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APPLICATION OF ADSORPTION MATRICES CONSISTING OF MIXED BIOMASS RESULTING FROM WASTEWATER TREATMENT PROCESSES FOR THE REMOVAL OF ZINC AND NICKEL METALS

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ABSTRACT

The decontamination of heavy metals from industrial wastewater, especially from sources like galvanization processes, has posed significant challenges over the years. Conventional methods, though effective, often come with limitations due to their high costs and complex operations. Consequently, biosorption has emerged as a promising alternative, utilizing microorganisms like bacteria and microalgae as biosorbents. These microorganisms are advantageous because of their high surface-to-volume ratio, rapid adsorption and desorption kinetics, and cost-effectiveness.

This research evaluated the efficiency of microalgae-bacteria biomass waste from municipal wastewater treatment, repurposed into polymer-based granular materials, as adsorbents for removing zinc and nickel ions. The study was conducted in two phases: in the preliminary phase, granulated adsorbent materials were developed and tested to determine the required biosorbent concentration for targeted heavy metal removal. These granules, created by mixing sodium alginate with ground biomass (in a 9:1 ratio) and dripping the mixture into a 2% $CaCl_2$ solution, had a compact structure and a diameter of approximately 4-6 mm. Additionally, raw biomass waste was tested as a comparative baseline.

Subsequent experiments focused on identifying the optimal pH and adsorption isotherm. Both zinc and nickel achieved the highest removal efficiencies at pH 4. Initial metal concentrations ranged from 5-60 mg/L for zinc and 5-30 mg/L for nickel, with removal efficiencies varying between 30% and 90%, depending on the metal concentration and adsorbent type: granular *vs.* suspended biomass. The Langmuir adsorption isotherm model revealed a strong correlation between metal concentration and adsorption capacity, with maximum adsorption capacities of 16.39 mg Zn/g adsorbent material and 11.715 mg Ni/g adsorbent material for nickel. Tests using biomass in suspension demonstrated lower adsorption capacities, underscoring the advantages of the granular structure, increased contact surface area, and the role of sodium alginate in enhancing biosorption efficacy.

KEYWORDS

Biosorption; adsorption; heavy metals; wastewater; bacteria; microalgae

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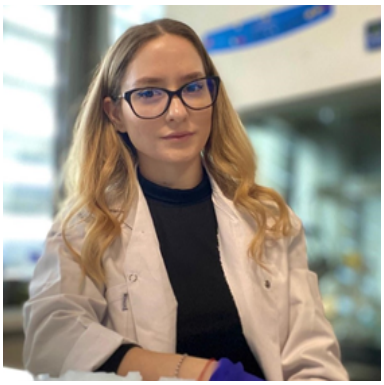

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BIOGRAPHY

Tatiana Buse - Scientific Research Assistant at the National Institute for Research and Development for Industrial Ecology - ECOIND (Romania) involved in the implementation of research activities addressed to the microalgae biotechnology field (microalgae-based wastewater treatment, microalgae biomass assessment for valuable compounds, harnessing of the microalgae biomass and microalgae-based waste for the production of bioproducts); from this year I am enrolled in doctoral studies in the field of Environmental Engineering organized by the Doctoral School of Biotechnical Systems within the National University of Science and Technology Politehnica Bucharest, with the theme "Obtaining adsorbent materials by valorizing the resulting waste from sustainable wastewater treatment processes through the microalgae-bacteria granular system".

ORGANIZATION PROFILE

The National Research and Development Institute for Industrial Ecology - ECOIND is a leading Romanian public research institute, renowned for its multidisciplinary expertise in environmental protection and innovation, committed to addressing complex environmental challenges and providing sustainable solutions. With a team of around 150 scientists, ECOIND is organized into four key departments specializing in pollution control, environmental impact assessment, technologies and biotechnologies, and environmental monitoring. The Institute's expertise covers a wide range of environmental issues, including air, water, soil and waste pollution control, ecotoxicological studies, biological remediation and consultancy services. In addition, ECOIND conducts specialized research in odour assessment, bioassays and biological conversion of organic waste. The institute has also a strong portfolio of more than 55 patents and patents requests and is the author of around 600 scientific articles published in national and international journals.