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BOTANICAL DEFENDERS: A COMPREHENSIVE REVIEW ON THE USE OF PLANT EXTRACTS AS GREEN CORROSION INHIBITORS FOR STEEL IN CONCRETE

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ABSTRACT

This comprehensive review delves into the eco-friendly realm of corrosion inhibition by exploring the application of plant extracts as green inhibitors for steel reinforcement in concrete structures. Plant extracts, known for their rich composition of bioactive compounds, have exhibited remarkable potential in hindering the corrosion of steel in aggressive concrete environments. The review synthesizes recent advancements, methodologies, and findings in this burgeoning field, offering insights into the mechanisms underlying the corrosion inhibition process. The ecological and economic benefits of utilizing plant extracts as corrosion inhibitors are discussed, providing a holistic perspective on sustainable practices in concrete protection.

KEYWORDS

Corrosion inhibition, green inhibitors, plant extracts, steel reinforcement, concrete structures, eco-friendly, bioactive compounds, sustainable practices, corrosion protection, environmental impact.

INTRODUCTION

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The Corrosion of steel reinforcement in concrete structures is a pervasive and formidable challenge, leading to significant structural deterioration and economic repercussions. Traditional corrosion inhibitors often involve chemicals that pose environmental concerns, prompting a shift toward sustainable and eco-friendly alternatives. In this context, the exploration of plant extracts as green corrosion inhibitors emerges as a promising avenue. The inherent bioactive compounds present in plant extracts offer a unique potential to combat corrosion in a manner that is both effective and environmentally benign. This comprehensive review delves into the evolving landscape of corrosion inhibition, specifically focusing on the application of plant extracts as botanical defenders for steel reinforcement in concrete. By examining recent research, methodologies, and outcomes, this review aims to provide a nuanced understanding of the mechanisms involved in corrosion inhibition by plant extracts. Furthermore, the discussion encompasses the ecological and economic advantages of adopting plant extracts as corrosion inhibitors, thereby highlighting the potential of integrating sustainable practices into concrete protection strategies. As we embark on this exploration of botanical defenders, the aim is to elucidate the promising developments in green corrosion inhibition and underscore the significance of eco-friendly solutions for enhancing the durability and longevity of concrete structures.

METHOD

The process of conducting this comprehensive review on the use of plant extracts as green corrosion inhibitors for steel in concrete involved several systematic steps to ensure a thorough and insightful analysis of the current state of research in this field.

The initiation of the review began with an extensive literature search across reputable databases, including PubMed, ScienceDirect, and Google Scholar. Keywords such as "corrosion inhibition," "plant extracts," "green inhibitors," and "steel in concrete" were strategically employed to identify a diverse range of relevant studies. The inclusion criteria focused on recent works, ensuring that the review encapsulated the latest advancements in the application of plant extracts as corrosion inhibitors.

Following the identification of potential articles, a meticulous data extraction process was employed to gather pertinent information from each study. This encompassed details on the types of plant extracts investigated, the experimental methodologies employed, the corrosion inhibition mechanisms studied, and the outcomes reported in the literature. The extracted data were systematically organized and synthesized to create a structured framework for analysis.

A crucial aspect of the review involved a mechanistic analysis to unravel the intricacies of how plant extracts function as corrosion inhibitors. This stage scrutinized experimental setups, corrosion measurement techniques, and reported outcomes to gain insights into the interactions between the bioactive compounds

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present in plant extracts, the steel surface, and the corrosive environment.

Furthermore, the review incorporated an evaluation of the ecological and economic impact of utilizing plant extracts as corrosion inhibitors. Studies reporting on the environmental friendliness and cost-effectiveness of these botanical defenders were critically assessed, providing a holistic perspective on the broader implications of adopting plant extracts in corrosion protection strategies.

The final stage of the process involved synthesizing the gathered information to present a cohesive and comprehensive overview of the subject matter. The findings were organized thematically, addressing key aspects such as types of plant extracts, inhibitory mechanisms, experimental methodologies, and ecological and economic considerations. This synthesis aimed to provide a structured narrative that captures the diversity of research approaches and outcomes in the burgeoning field of plant extract-based corrosion inhibition.

By adhering to this systematic process, the review aspires to contribute to the collective understanding of plant extracts as botanical defenders against corrosion, offering valuable insights and considerations for future research, application, and sustainable practices in concrete protection.

Literature Search and Selection:

The methodology of this comprehensive review involved a meticulous search of scholarly databases, including but not limited to PubMed, ScienceDirect, and Google Scholar. Keywords such as "corrosion inhibition," "plant extracts," "green inhibitors," and "steel in concrete" were employed to identify relevant studies, peer-reviewed articles, and research papers. The inclusion criteria focused on works published within a defined timeframe to ensure the review encompassed recent advancements in the field.

Data Extraction and Synthesis:

Upon identifying potential articles, a systematic data extraction process was employed to gather information on the application of plant extracts as green corrosion inhibitors for steel in concrete structures. Extracted data included details on the types of plant extracts studied, experimental methodologies, corrosion inhibition mechanisms, and the outcomes of these investigations. The extracted information was organized, categorized, and synthesized to facilitate a comprehensive understanding of the current state of research in this specific domain.

Mechanistic Analysis:

To unravel the mechanisms underlying the corrosion inhibition process by plant extracts, a thorough analysis of the identified studies was conducted. This involved scrutinizing the experimental setups, corrosion measurement techniques, and the reported outcomes. The focus was on elucidating how the bioactive compounds present in plant extracts interact with the steel surface and the corrosive environment, thereby hindering the corrosion process. Insights gained from this mechanistic analysis were crucial for

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providing a deeper understanding of the efficacy of plant extracts as green corrosion inhibitors.

Evaluation of Ecological and Economic Impact:

A key aspect of this review involved evaluating the ecological and economic impact of utilizing plant extracts as corrosion inhibitors. Studies reporting on the environmental friendliness and cost-effectiveness of these botanical defenders were critically assessed. This evaluation aimed to shed light on the potential of plant extracts to contribute to sustainable practices in corrosion protection for concrete structures.

Synthesis and Presentation:

The final stage involved synthesizing the gathered information to present a comprehensive overview of the use of plant extracts as green corrosion inhibitors for steel in concrete. The findings were organized thematically, addressing key aspects such as the types of plant extracts studied, their inhibitory mechanisms, experimental methodologies, and the ecological and economic considerations. This synthesis provides a structured and insightful narrative that captures the current state of knowledge in this evolving field.

By employing this rigorous methodology, the review aims to contribute to the understanding of plant extracts as botanical defenders against corrosion, offering a valuable resource for researchers, practitioners, and policymakers seeking sustainable solutions in concrete protection.

RESULTS

The comprehensive review on the use of plant extracts as green corrosion inhibitors for steel in concrete synthesized a wealth of information from diverse studies. Various types of plant extracts, including those from leaves, seeds, and stems, were investigated for their potential to inhibit corrosion. Mechanistic insights revealed that the bioactive compounds present in these extracts, such as alkaloids, flavonoids, and tannins, played a pivotal role in hindering the corrosion process. Experimental methodologies varied, encompassing immersion tests, electrochemical techniques, and surface analysis methods, reflecting the diverse approaches in this field. The results collectively indicated the efficacy of plant extracts in mitigating corrosion and protecting steel reinforcement in concrete environments.

DISCUSSION

The discussion segment delved into the nuanced aspects of the findings, addressing the variability in inhibition efficiency observed among different plant extracts. Factors influencing inhibition, such as extract concentration, exposure conditions, and steel surface morphology, were critically examined. The mechanistic understanding of how plant extracts formed protective layers on the steel surface, impeding corrosive reactions, highlighted the potential for tailored approaches in corrosion inhibition strategies. Additionally, the discussion explored the ecological advantages of utilizing plant extracts, emphasizing their

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renewable nature and minimal environmental impact compared to traditional corrosion inhibitors. The economic feasibility and scalability of incorporating botanical defenders in large-scale concrete applications were considered, providing a holistic view of the challenges and opportunities in adopting green corrosion inhibitors.

Conclusion

In conclusion, the comprehensive review consolidated a diverse array of studies, providing a thorough understanding of the application of plant extracts as green corrosion inhibitors for steel in concrete. The results collectively underscored the potential of plant extracts to serve as botanical defenders against corrosion, offering effective protection to steel reinforcement. The discussion illuminated the need for standardized testing protocols and emphasized the importance of tailoring approaches based on specific environmental conditions and extract characteristics. The ecological and economic advantages of plant extracts showcased their potential as sustainable alternatives in concrete protection.

The findings from this review contribute valuable insights to researchers, engineers, and policymakers seeking environmentally friendly and economically viable corrosion inhibition solutions. As the field continues to evolve, this synthesis of information lays the groundwork for further exploration and innovation in the realm of green corrosion inhibitors, ultimately promoting sustainable practices in the construction and maintenance of concrete structures.

References

1. Abbas, A.S.É.F. & T.I.Török,. (2018). Corrosion studies of steel rebar samples in neutral sodium chloride solution also in the presence of a bio-based (green) inhibitor, Int. J. Corros. Scale Inhib., 7(1), 38–47.
2. Abiola, O.K.N.C.O., E. E. Ebenso, and N. M. Nwinuka. (2007). Eco-friendly corrosion inhibitors: The inhibitive action of Delonix Regia extract for the corrosion of aluminium in acidic media. Anti-Corrosion Methods and Materials, 54, 219-224
3. Akshatha, G.B.G.J., Kumar & Pushpa. (2015). Effect of Corrosion Inhibitors in Reinforced Concrete. International Journal of Innovative Research in Science, Engineering and Technology. 4(8).
4. Alia, F.F., et al., (2017). High temperature oxidation in boiler environment of chromized steel. IOP Conference Series: Materials Science and Engineering. 257(1), 012086.
5. Amitha R. B. E, B.B., J. Basu., (2012). Green Inhibitors for Corrosion Protection of Metals and Alloys: An Overview. International Journal of Corrosion.
6. Asma, R., Y.P. Asmara, and C. Mokhtar. (2011). Study on the effect of surface finish on corrosion of carbon steel in CO2 environment. Journal of Applied Sciences, 11(11), 2053-2057.
7. Asmara, Y.P. A.G.M.Z.J.J., J.P. Siregar, D. Bachtiar, T. Kurniawan, Corrosion inhibition

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of carbon steel in oil and gas environments, International Journal of Advanced and Applied Sciences, 3 (5), 2016.

8. Asmara, Y.P., A. Juliawati, and A. Sulaiman. (2013). Mechanistic model of stress corrosion cracking (scc) of carbon steel in acidic solution with the presence of H2s. in IOP Conference Series: Materials Science and Engineering.
9. Asmara, Y.P., et al., (2016) Long Term Corrosion Experiment of Steel Rebar in Fly Ash-Based Geopolymer Concrete in NaCl Solution. International Journal of Corrosion, 5.
10. Asmara, Y.P., et al., (2016). Predicting Effects of Corrosion Erosion of High Strength Steel Pipelines Elbow on CO2-Acetic Acid (HAc) Solution. IOP Conference Series: Materials Science and Engineering. 114(1), 012128.
11. Asmara, Y.P., et al., (2017) Development of green vapour corrosion inhibitor. IOP Conference Series: Materials Science and Engineering, 257(1), 012089