Sorbroot: Adsorption of Heavy Metals From Water Using a Humic-Like Functional Groups Containing Sorbent Derived From Plastic

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Every year, approximately 400 million tons of plastic are produced worldwide, yet only 9% is recycled. Meanwhile, heavy metal contamination of water poses significant risks to human health, while nearly one-third of arable soils lack essential metal ions, creating additional environmental challenges. This project addresses these interconnected issues by converting plastic waste into an effective sorbent for water purification. Oxidative pyrolysis of polyethylene terephthalate (PET) bottles produced a carbon-based residue with sorption properties. Infrared (IR) spectroscopy confirmed that the material consists of humic-like functional fragments. The synthesized sorbent demonstrated the ability to adsorb Cu2+, Pb2+, Zn2+, Mg2+, and Ca2+ ions. Optimal conditions were identified as pH 6.0, a temperature of 40 °C, and a contact time of 2 hours. The sorbent was tested in both vertical tower and sequential batch systems, with a continuous batch tower selected as the most effective configuration. Qualitative analysis was conducted using visual methods, while quantitative evaluation was performed using atomic absorption spectroscopy (AAS) and X-ray fluorescence (XRF). The results showed significant removal efficiencies: Zn2+ decreased by 82.7%, Cu2+ by 67.7%. Additionally, the sorbent improved water quality by reducing carbonate hardness, eliminating synthetic surfactants, and decreasing chloride and residual chlorine levels. However, molybdate ion adsorption showed no significant improvement. To overcome this, sodium alginate was added to the sorbent. This modification improved adsorption efficiency by the sorbent molybdate complex, resulting in enhanced molybdate binding. This approach establishes a pathway: plastic waste -> sorbent -> water purification.

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