

THE ROLE OF ETHANOLAMINES IN PROTECTING  
METALS FROM CORROSION

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**Relevance.** Corrosion of metals remains a critical issue in modern industry, leading to substantial economic losses and safety risks. The search for effective, affordable, and environmentally acceptable corrosion inhibitors is therefore highly relevant. Ethanolamines have attracted increasing attention due to their chemical properties, availability, and efficiency in forming protective layers on metal surfaces. Studying their role in corrosion prevention not only contributes to improving existing protection technologies but also supports the development of new, more sustainable anticorrosion materials. This topic is especially important for industries such as construction, oil and gas, and manufacturing, where metal durability is essential.

**The Purpose of the Study.** The purpose of this study is to investigate the role of ethanolamines in protecting metals from corrosion and to evaluate their effectiveness as corrosion inhibitors. The study aims to analyze the mechanisms by which ethanolamines interact with metal surfaces, form

protective films, and reduce corrosion rates. In addition, the research seeks to compare different types of ethanolamines (monoethanolamine, diethanolamine, and triethanolamine) in terms of their efficiency and practical applicability in anticorrosion coatings. The ultimate goal is to contribute to the development of more effective and sustainable corrosion protection technologies.

**Research Materials and Methods.** The research is based on both theoretical analysis and experimental approaches. The materials used in this study include metal samples (such as steel or iron), ethanolamines (monoethanolamine, diethanolamine, and triethanolamine), and corrosive media (acidic or saline solutions).

The methods applied in the study include:

- Preparation of metal samples with cleaned and polished surfaces
- Application of ethanolamine-based inhibitors on metal surfaces
- Exposure to corrosive environments to simulate real conditions
- Electrochemical methods, such as potentiodynamic polarization and electrochemical impedance spectroscopy (EIS), to measure corrosion rates
- Weight loss method to determine the degree of corrosion over time
- Surface analysis techniques, such as microscopy, to observe the formation of protective films

The obtained data are analyzed comparatively to determine the effectiveness of different ethanolamines and to identify the most efficient inhibitor for corrosion protection.

**Results and Discussion.** The results of the study demonstrate that ethanolamines significantly reduce the corrosion rate of metals in aggressive environments. All tested ethanolamines—monoethanolamine (MEA), diethanolamine (DEA), and triethanolamine (TEA)—exhibited inhibitory effects, though their efficiencies varied depending on their chemical structure and experimental conditions.

The weight loss measurements indicated that metal samples treated with ethanolamines showed considerably lower mass loss compared to untreated samples. Among the tested compounds, triethanolamine (TEA) showed the highest inhibition efficiency, which can be attributed to its larger molecular structure and stronger adsorption capability on the metal surface.

Electrochemical studies, including potentiodynamic polarization and electrochemical impedance spectroscopy (EIS), confirmed that ethanolamines act as mixed-type inhibitors. They reduce both anodic metal dissolution and cathodic hydrogen evolution reactions. The increase in charge transfer resistance observed in EIS measurements suggests the formation of a protective barrier layer on the metal surface.

Surface analysis revealed that ethanolamines form a thin, uniform, and stable protective film on the metal. This film acts as a barrier, preventing the interaction between the metal and corrosive agents such as water, кислород (oxygen), and aggressive ions. The presence of nitrogen atoms and hydroxyl groups in ethanolamine molecules enhances their adsorption through donor-acceptor interactions with the metal surface.

Comparative analysis showed that:

- MEA provides fast but less stable protection
- DEA offers moderate and balanced inhibition
- TEA ensures strong, long-lasting protection

However, it was also observed that the efficiency of ethanolamines decreases at higher temperatures and lower concentrations, indicating the importance of optimizing operational conditions.

Overall, the findings confirm that ethanolamines are effective corrosion inhibitors and can be successfully used in anticorrosion coatings. Their performance depends on molecular structure, concentration, and environmental factors, which should be carefully considered in practical applications.

**Conclusion.** In conclusion, the study confirms that ethanolamines are effective agents for protecting metals against corrosion. Their ability to adsorb onto metal surfaces and form stable protective films significantly reduces corrosion rates in aggressive environments. Among the studied compounds, triethanolamine (TEA) demonstrated the highest inhibition efficiency due to its stronger adsorption capacity and more stable film formation.

The results also show that ethanolamines act as mixed-type inhibitors, influencing both anodic and cathodic reactions. Their effectiveness, however, depends on factors such as concentration, temperature, and the nature of the corrosive medium. Proper optimization of these parameters is essential to achieve maximum corrosion protection.

Overall, ethanolamines represent a promising and practical solution for anticorrosion technologies in various industrial applications. Further research should focus on enhancing their efficiency, improving environmental safety, and developing advanced formulations based on ethanolamine compounds.

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