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OPTIMIZING PALM OIL MILL EFFLUENT (POME) DECOLOURISATION: ENHANCED EFFICIENCY WITH TREATED COAL BOTTOM ASH

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Abstract

This study focuses on optimizing the decolourisation process of Palm Oil Mill Effluent (POME) by employing treated coal bottom ash as an efficient adsorbent. Coal bottom ash, treated through a tailored process, demonstrates enhanced capabilities for removing colorants from POME. The experimental investigations involve assessing the influence of adsorbent dosage, contact time, and pH on the decolourisation efficiency. The results reveal a significant improvement in POME decolourisation, underscoring the potential of treated coal bottom ash as a sustainable and effective adsorbent for the remediation of POME.

Keywords

Palm Oil Mill Effluent (POME), Decolourisation, Treated Coal Bottom Ash, Adsorption, Adsorbent Dosage, Contact Time, pH Optimization, Colorant Removal, Environmental Remediation, Sustainable Wastewater Treatment.

INTRODUCTION

Palm Oil Mill Effluent (POME) is a wastewater stream generated during the processing of palm oil, characterized by high organic content and a distinctive dark color resulting from the presence of various pigments and contaminants. Effective decolourisation of POME is essential for environmental sustainability and regulatory compliance. This study focuses on optimizing the decolourisation process of POME through the utilization of treated coal bottom ash, a promising adsorbent known for its potential in wastewater treatment.

The palm oil industry, a significant contributor to global vegetable oil production, faces increasing scrutiny for its environmental impact, particularly concerning wastewater management. POME, if not treated adequately, can pose significant environmental challenges due to its high chemical oxygen demand (COD) and color content. Decolourisation, therefore, becomes a pivotal step in mitigating the environmental impact of POME.

Treated coal bottom ash, a byproduct of coal combustion, has shown promise as an adsorbent in wastewater treatment due to its porous structure and potential surface reactivity. This study explores the enhanced efficiency of treated coal bottom ash in decolourising POME. The tailored treatment process is expected to optimize the adsorption capacity of coal bottom ash for colorant removal from POME.

The introduction of treated coal bottom ash as an adsorbent in POME decolourisation aligns with the broader goal of sustainable and eco-friendly wastewater treatment practices. The investigation will delve into the influence of key parameters such as adsorbent dosage, contact time, and pH on the decolourisation efficiency. The findings aim to contribute to the development of effective and environmentally conscious strategies for managing POME, fostering a more sustainable approach within the palm oil industry. As we strive to address the environmental challenges associated with POME, the utilization of treated coal bottom ash emerges as a promising avenue for enhancing the efficiency of decolourisation processes, ultimately promoting sustainable practices in the palm oil sector.

METHOD

The optimization of Palm Oil Mill Effluent (POME) decolourisation was conducted through a systematic and controlled process, primarily employing treated coal bottom ash as an efficient adsorbent. Initial steps involved the collection of representative POME samples from a local palm oil mill, subject to comprehensive characterization to establish baseline color content, chemical oxygen demand (COD), and other pertinent parameters. Simultaneously, coal bottom ash, a byproduct of coal combustion, underwent a carefully designed treatment process to enhance its adsorption capabilities, including washing, drying, and activation, ensuring the suitability of the material for effective POME decolourisation.

The heart of the investigation lay in optimizing key adsorption parameters for enhanced efficiency. Batch adsorption experiments were meticulously conducted, varying adsorbent dosage, contact time, and pH levels to systematically evaluate their influence on the decolourisation process. Different concentrations of treated coal bottom ash were introduced to POME samples, and the mixtures were agitated under controlled conditions. This iterative process allowed for a nuanced understanding of the interplay between adsorbent characteristics and optimal conditions for colorant removal.

Decolourisation efficiency was assessed by monitoring color removal at specific time intervals using a spectrophotometer, while the adsorption isotherms and kinetics were analyzed to determine the adsorption capacity and rate of colorant removal by treated coal bottom ash. Post-decolourisation, the treated POME samples underwent thorough characterization to assess changes in COD, suspended solids, and residual color, validating the effectiveness of the treatment process.

The methodology also incorporated statistical analyses, including regression analysis and analysis of variance (ANOVA), to interpret the relationships between the optimized parameters and decolourisation efficiency. This statistical insight provided a robust foundation for understanding the significance of each parameter in enhancing the performance of treated coal bottom ash in the decolourisation of POME.

This comprehensive and systematic approach aimed to contribute not only to the efficiency of POME decolourisation but also to the broader goal of sustainable wastewater treatment within the palm oil industry. The utilization of treated coal bottom ash offers a promising avenue for addressing environmental concerns associated with POME, paving the way for more environmentally conscious practices in the treatment of palm oil mill effluent.

Collection and Characterization of POME:

Palm Oil Mill Effluent (POME) samples were collected from a local palm oil mill and characterized for initial color content, chemical oxygen demand (COD), and other relevant parameters. This baseline characterization served as a reference for evaluating the efficiency of the decolourisation process.

Preparation of Treated Coal Bottom Ash:

Coal bottom ash, obtained as a byproduct of coal combustion, underwent a tailored treatment process to enhance its adsorption properties. This involved washing, drying, and activating the ash through a controlled procedure. The treated coal bottom ash was then characterized for surface properties and porosity to ensure its suitability as an effective adsorbent.

Optimization of Adsorption Parameters:

A series of batch adsorption experiments were conducted to optimize key parameters influencing the decolourisation efficiency. These parameters included adsorbent dosage, contact time, and pH. Various concentrations of treated coal bottom ash were introduced to POME samples, and the mixtures were agitated under controlled conditions. The impact of different contact times and pH levels on decolourisation efficiency was systematically examined.

Decolourisation Efficiency Assessment:

The efficiency of the decolourisation process was evaluated by monitoring the color removal at specific time intervals using a spectrophotometer. The adsorption isotherms and kinetics were analyzed to understand the adsorption capacity and the rate of colorant removal by treated coal bottom ash.

Characterization of Treated POME:

Post-decolourisation, the treated POME samples were characterized to assess changes in COD, suspended solids, and residual color. The effectiveness of the treatment process was verified through comparisons with pre-treatment parameters.

Statistical Analysis:

Statistical analyses, including regression analysis and analysis of variance (ANOVA), were employed to interpret the relationships between the optimized parameters and decolourisation efficiency. This provided insights into the significance of each parameter in enhancing the treated coal bottom ash's performance in POME decolourisation.

This comprehensive methodology aimed to systematically optimize the decolourisation process of POME using treated coal bottom ash. By investigating the influence of key adsorption parameters, the study sought to enhance the efficiency of colorant removal and contribute to sustainable practices in the treatment of palm oil mill effluent.

RESULTS

The optimization of Palm Oil Mill Effluent (POME) decolourisation using treated coal bottom ash yielded promising results. The batch adsorption experiments, varying adsorbent dosage, contact time, and pH, demonstrated substantial improvements in the decolourisation efficiency. Spectrophotometric analysis revealed a notable reduction in color content over specific time intervals. The adsorption isotherms and kinetics analyses provided insights into the adsorption capacity and the rate of colorant removal by the treated coal bottom ash.

DISCUSSION

The results underscore the significance of each optimized parameter in enhancing the efficiency of treated coal bottom ash in POME decolourisation. The variation in adsorbent dosage exhibited a clear influence on color removal, with an optimal dosage maximizing the decolourisation efficiency. The impact of contact time on colorant removal highlighted the kinetics of the adsorption process, revealing a rapid initial removal followed by a gradual approach toward equilibrium. pH optimization demonstrated that the treatment efficiency was influenced by the solution's acidity or alkalinity, emphasizing the need for careful control of environmental conditions.

The treated coal bottom ash, owing to its enhanced adsorption capabilities, effectively interacted with colorants present in POME, leading to a substantial reduction in color content. Statistical analyses, including regression analysis and ANOVA, corroborated the significance of the optimized parameters in influencing the treated coal bottom ash's performance, providing a robust statistical foundation for the observed trends.

CONCLUSION

In conclusion, the optimization of POME decolourisation using treated coal bottom ash proves to be a viable and efficient strategy. The tailored treatment process significantly enhanced the adsorption capacity of coal bottom ash, resulting in improved color removal from POME. The systematic investigation of adsorbent dosage, contact time, and pH levels provided valuable insights into the interplay of these parameters, allowing for the identification of optimal conditions for enhanced efficiency.

This study contributes to sustainable practices in the palm oil industry by offering an effective and environmentally conscious approach to POME treatment. Treated coal bottom ash emerges as a promising adsorbent for mitigating the environmental impact of POME, aligning with the industry's commitment to responsible and eco-friendly practices. The optimized process provides a foundation for future advancements in the field of wastewater treatment, demonstrating the potential for enhancing the efficiency of decolourisation processes in industries grappling with complex effluents.

REFERENCES

1. Ratpukdi, T. (2012). Decolorization of anaerobically treated palm oil mill wastewater using combined coagulation and vacuum ultraviolet-hydrogen peroxide. Int. J. Chem. Eng. Appl., 3(5), 333-336,
2. Limkhuansuwan, V. & Chaiprasert, P. (2010). Decolorization of molasses melanoidins and palm oil mill effluent phenolic compounds by fermentative lactic acid bacteria. J. Environ. Sci., 22(8), 1209-1217,
3. Ng, F. Y. et al. (2011). A renewable future driven with Malaysian palm oil-based green technology. J. Oil Palm Res., 2, 1-7.
4. Wu, T. Y. et al. (2010). Pollution control technologies for the treatment of palm oil mill effluent (POME) through end-of-pipe processes. J. Environ. Manage., 91(7), 1467-1490,
5. Neoh, C. H. et al. (2013). Optimization of decolourization of palm oil mill effluent (POME) by growing cultures of Aspergillus fumigatus using response surface methodology. Environ. Sci. Pollut. Res., 20, 2912-2923,
6. Zahrim, A. Y., Nasimah, A. & Hilal, N. (2014). Pollutants analysis during conventional palm oil mill effluent (POME) ponding system and decolourisation of anaerobically treated POME via calcium lactate-polyacrylamide. J. Water Process Eng., 4, 159-165,
7. Amat, N. A. A. et al. (2015). Tackling colour issue of anaerobically-treated palm oil mill effluent using membrane technology. J. Water Process Eng., 8, 221-226,
8. Subramaniam, M. N. et al. (2017). Hydrophilic hollow fiber PVDF ultrafiltration membrane incorporated with titanate nanotubes for decolourization of aerobically- treated palm oil mill effluent. Chem. Eng. J., 316, 101-110,
9. Elmi, H. S. A., Nor, M. H. M. & Ibrahim, Z. (2015). Colour and COD removal from palm oil mill effluent (POME) using Pseudomonas aeruginosa strain NCIM 5223 in microbial fuel cell. Int. J. Waste Manage., 5(3), 1-3,
10. Bashir, M. J. K. et al. (2017). Electro persulphate oxidation for polishing of biologically treated palm oil mill effluent (POME). J. Environ. Manage., 193, 458-469,