MODERN ADSORBENTS FOR HEAVY METALS CAPTURED FROM WASTEWATER INTO THE CIRCULAR ECONOMY

Adina-Elena Segneanu[1], Melinda Cepan[2] Claudiu Cepan[2], Maria Mihailescu[2], Marin Catalin[3], Ioan Grozescu[2]

[1] *Institute for Advanced Environmental Research-West University of Timisoara (ICAM-WUT)* Oituz nr. 4, Timișoara, Romania
[2] *Politehnica University of Timisoara, Piața Victoriei 2, 300006 Timișoara, Romania*
[3] *West University of Timisoara, Blvd.V. Parvan 4, 300223, Timisoara, Romania*
e-mail: adina.segneanu@e-uvt.ro

Abstract
Intensive industrialization as a requirement of the development of modern society has harmed the environment with severe repercussions on biodiversity, human health and food security. Special efforts are made to set highly effective methods for environmental remediation in the circular economy.

Introduction
Heavy metal pollution of industrial effluents is one of the main problems recognized at the global level. There are several techniques for decontamination with heavy metals: chemical, electrochemical, membrane separation, ion exchange, reverse osmosis, electrodialysis, and adsorption. The implementation of a method at an industrial level requires several requirements: high performance, ease of operation, and economic efficiency. And many of these methods of removing heavy metals are expensive and, in addition, generate secondary products that require additional steps of decontamination and subsequent storage.
Adsorption is considered the most advantageous method of removing heavy metals in terms of cost and efficiency. Many adsorbents are known: as natural or synthesized. Recent research is focused on testing waste from the food industry or agriculture as adsorbents for various heavy metals removal from wastewater.
The mixed research team composed of researchers from the Western University of Timisoara and the Politehnica University of Timisoara are engaged in research studies aimed at the valorization of some biowaste and industrial waste for the preparation of new engineered adsorbents with high performance for removing heavy metals from wastewater.

Experimental
Regardless of its nature, the waste is subjected to an appropriate heat treatment to avoid altering the adsorption properties, followed by a micronisation stage. Different techniques were used to characterized the new adsorbents: nitrogen adsorption-desorption isotherms, FTIR spectroscopy, XRD spectroscopy, microscopy SEM coupled with EDX.
The heavy metal initial and final concentration were determinate through atomic absorption spectroscopy.

Results and discussion
The results obtained in the characterization of the physico-chemical properties of the new prepared materials showed that a substantial increase in surface area and pore size was achieved.

The effect of different parameters like temperature, pH, contact time, adsorbent dosage, and initial and final concentration on the adsorption rate of the new materials prepared was systematically investigated. The adsorption behavior of the new adsorbents was investigated using adsorption isotherm, kinetic, thermodynamic and desorption studies, and adsorption mechanism.
Studies of the adsorption process have demonstrated an increase in the adsorption performance compared to the adsorption capacity of each waste.
In addition, the feasibility of adsorbents was demonstrated by remediating heavy metal-contaminated soil sludge samples.

Conclusion

The results of our studies have shown that reusing waste can be used to obtain ecological, low-cost and high-performance materials for the sustainable management of wastewater and waste.

References

[1] WHO (World Health Organization), Health through safe drinking water and basic sanitation; http://www.who.int/water_sanitation_health/mdg1/en/index.html (2008).
[2] P. Ghisellini, C. Cialani, S. Ulgiati, A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean Prod. 114, (2016) 11–32;
[3] R.K., Gautam, S.K. Sharma, S. Mahiya, C. Chattopadhyaya Mahesh, Major contaminants in industrial and domestic wastewater a contamination of heavy metals in aquatic media: transport, toxicity and technologies for remediation, Heavy Metals in Water: Presence, Removal and Safety (ed. Sharma S.K.) (The Royal Society of Chemistry, 2015).
[4] Fernández-Reyes B., Ortiz-Martínez K., Lasalde-Ramírez J.A., Hernández-Maldonado A.J., Engineered adsorbents for the removal of contaminants of emerging concern from water. Contaminants of Emerging Concern in Water and Wastewater: (2020) 3–45.
[5] Qasem N.A.A., Mohammed R.H., Lawal D.U., Removal of heavy metal ions from wastewater: a comprehensive and critical review. npj Clean Water 4 (2021) 36.
[6] Segneanu, AE., Marin, C.N., Vlase, G. *et* al, Highly efficient engineered waste eggshell-fly ash for cadmium removal from aqueous solution, Scientific Reports,, 12 (2022) 9676.
[7] Cepan C, Segneanu A-E, Grad O, Mihailescu M, Cepan M, Grozescu I., Assessment of the different type of materials used for removing phosphorus from wastewater, Materials,14(16) (2021) 4371