Waste activated sludge valorisation derived resource recovery and environmental remediation

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Abstract:

Global concerns over waste management and resource recovery have driven growing interest in valorising waste activated sludge (WAS) to synthesise functional environmental materials. WAS, a typical byproduct of wastewater treatment plants, contains high moisture and easily degradable organics, making its post-treatment both challenging and energy-intensive. Nevertheless, its abundant organic matter, diverse inorganic components, and potential phosphorus sink render it a promising precursor for material synthesis and resource recovery.

In this study, we propose two valorisation pathways to convert WAS into materials for environmental catalysis and energy storage, respectively. (1) Catalyst synthesis: Silicon, aluminum, iron, and sulfur were selectively recovered from WAS incineration ash and fabricated into an S-doped Fe@zeolite catalyst. The Fe2+ sites in the catalyst can activate peroxides to generate reactive oxygen species, effectively degrading various emerging contaminants. The doped S forms chemical bonds with Fe2+, facilitating electrochemical performance, Fe2+ regeneration and retention in the catalyst, thereby significantly enhancing its catalytic capacity and durability. (2) Energy storage material alternative: Hydrothermal treatment reduces Fe3+ into Fe2+ by consuming organic matter in WAS, yielding vivianite-carbon composite. This composite can further react with LiOH to form LiFePO4, a widely used energy storage material for lithium-ion batteries. The residual carbon material can finally act as conductive agent to improve the poor ionic and electronic conductivity within LiFePO4.

Overall, the volarisation of WAS achieves dual achievements in resource recovery and environmental remediation, offering a sustainable strategy for circular economic applications.