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Opinion

Practical Significance of Biomass Regeneration Metal Adsorbent

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Opinion

The practical significance of biomass-based regenerative metal adsorbents lies in their provision of an economical, efficient, and environmentally friendly solution for managing heavy metal pollution in industrial wastewater. These adsorbents are typically derived from abundant agricultural and forestry waste, modified through chemical reactions and graft copolymerization techniques such as 60Co-γ irradiation initiation, to attach monomers like acrylamide and acrylic acid onto cellulose and other biomasses [1]. This approach not only reduces the environmental burden of waste but also achieves the recycling of resources, aligning with the concept of a circular economy. In practical applications, these adsorbents demonstrate strong adsorption capabilities for heavy metals like lead, copper, and zinc, operate effectively over a broad pH range, and exhibit good regeneration performance and reusability, which are crucial for reducing wastewater treatment costs and enhancing treatment efficiency [2,3]. Moreover, the biodegradability of these adsorbents minimizes the risk of long-term environmental pollution, adhering to the principles of green chemistry and sustainable development. These research outcomes not only drive the advancement of environmental protection technologies but also provide new directions for scientific research across various fields, contributing to the formation of new environmental material industries and promoting international cooperation and policy support [3]. Additionally, they raise public awareness about heavy metal pollution issues and motivate more individuals to engage in environmental protection actions, thus playing a significant role in environmental conservation and resource recycling.

The importance of biomass recycled materials in the treatment of heavy metal wastewater cannot be ignored. Not only do these materials provide a cost-effective solution to remove or recycle heavy metals from wastewater, but their application also helps to reduce the burden of industrial activities on the environment. The renewability and biodegradability of biomass regenerated materials reduce the reliance on traditional adsorbents, which can be costly and environmentally harmful [4]. By using agricultural and forestry waste, biomass regenerated materials promote waste recycling and reduce the need for landfills and incineration, thereby reducing greenhouse gas emissions and environmental pollution. In addition, the highly efficient adsorption properties of these materials reduce the pollution of heavy metals to water bodies, protecting aquatic ecosystems and human health. Pehlivan et al. [5] thermochemically modified barley straw with citric acid to prepare a novel biological adsorbent for the removal of copper ions from aqueous solutions. The experimental results show that the modified barley straw (CA-BS) has a significantly enhanced adsorption capacity for copper ions, and its equilibrium adsorption capacity reaches 31.71mg/g, which is much higher than that of unmodified barley straw (4.64mg/g). At an optimal pH value of 7.0, CA-BS has a removal efficiency of 88.1% for copper ions, showing its potential as an efficient and lowcost heavy metal adsorbent. therefore, the application of biomass recycled materials in the treatment of heavy metal wastewater not only contributes to the achievement of environmental protection goals, but also is a key step in promoting sustainable industrial development and green chemistry practices.

Furthermore, the application of biomass-based adsorbents also enhances the flexibility and adaptability of industrial wastewater treatment. Due to their customizable characteristics, the chemical structure and physical form of the adsorbents can be adjusted to achieve efficient adsorption of specific heavy metal ions, based on the composition of the wastewater and treatment requirements [6]. This targeted design gives biomass adsorbents potential application value across various industrial scenarios, including electronics manufacturing, mining, electroplating, and chemical industries. The research and application of biomass adsorbents also foster interdisciplinary collaboration, involving fields such as materials science, environmental engineering, and chemical engineering [6,7]. This cross-disciplinary cooperation not only propels the development of new technologies but also presents researchers with new opportunities and challenges [8]. As global attention to environmental protection and sustainable development continues to grow, research on biomass adsorbents is expected to garner more attention and investment, further driving technological progress and innovation.

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