Preparation of Low Cost Adsorbents: A Review

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Abstract:

Use of low cost adsorbent from various raw materials in growing in order to economize the process. Adsorption, an easy and very effective tool for removal of various pollutants, can become more economical and efficient if the adsorbent is having low cost. Other aspects of this kind of researches are related to the activation temperature, use of various chemical agents and impregnating agent in order to render economy and effectiveness to the process. This review provides the studies on research in this aspect of adsorption preparation and the other parameters like carbonization temperature, use of chemical agents etc.

Keywords:

Adsorbent; adsorption; removal; efficiency

Introduction

Adsorption is very effective method for removal of various pollutants. Various pollutants like phenol, heavy metals have been removed successfully by using low cost adsorbents [1, 2, and 3]. Removal of organic matter was carried out by using low cost adsorbent like flash [4]. Studies have also been reported on use of fluidized bed contactor for the phenol removal [5]. Various materials were used for adsorbent preparation like rice husk, groundnut shells, leaf litters, and tamarind shells for removal of organic and inorganic pollutants [6, 7, and 8]. Fixed bed studies for adsorption are also reported and the removal obtained was satisfactory [9, 10]. One of the main investigating area that needs further attention is the preparation of adsorbent. With small modification in the preparation methods, larges favorable changes in the adsorbent properties can be obtained.

Various methods and materials for adsorbent preparation have been discussed in the present review.

Materials and Methods for Adsorbent Preparation

Wankhade and Ganvir prepared Low Cost Activated Carbon from Tea Waste [11]. They used sulphuric acid as an activating agent. They studied effect of the parameters like carbonization temperature, sulphuric acid concentration, and contact time of the adsorbent. According to their investigation, the optimum temperature for preparation of the adsorbent in this case was 500^{O}C.Hanumantharao et. al. prepared activated adsorbent indigenously from Acacia farnesiana carbon (AFC)[12].They used it for fluoride removal. It was found to be very effective alternative for commercial activated carbon. Ganvir and Dwivedi

prepared the activated carbon from oil cake[13]. They also studied the characterization of the adsorbent. They used waste seeds of Mahua oil extraction. According to their results, with increase in the carbonization temperature the yield decreases. Carbonization temperature of 500 ^{o}C and time of 2 hours was required in their studies. Fluted pumpkin stem waste was used for adsorbent preparation by Ekpete et.al[14]. They obtained encouraging results for chlorophenol removal.

Alau et.al. used Neem (Azadirachta indica) Husk for preparation of adsorbent[15].They used H_3PO_4, KOH and $ZnCl_2$ for chemical activation. According to the investigation, temperatures for activating $ZnCl_2$, H_3PO_4 and KOH were 400^{0}C, 500^{0}C and 350^{0}C respectively. The yield of the adsorbent was 63 percent. This adsorbent was found suitable for adsorption of methylene blue. Zhang et.al used genistein as the template molecule for preparation of a novel silica adsorbent[16]. During their investigation, they observed that the silica adsorbent had high specific area, special selectivity and high adsorption capacity for genistein. The adsorption was consistent with Langmuir theory. Dash and Murti prepared the adsorbent from leaf litter for removal of heavy metals[17].They used H_3PO_4 solution (2N) as an activating agent. The adsorbent was found suitable for heavy metal removal. Jute fibers were used for the preparation of adsorbent by Hossain et.al[18]. N-butyl methacrylate (n-BMA) & Phosphoric acid using gamma –radiation was used for curing. They observed that the polymer loading values increases with initial radiation doses upto a certain and then decreases as the radiation dose increases. It was observed that the tensile strength decreased after 16-17 percent polymer loading. They obtained encouraging results for copper. Poinern et.al studied preparation, characterization and As(V) adsorption behavior of CNT-ferrihydrite composites[19]. They observed that CNT-Ferrihydrite was a good adsorbent for arsenic. 2-ethylhexyl hydrogen-2-ethylhexylphosphonate (EHEP) was used as a functional group on a polyethylene fabric with radiation-induced graft polymerization(RIGP) by Hoshina et.al[20].They tried to remove Scandium (Sc) by using this adsorbent. They observed that this adsorbent had high selectivity for Scandium.

Yang et.al carried out preparation, characterization and adsorption performance of a novel anionic starch microsphere[21]. They used an inverse micro emulsion technology with epichlorohydrin as a crosslinker and soluble starch as starting material for synthesis of neutral starch microspheres (NSMs). According to these studies, structure of the microspheres was compact and the hardness of microspheres was great, and the average diameter of the product was about 75 µm. The adsorption of methylene blue was studied by them. The adsorption results were satisfactory. Shah et.al. obtained low cost adsorbent from coal of Lakhra Power Plant Jamshoro's waste through physical and chemical treatment[22]. According to their investigation, the adsorptive capacity of adsorbent declined on the ever-increasing adsorbent quantity.

Giron et. al. used forest biomass for the preparation of adsorbent[23]. They studied the two concentrated unburned processes. The more effective precursor was obtained

by means of dry sieving. Also it was observed that an increase in the precursor/hydroxide ratio leads to enhanced surface areas. Baral and Jha used waste tyres for preparation of adsorbents[24]. They carried out pyrolysis in four different atmospheres: (1) Pyrolysis in open air (Type I), (2) Pyrolysis in inert atmosphere (passage of Nitrogen gas) under constant bubbling of nitrogen gas (Type II), (3) Pyrolysis in inert atmosphere along with steam (Nitrogen gas through water-steam generated at 60°C)(Type III), (4) Chemical impregnation with H3PO4 prior to pyrolysis in inert atmosphere along with N_2-water-steam(Type IV). It was observed that the specific surface area increased under the atmosphere of Nitrogen and steam. Pang et.al. used magnetic nanoparticles for rapid removal of Cr(VI)[25]. They grafted water Soluble Polyethylenimine (PEI) to the nanoparticles. Their results suggested the potential application of the PEI-modified magnetic nanoparticles in selective removal of Cr(VI).

Conclusion

The adsorption process can be improved with used of selective adsorbents. Low cost of the raw material for adsorbent can prove deciding factor while selecting the treatment method. The modification in the preparation method, use of various activating agent can be the factors in improving the properties of adsorbent. The properties of the adsorbents are affected by the parameters like activation temperature, concentration of activating agent and activation time. Optimum use of these factors is very important for economical and effective use of this operation.

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