

SYNTHESIS OF A MULTIFUNCTIONAL CORROSION INHIBITOR FROM THE REACTION OF HEXAMETHYLENEDIAMINE AND OLEIC ACID IN A RATIO OF 1:2 AND ITS INVESTIGATION AS AN INHIBITOR FOR CO₂ CORROSION

*Duzdaban K.,
Mursalov N.*

Institute of Petrochemical Processes named after Y.H. Mammadaliyev

Abstract

Hexamethylenediamine and oleic acid were mixed in a 1:2 mol ratio. For three hours, the reaction was carried out at 140°C. The process continues with the separation of water using a Dean-Stark unit. The synthesised amide compound has a 95.4% yield. The impact of an amide compound synthesised on the basis of hexamethylenediamine and oleic acid in a 1:2 mole ratio on the corrosion process of C1018 steel in a carbon dioxide atmosphere was investigated. The corrosion protection properties of the compound were studied, and it was established that the amide compound had a corrosion protection effect of 40%, 76%, and 97.5% at concentrations of 10, 25, and 50 mg/l, correspondingly. The time-based dependence of metal loss has been explored as a consequence of the study. Metal loss results begin to stabilise after the first hour of the experiment at concentrations of 25 and 50 mg/l of amide, and metal loss is totally stabilised after 5 hours.

Keywords: carbon dioxide corrosion, corrosion inhibitor, metal loss, amide.

The most pressing issue in today's constantly evolving technology is the corrosion protection of metal-based systems, equipment, and their parts. The fact that steel belts and equipment are subjected to numerous corrosion processes during gas and oil production, transportation, and processing, which is the fundamental component of the oil industry and its foundation, exacerbates the problem. The expense of resolving corrosion-related issues accounts for a major portion of the overall expenditures incurred by oil and gas production businesses worldwide.

Corrosion is recognised to occur on the surface of all equipment used in oil refining operations, beginning with wells and continuing with storage tanks, pipelines, and other equipment. Corrosion reduces the output capacity of the equipment utilised and, in many circumstances, produces significant economic losses owing to the entire shutdown of the operations, resulting in the loss of millions of tonnes of metal each year. Because the world's metal sources are finite and there is a significant amount of metal lost due to corrosion, corrosion will always be an important problem that demands a solution. Scientists are conducting research in this sector to discover answers to this problem that are both

economically efficient and in the direction of metal preservation.

Corrosion issues can result in idle stops, completed product loss, product contamination, and so forth. In this sense, our country's corrosion problem remains a top priority. Taking all of this into consideration, the oil and gas sector has dedicated significant resources to the research of corrosion concerns via the application of efficient corrosion prevention measures such as inhibitors, conservation solutions, and lubricants.

As a result of the research, multifunctional corrosion inhibitors with good performance were synthesised by reacting hexamethylenediamine with oleic acid in a 1:2 mol ratio. The reaction continues at 140 °C, with water separation. The yield of the amide product produced by the reaction of oleic acid with hexamethylenediamine was determined to be 96.3%. The amide compound formed as a result of the reaction is a solid material with a dark colour and a distinct odour. The infrared (IR) spectra of the synthesised amide compound were obtained, and the composition's molecular structure was validated using the matching absorption bands. Figure 1 depicts the IR spectra of an amide synthesised from hexamethylenediamine and oleic acid.

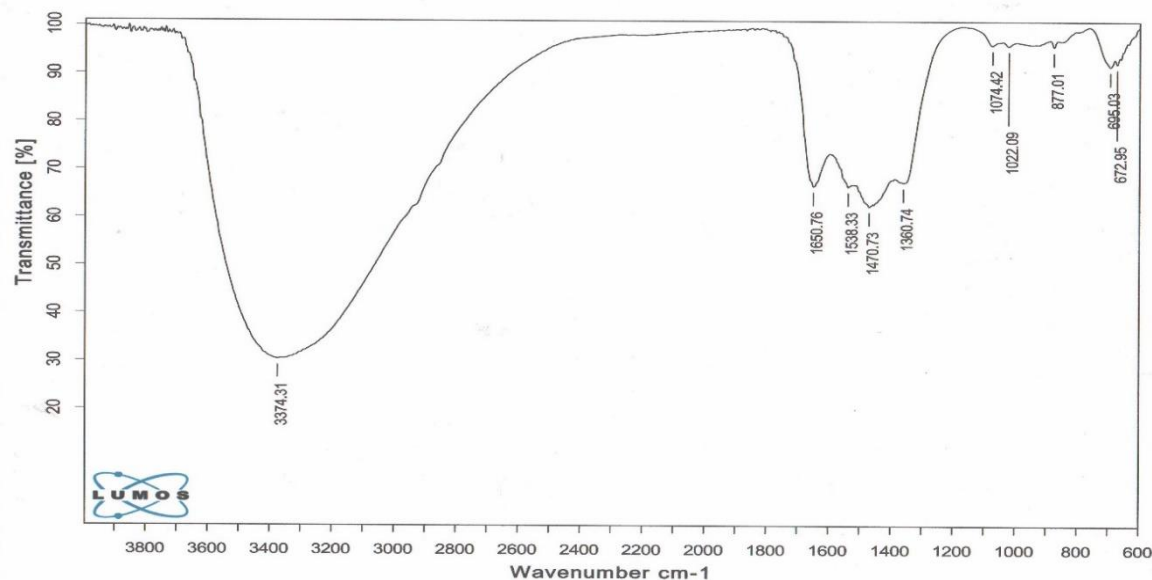
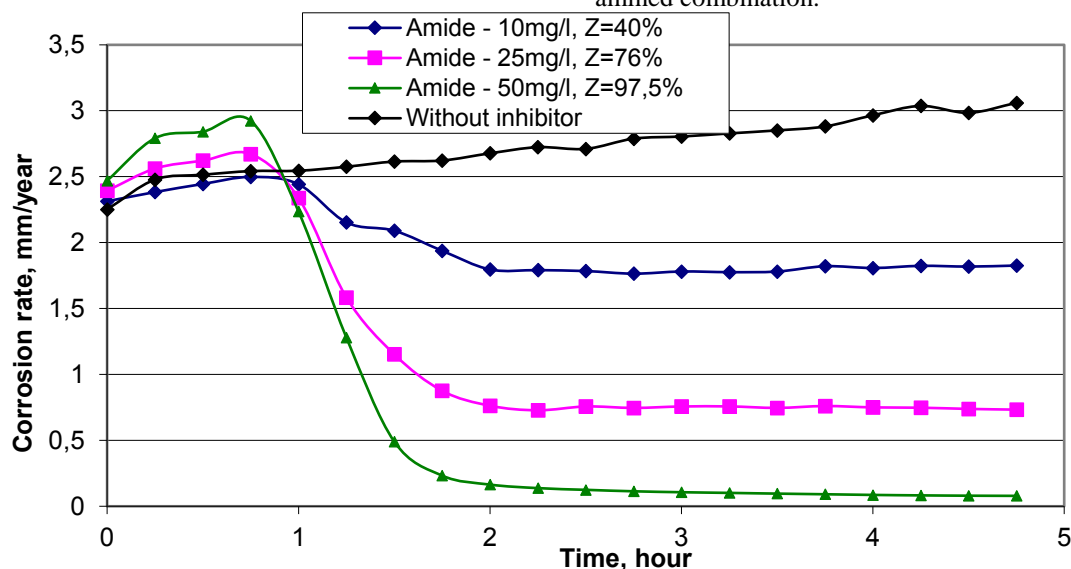


Figure 1: Infrared spectrum of an amine synthesised from hexamethylenediamine and oleic acid.

The "Infra LUM FT-02" spectral instrument was used to record the IR spectrum of the imidazoline chemical. The IR spectrum analysis reveals that the synthesised compound contains the following groups of oscillations: valence oscillations for the C-H bond of CH_2 and CH_3 groups at 1360 cm^{-1} , 1470 cm^{-1} ; 1650 cm^{-1} for the C=O bond of CH_3 group, 1538 cm^{-1} for C-H bond; and $\nu=1655\text{ cm}^{-1}$ for the C=N bond in imidazolines. Valence oscillations for the C-O bond are found at 1022 cm^{-1} , 1074 cm^{-1} , and 3374 cm^{-1} , whereas valence oscillations for the H-O bond are detected at 3374 cm^{-1} .

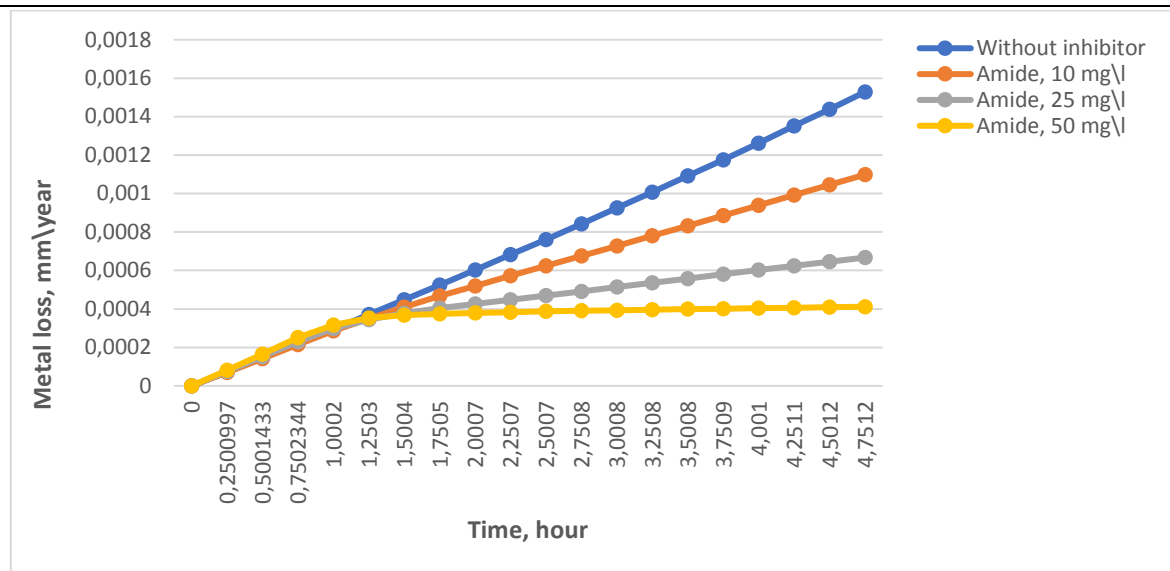
The anti-corrosion properties of hexamethylenediamine and oleic acid at concentrations of 10, 25, and 50 mg/l were investigated. The amide synthesised at a concentration of 10 mg/l has a 40% protective effect against CO_2 corrosion, whereas the amide at a dosage of 25 mg/l has a 76% protective impact. It has been established that as the density increases, so do their protective benefits. Thus, the synthesised combination of hexamethylene and oleic acid at 50 mg/l in a 1:2 ratio had a greater - 97.5% protective impact. Graph 1 depicts the time dependency of the corrosion rate in the corrosion protection of the steel for 5 hours of the examined combination.



Graph 1. 1:2 complex of hexamethylenediamine and oleic acid.

The impact of sterilising in a 1% NaCl solution in water saturated with CO_2 on corrosion kinetics.

The temporal dependency of the synthesised amide's influence on metal loss at varied concentrations was also investigated. Graph 2 depicts the temporal dependence of metal loss.

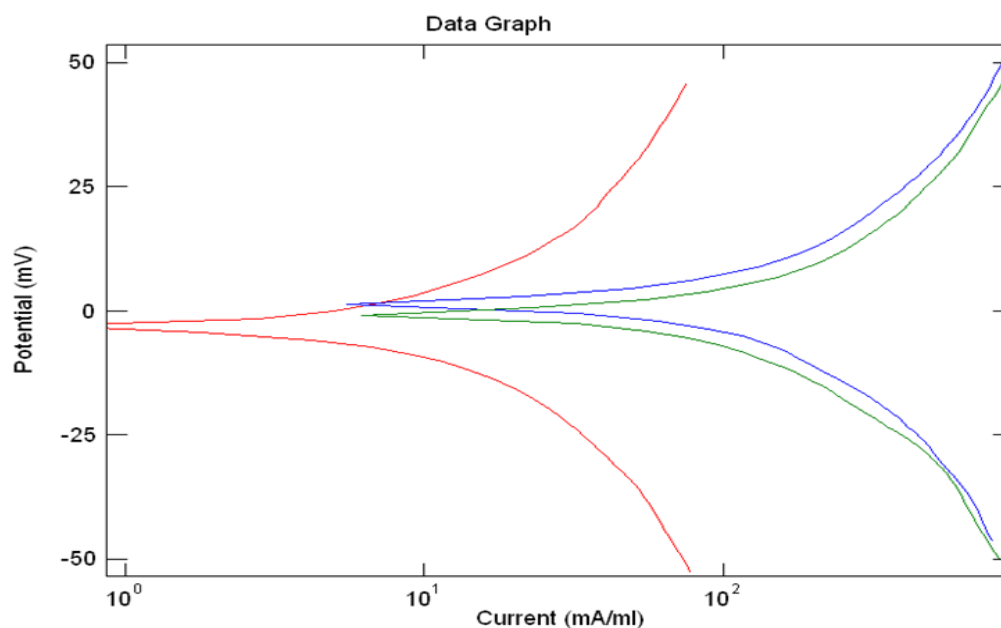


Graph 2. In the presence of hexamethylenediamine and oleic acid, time dependence of metal loss in CO_2 environment of amide inhibitor synthesized in 1:2 molar ratio.

According to studies, there is a steady linear rise in metal loss as a function of time in a medium without an inhibitor during a five-hour period, but adding an inhibitor to the medium drastically lowers metal loss. In contrast to the amide concentration of 10 mg/l, the metal loss values begin to stabilise at 25 and 50 mg/l during the first hour of the experiment, and the metal loss is totally stabilised after 5 hours. As shown in graph 2, although the metal loss without inhibitor was 0.00016 mm after 5 hours, the metal loss was 0.0011

mm, 0.0007 mm, and 0.0004 mm with the addition of amide molecule at doses of 10, 25, and 50 mg/l, respectively. This demonstrates that metal loss prevention is greatly decreased.

Polarisation curves of an imidazoline molecule synthesised in H_2S medium from hexamethylenediamine and oleic acid were obtained at concentrations of 25 and 50 mg/l, as well as in media without inhibitors. The graph below depicts the polarisation curves.



Graph 3. Polarization curves in H_2S environment: 1) without inhibitor; 2) 25 mg/l; 3- 50 mg/l

As a result of the investigation, it was discovered that, like other imidazoline-type compounds, the synthesised amide compound exhibits both anode and cathode effects, with the polarisation curves shifting towards the cathode area. This demonstrates that imidazoline-type chemicals inhibit further metal anodic processes - metal dissolution.

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