OBTAINING A LIGNIN-SILICA COMPOSITE FROM RICE HUSK AND INVESTIGATING ITS ADSORPTION PROPERTIES

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Relevance

The processing of agricultural waste (specifically rice husks) to produce high-value functional materials is a priority area within green chemistry and the circular economy. The natural presenc of a cellulose, hemicellulose, lignin, and silicon dioxide (SiO2) complex in rice husks provides a vast raw material base for the cost-effective production of lignocellulosic composites. Utilizing these composites in modern technologies—particularly as effective sorbents for wastewater treatment and in environmentally friendly battery manufacturing and recycling processes—is a matter of significant importance.

Research Objective

To develop an efficient technology for producing a lignino-silica composite based on the natural components inherent in rice husks (SiO_2, hemicellulose, and lignin)—without the use of external chemical reagents—and to investigate its adsorption properties.Materiallar va usullar (Sintez jarayoni)

No additional silica-containing reagents (such as sodium silicate) were used in the study. The synthesis was based on literature data indicating a 1:1 ratio of lignin to SiO2 in rice husks. The composite synthesis was carried out in the following sequence: Dissolution (Extraction) stage: Prepared rice husks (the initial raw material) were placed in a 10% sodium hydroxide (NaOH) solution. The resulting mixture was heated and boiled for 2 hours at 90–100°C under constant mechanical stirring. During this process, the lignin and silicon dioxide (SiO2) present in the husks passed into the solution within the alkaline medium. Acid treatment and titration: The dark brown solution resulting from the boiling process was carefully titrated to a pH of 2–3 using a 2 M hydrochloric acid (HCl) solution. Under the influence of the acid, the dissolved silicates and lignin macromolecules co-precipitated.Separation and purification: The resulting precipitate mixture was separated from the liquid phase via centrifugation. The obtained solid phase was washed repeatedly with distilled water until neutrality was reached, dried, and set aside for further analysis. It was determined that the resulting lignin-silica composite adsorbed 97.5 mg/g of Ni(II) ions during sorption studies. This indicates the potential of the composite to serve as a biosorbent. Spectroscopic and morphological analysis: FTIR spectroscopy revealed the formation of hydrogen bonds between the silanol (Si–OH) groups of the silica and the biopolymers Adsorption properties: Due to its high surface area and active sites, the resulting lignino-silica composite serves as an effective adsorbent for capturing heavy metal ions from wastewater and for applications in battery technologies (such as waste recycling and ion-exchange processes).

Conclusion

The technology for producing a lignocellulosic composite from rice husks—utilizing direct alkaline extraction and acid titration (with centrifugation) without the need for

additional reagents—is distinguished by its cost-effectiveness and environmental safety. The resulting hybrid material holds great potential for widespread application as an inexpensive and efficient adsorbent in addressing various environmental issues.

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