



International Journal of Engineering, Science and Humanities

An international peer reviewed, refereed, open-access journal
Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

Matal Corrosion Inhibition Potential Of Benzothiazole Schiff Base Compound in Acidic Medium

Poonam Choudhary

Research Scholar, Department of Chemistry, SKD University, Hanumangarh, Rajasthan

Prof. V.K.Swami

Research Supervisor, Department of Chemistry, SKD University, Hanumangarh, Rajasthan

Abstract:

The paper explores a multifaceted investigation into the corrosion inhibition capabilities of a newly synthesized benzothiazole compound. Employing a diverse approach, the study aims to comprehensively assess the compound's effectiveness in mitigating corrosion across different metal substrates. Various analytical techniques, including electrochemical methods and surface analysis are utilized to evaluate the compound's corrosion inhibition potential.

Keywords: Corrosion, Inhibitor, metal.

Introduction: -

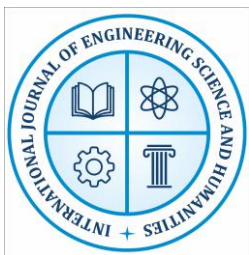
Corrosion may be described as an assault on a substance by reactivity with a surrounding media. Both the procedure itself and the harm it causes may be described by this term "Corrosion". Corrosion in metals is often electrochemical in nature due to their high electric conductivity. Materials that do not conduct electricity, such as plastics and ceramics, nonetheless degrade chemically, but they do so according to different physicochemical laws.

Metal corrosion requires more care today than it did in the past because of:

1. A rise in metal consumption throughout the technological spectrum.
2. Use of precious metals that are difficult and costly to preserve for distinctive purposes (as in the atomic energy industry).
3. As air and water pollution rise, the environment becomes increasingly corrosive.
4. The shift to lighter, thinner metal structures that are less resistant to corrosion than their bulkier predecessors.

Effects and Types of Corrosion: -

Directly, rust affects our daily lives by reducing the life of the useful objects we own, and indirectly, it affects the prices we pay for goods and services since producers and suppliers have to factor in the costs of corrosion. Things like automobile panels, barbecues, patio furniture, and garden tools all show signs of corrosion in the house. Preventative maintenance, such as painting, may help reduce the likelihood of corrosion. Although corrosion is an issue in many different sorts of industrial settings, it poses the greatest risk in those that work with electricity or chemicals. Corrosion may force factories to shut down, which can have immediate and long-term consequences. Corrosion in the industrial sector has far-reaching



International Journal of Engineering, Science and Humanities

An international peer reviewed, refereed, open-access journal
Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

repercussions on our economy, society, and security. There might be widespread repercussions for the economy that call for a variety of actions at varying prices. Some of the many negative results of corrosion are: equipment failure, product contamination, decreased efficiency, loss of valuable goods contained within corroded containers, and the inability to use corroded containers at all.

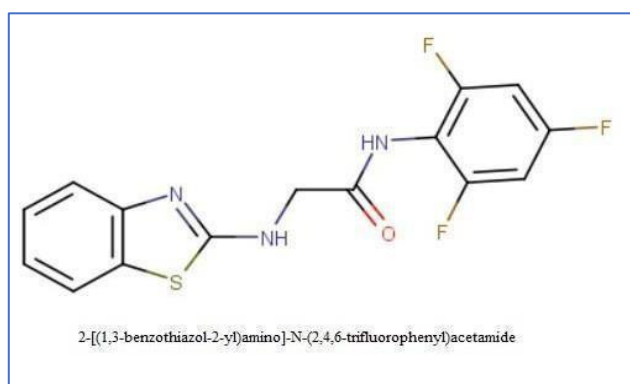
Corrosion is a natural process that deteriorates materials, usually metals, as a result of various environmental and chemical factors. Following are the different forms of corrosion:

- 1. Uniform Corrosion:** It occurs in the presence of oxygen and moisture, such as rusting of iron.
- 2. Galvanic Corrosion:** This type of corrosion is often seen in structures or machinery made of multiple metals.
- 3. Crevice Corrosion:** It is common in places like gaskets, fastener threads, and under deposits.
- 4. Filiform Corrosion:** Filiform corrosion is a type of corrosion that appears as thread-like, worm-like, or filament-like corrosion beneath a protective coating on metals like aluminium. It often happens in high humidity environments.
- 5. Erosion Corrosion:** Erosion corrosion occurs when the surface of a material is worn away due to the combined action of corrosion and mechanical abrasion, such as in pipes carrying abrasive fluids.
- 6. Hydrogen Embrittlement:** This is a type of corrosion that involves the diffusion of hydrogen into metals, causing embrittlement and potential catastrophic failure of the material.

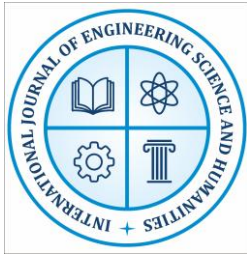
Experimental: -

2-[(1,3-benzothiazol-2-yl)amino]-N-(2,4,6-trifluorophenyl)acetamide is used as corrosion inhibitor. Following figure shows the structure of the benzothiazole compound used as corrosion inhibitor.

Fig 1: Structure of Inhibitor Compound:



The assessment of corrosion inhibition is done using various techniques such as thermometric,



International Journal of Engineering, Science and Humanities

An international peer reviewed, refereed, open-access journal
Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

EIS, potentiodynamic polarization and SEM analysis.

Thermometric Method: -

This process entails placing individual specimen into a reaction chamber with 100 milliliters of solution initially at a temperature of 25 ± 0.10 degrees Celsius. Temperature variations were monitored using a thermometer with an accuracy of

0.01 Kelvin, and both the starting and highest recorded temperatures were documented.

$$RN = (T_m - T_0) / t$$

where T_m is maximum temperature, T_0 is initial temperature and t is the time required to reach the maximum temperature. % inhibition efficiencies were calculated as:

$$\eta = [(RN_{free} - RN_i) / RN_{free}] * 100$$

where RN_i is the reaction numbers in the presence of inhibitors and RN_{free} is the reaction number in the absence of inhibitors.

Table 1: Thermometric Analysis Observations

Sample	RN ($^{\circ}\text{Cmin}^{-1}$)	IE (%)
Milled Steel (Uninhibited)	24.42	-
Milled Steel (Inhibitor)	7.53	69.16461916
Al (Uninhibited)	31.53	-
Al (Inhibitor)	11.53	63.43165239
Zn (Uninhibited)	34.53	-
Zn (Inhibitor)	10.45	69.73646105

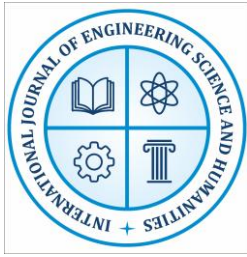
EIS Method: -

Electrochemical impedance spectroscopy (EIS) assessments are conducted using the electrochemical setup (Tacussel), comprising a digital potentiostat of Autolab

1.7 model, connected to a computer at the Ecorr following submersion in a solution without aeration. The inhibition efficiency, derived from the charge transfer resistance, is then determined as follows:

$$E_{RT} \% = 100 * (R_t - R_{t_0}) / R_t$$

where R_t and R_{t_0} are the charge transfer resistances in inhibited and uninhibited solutions respectively.



International Journal of Engineering, Science and Humanities

An international peer reviewed, refereed, open-access journal
 Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

The charge transfer resistance (R_t) values are determined by computing the impedance variance between lower and higher frequencies, following the approach proposed by Tsuru and colleagues in 1978.

Table 2: EIS Observations

Sample	R_t ($\Omega \text{ cm}^2$)	ER_t (%)
Milled Steel (Uninhibited)	6.34	-
Milled Steel (Inhibitor)	22.34	71.62041182
Al (Uninhibited)	8.65	-
Al (Inhibitor)	23.34	62.93916024
Zn (Uninhibited)	7.24	-
Zn (Inhibitor)	24.45	70.38854806

Potentiodynamic Polarization Method: -

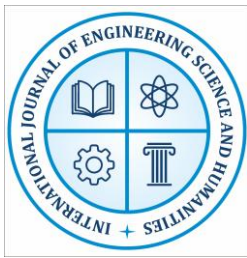
The study was conducted using a three-electrode setup in conjunction with an Auto lab. A resin-mounted sample was immersed in an acidic environment. The polarization experiment involved inhibitor while scanning at a rate of 0.0066 volts per second within the voltage range of -1.5 to +1.5 volts.

$$IE\% = (I_{\text{corr}} - I_{\text{corr}}^I / I_{\text{corr}}) * 100$$

where I_{corr} and I_{corr}^I are the corrosion current density values in the absence and presence of inhibitors respectively.

Table 3: Potentiodynamic Polarization Observations

Sample	I_{corr} (A/cm^2)	IE (%)
Milled Steel (Uninhibited)	0.5433	-
Milled Steel (Inhibitor)	0.1832	66.28013989
Al (Uninhibited)	0.4532	-
Al (Inhibitor)	0.1722	62.00353045
Zn (Uninhibited)	0.5323	-
Zn (Inhibitor)	0.1634	69.30302461



International Journal of Engineering, Science and Humanities

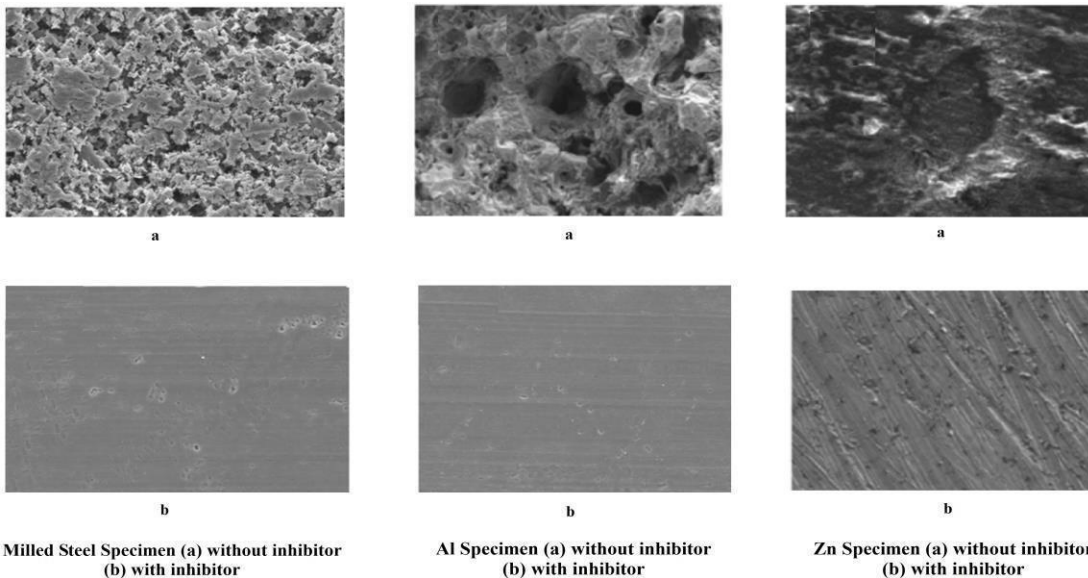
An international peer reviewed, refereed, open-access journal
Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

SEM Analysis: -

The study employed scanning electron microscopy to examine the surface structure of the test samples under both inhibitor-present and inhibitor-absent conditions, as illustrated in the figure.

Fig 2: SEM Analysis

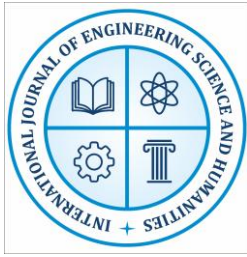
From Thermometric Analysis Observations, the % Inhibition Efficiency values for the three



metals are approximately 69.16% for Milled Steel, 63.43% for Aluminum, and 69.74% for Zinc. These values indicate a significant reduction in the corrosion rate when the inhibitor is present, further supporting the inhibitor's effectiveness in protecting these metals from corrosion. The E_{Rt} values from EIS analysis for the three metals are approximately 71.62% for Milled Steel, 62.94% for Aluminum, and 70.39% for Zinc. These values reflect that the inhibitor is effective in enhancing the corrosion resistance of these metals. The IE values from Potentiodynamic Polarization Analysis for the three metals are approximately 66.28% for Milled Steel, 62.00% for Aluminum, and 69.30% for Zinc. These values indicate a substantial reduction in corrosion current density, reflecting that the inhibitor is effective in providing corrosion protection for these metals. The IE% values showed by different methods indicate that synthesized compound is significantly effective at inhibiting corrosion. SEM analysis showcased a significant efficiency of the inhibitor compound. A smoother surface suggested reduced corrosion and indicated the inhibitor's ability to protect the metal specimens from degradation.

Conclusion:

The comprehensive investigation employing various analytical techniques demonstrates the remarkable efficacy of the synthesized benzothiazole compound as a corrosion inhibitor for a range of metals. Across multiple evaluation methods including Thermometric Analysis, EIS,



International Journal of Engineering, Science and Humanities

An international peer reviewed, refereed, open-access journal
Impact Factor 8.3 www.ijesh.com ISSN: 2250-3552

and Potentiodynamic Polarization Analysis, consistent and substantial % Inhibition Efficiency values were observed for Milled Steel, Aluminum, and Zinc.

Reference: -

1. Ebrahim Fathabadi, Hadi & Ghorbani, mohammad & Mokarami Ghartavol, Hajar. (2021). Corrosion Inhibition of Mild Steel with Tolyltriazole. *Materials Research*. 24. 10.1590/1980-5373-mr-2020-0395.
2. Ibrahim, Noradhiha & Wan abdullah, Wan rafizah & Rooshde, Maishara & Ghazali, Mohd & wan nik, wan sani. (2020). Corrosion Inhibition Properties of Epoxy-Zinc Oxide Nanocomposite Coating on Stainless Steel 316L. *Solid State Phenomena*. 307. 285-290. 10.4028/www.scientific.net/SSP.307.285.
3. Kadhim, Mustafa & Al, Layla & AlJanabi, Ahmed. (2021). Estimation of the Efficiency of Corrosion Inhibition by Zn-Dithiocarbamate Complexes: a Theoretical Study. *Iraqi Journal of Science*. 62. 3323-3335. 10.24996/ij.s.2021.62.9(SI).3.
4. Kilo, M. & Rahal, H. & El-Dakdouki, Mohammad & Abdel-Gaber, A.M.. (2020). Study of the corrosion and inhibition mechanism for carbon steel and zinc alloys by an eco-friendly inhibitor in acidic solution. *Chemical Engineering Communications*. 208. 1-10. 10.1080/00986445.2020.1811239.
5. Mas, Faiz & Zahari, Azeana & Awang, Khalijah & Hussin, Mohd Hazwan. (2020). Corrosion inhibition on mild steel in 1 M HCl solution by *Cryptocarya nigra* extracts and three of its constituents (alkaloids). *RSC Advances*. 10. 6547-6562. 10.1039/C9RA05654H.
6. Olugbade, Temitope. (2020). Electrochemical Characterization of the Corrosion of Mild Steel in Saline Following Mechanical Deformation. *Analytical Letters*. 54. 1-13. 10.1080/00032719.2020.1793994.
7. Pais, Mikitha & Rao, Padmalatha. (2021). An Up-to-Date Review on Industrially Significant Inhibitors for Corrosion Control of Zinc. *Journal of Bio- and Tribo-Corrosion*. 7. 10.1007/s40735-021-00556-x.
8. Poddar, Vaishali & Rathod, Manoj. (2021). Evaluation of mechanical properties of cold roll bonded mild steel and aluminum. *Materials Today: Proceedings*. 43. 10.1016/j.matpr.2021.01.363.
9. Tymus, M & Zin, Ivan & Khlopyk, O & Pokhmurskii, V. & Holovchuk, M & Korniy, Sergiy. (2022). Corrosion Inhibition of Aluminum Alloy by a Composition of Guar Gum and Tartrate. *Materials Science*. 57. 10.1007/s11003-022-00595-w.