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Universität Stuttgart · WAREM · Pfaffenwaldring 7 · 70569 Stuttgart

Pfaffenwaldring 7
70569 Stuttgart
Telefon: (0711) 685 - 66615 / 66616
Telefax: (0711) 685 – 66600
warem@iws.uni-stuttgart.de
http://www.warem.uni-stuttgart.de/

Anne Weiss M.A., M.Sc.
(Durchwahl: - 66616)

Master Thesis Abstract

Of Nowroz Farhan Noor

Adsorption capacity of iron containing granular filter materials with respect to phosphorus compounds in wastewater

The present investigation consists of studies on the capacity of different iron containing granular materials in removing phosphorus compounds, focusing on phosphonates, from wastewaters by adsorption, and various factors influencing their adsorption behavior. The adsorption experiments were done with hard, low organic content wastewaters: wastewater treatment plant (WWTP) effluent, membrane concentrate and cooling tower effluent; including synthetic solution matrices containing concentrations of different ions in the presence of P compounds similar to real wastewaters.

The increasing global consumption of phosphonates has become a growing concern in the last few decades due to their potential contribution to eutrophication along with various negative impacts on waterbodies. Moreover, direct discharge of phosphonates from some industries along with hindrance in WWTP operation and stricter legal limit of discharge of phosphorus in waterbodies, generates a high demand for new or optimized processes for effective phosphonate removal from wastewaters. By utilizing the polar characteristics of iron (hydr)oxide materials, adsorption on such materials can be a possible alternative in removing phosphonates. Thus, iron hydroxide granule (Ferrosorp RW), iron oxide coated granular activated carbon (nFe-GAC) and iron oxide coated sand (IOCS-2) were investigated for adsorptive removal of P compounds from wastewaters. At first, adsorption behavior of 2-hydroxy phosphonoacetic acid [HPAA] with the three materials under varying pH was studied to evaluate it in comparison with other frequently used phosphonates. Following adsorption experiments were conducted with three wastewaters under different conditions - two different pH, varying adsorbent dosages, different P compounds, different synthetic matrices with various ion compositions - for the assessment of the adsorption capacity of the materials and influence of various ions on adsorption of phosphorus compounds.

Ferrosorp RW was found to be more effective to adsorb HPAA due to its stable nature at varied pH and HPAA belongs to the phosphonates with best adsorption behavior. Furthermore, Ferrosorp RW showed the best adsorption by achieving highest maximum adsorption capacity in almost all the selected wastewater conditions. Iron containing adsorbents were proved to be highly effective in DTPMP removal for their selective nature and high loading at different pH. However, in WWTP & cooling tower effluent, they showed higher affinity towards PO_4-P thus, seems to be less suitable for phosphonate removal from

these two wastewaters. Ca^{2+}, SO_4^{2-} & HCO_3^- have almost no influence in DTPMP adsorption in synthetic membrane concentrate condition. However, in HPAA adsorption in synthetic cooling tower effluent condition, Ca^{2+} has a positive and SO_4^{2-} & HCO_3^- has a negative influence. nFe-GAC performs as the second-best adsorbent material but, influenced by pH and various ions more profoundly than Ferrosorp RW. In greater than 4 g/L concentrations, IOCS-2 material dissolute the iron coating and showed highly disruptive adsorption.

This allowed to determine the best materials for removal of phosphonates from wastewaters. Further investigations and recommendations are given for future applicability of these adsorbents.

Keywords: Adsorption, phosphonates, influence, wastewater, iron (hydr)oxide