Studies and Research on Mercury Removal from Water : A Review

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Abstract:

Rapid industrialization in the fast moving economy calls for solution for adverse environmental effects. Heavy metals are present in the wastewater from the industries ranging from mining to fertilizer. Mercury is present in the waste from smelters, effluents from plastics, textiles, microelectronics etc. Various chemical and physical methods have been used for removal of mercury by various researchers. The current review aims at studying various methods investigated by researchers for mercury removal.

Keywords:

Removal, batch, kinetics, sorption, equilibrium.

Introduction

Removal of various organic and inorganic pollutants can be carried out by physical, chemical and biological methods. Organic pollutants can be removed by using adsorption, activated sludge process, trickling filter and various membrane separation processes [1, 2, 3, 4, 5, 6, 7].Heavy metals present in the wastewater from various industries is a major cause of concern for human being. The presence of heavy metal can lead to various short term and long term diseases [8, 9, 10, 11). Removal of various heavy metals can be carried out by using biological and non biological processes such as adsorption, ion exchange, coagulation etc [11, 12, 13, 14, 15]. Adsorption is one of the major method used for removal of heavy metals such as cadmium, chromium, zinc and copper [16, 17, 18, 19, 20, 21]. Mercury is one of these heavy metals which affect adversely man and environment if present in wastewater. The current review aims at summarizing the research carried out for removal of mercury from effluent.

Research on Solute Uptake, Isotherm and Kinetics of Mercury Removal from Wastewater

Activated Carbon of palm oil empty fruit bunch{EFB} was used for mercury removal from water by Wahi et.al.[22]. They used chemical and physical activation process for adsorben used for the mercury removal. They observed EFB adsorbent was able to remove almost 100 percent mercury from effluent. They concluded that EFB activated carbon was good adsorbent with almost 100 percent removal efficiency for mercury .Clercq used a new ultra stable mesoporous adsorbent and commercial ion exchange resins for mercury removal from water[23]. They used mercury nitrate for preparation of the aqueous solution. They carried out equilibrium and kinetic studies on the mercury removal process. They observed that the adsorptivity decreased with increasing mercury concentrations, whereas the adsorption capacity increased. At lower

initial concentration, the removal was total. They also observed that the adsorption capacity increases until equilibrium was reached. At lower concentration the adsorption of mercury was faster.Wilopo et.al. used tuff from local material to remove mercury using batch experiment[24].The batch experiment data followed Freundlich isotherm. The tuff of finer grain size was more effective because of high surface area. Also their study indicated that the removal of mercury was not only physical process but also was similar to ion exchange.Oehmen et.al. studied ion exchange membrane bioreactor(IEMB) concept for removal of mercury from water[25].They achieved the removal levels below 1 ppb in their experiments. This process was very efficient and reduced the overall environmental impact to a great extent.Chojnacki et.al discussed natural zeolites for mercury removal[26]. They carried out investigation on sorption mechanisms (adsorption or ion-exchange) and sorption equilibria. Their experiments showed that the zeolites were efficient in removal of mercury from effluent. They observed that, sorption of mercury was first order reversible reaction.Adegbembo et.al carried out studies on estimation of the quantity of dental amalgam that Ontario dentists release into waste water[27].They carried out postal survey combined with the experiments on the weight of amalgam restorations and the quantity of amalgam waste that bypasses solids separators in dental offices. They concluded that the use of amalgam separators by all dentists could reduce the quantity of amalgam (and mercury) entering waste water.Henneberry et.al. carried out investigation on removal of inorganic mercury and methylmercury from surface waters[28]. Their research was focused on potential use of metal-based coagulants as a means to remove both dissolved Hg and MeHg from natural waters. According to their investigation, the removal of Hg is mediated by DOM-coagulant interactions.Bhakta et.al used activated ceramic for Improved Mercury Removal from Water29].They used 1 and 5% sodium carbonate (Na_2CO_3) for chemical activation. They optimized the parameters like contact time, solution pH, adsorbent dosage and adsorbate concentration. They observed that adsorption capacity increased rapidly in first 30 minutes and then it increased gradually. Neutral pH favoured mercury removal. Adsorption dose of 1.2 g/l was optimum. Li et.al. used Mercury nano-trap for effective and efficient removal of mercury(II) from aqueous solution[30].According to their investigation porous organic polymer-based mercury nano-trap exhibited a record-high saturation mercury uptake capacity of over 1,000mg/g. Warwick et.al studied the mercury vapour exposure during dentist training[31]. They observed that when spray and suction was done , the mercury level average was 8 $\mu g/m^3$.Crandallite-type compounds were used for elimination of mercury from wastewater by Monteagudo et.al.[32].During the investigation, the mercury content of the waste water from 70 to 90 ppm was reduced to less than 0.1ppm. The removal followed Langmuir isotherm. By used hydrochloric acid, recuperation of mercury was achieved.75 percent of mercury was recovered and the Crandallite-type compounds could be reused. Parham et.al. used magnetic iron oxide nanoparticles modified with 2-mercaptobenzothiazole for removal of mercury from water[33].Their study indicated that the pH didn't have any major effect on mercury removal. Non-modified magnetic iron oxide nanoparticles (MIONPs) adsorbed 44 percent mercury while modified magnetic iron oxide nanoparticles (M-MIONPs) adsorbed 98.6% for the same concentration. Pederson et. al.

used polymer treatment for mercury removal from Dental-operatory Wastewater[34].It was possible to remove 75-90 percent mercury by using this method.

Conclusion

Removal of mercury can be carried out by using various adsorbents, nanoparticles, polymer treatment, coagulants and ion exchange resins. Low cost materials such as activated carbon of palm oil empty fruit bunch{EFB},ultra stable mesoporous adsorbent, commercial ion exchange resins, tuff from local material were used for removal of mercury with promising results. ion exchange membrane bioreactor(IEMB) concept was also used with reduction of mercury level to 1 ppb.Use of coagulation method for mercury removal also showed promising results. It can be concluded that, adsorption is most efficient method for mercury removal. There is scope for research on new adsorbents with low cost and regenerative properties. Selection of removal method for mercury depends on initial mercury concentration, removal required, cost of removal and available resources.

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