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Some Acetophenone Derivatives as Corrosion Inhibitors for Diesel Fuels

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Abstract

The corrosion inhibition activities 2.4-dimethylasetophenone semicarbazone (**1**), 2.4-dimethylacetophenone thiosemicarbazone (**2**), (*E*)-3-(2-allyloxy)phenyl)-1-(4-hydroxy-2-methylphenyl)prop-2-en-1-one (**3**), (*E,E*)-3-(5-bromo-2-hydroxyphenyl)-1-(4-hydroxy-2-methylphenyl)prop-2-en-1-one thiosemicarbazone (**4**) and 3-hydroxy-3-(2-(2-hydroxy-5-methylphenyl)-2-oxoethyl)indolin-2-one (**5**) have been studied by weight loss measurements for mild steel-3 specimen in diesel fuel. The corrosion rates of the steel-3 are decreased with the increase of the carbazones, chalcone, indolinone concentration, while the inhibition efficiencies are increased.

Keywords: Diesel duels, Corrosion, Inhibition, Adsorption, Metal surface

INTRODUCTION

The acetophenone derivatives are important compounds in thin organic synthesis and medicinal chemistry. They are significant intermediates for the synthesis of various heterocyclic compounds with physiological importance. Due to the presence of various functional groups in acetophenone derivatives, these compounds exhibit biological activities such as antimicrobial, antibacterial, antifungal, anticancer, antituberculosis, antiviral, anti-inflammatory, and antihyperglycemic (Elkanzi et al., 2022; Gwaram et al., 2012; Khalilov, 2021; I. G. Mamedov et al., 2019; I. Mamedov, Mamedov, Gasimova, & Mamedova, 2023; Sashidhara, Kumar, & Kumar, 2012; Saxena & Jain, 2002; Wang et al., 2015; Zubkov & Kouznetsov, 2023)

Also, acetophenones and different derivatives are the best anticorrosion reagents in aggressive media (Ibrahim et al., 2022; Karthik et al., 2015; Misriyani et al., 2015; Panggabean & Rachman, 2016; Singh et al., 2019; Verma et al., 2014).

In our previous studies (Farzaliyeva et al., 2020; Maharramov et al., 2017), we reported on the preparation and application of different acetophenone derivatives. Our goal in this work was to examine the inhibition activity of the investigated compounds against the corrosion of a steel-3 specimen immersed in diesel fuel. The molecular structure of the investigated compounds is shown in Figure 1.

METHODOLOGY

Materials and Instrumentals

The composition (wt %) of the steel-3 specimen, which was used for all experiments, is as follows: (0.14-0.22% C, 0.05-0.17% Si, 0.4-0.65% Mn, 0.3% Ni, 0.3% Cu, 0.3% Cr, 0.08% As, 0.05% S, 0,04% P and the remainder iron) are abraded with different emery papers up to 1200 grade, washed thoroughly with bidistilled water, degreased, and dried with acetone.

As the aggressive corrosion medium was diesel fuel (0, blank), the weight of inhibitors was 5, 10 and 30 mg in 450 mL (Figure 1). Gravimetric measurements are carried out in the absence and presence of the investigated compounds in a 500 mL glass flask supplied with a mixer. Finely abraded and dried steel-3 specimens of dimensions 3.5 cm, 2.0 cm, and 0.25 cm were weighed on a digital electronic balance with a sensitivity of 0.00001g.

The corrosion of steel-3 in diesel fuel was studied by weight loss at 298K after a 5-hour immersion period. Corrosion rate (C_R), inhibition efficiency (*IE*, η%) surface coverage (θ), and standard free energy of adsorption (ΔG^0_{ads}) are calculated as follows (Equation 1-5):

$$C_R = \frac{W}{St} \quad (1)$$

$$\eta\% = \frac{C_R - C_{R(i)}}{C_R} \times 100 \quad (2)$$

Table 1. Corrosion rate* (CR, $mg/cm^2 \cdot hour$), inhibition efficiency (*% IE*) of compounds (1-5) in 450 mL diesel fuel at 25 ^{o}C

C_{inh}, g	Compound **1**		Compound **2**		Compound **3**		Compound **4**		Compound **5**	
	CR	IE	CR	IE	CR	IE	CR	IE	CR	İE
0.005	$1.01 \cdot 10^{-2}$	19.2	$8.8 \cdot 10^{-3}$	29.6	$8.5 \cdot 10^{-3}$	47.5	$5.6 \cdot 10^{-3}$	55.2	$5.1 \cdot 10^{-3}$	68.5
0.01	$6.0 \cdot 10^{-3}$	52.0	$4.4 \cdot 10^{-3}$	64.8	$6.0 \cdot 10^{-3}$	70.0	$3.8 \cdot 10^{-3}$	69.6	$3.4 \cdot 10^{-3}$	79.0
0.03	$3.6 \cdot 10^{-3}$	71.2	$1.9 \cdot 10^{-3}$	84.8	$4.3 \cdot 10^{-3}$	73.5	$2.5 \cdot 10^{-3}$	80.0	$9.0 \cdot 10^{-4}$	94.4

*corrosion rate (CR, $mg/cm^2 \cdot hour$), from weight loss measurements of St-3 specimens for blank sample at 25 ^{o}C is $1.62 \cdot 10^{-2}$.

$$\theta = \frac{C_R - C_{R(i)}}{C_R} \quad (3)$$

$$\frac{C_{inh}}{\theta} = \frac{1}{K_{ads}} + C_{inh} \quad (4)$$

$$\Delta G^{0}_{ads} = -RT \ln (55.5K_{ads}) \quad (5)$$

Where *W* is the weight loss of mild steel specimens, St is the area of the specimen, C_R and $C_{R(i)}$ are the corrosion rate values in the absence and presence of inhibitors, respectively, K_{ads} is the equilibrium constant of the adsorption-desorption process, and C_{inh} is the molar concentration of inhibitors.

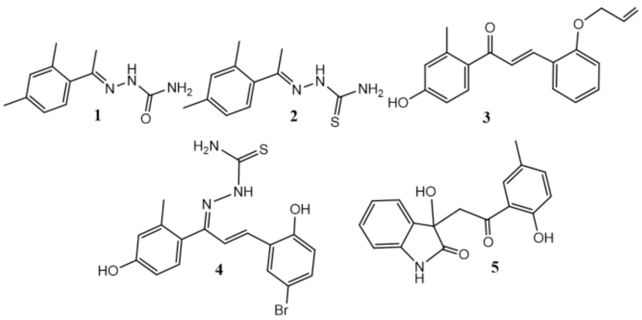

Figure 1. The molecular structure of tested

RESULTS AND DISCUSSION

Mild steel is a material frequently used in the automobile industry and different areas of chemical technology. The stability of the composition of diesel engine fuels is one of the actual problems. Therefore, various additives are used to maintain the stability of the diesel fuel composition.

As we know, the corrosion process takes place in contact with the aggressive media on the metal surface. Different organic reagents were successfully used as corrosion inhibitors. Among these anticorrosion regents, acetophenone derivatives are well-known as good inhibitors in aggressive media. In this work, gravimetric measurements are used for steel-3 immersed in diesel fuel.

Weight loss measurements

The weight losses of steel-3 specimens in diesel fuel media (without and with the addition of different investigated inhibitors) are determined at 5 hours of immersion time and 25 °C. The values of *CR* and % *IE* are given in Table 1.

Figure 1. Diesel fuel was tested as a corrosion medium

In all cases, increasing inhibitor concentration was accompanied by a decrease in weight loss and an increase in % IE. These results have led to the conclusion that compound **5** under investigation is the most efficient inhibitor for steel-3 in diesel fuel. Heterocyclic compounds like indoles can inhibit the corrosion of steel in diesel fuel due to the adsorption of electrons in the indole and aromatic rings. The indole nitrogen and aromatic electrons represent the most available centers for adsorption. Indeed, as we

Table 2. Thermodynamic parameters for adsorption of **1-5** (5, 10, 30 mg in 450 mL) on stell-3 surface at 5 hours immersion time in diesel fuel at different concentrations

$C_{inh,}$ mg	$K_{ads}·10^{-3}$ (l/mol)	$-\Delta G^0_{ads}$ kJ/mol	$C_{inh,}$ mg	$K_{ads}·10^{-3}$ (l/mol)	$-\Delta G^0_{ads}$ kJ/mol	$C_{inh,}$ mg	$K_{ads}·10^{-3}$ (l/mol)	$-\Delta G^0_{ads}$ kJ/mol
5	1.02	53.6	5	0.54	35.9	5	0.19	46.6
1 10	0.49	37.3	**2** 10	0.25	44.4	**3** 10	0.15	49.9
30	0.59	35.5	30	0.24	44.7	30	0.36	40.5
5	0.12	51.9	5	0.77	32.6			
4 10	0.13	45.2	**5** 10	0.09	53.1			
30	0.23	43.8	30	0.06	55.9			

have seen from the obtained results (Table 1), indolinone (**5**) showed a higher inhibition efficiency (94.4%) than other inhibitors (71.2–84.8%). Thus, the increase in basicity, among other factors, would be expected to increase inhibition efficiency. Thermodynamic parameters for adsorption of **1–5** on a steel-3 surface at a 5-hour immersion time in diesel fuel at different concentrations given are in Table 2.

It is well known that values of ΔG^0_{ads} -20 kJ/mol or lower indicate a physical adsorption, while those more negative than -40 kJ/mol involve the sharing or transfer of electrons from the inhibitor molecules to the metal surface to form a coordinate type of bond (chemical adsorption). The possible adsorption mechanism are: (i) electrostatic interaction between the charged inhibitor molecules and charged steel surface (called as physical adsorption, (ii) direct adsorption on the basis of donor-acceptor interactions between the lone pairs of electrons of hetero-atoms, p-electrons of benzene and heterocyclic rings and the vacant d-orbitals of iron surface atoms (called as chemical adsorption (Ahamad et al., 2010). As we have seen from Table 2, the ΔG^0_{ads} value for isoxazole **5** in high concentrations (-53.1 and -55.9 kJ/mol) clearly indicates its chemical adsorption, but low concentrations, it indicates complex adsorption on the steel surface.

CONCLUSION

The investigated compounds are efficient corrosion inhibitors (especially compound **5**) of the steel-3 specimen immersed in diesel fuels. For indolinone (**5**) at high concentrations, chemical adsorption takes place; in other cases (**1-4**), mixed-type adsorption on the steel surface was characteristic.

REFERENCES

Ahamad, I., Prasad, R., & Quraishi, M. A. (2010). Thermodynamic, Electrochemical and Quantum Chemical Investigation of Some Schiff Bases as Corrosion Inhibitors for Mild Steel in Hydrochloric Acid Solutions. *Corrosion Science*, *52*(3), 933–942.

Elkanzi, N. A. A., Hrichi, H., Alolayan, R. A., Derafa, W., Zahou, F. M., & Bakr, R. B. (2022). Synthesis of Chalcones Derivatives and Their Biological Activities: A Review. *ACS Omega*, *7*(32), 27769–27786.

Farzaliyeva, A. E., Mamedova, Y. V., Gasimova, Sh. Z., Huseynova, R. A., & Mammadov, I. G. (2020). *Functionalized acetophenone derivatives study as a corrosion inhibitor*. Baku University news.

Gwaram, N. S., Ali, H. M., Saharin, S. M., Abdulla, M. A., Hassandarvish, P., Lin, T. K., … Ooi, C. L. (2012). Synthesis, Characterization, and Biological Applications of Some 2-Acetylpyridine and Acetophenone Derivatives. *Journal of Applied Pharmaceutical Science*, *2*(12), 27–38.

him, S., Sanmugapriya, R., Selvi, J. A., Malini, T. P., Kamaraj, P., Vivekanand, P. A., … Khanal, S. (2022). Effect of 3-Nitroacetophenone on Corrosion Inhibition of Mild Steel in Acidic Medium. *International Journal of Photoenergy*, *2022*, 7276670.

Karthik, R., Vimaladevi, G., Chen, S.-M., Elangovan, A., Jeyaprabha, B., & Prakash, P. (2015). Corrosion Inhibition and Adsorption Behavior of 4–Amino Acetophenone Pyridine 2-Aldehyde in 1 M Hydrochloric Acid. *International Journal of Electrochemical Science*, *10*(6), 4666–4681.

Khalilov, A. N. (2021). Environmentally Benign Synthesis of New 1,3-Oxazolidines and Azomethynes on the Base of Arylaminopropanols. *Academia Romana: Revue Roumaine de Chimie*, *66*(8–9), 719–723.

Maharramov, A. M., Farzaliyeva, A. E., Bayramov, M. R., & Mamedov, I. G. (2017). Investigation of (e)-(4-Hydroxy-2-Methylphenyl) Acetophenone Oxime and (e)-4-Hydroxy-2-Methylacetophenone Thiosemicarbazone in Solutions by Nmr Spectroscopy. *AZƏRBAYCAN KİMYA JURNALI*, *3*, 12–16.

Mamedov, I. G., Shikhaliyeva, I. M., Baku State University, Azerbaijan, Mamedova, Y. V., Gasimova, Sh. Z., Baku State University, Azerbaijan, … Baku State University, Azerbaijan. (2019). Some Acetophenone Derivatives as Corrosion Inhibitors. *Chemical Problems*, *17*(2), 302–309.

Mamedov, I., Mamedov, E., Gasimova, I., & Mamedova, Y. (2023). Synthesis of 2-Amino-3-cyanopyridine Derivatives and Investigation of Their Antibacterial and Antifungal Properties. *Indonesian Journal of Chemical Research*, *11*(1), 23–28.

Misriyani, M., Wahab, A., Taba, P., & Gunlazuardi, J. (2015). Application of TiO2 Nanotube As Photoelectrode for Corrosion Prevention of Stainless Steel In pH Variation of NaCl. *Indonesian Journal of Chemical Research*, *3*(1), 242–248.

Panggabean, A., & Rachman, A. (2016). Validasi Metode X-Ray Fluorescence untuk Analisis Ion Fe dalam activated Methyl Diethanol Amine (aMDEA). *Indonesian Journal of Chemical Research*, *3*(2), 302–307.

Sashidhara, K. V., Kumar, M., & Kumar, A. (2012). A Novel Route to Synthesis of Flavones from Salicylaldehyde and Acetophenone Derivatives. *Tetrahedron Letters*, *53*(18), 2355–2359.

Saxena, S., & Jain, D. C. (2002). A New Acetophenone Derivative from Artemisia Maritima. *Journal of Indian Chemical Society*, *79*(12), 970–971.

Singh, D. K., Sharma, S., Thakur, A., Kumar, S., & Singh, S. (2019). Pharmaceutical Analysis | Drug Purity Determination. In P. Worsfold, C. Poole, A. Townshend, & M. Miró (Eds.), *Encyclopedia of Analytical Science (Third Edition)* (pp. 188–199). Oxford: Academic Press.

Verma, C., Reddy, M. J., & Quraishi, M. A. (2014). Microwave Assisted Eco-friendly Synthesis of Chalcones using 2 , 4-dihydroxy Acetophenone and Aldehydes as Corrosion Inhibitors for Mild Steel in 1 M HCl. *Chemistry, Environmental Science*. Retrieved from https://api. semanticscholar.org/CorpusID:201046864

Wang, Z.-M., Li, X.-M., Xu, W., Li, F., Wang, J., Kong, L.-Y., & Wang, X.-B. (2015). Correction: Acetophenone Derivatives: Novel and Potent Small Molecule Inhibitors of Monoamine Oxidase B. *Medicinal Chemistry Communications*, *6*, 2234.

Zubkov, F. I., & Kouznetsov, V. V. (2023). Traveling across Life Sciences with Acetophenone-A Simple Ketone That Has Special Multipurpose Missions. *Molecules (Basel, Switzerland)*, *28*(1).