weight, nevertheless characteristics change and the material could probably unexpectedly fail as a result of some changes in the material. These changes may resist visual ordinary examination or determinations of weight change.

VIII. MECHANISM OF CORROSION INHIBITION

Most applications of inhibitors in (partly) aqueous systems are related to four basic environment types:

1. Aqueous acid solutions used for example in processes of metal-cleaning such as pickling for mill scale or removal of corrosion in production and metals fabrication or in the metal surfaces post service cleaning. The metals corrosion in acid solutions can possibly be inhibited by many substances, like carbon monoxide, halide (Cl, Br, ..) ions, and many other organic derivatives.

2. Supply waters, natural waters, and industrial cooling waters in the near-neutral pH range (5 to 9).

Rust or corrosion takes place when the pipe metal reacts with oxygen in the water. Pipelines with low-mineral or stagnant water are mostly to be influenced by damage of corrosion. Standing water releases oxygen. It reacts with the iron wall of the pipe and leads to corrosion.



Corrosion damages the surface and it could erode the substance. In metals, it is noticed in form of rust. The metal in the pipe reacts with oxygen in water. Pipes where the water is stagnant are more subject to corrosion. Turbidity in water and brown coloring is a sign of corrosion in the water pipe. This is due to rust or material removal by a chemical reaction or corrosion. Hence, the iron in the pipe is attacked by the corrosion leading to rust. In circuits, the rust is concentrated at places of flow. Under certain unfavorable circumstances, the rust eats down the metal; a phenomenon called pitting.

IX. CONCLUSIONS

Some of the important factors in any erosion situation is conditions of the environment, For erosion and trust in aqueous media, two essential variables ((corrosion potential and pH))

The prepared azo-anil inhibitors (1, 2 and 3) were tested successfully as trust inhibitors on the surface in acid (1M H₂SO₄) solution at 30°C. The results of efficiency of inhibitive (E %) appeared interesting inhibitive effects for prepared inhibitors due to the interaction between the elements surface and the inhibitor (formatted chemicals).

X. REFERENCES

- [1] Hubert Gräfen, Elmar-Manfred Horn, HartmutSchlecker, Helmut Schindler "Corrosion" Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH: Weinheim, 2002., doi:10.1002/14356007.b01_08
- [2] M. Finšgarand I. Milošev "Inhibition of copper corrosion by 1,2,3 benzotriazole : A review" Corrosion Science 2010, 52, 2737-2749doi:10.1016/j.corsci.2010.05.002 .
- [3] Shreir LL, Jarman RA, Burstein G.T. Corrosion Control. 3rd edn. Oxford, U.K.: Butterworths Heinemann, 1994.
- [4] Wenner F. A method of measuring earth resistivity. Bulletin of the Bureau of Standards 1915; 12: 469–78.
- [5] Shepard ER. Pipe line currents and soil resistivity as indicators of local corrosive soil areas. National Bureau of Standards Journal of Research 1931; 6: 683–708.
- [6] Wagner C, Traud W. Über die deutung von korrosionvorgangendurchuberlagerung von elektrochemischenteilvorgangen und uber die potentialbildung an mischellektroden. Zeitschrift fur Elektrochemie 1938; 44: 391–402.
- [7] Evans UR. An Introduction to Metallic Corrosion. London, U.K.: Edward Arnold, 1948.
- [8] Van Orden AC. Applications and problem solving using the polarization technique. CORROSION 98, Paper # 301. Houston, Tex.: NACE International, 1998.
- [9] Silverman DC. Tutorial on cyclic potentiodynamic polarization technique. CORROSION 98, 299. Houston, Tex.: NACE International, 1998.
- [10] Grauer R, Moreland PJ, Pini G. A Literature Review of Polarisation Resistance Constant (B) Values for the Measurement of Corrosion Rate. Houston, Tex.: NACE International, 1982.
- [11] Standard Guide for on-line monitoring of corrosion in plant equipment (Electrical and electrochemical methods). Annual Book of ASTM Standards. Philadelphia, Pa.: American Society for Testing of Materials, 2001; 03(02): G 96–90.
- [12] Dean SW. Corrosion monitoring for industrial processes. In: Cramer DS, Covino BS, eds. Vol. 13A: Corrosion: Fundamentals, Testing, and Protection. Metals Park, Ohio: ASM International, 2003; 533–41.
- [13] Hugel G. Corrosion Inhibitors—Study of their Activity Mechanism. 1st European Symposium on Corrosion Inhibitors. Ferrara, Italy: University of Ferrara, 1960.
- [14] NaghamMahmoodAljamali., "Synthesis and Chemical Identification of Macro Compounds of (Thiazol and Imidazol)".,Research J. Pharm. And Tech, 2015, 8,1, 78-84.
- [15] MicaadMohamd, NaghamMahmoodAljamali , WassanAlaShubber, Sabreen Ali Abdalrahman., " New Azomethine- Azo Heterocyclic Ligands Via Cyclization of Ester"., Research J. Pharm. and Tech.11, 6 , 2018.
- [16] Schorr M, Valdez B, Zlatev R, Santillan N. Agitator corrosion in wet phosphoric acid production. Materials Performance. 2007;46:50
- [17] Hael AE, Mohammad AS, Hassan H. The effect of motion on the behavior of corrosion stainless steels in industrial phosphoric acid. Open Access Scientific Report. 2012;1:9
- [18] Jang W, Pozzo RL, Iwasaki I. Technical note: Estimation of corrosive wear of grinding media by electrochemical measurements. Corrosion. 1988;44(11):836–838
- [19] ASTM Standard G59-78. Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements. West Conshohocken, PA: ASTM International; 1984
- [20] Agarwal DC. Phosphoric acid production for fertilizer applications. Stainless Steel World. 2002;14:58–65.
- [21] Santana I, Pepe A, Jimenez-Pique E, Pellice S, Ceré S. Silica-based hybrid coatings for corrosion protection of carbon steel. Part I: Effect of pretreatment with phosphoric acid Surface and Coatings Technology. 2013;236:476–484
- [22] RotemAmfert Negev. Food grade phosphoric acid 85%. Product specification. RotemAmfert Negev; 2012
- [23] Li YL, Xiang S, Zeng HT, Wang JP, Wang QD. The corrosion behavior of 304L and 316L stainless steels in food grade phosphoric acid solutions. Applied Mechanics and Materials ,2012;109:28–31
- [24] Calcium Phosphates [Internet]. 1997–2016. Available from: [http:// www.chemeurope.com/en/encyclopedia/Calcium_phosphate.html](http://www.chemeurope.com/en/encyclopedia/Calcium_phosphate.html) [Accessed: February 20, 2015].
- [25] NaghamMahmoodAljamali, SaherMahmood J, ZainabMahmood J ,Intisar ObaidAlfatlawi ., "Inhibition Activity of (Azo – Acetyl acetone) on Bacteria of Mouth"., Research J. Pharm. and Tech. ,10, 6, 2017, 1683-1686.
- [26] Intisar ObaidAlfatlawi, Nuha Salman S, ZainabMahmood J , NaghamMahmoodAljamali , "Synthesis of New Organic Compounds Via Three Components Reaction with Studying of (Identification ,Thermal Behavior, Bioactivity on Bacteria of Teeth) "., Journal of Global Pharma Technology., 2017; 11, 9 ,157-164.
- [27] Schorr M, Valdez B. The phosphoric acid industry: Equipment, materials, and corrosion., Corrosion Reviews. 2016;34:85–102
- [28] Jasinski SM. Phosphate rock. USGS Minerals Information. Personal Communication; February 2009.
- [29] Fitzgerald III, JH. Longevity of a graphitized cast iron water main. Materials Performance, 2007; 46: 30.
- [30] Roberge PR. Corrosion Basics—An Introduction. 2nd edn. Houston, Tex.: NACE International, 2005.
- [31] Petroleum and natural gas industries—Materials for use in H₂S-containing environments in oil and gas production, NACE MR0175/ISO 15156. Houston, Tex.: NACE International, 2001.
- [32] E.M. Mabrouk , S. Eid , M.M. Attia ., " Corrosion inhibition of carbon steel in acidic medium using azochromotropic acid dye compound" ., Journal of Basic and Environmental Sciences 4 (2017) 351-355.
- [33] A.M. Nagiub,a M.H. Mahross,a H.F.Y. Khalil,b B.N.A. Mahran,c M.M. Yehiac and M.M.B. El-Sabbah ., " Azo Dye Compounds as Corrosion Inhibitors for Dissolution of Mild Steel in Hydrochloric Acid Solution"., PortugaliaeElectrochimicaActa 2013, 31(2), 119-139.
- [34] ASTM G 31 – 72, —Standard Practice for laboratory Immersion Corrosion Testing of Metals, West Conshohocken, PA; ASTM, 1990.
- [35] Ajmal, M.; Mideen A. S.; Quraishi, M. A.; "2-hydrazino-6-methyl-benzothiazole as an effective inhibitor for the corrosion of mild steel in acidic solutions", Corros. Sci., 36, 79, 1994.