CHAPTER 1

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Recently most of scientists become more interested in effluent water treatment specially the removal of heavy metals contaminants as Chromium, Copper, Manganese, Mercury and Cadmium which are significantly toxic to living creatures, ecological environments and increase the water pollution due to their disposal from different industrial sectors.

Numerous techniques are available for effluent wastewater treatment. Many of these are established methods such as reverse osmosis, chemical precipitation, adsorption and ion exchange while others are still in academic research phase.

Chromium is extensively used in many chemical processes such as pigments and paints, leather tanning, fungicides, electroplating, cement, steel, ceramic and glass industries. Chromium plating was once widely used to give steel a polished silvery mirror coating. Chromium is used in metallurgy to impart corrosion resistance and a shiny finish; Chromium (IV) oxide (CrO_2) is used to manufacture magnetic tape. The presence of Cr(VI) ion in the wastewater generated from these industries has become a major concern today due to its deleterious effects on health and environment.[1,2]

Chromium is unique among regulated toxic elements in the environment in that, chromium exists in nature in three oxidation states namely : Cr(II), Cr(III) and Cr(VI), only the latter two are stable[3]. The most common Cr(VI) forms are chromate (CrO_4^{2-}), and hydrogen chromate ($HCrO_4^-$) also called bichromate. The relative amount of these two species depends on ph., and concentration, dichromate ($Cr_2O_7^{2-}$) can also occur.

Hexavalent chromium is known to be toxic to human, animals, plants and microorganisms. In contrast trivalent chromium is essential for human and less toxic than hexavalent chromium and easily to be removed by simple chemical precipitation by lime as $Cr(OH)_3$. [4]

Ion exchange materials are insoluble substances containing loosely held ions which are able to be exchanged with other ions in solutions which come in contact with them. These exchanges take place without any physical alteration to the ion exchange material. Ion exchangers are insoluble acids or bases which have salts which are also insoluble, and this enables them to exchange either positively charged ions (cation exchangers) or negatively charged ones (anion exchangers). [5]

The main advantages of ion exchange are recovery of metal value, selectivity, less sludge volume produced and the meeting of strict discharge specifications. Ion exchange using synthetic resins is the method of choice for removing toxic metal contaminants in water and wastewater [6].

Ion exchange contactors are batch or continuous (fixed, moving and fluidized bed); Batch reactors were easy to use in the laboratory study, but less convenient for industrial applications.

In order to obtain basic engineering data for real life applications of the absorbent, it is essential to study the continuous flow system in a fixed bed. More so, the adsorption capacity from batch studies may not give accurate scale-up information in the column operation system. A fixed bed column is an effective process for cyclic sorption/desorption, as it makes the best use of the concentration difference known to be a driving force for adsorption and allows more efficient utilization of the sorbent capacity and results in a better quality of the effluent. A fixed bed column study is important to predict the column breakthrough or the shape of the wave front, which determines the operation life-span of the bed and generation time. Continuous fixed bed sorption has also a number of process-engineering advantages including high-yield operations and relatively easy scaling up from a laboratory scale procedure. The stages in the separation protocol can also be automated and high degrees of purification can often be achieved in a single step process. A large volume of wastewater can be continuously treated using a defined quantity of sorbent in the column. After pollutant loading, the pollutant may be concentrated in a small volume of solid material or desorbed into a small volume of eluent for recovery, disposal, or containment [7].

The main objective of the present study is to investigate the equilibrium and kinetic of Diaion SA20A strong anion exchange resin for the removal of Cr (VI) from synthetic wastewater. To this end the following various parameters are studied: initial Cr(VI) ion concentration, temperature, contact time, rpm , and initial pH values. In addition column studies are conducted to construct the breakthrough curves under different parameters, such as column bed depth and flow rate. The breakthrough curves are analyzed using Adams–Bohart, BDST, Thomas and Yoon–Nelson models, to optimize the conditions for effective removal of Cr(VI) ion from aqueous solution.