INTRODUCTION

The vast development of nuclear energy activities may release relatively large quantities of wide varieties of radionuclides, which lead to environmental radioactive contamination. The possibility of removal of the radioisotopes from radioactive waste solutions is considered as an important way of environmental radioactive decontamination. The presence of organic substances, in radioactive waste solutions, is one of the most significant and complicated problems. This is because the organic materials change the cationic species of radionuclides and elevate the leachability of the cationic contaminants from the solidified barriers.

The treatment of radioactive waste solutions with sorbents provides a simple way of converting the liquid to a solid form. Natural materials such as clay minerals possess ion exchange properties and are well known for their capacity to adsorb metal ions and some organic pollutants from their respective solutions. In Egypt large deposits of clay minerals, which belong to the cemectite, are known to exist. These clay minerals are extremely cheap and can be used in their natural form and with pretreatment. Activated carbon is also a natural material and well known for its capacity to adsorb metal ions and some organic contaminants from their respective solutions.

The radioactive waste solutions contain chemicals mainly used in decontamination processes at the nuclear power plants such as phenols. The recovery of ^{134}Cs, ^{89}Sr, ^{60}Co, and phenol from aqueous radioactive waste solutions has become of wide interest. The huge volume of aqueous radioactive waste solutions resulting from the nuclear activities should be treated before discharged to the environment. This requires highly selective sorbents or ion exchangers. Further, at high radioactive doses present in the solution, inorganic ion exchangers are resistant to radiation damage and can exhibit remarkably high selectivity **(Clearfield, et al; 2001).**

I. 1 Clay minerals and their surface properties

Generally, the major groups commonly found in clay mineral are aluminosilicates, oxides and organic matter. Through their surface electrochemical properties, these clay minerals control adsorption, transformation and release behavior of chemical constitutes to water or clay. Clay-surface electrochemical properties vary between clay types. Some of the chemical properties of soil include: *Permanent charge*; defined as cation exchange capacity, CEC, which is independent of pH. *Variable charge*; defined as pH-dependent on CEC. *Point of zero charge, PZC*; defined as the pH at which the net surface charge is zero. *Hydrophobic-hydrophilic potential*; defined as the potential of clay to adsorbed water. The physicochemical properties of soil play a major role in regulating surface and ground water chemistry or quality (**Evangelou, 1998**).

I. 1. 1 Isoelectric point

Isoelectric point (point of zero charge, PZC) is the value of pH at which the adsorbent can act as cation and anion exchanger, where both cations and anions are exchanged (**Lehto, 1987**). It is determined by the construction of what is called "the adsorption titration curve". This curve was constructed by preparing a set of solutions with fixed ionic strength and varying pH values using NaOH and HCl, as shown in figure (1). Point of zero charge defined as the pH at which the net surface charge is zero or CEC minus AEC, anion exchange capacity, equals zero (**Evangelou, 1998**). In particular situations where the pH of the ambient solution is greater than the colloid PZC, the colloid surface is negative and has an electrostatic affinity for positive species (cations). Conversely, where the pH of the solution is less than the colloid PZC, the surface becomes protonated and the colloid therefore attains a net positive surface charge. In this state it is able to attract electrostatically and adsorb negative species (anions). In some common situations, the hydrated iron and aluminum oxides develop a positive surface (**Gary and Stephen, 2002**).