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An Insight into Research and Studies on Phosphorous Removal

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ABSTRACT

Wastewater treatment is gaining increasing importance because of ever increasing population and industrialization. Various physical, chemical and biological treatments are available for treating wastewater. Nitrates and phosphates enter the water bodies as they are important nutrients for plants. Various causes for presence of phosphorus in water bodies include use of fertilizers, domestic and industrial wastewater, and atmospheric deposition. Various processes for phosphorus removal include electrochemical treatment, coagulation, aeration, sorption and simultaneous sludge minimization and enhanced biological phosphorus removal. The current review summarizes research carried out on phosphorus removal by various investigators on phosphorus removal.

Keywords: aeration, coagulants, electrochemical treatment, sorption.

INTRODUCTION

Rapid industrialization has caused the problems such as depletion in energy resources and pollution. The wastewater treatment has become an important aspect in the current era of rapid industrialization. The various water pollutants like organic matter, heavy metals and biological waste are being disposed in river and sea. The treatment of this wastewater needs to be carried out to bring down the concentration of these pollutants. The organic matter can be treated by various physical, chemical and biological methods. [1-3] The biological treatments were found to be effective in various studies. [4-7] The organic matter removal by adsorption is studied by various investigators with excellent results. Membrane separation is also very effective treatment method. [8] The heavy metal removal can be carried out by various chemical and biological methods. [9-12] Phosphorus enters the water bodies because of fertilizers, domestic and industrial wastewater, and atmospheric deposition. Various processes for phosphorus removal include electrochemical treatment, coagulation, aeration, sorption and simultaneous sludge minimization and enhanced biological phosphorus removal. The current review summarizes research carried out on phosphorus removal by various investigators on phosphorus removal.

RESEARCH AND STUDIES ON PHOSPHOROUS REMOVAL

Nassef carried out investigation on electrochemical method for removal of phosphorus from waste water. [13] Sweep coagulation and adsorption were two important effects associated with the phosphorus removal. They studied various parameters like pH, operating time, current density, initial phosphorus concentration and addition of NaCl. They found that at optimum conditions, it was possible to remove 100 percent phosphorous from wastewater. They observed that with the increase in initial phosphorus compound concentration, removal efficiency of phosphorus compounds decreases. pH value of 7 was found to be optimum for phosphorus removal. The optimum temperature required was 25^{o}C.

Nedjah and Laskri carried out an investigation on removal of phosphorus from urban wastewater via chemical and combined treatment against eutrophication of receiving environment. [14] They

highlighted the importance of wastewater treatment and removing phosphorus from these waters. They carried out an investigation on three treatment types namely chemical, biological and a combined one. The phosphorus removal by chemical method was 88 percent and by biological method was 49 percent. The combined treatment was able to remove 83 percent phosphorus. Karimipour and Quigley developed a set of criteria to achieve effective phosphorus removal from storm water discharges. [15] Nedjah et.al. carried out an investigation on phosphorus removal by physico-chemical treatment for urban wastewater. [16] They also studied the prevention of water eutrophication. They used lime, ferric chloride and aluminium sulfate as coagulant for phosphorus treatment. 150 mg/l of aluminium sulphate was optimum for phosphorous removal. Ferric chloride required was 200 mg/l. The lime required from similar study was observed to be 500 mg/l. About 89 to 90 percent phosphorous was removed by using these coagulants.

Holba et. al. carried out an investigation on environmentally friendly technologies for phosphorus removal from wastewater. [17] They carried out tertiary treatment using iron nanoparticles for removal of phosphorous from wastewater. They verified hypothesis of possible NZVI and ferrate full-scale application for phosphorus removal as a tertiary treatment step. Mohammed and Rashid used oven-dried alum sludge for phosphorous removal from wastewater. [18] They heated oven dry alum sludge to $105^{O}C$ .They carried out experiments in two modes, batch and fixed bed. They observed that the removal increased with adsorbent dose. For batch studies equilibrium time required was 6 days. Maximum phosphorus removal of 85 percent was obtained at optimum condition.

Ndegwa et. al. used swine manure for phosphorus removal. [19] They studied influence of temperature and time on phosphorus removal. They observed that there was increase in removal of soluble orthophosphates with increase in aeration time. They also observed that the phosphorus removal was maximum at temperatures of 20 and $25^{O}C$.They observed that the contribution of insoluble inorganic P to the removal of ortho-P was approximately 61%.According to these studies, physical-chemical precipitation is the principal mechanism of soluble ortho-P conversion into insoluble inorganic P during aeration of swine manure at between 5 and $25^{O}C$. It accounted for approximately 90 percent phosphorus removal.

Goel and Noguera carried out investigation on the potential for simultaneous sludge minimization and enhanced biological phosphorus removal (EBPR) in Cannibal solids reduction processes. [20] They used bench-scale Control-EBPR and Cannibal-EBPR systems in their studies. They concluded that further investigation is required to establish the long-term biological phosphorus removal performance of Cannibal-EBPR systems. Yamashita and Yamamoto-Ikemoto carried out an investigation on an anoxic bioreactor packed with wood and iron for phosphorus removal from wastewater treatment plant effluent via bacterial sulfate reduction. [21] They observed that, compared to the bioreactor packed with cedar chips and iron, the denitrification and phosphate removal rates in the bioreactor packed with aspen wood and iron were higher. They also observed that the phosphorus removal continued for 500 days for the bioreactor packed with cedar chips and iron.

Flyash and modified flyash was used for phosphorus removal by Mikendova et.al. [22] They also explored possibilities of using the wavelength dispersive x-ray fluorescence (WD XRF) spectrometry method for the analysis of phosphorus in liquid samples. They observed that the flyash with highest initial CaO concentration absorbed the greatest amount of phosphorus. They validated the application of WD XRF for the analysis of P in water. According to an investigation carried out by Wang et. al., the green alga

chlorella sp. can be used effectively for phosphorus removal. [23] They obtained maximum removal efficiency above 97 percent for phosphorus.

Mulkerrins et. al. reviewed parameters affecting biological phosphate removal from wastewaters. [24] According to these studies, the key composition parameters affecting the phosphorus removal includes COD content, volatile fatty acid (VFA) content, cation concentration, phosphorus load, pH and food to microorganism ratio. The discussion also focuses on operational parameters affecting successful nutrient removal in wastewater treatment plants such as temperature, sludge quality, sludge settlement, dissolved oxygen (DO) concentration, anaerobic P-release and secondary P-release. According to the studies carried out by Hernandez et. al., in case of microalga Chlorella sp. co-immobilized with azospirillum brasilense, starvation increases phosphorous removal from water. [25]

CONCLUSION

Electrocoagulation was found to be one of the effective methods for phosphorus removal. At optimum conditions, it was possible to remove 100 percent phosphorous from wastewater. The phosphorus removal by chemical method was 88 percent and by biological method was 49 percent. About 89 to 90 percent phosphorous was removed by using coagulants like aluminium sulphate, Ferric chloride and lime. Maximum phosphorus removal of 85 percent was obtained at optimum condition by using oven-dried alum sludge. Maximum removal efficiency was above 97 percent for phosphorus by using the green alga chlorella sp. The key composition parameters affecting the phosphorus removal includes COD content, volatile fatty acid (VFA) content, cation concentration, phosphorus load, pH and food to microorganism ratio.

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