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ADSORPTION OF FLUORIDE IN SOILS OF RAJASTHAN

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Abstract: The present study deals with the adsorption of fluoride by soil. The soil samples were taken from south east areas of Rajasthan . Various experiments have been carried out using batch adsorption technique to study the effect of main parameters such as the influence of amount of soil ,Fluoride concentration, temperature and pH.The results showed that the adsorption percentage increased with the increase of soil and decreased with the increase in Fluoride concentration and the adsorption become maximum at 35^{O}C and afterward it become decreases and the adsorption percentage was maximum at pH 6.5 and after this it becomes decreases

Index Terms **- Adsorption,Fluoride,soil, batch method ,pH.**

I. INTRODUCTION

Fluoride is one of the important heavy metal present in water and waste water. In the Earth crust, fluoride ranks thirteenth in terms of abundance ,which amounts to 0.077% of the earth's crust .(Cai H et al 2017) .It is a member of the halogen family. It is very reactive pale yellow gas and exists in combined state in the form of fluorides. Fluorine is usually present in soils in the form of cryolite ,flurapatite and other phosphate rocks. In soil Fluoride arise from Phosphate fertilizers , insecticides and through rain water .The presence of fluoride in drinking water ,within permissible limits of 0.5 -1.0 mg/L is beneficial for production and maintenance of healthy bones and teeth as the fluoride ion is attracted by positively charged calcium in teeth and bones due to its strong electronegativity ,while excessive intake of fluoride causes dental or skeletal fluorosis which is a chronic disease manifested by mottling of teeth in mild cases ,softening of bones and neurological damage in severe cases (Wang Y et al 2001) .The World Health Organization (WHO) has specified the tolerance limit of fluoride contents of drinking water as 1.5 mg/L (WHO guideline 2008).Fluoride occurrence and concentrations in water resources, surface water and groundwater, depends on several contributing factors, such as pH,total dissolved solids, alkalinity, hardness and geochemical composition of aquifers (WHO Health criteria1984),(Karthikeyan,G et al 2000),(Meenakshi,R.C et al 2006), but in many countries worldwide,There are several methods like Adsorption(A.A.M.Daifullah etal2007) (M.M.Shihabudheen et al 2006) , precipitation[R.Aldaco et al2007), (E.Akbar 2008), ionexchange(S.Meenakshi et al2007),donnadialysis(A.Tor,2007),electrodialysis (S.Lahnid et al 2008)],reverse osmosis(P .Sehn,2008),and nanofiltration (J.Liu et al 2007)which have been used to remove Fluoride from water.Adsorption is the technique ,in which fluoride is adsorbed onto a membrane, or a fixed bed packed with resin or other mineral particles.Adsorption studies of fluoride on clays and bauxite show that bauxite has the best adsorption capacities,followed by bentonite and palygorskite,while kaolinite had the lowest adsorption capacity (Ismail,A et al 2014).Other adsorbent studied for defluoridation is China clay(Meenakshi,S et al 2008). Various studies have been carried out by subjecting clay to high temperatures to produced clay wares with optimal fluoride binding capacity .The results of these studies showed that clay could be a promising choice adsorbent for defluoridation of water(Tor,A et al 2009). Clay soil is the best adsorbent for the adsorption studies the present experiments were carried out with the kaithun soil of kota district of Rajasthan which has the high clay in soil and it can be used for Adsorption studied.

II. MATERIAL & METHOD

The Batch test were carried out in 250 ml flask using a natural soil as a sorbent. The soil samples were collected from the industrial area, Bhilwara and agriculture area Kaithun from Kota Rajasthan. The soil samples were dried in air for about three weeks. After drying the soil was sieved in order to obtain different particle size distribution (100-300 BSS). Fluoride samples were prepared by dissolving desired quantity of NaF in double-distilled water and make 1000 ppm solution and used as a stock solution and diluted to the required initial concentration. A 2g natural soil was mixed with 100ml of the aqueous solutions of various initial concentration (0.5mg/L, 1mg/L, 2mg/L, 3mg/L and 4 mg/L) of Fluoride in each flask. The stirring speed was kept constant at 120 rpm. The flasks were shaken at a constant rate, allowing sufficient time for adsorption equilibrium. It was assumed that the applied shaking speed allows all the surface area to come in contact with heavy metal ions over the course of the experiments. The study was performed at room temperature to be representative of environmentally relevant condition. The pH of the solution was measured with a HACH-pH meter. The effects of various parameters on the rate of adsorption process were observed by varying contact time, adsorbent concentration, initial Fluoride Concentration, and pH of the solution. The solution volume was kept constant. The measurements were made Fluoride ion selective electrode , Fluoride removal studies were carried out by using 2 g of adsorbent and with 50 mL of fluoride ion solution under different conditions for two hours. The adsorption studies were conducted at a temperature of 25 ± 2 °C using thermostated water bath to determine the effect of pH, contact time and initial fluoride ion concentration on the adsorption of fluoride. The residual fluoride ion concentration was determined by using fluoride ion selective electrode. All experiments were carried out in triplicate, and the concentrations given are average values of the triplicate analysis. Adsorption kinetics was studied by varying fluoride ion concentration in the test solution and the adsorbent dosage. The effect of temperature on the thermodynamic parameters was studied by varying the adsorption temperatures. The amount of adsorption at time t, qt (mg/g), was calculated using the following relation:

$$q_t = (c_o - c_t)/w$$

Where Ct (mgL^{-1}) is the liquid phase concentrations of fluoride ion at any time t, C0 (mgL^{-1}) is the initial concentration of the fluoride ion in solution. V is the volume of the solution (L) and W is mass of the adsorbent (g). The amount of equilibrium adsorption, qe (mg /g), was calculated using the formula.

$$q_e = (c_o - c_e)/w$$

Where Co and Ce (mgL-1) are the liquid-phase concentrations of fluoride ions initially and at equilibrium The percentage adsorption of fluoride ion in the solution was calculated by using the following equation.

$$\% \text{ adsorption} = (c_o - c_e)/ c_o$$

Where C_0 and C_e (mgL-1) are the initial and equilibrium concentration of the fluoride ion respectively.

III. RESULT AND DISCUSSION

A Influence of variation of amount of soil.

To study the influence of variation of amount of soil the soil samples were taken 2gm ,4gm,6gm and 8 gm and the results reveals that the Percentage adsorption increases as the amount of soil increases as shown in the fig.1 this is due to the increase in surface area and availability of more active sites for adsorption of fluoride(T.K.Rout et al 2015) There is a significant correlation between maximal fluoride adsorption and clay content as the dosage increases more sites and surfaces become available for fluoride uptake. At low adsorbent dosage, there is rapid fluoride adsorption since the active sites are more easily available while at high adsorbent dosage ,the adsorbate species find it difficult to access the adsorption sites due to less available sites as a result of the fluoride filling of these sites(Obijole,O.A et al 2019)

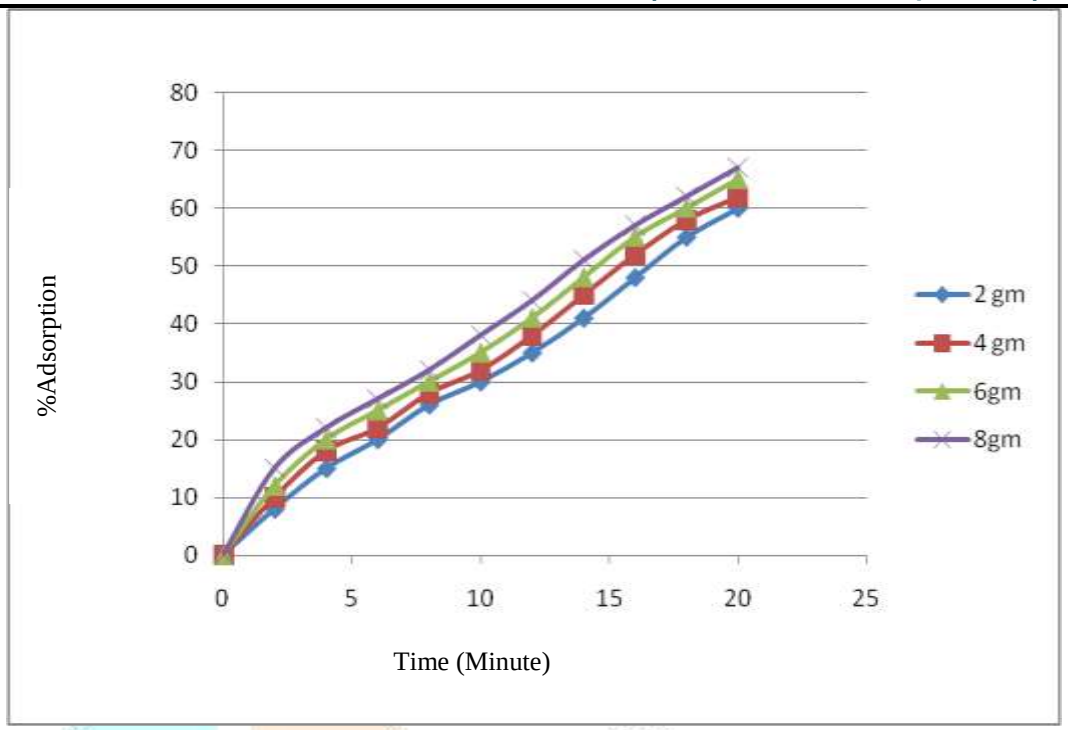

Fig.1 influence of amount of soil on adsorption of fluoride

B Influence of variation of initial fluoride concentration

To study the variation of initial fluoride concentration the Initial fluoride concentration is taken 5 ppm and increased up to 50 ppm it is observed that when the Fluoride concentration increases the percentage adsorption decreases. It is due to at low initial concentrations of fluoride, the ratio of the initial number of fluoride molecules to the available surface area is low and subsequently the fractional adsorption becomes independent of the initial concentration.(Zazouli MA et al 2014) However, at higher initial concentrations of Fluoride , the ratio of the initial number of Fluoride molecules to the available surface is greater with relatively fewer sites available of adsorption. Thus, the percentage removal of Fluoride is dependent upon the initial Fluoride concentration. (Balarak D et al2016)

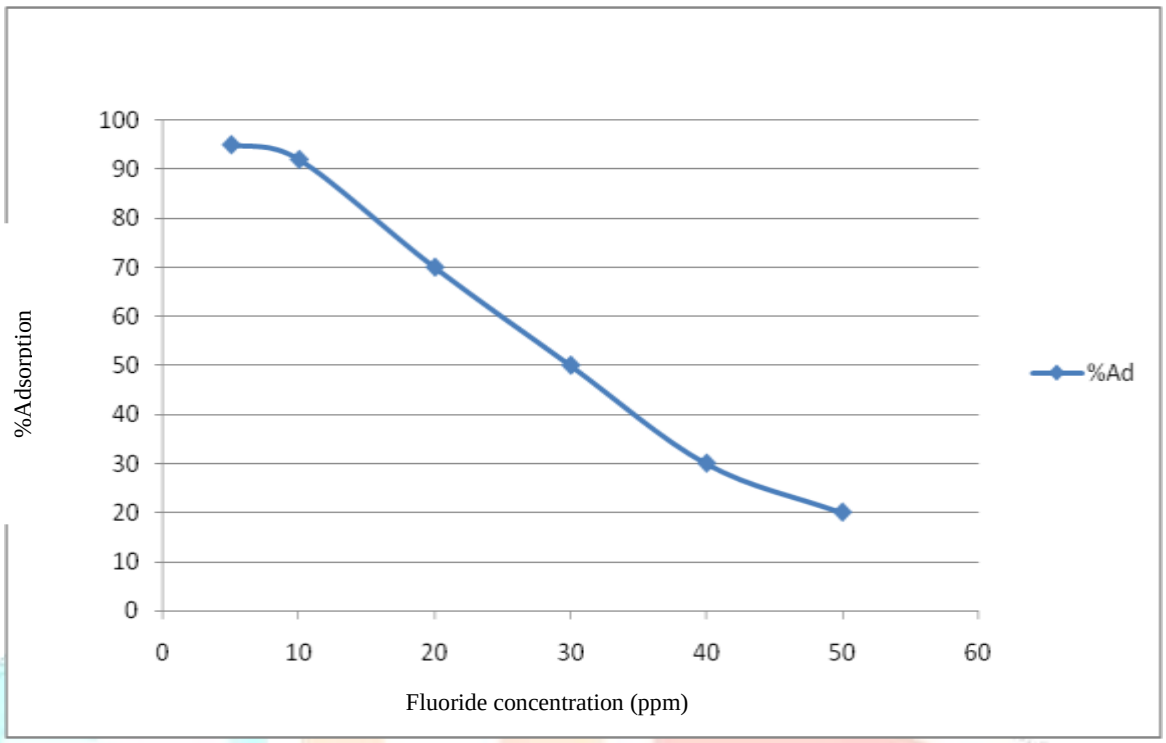

Fig.2 Effect of fluoride concentration on adsorption

C Effect of temperature on Fluoride concentration

To study the effect of temperature on fluoride concentration the temperature is increased from 25^{O}C to 45^{O}C ,as the temperature is increased the Fluoride adsorption is also increased and at a certain point it is maximum at 35 ^{O}C Celsius and after this when the temperature is increased the Fluoride adsorption become decreased . Temperature is the factor that controls the adsorption equilibrium of fluoride at the soil surfaces because of its influence on the adsorption energy, adsorption kinetics and on the reaction activation energy. (Biswas, K.,et al 2010) Higher temperatures enhance the rates of adsorption by enhancing faster solute transport through solution onto the adsorbent surfaces. Very high temperatures may, however, counter the adsorption fluxes from solution and reduce the rates and magnitude of uptake of a particular adsorbate by the adsorbent. As shown in the fig.3 initially the percentage adsorption become increase with the temperature and after certain point it is maximum and afterwards it become decrease.

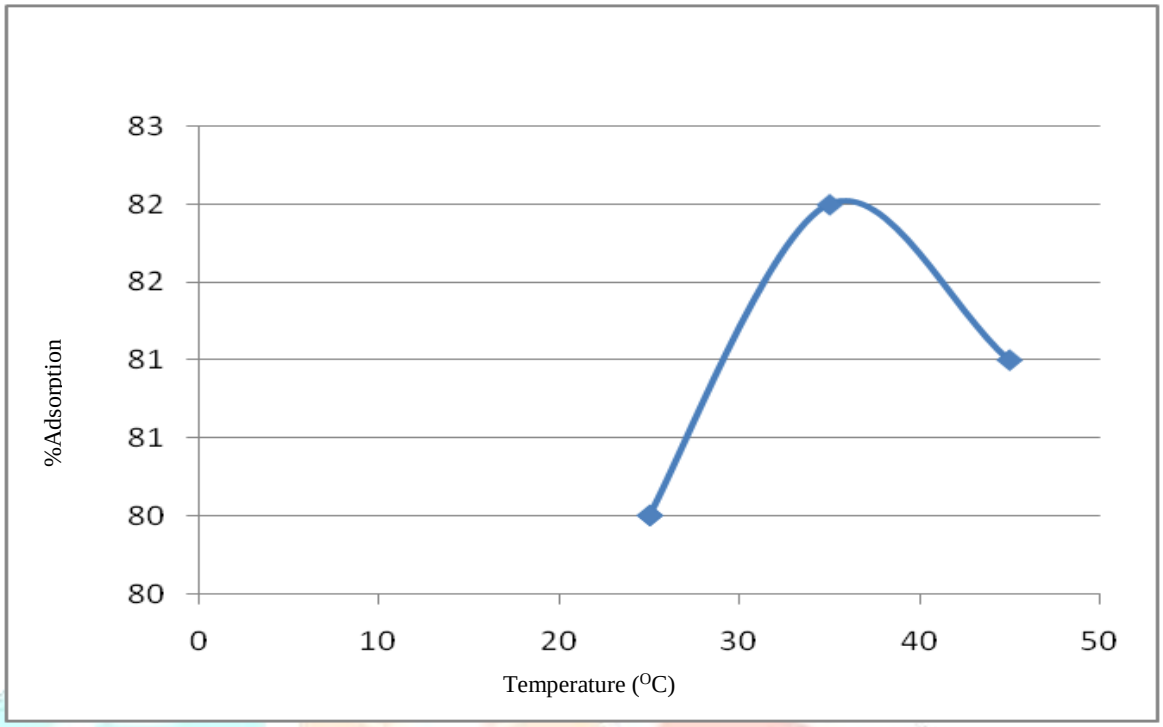

Fig.3 Effect of temperature on Fluoride adsorption

D Effect of pH on Fluoride concentration

pH is the important factor which effect the adsorption of Fluoride .To study the effect of pH on Fluoride adsorption the pH is increased from 4 to 9 and it is observed that when the pH is increased the percentage adsorption is also increased and at pH 6.5 it is maximum and after this the Percentage adsorption become decreased by increasing pH, which it is probably be due to an inappropriate surface charge and to competition for adsorption sites because of excess anion at alkaline conditions. However, there were no significant differences in fluoride adsorption . This finding is in agreement with the literature.(Dobaradaran S et al 2015,) (Zazouli MA et al 2015).

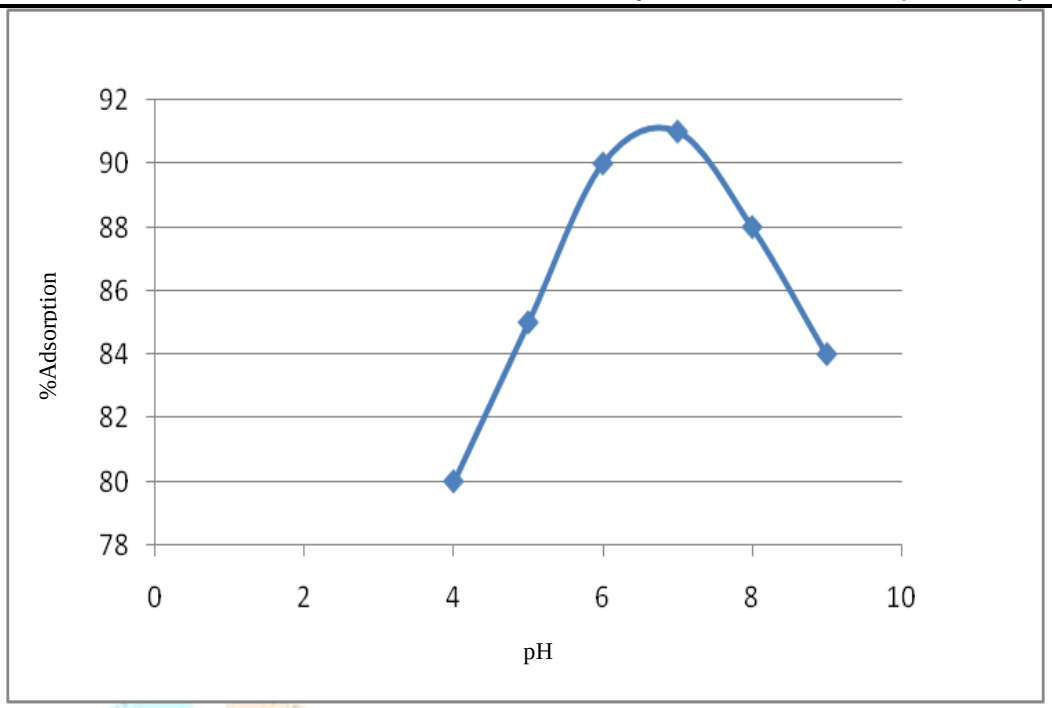

Fig.4 Varietion of pH on adsorption of Fluoride

IV. CONCLUSION

Soil Adsorbents that have attracted the highest interest as possible adsorbents for the study of adsorption of fluoride and it can be concluded from the above study that when the amount of soil is taken into consideration it is found that the percentage adsorption is also increased. And with respect to fluoride concentration it is found that the adsorption become decrease when the fluoride concentration is increased. And it is found that at 35° C the adsorption is maximum and when the pH factor is taken into consideration it is found that at pH 6.5 it is also maximum.

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