Removal of Heavy Metals from Wastewater and Advancement through Zeolites-A Review

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Introduction

Heavy metals are five times denser than water and naturally occurring components, non-biodegradable, hence persist in the environment. Few of heavy metals are useful for our dietary purposes but most of the heavy metals in their trace concentrations also found to be dangerous. The rapid growth of industrialization, urbanization, and increased living standards are leading to the use of numerous products developed from heavy metals. Wastewaters generated from these processes are posing a great threat to the environment. Heavy metal pollution considered as one of the major environmental concern due to its taxological and carcinogenic nature. This draws towards the removal of heavy metals from wastewater.

Heavy metal removal methods are in effect form past few decades like precipitation, adsorption, ion exchange, membrane filtration, floatation. The chemical precipitations using various chemicals like soda ash, lime, chitosans, peroxides resulted in removal efficiencies varying from partial removal of 70% to complete removal (Quanyuan Chen et al 2018, Junxing Hao 2018, Tiecheng Wang 2019). Adsorption of heavy metal includes various adsorbents like low-cost adsorbents generated from wastes, and effective adsorbents like activated carbon are proven to be prominent in adsorption of heavy metals (S. Ricordel et al 2001, M. Kobya et al 2005). Ion exchange with media prepared for selective metals have shown efficiencies more than 90% (Omid Tavakoli 2017, T.M. Zewail et al 2015, James P. Bezzina et al 2019). Filtrations are suitable for low concentration of heavy metals which yields maximum efficiencies with a decrease in pore size, reverse osmosis is accepted widely due to its efficiency (N. Abdullah et al 2019, Chun-Chun Ye et al 2019, Yifeng Huang et al 2016). Flotation techniques achieve complete removal of heavy metals with the usage of multi-stage cascades along with surfactants (Hongyang Wu et al 2019, Mojtaba Taseidifar 2017).

The objective of the study is to review the current scenario of heavy metal removal techniques and to compare them with the advanced adsorption methodologies using zeolites prepared from industrial wastes like fly ash and bottom ash based on the available literature.

Methodology

Fly ash and bottom ashes generated from power plants are rich in SiO_2 and Al_2O_3 which are building blocks of zeolite. Zeolites are hydrated aluminosilicate minerals made from interlinked tetrahedra of alumina (AlO_4) and silica (SiO_4). These tetrahedral units form clusters of polyhedral units with a negative charge to hold a cation in their tetrahedral housing. The research conducted in this area suggested the Characterization of ashes and mineral composition of fly ash are key elements in the synthesis of zeolite using hydrothermal treatment or alkali activation (Maria Visa 2016, Jessica A. Oliveira 2019). From the extensive literature available on the zeolites preparation and their use as ion exchangers stressed their use as excellent adsorbents of mono, bi, trivalent ions of selective metal or multi-metals (Claudia Belviso 2018).

Results and concluding Remarks

The research carried on the methodologies for removal of heavy metals from wastewaters adsorption has proven efficient and economical due to its availability, regeneration ability. Zeolites are adsorbents prepared from secondary wastes like fly ash and bottom and their ability to adsorb heavy metals makes them a promising material. The research on the fly ashes carried out with a primary objective of using it as a low-cost adsorbent, succeeded in the development of zeolites from fly ash using alkali activation and hydrothermal treatment. The zeolites synthesis and its use as an adsorbent are proven to be successful but extensive work has to be carried out on the stability of zeolite, leaching phenomenon of zeolite, effects of multivalent cations and their selective capture and recycling opportunities of the exhausted zeolite.

Zeolite generated from fly ash used as low-cost adsorbents. The review of zeolites as an adsorbent of heavy metals seeks attention in assessing its reusable criteria and effect of various operating parameters. It also highlights the need for study on the suitability of final wastes generated as a replacement for building material in less important structures.

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