8th National Congress on Civil Engineering, 7-8 May 2014
Babol Noshirvani University of Technology, Babol, Iran

Study of Nitrate Adsorption Process on Red Mud; an Emerging Adsorbent Obtained from Industrial Waste

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Abstract

Red Mud (RM) is a solid industrial waste remains from Bayer's process to produce of alumina from Bauxite ore. Annually, about 60 million tons of RM is produced all over the world that may cause serious danger for environment (due to its high alkalinity). RM has found many applications in science and industry e.g. production of color bricks, ceramics, cement, and adsorbents. Application of RM for environmental friendly purposes e. g. removal of heavy metal ions, inorganic anions, organics, dyes and pathogens from aqueous solution, have been widely developed recently. In this paper, process of nitrate adsorption on surface of RM adsorbent is discussed. Laboratory batch experiments conducted to study removal behavior of adsorbent under different pH solution conditions. The results show that increasing or decreasing in pH of solution, may result in reduced nitrate removal capacity. Optimum pH of adsorption was in range of natural water (pH=6.5). FT–IR test also implemented to investigate characteristics of RM adsorbent (before and after adsorption process). It shows that adsorption process obeys both physical and chemical procedure. Finally, Ligand–Exchange process on hydroxylated surface is supposed as the main process of nitrate ion adsorption on RM.

Keywords: Red Mud, Nitrate, Adsorption, Ligand–Exchange Process, Water Treatment.

1. INTRODUCTION

Red mud (RM) is a reddish-brown, insoluble and fine size powder that is industrial waste by–product of "Bayer process" in manufacturing alumina (Al_2O_3) from bauxite ore [1]. It was reported that 0.8~1.5 tons of RM is produced by each 1 tons alumina produced. Globally, the total amount of RM produced every year is between 60 to 120 million tons. Studies on the physical and chemical properties and comprehensive utilization of RM have become a focus of related materials within science and engineering fields [2]. Recently, RM has many useful applications; the most important of them is listed below [7]:

- Improvement of soil quality
- Water and wastewater treatment.
- Recovery of valuable elements.
- Product of building and road materials (e.g. cement, bricks, ceramics and glass).

In recent years, development in using RM as adsorbents for water and wastewater treatment has also been widely reported. Utilization of industrial wastes for another waste treatment has many benefits in terms of economy and environment [6]. RM adsorbent was used to remove removal of heavy metal ions (e. g. Cu^{2+}, Pb^{2+}, Cd^{2+}, Zn^{2+}, Cr^{6+}, Ni^{2+}, As^{5+} and As^{3+} cations), inorganic ions (e.g. nitrate, phosphate, fluoride and boron anions), dyes (e. g. Methylene blue, Reactive black, Acid Blue, Rhodamine B and Congo Red), organics (e.g. phenols and Chlorophenols) and pathogens (e.g. Polioviruses, Salmonella Adelaide and Escherichia Coli). [3].