HARNESSING SEWAGE SLUDGE TO REMOVE HIGH ORGANIC LOADS THROUGH BIOSORPTION

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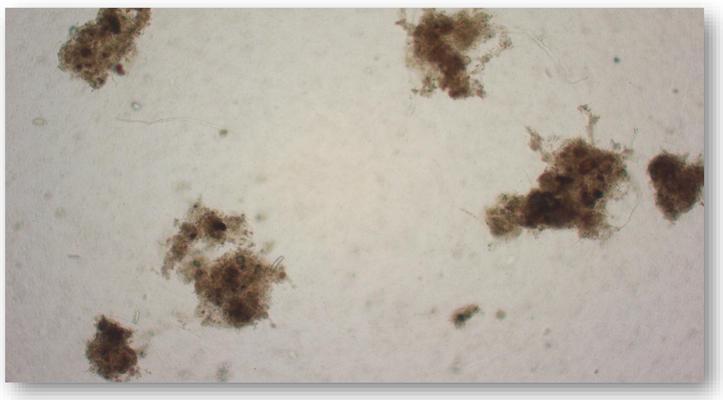
21 Ružičkini dani
DANAS ZNANOST – SUTRA INDUSTRIJA
9. – 11. rujna 2026. • Vukovar • Hrvatska

Biosorption is a physicochemical process in which pollutants bind to biological materials, enabling biomass to be used as a natural, accessible and environmentally friendly biosorbent. Due to the presence of diverse functional groups, EPS and porous floc structures, biomass interacts with contaminants through adsorption, ion exchange and complexation. Highly loaded wastewater, particularly leachate from waste management systems, contains very high concentrations of organic matter and therefore requires efficient, sustainable and resource-oriented treatment approaches capable of operating under extreme pollutant loads.

This study investigates the valorisation of sewage sludge as a biosorbent for the removal of organic pollution from leachate with an initial chemical oxygen demand of 12,868 mg O_2/L. Biosorption was tested at sludge concentrations ranging from 1 to 6 g/L. The maximum removal efficiency achieved was 30.0%, and the biosorption capacity of the activated sludge was 649 mg/g, confirming the strong biosorption potential of sludge due to its floc structure, active EPS matrix and diverse functional groups. The Temkin isotherm model provided the most accurate description of biosorption equilibrium (F = 0.971). Its good fit reflects the heterogeneous nature of activated sludge and the variable energy distribution of sorption sites.

LEACHATE

SEWAGE SLUDGE



BIOSORBENT

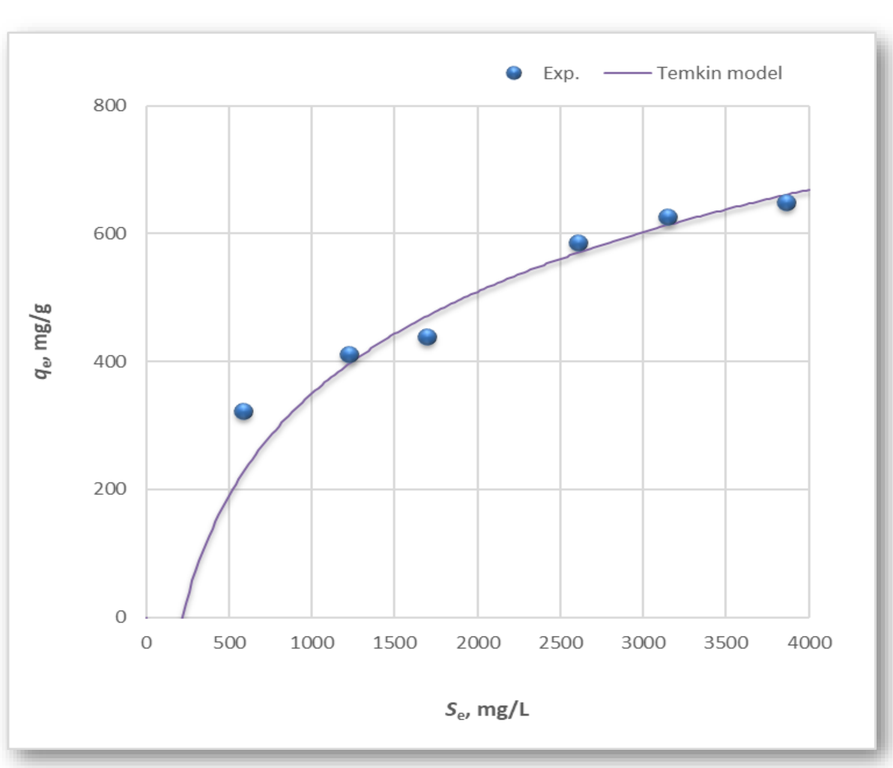
RESULTS OF BIOSORPTION

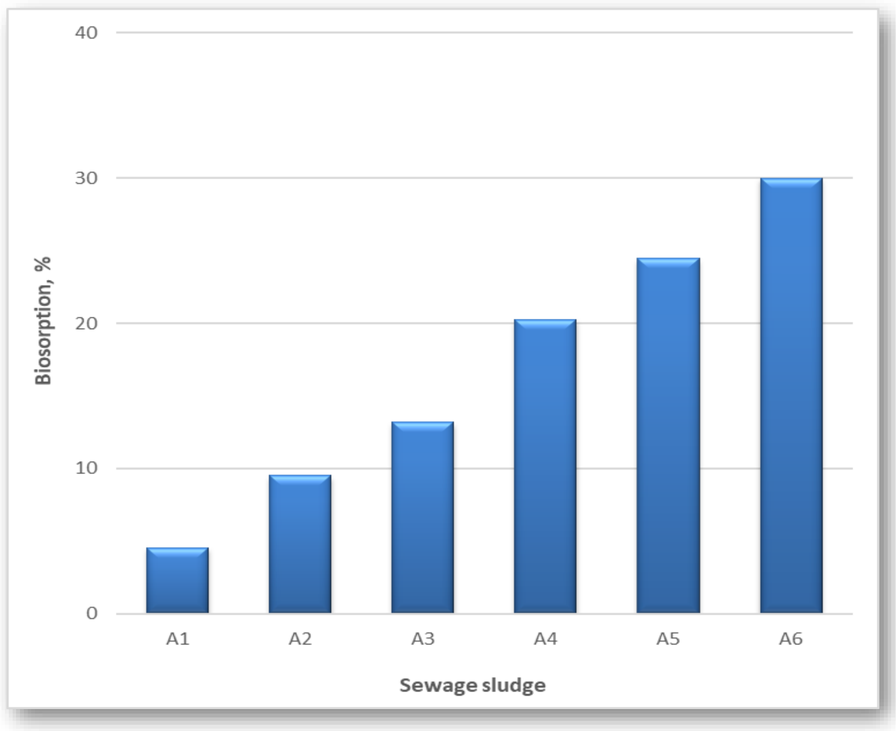
TS, g/L	10.25
VS/TS, -	0.802
COD, mg O_2/L	12868
BOD_5/COD, -	0.664
pH, -	4.74
DO, mg O_2/L	1.96
EV, mS/cm^3	3,19
CFU (bacteria), st/mL	3,4×10^6
CFU (fungi), st/mL	4,5×10^3

Samples #	Sewage sludge g/L
A1	1,81
A2	2,98
A3	3,86
A4	4,45
A5	5,03
A6	5,95

ESTIMATED MODEL PARAMETERS

B_T, -	10,8
A_T, L/g	1,7
F-test, -	0,971





Using sludge as a biosorbent supports circular-economy principles by repurposing a readily available treatment by-product. Overall, the results demonstrate that sewage sludge is a promising and resource-efficient biosorbent for highly contaminated leachate. These findings highlight the potential of sludge-based biosorbents to enhance sustainable wastewater management strategies for heavily polluted effluents.