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Adsorption and desorption processes of toxic heavy metals, regeneration and reusability of spent adsorbents: Economic and environmental sustainability approach

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Abstract

A growing number of variables, including rising population, water scarcity, growth in the economy, and the existence of harmful heavy metals in the water supply, are contributing to the increased demand for wastewater treatment on a global scale. One of the innovative water treatment technologies is the adsorptive removal of heavy metals through the application of natural and engineered adsorbents. However, adsorption currently has setbacks that prevent its wider application for heavy metals sequestration from aquatic environments using various adsorbents, including difficulty in selecting suitable desorption eluent to recover adsorbed heavy metals and regeneration techniques to recycle the spent adsorbents for further use and safe disposal. Therefore, the recovery of adsorbed heavy metal ions and the ability to reuse the spent adsorbents is one of the economic and environmental sustainability approaches. This study presents a state-of-the-art critical review of different desorption agents that could be used to retrieve heavy metals and regenerate the spent adsorbents for further adsorption-desorption processes. Additionally, an attempt was made to discuss and summarize some of the independent factors influencing heavy metals desorption, recovery, and adsorbent regeneration. Furthermore, isotherm and kinetic modeling have been summarized to provide insights into the adsorption-desorption mechanisms of heavy metals. Finally, the review provided future perspectives to provide room for researchers and industry players who are interested in heavy metals desorption, recovery, and spent adsorbents recycling to reduce the high cost of adsorbents reproduction, minimize secondary waste generation, and thereby provide substantial economic and environmental benefits..