

Abstract

RECYCLING OF ERDITE AND KFeS_2 FROM WASTE SLUDGE AS FUNCTIONAL MATERIALS FOR ENVIRONMENTAL PROTECTION

DOI: 10.5937/EcoTER26642J

Student: Aleksandra Jović¹

Mentor: Maja Nujkić^{1*,a}

¹University of Belgrade, Technical Faculty in Bor, Vojske Jugoslavije 12, 19210 Bor, SERBIA

^a <https://orcid.org/0000-0002-6110-5135>

Abstract

In the context of rapid urbanization and industrial development, sludge management has become a major environmental protection challenge. Traditional sludge disposal methods, such as landfilling and incineration, pose risks of secondary contamination to soil, water, and air, as well as the loss of potentially valuable resources contained in sludge. As a result, modern sludge management increasingly relies on the principles of sustainable development and the circular economy, which promote waste recycling and its conversion into useful products and energy.

This paper analyzes the composition of municipal and industrial sludge, with particular emphasis on iron-rich sludge generated during water treatment, electroplating, and metallurgical processes. Special attention is given to sludge purification and recycling methods, including calcination, hydrothermal treatment, Fenton oxidation, gasification, and anaerobic digestion. These methods enable waste reduction, energy recovery, and the production of functional materials with broad applications in environmental protection.

The main focus of the paper is the synthesis of erdite and KFeS_2 from iron-rich sludge. These Fe–S functional materials exhibit significant adsorption and catalytic properties due to their specific structure and large number of active surface groups. Hydrothermal synthesis enables the transformation of Fe oxides from sludge into nanostructured materials capable of efficiently removing organic pollutants, antibiotics, and heavy metals from wastewater. Research results indicate that the synthesized materials achieve high pollutant removal efficiency, transforming waste sludge into a valuable secondary raw material for the production of adsorbents and catalysts.

The paper also highlights the importance of modernizing wastewater treatment plants and implementing waste-to-energy technologies such as anaerobic digestion, incineration, and gasification. Integrating these technologies can reduce waste quantities, improve energy efficiency, and contribute to sustainable resource management. The paper concludes that recycling sludge into functional materials is an environmentally and economically justified solution that reduces pollution and advances circular economy principles.

*mnujkic@tfbor.bg.ac.rs

Keywords: waste sludge, recycling, erdite, KFeS_2 , functional materials, environmental protection, circular economy.

ACKNOWLEDGEMENT

The authors are grateful to the Ministry of Science, Technological Development and Innovation of the Republic of Serbia for financial support according to the contract with registration No. 451-03-34/2026-03/ 200131.

REFERENCES

1. Chen, X., Liu, Y., Wang, Z., *et al.* J Hazard. Mater. 2022, 430, 128412–128425.
2. Hu, Y., Zhang, L., Li, X., *et al.* J. Clean Prod. 2020, 258, 120715–120724.
3. Kiselev, A., Magaril, E., Rada, E.C., *et al.* Sustainability. 2020, 12(18), 7451–7465.
4. Olasupo, A.O., Ramphal, S.R., Maboeta, M.S., *et al.* Environ. Pollut. 2026, 345, 122345–122360.
5. Tyagi, V.K., Lo, S.L. Renew. Sustain. Energy Rev. 2013, 25, 708–728.