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Removal of lead (II) from aqueous solution using low cost abundantly available adsorbents: A review

Manish Singh Rajput, Ashok K Sharma, Sarita Sharma, Sanjay Verma

Abstract

Lead is known to be very toxic for human body system i.e. nervous, digestive and skeleton system even if it is present in low levels. Today's demand for safe, eco-friendly, easily available and low cost adsorbents for the removal of Lead from contaminated water has necessitated research interest towards the production of low cost alternatives that is why it is an urgent that all possible sources. This review gives some outlines of basic principles of adsorption and adsorption process.

Keywords: Lead; Aqueous solution; Low cost adsorbents; Adsorption.

1. Introduction

Lead is one of the heavy metals that are often found in industrial wastewater and its discharge into the environment poses a serious threat due to its toxicity to aquatic and terrestrial lives.^[1] It is a group IV element on the periodic table which is remarkably highly resistant to corrosion in most acid and naturally occur as element buried in the earth crust in insoluble and biologically inoffensive forms.^[2] Enhanced industrialization such as manufacturing of storage batteries, television tube, printing paints, pigments, photographic materials, gasoline additives, matches and explosives brought about lead bearing wastewater.^[3] Exposure to Lead is widely recognized as a major risk factor for several human diseases once it goes beyond the World Health Organisation (WHO) maximum permissible limit ($3-10 \mu\text{g}\cdot\text{L}^{-1}$) in drinking water.^[4] It forms complexes with Oxo-groups in enzymes to affect virtually all steps in the process of haemoglobin synthesis and porphyrin metabolism.^[5] Other problems associated with toxic levels of lead exposure are encephalopathy, seizures and mental retardation, anemia and nephropathy.^[6-8] Hence, lead must be removed as much as possible from industrial effluents to prevent environmental hazard from its discharge. Adsorption technology has been widely preferred to other traditional methods such as coagulation, flocculation, filtration, ozonation or sedimentation in the removal of pollutants from wastewater.^[9] In this technology, activated carbons are commonly used adsorbent due to their high adsorption capacity, a result of their high surface area and surface reactivity but their regeneration is, however, difficult and expensive.^[10] Quest for effective and economical technologies have brought about biosorption. It is based on metal binding capacities of various biological materials, mainly composed of cellulose, hemicelluloses and lignin that make them effective adsorbents for a wide range of pollutants due to the presence of functional groups such as hydroxyl, carboxyl, methoxyl and phenols.^[11] Recent studies have shown that heavy metals can be removed using plant materials such as empty palm oil fruit bunch^[12], sour soup seeds^[13], modified casava fibre^[14], coconut shell^[15], duck weed^[16], sugo waste^[17], African spinach stalk^[18], palm fruit fibre^[19], hop^[20], orange peels^[21] and spent tea leaves.^[19,22] Banana Stalks (BS) are generated in large amount as waste product after the consumption of banana and these constitute an environmental menace due to the fact that they are left to decompose being of non-economic importance.^[23] However, BS is a rich ligno-cellulosic agricultural waste, whose previous application has been limited to the production of activated carbon for malachite green dye removal^[24] and not yet applied to Pb(II) removal.^[25] The present study investigated the adsorptive capacity of BS as a low-cost adsorbent for the biosorption of Lead(II) from aqueous solution. The effects of physical parameters such as initial concentration, pH, and temperature and bio-adsorbent dosage on the biosorption process have been investigated. In addition, the biosorption equilibrium isotherms, kinetics and thermodynamic parameters have been determined.

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Commeiras, Kuwat Triyana, Indriana
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Proceedings of the International Conference on Systems, Science, Control, Communication, Engineering and Technology 2015 Kokula Krishna Hari K, Keerthivasan M, D Bhanu, 2015-08-10 ICSSCET 2015 will be the most comprehensive conference focused on the various aspects of advances in Systems Science Management Medical Sciences Communication Engineering Technology Interdisciplinary Research Theory and Technology This Conference provides a chance for academic and industry professionals to discuss recent progress in the area of Interdisciplinary Research Theory and Technology Furthermore we expect that the conference and its publications will be a trigger for further related research and technology improvements in this important subject The goal of this conference is to bring together the researchers from academia and industry as well as practitioners to share ideas problems and solutions relating to the multifaceted aspects of Interdisciplinary Research Theory and Technology

Lead Toxicity Mitigation: Sustainable Nexus Approaches Nitish Kumar, Amrit Kumar Jha, 2024-01-01 This edited book brings together a diverse group of researchers to address the challenges posed by global mass poisoning caused by lead contamination of soil and plants Lead is among the elements that have been most extensively used by man over time This has led to extensive pollution of surface soils on the local scale mainly associated with mining and smelting of the metal and addition of organic lead compounds to petrol Release of lead to the atmosphere from various high temperature processes has led to surface contamination on the regional and even global scale Lead is particularly strongly bound to humic matter in organic rich soil and to iron oxides in mineral soil and is rather immobile in the soil unless present at very high concentrations In addition plants grown on lead rich soils incorporate lead and thus the concentration of lead in crop plants may be increased Lead enters in the food chain through consumption of plant material A high concentration of lead has been found to be harmful to vegetation As the lead concentration increases it adversely affects several biological parameters and eventually renders the soil barren The book sheds light on this global environmental issue and proposes solutions to contamination through multi disciplinary approaches This book contains three sections First section describes the different sources and distribution of lead in soil and plant ecosystems Second section explains the health risks linked to lead toxicity Third section addresses sustainable lead toxicity mitigation strategies using the potential applications of recent biological technology This book is a valuable resource to students academics researchers and environmental professionals doing field work on contamination throughout the world

Sustainable Heavy Metal Remediation Eldon R. Rene, Erkan Sahinkaya, Alison Lewis, Piet N.L. Lens, 2017-10-13 This book presents an assortment of case studies pertaining to the use of sustainable technologies for heavy metal removal and recovery from mining and metallurgical wastes construction and demolition wastes spent catalysts and electronic wastes Wastewaters from diverse industrial and mining activities have caused pollution problems but these sectors also serve as a hotspot for metal recovery Several metal removal technologies based on physical chemical and biological processes have been successfully implemented

in full scale operation while metal recovery which is beneficial for economic and environmental reasons is still limited due to challenges arising from downstream processing For instance microbial recovery bioleaching of metals from their ores is an established technology with a number of full scale applications Bioleaching of electronic wastes to recover metals is also a highly promising technology with low environmental impact and high cost effectiveness yet this technology is still at its infancy As the individual chapters of this book focuses on the applications and limitations of different technologies this book will serve as an excellent resource for chemical engineers environmental engineers mining engineers biotechnologists graduate students and researchers in these areas

Symposium of Materials Science and Chemistry III Ahmad Kusumaatmaja, Tutik Dwi Wahyuningsih, Melati Khairuddean, Indriana Kartini, Roto Roto, Keisuke Ohto, Dwi Siswanta, Julius Motuzas, Taufik Abdillah Natsir, 2021-05-04 Selected peer reviewed full text papers from the 6th International Conference on Science and Technology ICST 2020 Selected peer reviewed papers from the 6th International Conference on Science and Technology ICST 2020 September 7 8 2020 Yogyakarta Indonesia

Symposium of Materials Science and Chemistry II Tutik Dwi Wahyuningsih, Roto Roto, Rohana Adnan, Laurent Commeiras, Kuwat Triyana, Indriana Kartini, Julius Motuzas, Dwi Siswanta, 2020-04-24 5th International Conference on Science and Technology ICST 2019 Selected peer reviewed papers from the 5th International Conference on Science and Technology ICST 2019 July 30 31 2019 Yogyakarta Indonesia

Metal Removal and Recovery from Mining Wastewater and E-waste Leachate Suthee Janyasuthiwong, 2020-02-18 Metal contamination in the environment is a persisting global issue The metal reservoirs in the earth have declined due to society's needs and due to uncontrolled mining activities Therefore the idea to recover metals from waste streams has emerged In this thesis cost competitive technologies such as adsorption using agro wastes and precipitation using an inverse fluidized bed IFB reactor were investigated with special emphasis on the recovery of base metals Groundnut shell showed good potential for metal Cu Pb and Zn removal From artificial neural network modeling the performance of the sulfate reducing bacteria SRB was found to be strongly pH dependent the removal efficiency of Cu and Zn in the IFB at pH 5.0 was 97% Electronic waste is a good candidate as secondary metal resource The recovery of Cu from computer printed circuited boards PCBs using biogenic sulfide precipitation was investigated as well Using this technology Cu could be recovered at 0.48 g Cu/g PCBs

Advanced Functional Materials: Properties and Applications, Vol. II Inamuddin, Amir Al-Ahmed, 2016-10-03 Special topic volume with invited peer reviewed papers only

Sustainable Gold Mining Wastewater Treatment by Sorption Using Low-Cost Materials Mike Agbesi Acheampong, 2020-10-29 Sorption technique was employed to remove heavy metals from gold mining effluent using natural and plant materials for sustainability An assessment of the effluent quality of a gold mining company in Ghana indicated that arsenic copper and cyanide were the major pollutants in the process effluent Arsenic and copper were successfully removed from the effluent by the studied materials The research showed that the down flow fixed bed treatment configuration is an ideal system for the simultaneous removal of copper and arsenic from low

concentration gold mining effluent in addition to other heavy metals present in very low concentrations

Biotechnology:
Recent Trends and Emerging Dimensions Atul Bhargava, Shilpi Srivastava, 2017-11-22 Biotechnology is a multidisciplinary field encompassing microbiology biochemistry genetics molecular biology chemistry immunology cell and tissue culture physiology This book describes the recent developments in these areas Current research topics such as Quorum sensing Integrons Phytomining are discussed which would serve as an excellent reference work for both academicians and researchers in the field *Functional Materials and Metallurgy II* Hui Jun Li, Mohd Hamdi Bin Abdul Shukur, 2019-07-25 3rd International Conference on Functional Materials and Metallurgy ICFMM 2018 Selected peer reviewed papers from the 3rd International Conference on Functional Materials and Metallurgy ICFMM 2018 November 10 12 2018 Wuhan China Journal of Chemical Engineering of Japan, 2005 Includes abstracts of Kagaku k gaku v 31 *Journal of Nano Research Vol. 61* Efsthios I. Meletis, 2020-02-12 The 61st volume of the Journal of Nano Research contains peer reviewed papers by the results of the research from the field of synthesis and properties analysis of various nanomaterials and nanostructures for the ecological goals and industrial applications in microelectronics and mechatronics This volume of the journal will be useful and interesting for a wide range of engineers scientists and students whose activity is related to the creation and use of nanomaterials and nanotechnologies in different branches of human activity

Industry-Academia Initiatives in Biotechnology and Chemistry Mohd Fadhilzil Fasihi Mohd Aluwi, Hazrulrizawati Abd Hamid, Pui Khoo Hong, Nina Suhaity Azmi, Natanamurugaraj Govindan, 2022-12-19 Selected peer reviewed extended articles based on abstracts presented at the International Conference on Industry Academia Initiatives in Biotechnology and Chemistry iCIABC21 Aggregated Book **Life Science, Materials and Applied Chemistry** Ahmad Kusumaatmaja, Ruchi Gupta, Melati Khairuddean, Roto Roto, Nobuyuki Ichikuni, Laurent Commeiras, Adhi Dwi Hatmanto, Muhammad Idham Darussalam Mardjan, Taufik Abdillah Natsir, 2022-09-19 Selected peer reviewed extended articles based on abstracts presented at the 7th Symposium of Life Science Materials and Applied Chemistry 7th ICST_LSMAC 2021 Aggregated Book Materials and Technologies of Industrial Application Taufik Abdillah Natsir, Roto Roto, Yurii Otrosh, Alexey Vasilchenko, Andrii Kovalov, Peng Sheng Wei, Mosbeh Kaloop, Driss Bria, Şükrü Taner Azgin, Mohamed El Malki, 2022-07-29 Special topic volume with invited peer reviewed papers only **Science and Engineering of Materials** Mohd Rafie Johan, Darman Singho Noorsaiyyidah, 2014-06-18 Selected peer reviewed papers from the 1st International Conference on Science Engineering of Materials 2013 ICoSEM 2013 November 13 14 2013 Kuala Lumpur Malaysia **Journal of Scientific & Industrial Research**, 2007 Journal of the Institution of Engineers (India). Institution of Engineers (India). Chemical Engineering Division, 2002 **Sámay Bulletin**, 2012 *Encyclopedia of Surface and Colloid Science, 2004 Update Supplement* P. Somasundaran, 2004-08-11 Appending the Encyclopedia of Surface and Colloid Science by 42 entries as well as 3800 new citations 1012 equations and 485 illustrations and chemical structures this important supplement

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feb 29 2020 here are some good general phrases to use i d like to welcome you all here today now let s get doen to business thank you all for coming perhaps we can make a start

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introductions if anyone at the meeting is new to the group or if there is a guest speaker this is the time when introductions should be made the person in charge of the meeting can

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the following are some general tips to help you in your role as a session chair at an iaia annual conference in addition to the specific instructions provided to you directly from the program

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feb 12 2023 the chairman s speech should report on the major occurrence of the year so the introduction should place that in context welcome shareholders and other interested parties

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speech of h e majed almesmar chairman of the conference mr secretary general your excellences distinguished guests ladies and gentlemen welcome to the smart city of

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1 welcome and opening remarks 2015 coast ssew symposium in the above example of opening remarks for a scientific

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mar 31 2022 3 explain the purpose once the subject matter and duration has been established touch on the purpose of the meeting the last thing you ll want is for attendees to be unsure

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chairman s speech dear shareholders today as we convene the 40th annual general meeting of infosys i warmly welcome each one of you it is always a pleasure to connect with

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helge lund chairman 12 may 2021 welcome in a few moments i will say something about the resolutions proposed but first i want to share some reflections on the past year a year

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