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Biosorption for Phenol Removal from Wastewater: an Insight into Studies and Investigations

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ABSTRACT

Phenolic effluent causes various long term and short term health problems. The sources of phenolic effluent include petroleum and petrochemical industries, pharmaceutical industries, fertilizer and chemical industries etc. Removal of phenol from wastewater can be carried out by using various biological and non biological methods. Biological phenol removal can be carried out by biosorption and various suspended and attached growth processes. Adsorption and ion exchange are also important methods for phenol removal. Use of waste material for biosorption is widely investigated area of research. Current review summarizes research and studies on biosorptive phenol removal from wastewater.

Key words: pH, initial concentration, biosorbent dose, percentage removal, contacts time.

INTRODUCTION

Phenolics are present in wastewater from industries like pesticide, coke preparation, synthetic rubber, textile, colour, explosive, petrochemical etc. Phenolic effluent causes various acute and chronic diseases to human beings. [1-4] Various methods used for phenol treatment of wastewater include chemical oxidation, solvent oxidation and adsorption onto activated carbon and other adsorbents. [5-8] Phenol removal by using various adsorbents such as activated carbon, tamarind bean adsorbent and flyash were found to be promising for phenol treatment. [9-12] Also other agricultural waste materials like rice husk, groundnut shells, leaf litters etc. were investigated for removal of phenol from effluent. [13-16] These materials were found to be useful for phenol treatment and proper pretreatment can make them more effective adsorbents. Various biological methods were employed by various investigators for phenol removal. [17-21] Biosorption is one of the biological treatment methods. Current review summarizes research and studies on biosorption for phenol removal.

RESEARCH AND STUDIES ON PHENOL BIOSORPTION

Quintelas et. al. investigated biosorption of ortho-cresol, phenol, chlorophenol and chromium (VI) from aqueous solution. [22] They carried out competitive biosorption using a bacterial biofilm supported on granular activated carbon. They observed that percentage removals obtained for phenol, chlorophenol and o-cresol were 97, 93 and 87% percent respectively. The biofilm was supported on granular activated carbon. It was able to remove organic compounds (phenol, chlorophenol and o-cresol) and Cr (VI). They also observed that the uptake of chromium (VI) increased with the presence of organic compounds. Bayramoglu et.al. investigated Funalia trogii pellets for biosorption of phenol and 2-chlorophenol. [23] They studied the effects of various parameters like contact time, solid/liquid ratio, optimum pH and temperature on the biosorption of phenol. With increasing biomass dose, they observed increase in the phenol removal. The biosorption was maximum at pH value of 8. Also they observed that second order rate equation described the phenol removal. The phenol removal also obeyed Langmuir isotherm reasonably well.

Hank et.al. carried out an investigation on biosorption of phenol by pseudomonas aeruginosa biofilm. [24] They observed that biological activated carbon (BAC) filter was effective in removing phenol from water using both adsorption and biodegradation removal mechanisms. They also studied the ability of the biosorption system to eliminate phenol by increasing the capacity of granular activated carbon. They observed that, in column studies, bed height and initial phenol concentration have positive effect on the growth rate. A comparative adsorption/biosorption for the removal of phenol and lead was carried out by Sulaymon et.al. [25] They used granular activated carbon and dried anaerobic sludge for adsorptive removal of phenol. They observed that optimum values of pH, temperature, mixing speed and contact time were 4, 30°C, 250 rpm and 24 h, respectively for both the sorbents. Abdi and Kazemi carried out review on biosorption of heavy metals. [26] Based on these studies, they also compared these biosorbents for phenol removal from wastewater. According to them, the main advantage of biosorption is that it is very cheap method. Also it shows good metal recovery results and is ecofriendly. According to them, there is scope for development of 'combo' biosorbents consisting more than one type of biomass. These biosorbents may remove variety of pollutants from waste water. Vimala and Grace used chemically treated wild macrofungus for biosorption of phenol. [27] They studied affecting factors such as the particle size, pH, temperature, contact time and biosorbent dosage. They observed that 150-300 μm, pH: 6.0 and biosorbent dosage: 6 g/L were optimum values of these parameters respectively. In their investigation, they observed that data fitted well to Langmuir isotherm model within the concentration range studied (100-500 mg/L). Pseudo-second-order kinetics described sorption kinetics reasonably well. They obtained 87 percent desorption in their experiments.

Sugasini et. al. investigated biosorption potential of aspergillus sp. [28] They isolated i23 fungi from tannery effluent. They observed that alkali pretreated form of species exhibited highest biosorption efficiency than the live biomass. Swamy and Devi carried out experimentation for studying the phenol biosorption abilities of cheaper materials such as rice husk carbon (rhc), casuarina wood carbon (cwc) and saw dust carbon (sdc). [29] They observed that the phenol removal increased with increase in phenol concentration. According to these studies, saw dust carbon (sdc) was best biosorbent for phenol removal. They obtained 73 percent removal of phenol by using saw dust carbon in their investigation.

Al-fawwaz et.al. carried out research aimed at investigating bio-removal ability of green micro-algal and fungal species. [30] These green micro-algal and fungal species were isolated from dry environment. They identified two isolated species as subsequently, as Desmodesmus sp. and Chlamydomonas sp. They investigated factors such as initial phenol concentration, contact time, and the synergistic effect (Desmodesmus sp. and Rhizopus sp.) for their effect on the bio-removal process. Both microalgae and fungi showed phenol bio-removal capacity. At 25 days and 25 mg/l concentration, Desmodesmus sp. indicated highest 75 percentage phenol removal. Gadd carried out critical review on Biosorption. [31] He studied scientific rationale, environmental importance and significance of biosorption. According to his studies there has been little or no exploitation of biotechnology in an industrial context. He discussed the benefits, disadvantages, and future potential of biosorption. According to him, specificity and shorter life cycle are limiting factors for biosorbents.

Nagda et.al. investigated ability of tendu leaf refuse for phenol removal. [32] They carried out experiments aimed at studying the potential of tendu (Diospyros melanoxylon) leaf refuse from bidi industry waste to remove phenol from aqueous solution. They carbonized the tendu leaf refuse and also subjecting it to chemical treatments with sulfuric acid. They carried out experiments for studying effect of various parameters like contact time, phenol concentration, adsorbent dose and pH on phenol removal. Kinetic data was well described by pseudo-second-order chemisorptions model. Chemically carbonized tendu leaf refuse exhibited four times higher adsorption capacity than raw tendu leaf refuse. Nweke and Okpokwasili used activated carbon and fungal biomass for removal of phenol from wastewater. [33] They carried out investigation on effect of various parameters like pH, adsorbent dose and contact time on phenol adsorption. They observed that Freundlich adsorption isotherm fitted the experimental data better than Langmuir model.

CONCLUSION

Removal of phenol from wastewater can be carried out by using various biological and non-biological methods. Biological phenol removal can be carried out by bio-sorption and various suspended and attached growth processes. Adsorption and ion exchange are also important methods for phenol removal. The percentage removal varied from 75 to 90 percent for various biosorbents. Use of low cost biosorbents serves twin purposes. It can minimize waste disposal problem and also helps in phenol removal from wastewater.

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