



International Journal OF Engineering Sciences & Management Research

PHENOL DESORPTION FROM ADSORBENT - A REVIEW

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KEYWORDS: adsorption, desorption, regeneration, recovery.

ABSTRACT

Recovery of used adsorbent is very important from the adoptability and economy point of view. Phenol is one of the major pollutants removed from wastewater by using adsorption technique. The problem in this process is regeneration of used adsorbent. The reuse of adsorbent is very important aspect of the adsorption process. Various thermal, chemical and other advanced techniques are available for the regeneration of adsorbent in phenol treatment. The current review aims at summarizing research carried out for desorption of phenol from adsorbent.

INTRODUCTION

Phenol is one of the major pollutants which are treated by adsorption[1,2,3]. Though other methods like chemical precipitation, electro dialysis, biological treatments are available for the phenol removal, adsorption is most widely used method because of its economical aspects and applicability[4,5,6,7]. Low cost adsorbents are used for phenol removal in various investigations successfully[7,8,9,10]. Removal of phenol is carried out in batch and packed bed experiments. Adsorption in column operation includes fixed and fluidized bed removal[8,9,10,11]. Low cost adsorbents like sawdust, tamarind bean shells, rice husk, flyash etc, have been used efficiently for phenol removal.[12,13,14,15,16]. The regeneration of used adsorbent is very important for the efficient and environmental friendly removal of phenol from the wastewater[16,17]. Various regeneration techniques include thermal regeneration, chemical regeneration, electrochemical, steam regeneration, ultrasonic regeneration etc.[18,19,20]. The economical and efficient regeneration of adsorbent is required for environment friendly phenol treatment. The current review aims at reviewing various desorption methods for adsorbent used for phenol removal.

RESEARCH ON DESORPTION OF ADSORBENT FOR PHENOL TREATMENT

Moreno-Castilla et.al. carried out investigation on thermal regeneration of an activated carbon exhausted with different substituted phenols[21]. They studied thermal desorption process for phenol, m-aminophenol, p-cresol and p-nitrophenol. They obtained the activated carbon by pyrolysis in N_2 and steam activation of a Spanish bituminous coal. They observed that, during the oven drying process of the different AP 10-phenolic compound systems, a fraction of the adsorbed phenol was released from the activated carbon. During thermal regeneration, 6 percent of phenol was desorbed at 300-425 °C. They also observed that the phenol desorbed between 425-925 was chemisorbed. Total weight loss detected by them was 71% of the adsorbed phenol (X) at 1100°C. According to them, the difference in weight loss between TG and MS (33%) is due to P and heavy compounds, coming from both the physisorbed and chemisorbed fractions evolved from the activated carbon and deposited at the outlet of the reactor. Bhatia et.al. investigated the effective diffusivity of phenol in activated carbon[22]. They generated desorption data by desorption of phenol loaded on GAC into the aqueous phase. They studied effect of various parameters like agitation speed, temperature and phenol concentration on desorption. According to them judicious choice of agitation speed can avoid external mass transfer resistance. They also observed that the rate of desorption increased with an increase in temperature. Bada carried out experiments with fly ash as an adsorbent for removal of phenol and its derivatives from synthetic effluent[23]. He carried out desorption studies in 250 ml conical flasks containing water at a temperature of 307 K, shaken at 300 rpm to attain equilibrium at 22 h. Earlier adsorbent used in batch adsorption was contacted with distilled water by him. The water sample was analyzed for phenol and this was continued till equilibrium. He observed that The desorption of 4-Nitrophenol from FA was found to be more difficult and more irreversible than that of 2-Nitrophenol and phenol. Desorption efficiency ranged from 10 percent for 4-nitrophenol to 18 percent for phenol. Adsorption efficiency for all three phenols was in the range of 88-92 percent.

Mahapatra with guidance from Kumar investigated two different types of activated carbons were used as adsorbents namely, commercial granular activated carbon and laboratory prepared water hyacinth activated carbon[24]. He used chemical activation method with phosphoric acid impregnation. Desorption studies were also performed by Vasu. His investigation suggested that the sorbed phenol molecules can be desorbed with dil. HCl[25]. He used water, dilute acetic acid and dilute HCl as eluent. By using first two, 25 and 52 percent desorption for phenol was observed, while for HCl 70 percent desorption was possible. Haydar et.al. investigated adsorption of phenol on activated carbon[26]. They prepared an activated carbon prepared from olive stones have been modified through oxidation by nitric acid or sodium hypochlorite. Kim et.al. carried out investigations on sorption and desorption kinetics of chlorophenols in hexadecyltrimethyl ammonium-montmorillonites[27]. They observed that Approximately 71% of 2-Chlorophenol(ChP), 34% of 2,4-Di ChP, and 17% of 2,4,5-Tri ChP was desorbed within 30 minutes. They also observed that The mass transfer coefficient for desorption (k_d) increased with K_{ow} due to the weaker interaction between the solute and the organoclay, as K_{ow} value decreases.



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Rege and Yang discussed feasibility study of using ultrasound to accomplish the difficult desorption of phenol from activated carbon and polymeric resin adsorbents [28]. They observed that desorption rates of activated carbon significantly increased by ultrasound at 40 kHz and 1.44 MHz. Initially they determined the stability of the resin beads under the influence of an ultrasonic field. Preliminary study showed that two resins i.e. XAD-4/1090 Amberlite polymeric resin and Dowex Optipore L493 polymeric adsorbent, had the potential for separation of phenol from water. Their research also indicated that ultrasonic desorption rates were favored by decreased temperature, aerated liquid medium, and increased ultrasound intensity. According to this investigation, The ultrasonic desorption method was particularly successful in the case of the polymeric resin adsorbent. Hu examined The adsorption capacities of coconut shells-based microporous and mesoporous activated carbons by uptake of phenol, 4-Chlorophenol (4-CP), 4-nitrophenol (4-NP), methylene blue and erythrosine red[29]. They also carried out regeneration by boiling water washing and subsequently thermal treating phenol-saturated activated carbon in nitrogen at temperatures from 300 to 700°C. They observed 90-110% recovery in adsorption capacity. Studies were carried out by Chang and Sparks for studying kinetics of phenol and aniline adsorption and desorption on an organo—clay [30]. They observed that about 42% of the adsorbed phenol was desorbed in 30 min.

CONCLUSION



Regeneration of adsorbent in phenol treatment can be carried out by using various solvents such as water, dilute acetic acid and dilute hydrochloric acid. Hydrochloric acid was most efficient for removal of phenol from the adsorbent. The thermal regeneration was also efficient for regeneration of the adsorbent. Use of recent techniques like electric and ultrasonic regeneration was also investigated. It can be concluded that the choice of regeneration method depends on the concentrations to be treated, cost of adsorbent, amount of effluent to be treated and solid disposal facilities available.

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