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Removal of Fluoride from Water by using Natural Adsorbent

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Abstract: Access to safe drinking water is not only the elementary need of human being but also honored as an mortal right .For overall development of the country , as acceptable nutrition, education, gender equivalency, and particularly the eradication of poverty in developing countries are required , along with that furnishing safe drinkable water is equally important . Fluoride one of the water quality parameters of concern, with redundant(beyond1.5 mg/ l, World Health Organization(WHO) guideline value of what contaminates groundwater coffers in numerous corridors of the world, and renders it not drinkable for mortal consumption, due to affiliated adverse health goods thus, knowledge of its junking, using the stylish fashion with optimum effectiveness demanded . Taking the inflexibility of the problem into consideration, the present paper aims to give a retrospective approach to the use of effective low- cost adsorbents for the junking of fluoride from water . The defluoridation capacity of certain low- cost natural adsorbents like Groundnut shell powder and Soya chunk powder were added in the list and discussed. The effect of pH, adsorbent dose, initial concentration , and contact time also delved . It's set up that the junking of Fluoride ions at optimum parameters like pH, adsorbent dose ,initial concentration and contact time is at 7, 2gm, 5mg/ l, and 100 minutes respectively for groundnut shell powder and 6, 2gm, 5mg/ l, and 100 minutes respectively for Soya chunk powder. For all optimum parameters, the maximum reduction in Fluoride ions observed in the range of 55 to 65% for groundnut shell powder whereas for soya chunk powder it's 40 to 50%
Keywords: Fluoride removal, Natural adsorbents, WHO, Soya Chunk, Ground Nut Shell.

I. INTRODUCTION

Water known as universal solvents because it dissolves most substance coming its contact. Safe drinking water is primarily need of everyone. Pure water is in limited quantity. Water may contaminated by naturally sources or industrial effluent. One such contaminant are fluoride.

Fluoride concentration in water recourse is increasing because of industrialisation and urbanisation. High concentration of fluoride in drinking water leads to various health effects like dental fluorosis and skeletal fluorosis .According the WHO standards, in drinking water, the fluoride should be within a range that slightly vary above and below 1 mg/L and in low water level, fluoride level is up to 1.5mg/L. According to Bureau of India standards, BIS (IS-10500), the desirable limit and allowable limit of fluoride in drinking water is 1.0 and 1.5 mg/L respectively. There are various methods for junking of fluoride from water like ion exchange , electrolysis , membrane separation and adsorption. But adsorption process is one of the best and most efficient method for junking of fluoride from water because of its initial cost , ease of operation , simplicity in design and flexibility. Hence, we used adsorption method junking fluoride testing. The efficiency of this techniques mainly depends on absorbents.

II. LITERATURE REVIEW

By golly, Palekar et al. done thought about takin' out fluoride using tea trash and drumstick as bio-adsorbents! When it comes to that fluoride stuff, teas ashy powder treated with acid was a smidge better than alkali-treated teas ashy powder at normal pH. But when it comes to MO or Moringa Oleifera, the alkali-treated MO powder done turned out better than the acid-treated MO powder at standard pH. Ya see, as the pH number goes up, the getting rid of that fluoride by sticking' it to these adsorbents goes up too, and it's at its peak at neutral pH. Both them their bio-adsorbents perform best when you throw in 400mg/lit of 'am and let 'end sit for 150mins, whether they're 212µ or 600µ. Them researchers reckon that the adsorption rate is quicker for the tiny 212µ particles because they got more surface area compared to them big of 600µ particles.

Ramesh et al., they totally checked out the batch column method for the deforestation of liquid solution using bottom ash. The period of contact with fluoride was recognized as 105 minutes at a 70mg/100ml bottom ash prescription. People received the maximal productivity of 73.5%.

To receive 83.2% of the selling efficiency, the pH was at 6. Similarly, the fluoride clearance tends to grow with a decrease in the atomic size. The most extreme monolayer absorption capacity of the bottom ash absorbent was clarified as 16.26 mg/g at 303 K. From the column method, it was recognized that the fluoride ions surge tends to grow in the bed height, because of an increase in the connection with time. Based on the Thomas model, the author viewed that the rate constant is 0.0619 l/min.mg, and the saturation point was recognized as 0.3714 mg/g. From the Yoon Nelson.

Saranya et al researched the DE fluoridization use bio adsorbents, like banana skin, enthusiasm fruit skid, furthermore enthusiasm fruit seed. Pre-eminent dismissal capability was accomplish by using banana skin powder. The writer terminated that the effectiveness of fluoride disposal ascends with increase in adsorbent dosage.

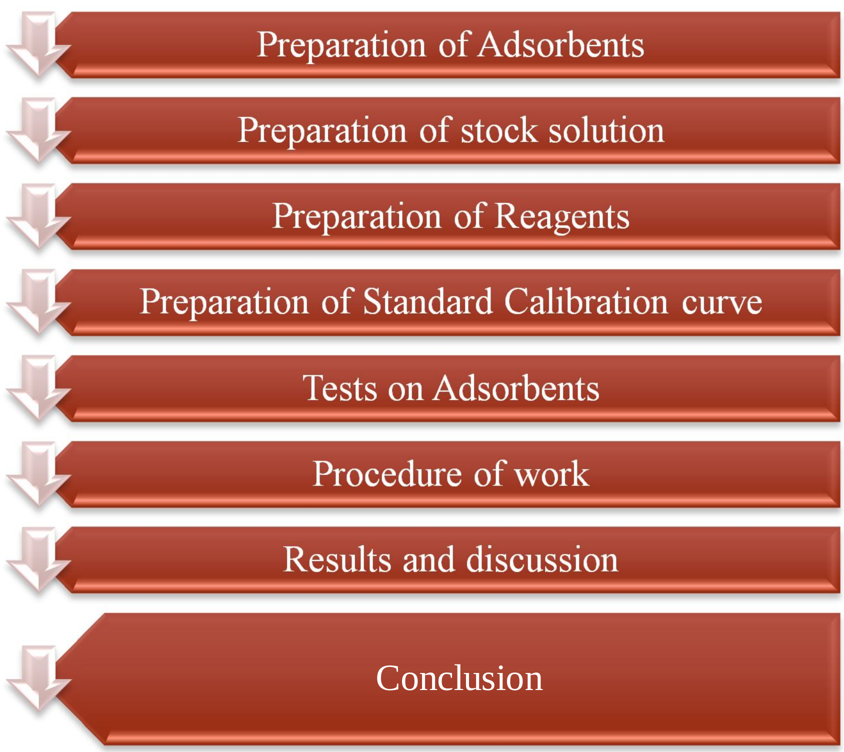
Aleena et al examined the defluorination of water by utilizing Moringa Oleifera and Tulsi. The author's observed that the removal of fluoride increases with an increased adsorbent dosing. The number of adsorbent doses were ranged from 0.1 mg/lit to 0.5 mg/lit in aqueous solutions. The authors also learned that for Moringa Oleifera bio-adsorbents, the maximal withdrawal capability of fluoride was 40% at 0.5 mg/lit while fluoride removal efficiency was 23% at 0.5 mg/lit by utilizing Tulsi as an adsorbent. Furthermore, the Moringa Oleifera seed flour was premier to Tulsi leaves for defluorination.

Sutapa Chakrabarty at al. explored the fluorine disappearance of tap water using neem stem as an adsorbent. The neem stem coal is perceived as an efficient adsorbent the fluoridation of drinking water origin. The adsorbent were effective with 94% efficiency in disposing of fluoride elements from watery solution of 10mg/l fluoride concentration. Biosorption balance was achieved inside 180 mins. The authors observed that the adsorption was dependent on pH and the most extreme adsorption achieved at pH of 5.0.

Bina Rani et al examined the defluoridation of water utilizing brick power as an adsorbent. The adsorbent efficiency of brick power was observed for fluoride removal from drinkable water samples of different concentrations. The writer inferred that adsorption of fluoride on brick power adsorbent from aqueous solution was considered as first order reaction and the mechanism of the removal of fluoride on adsorbent was found to be complex. The presence of other ions in groundwater didn't influence the defluorination procedure, in this way, showing that the brick power is an appropriate and economical adsorbent for fluoride.

III. METHODOLOGY

Flow chart of Methodology



A. Preparation of Adsorbents

1) Preparation of Groundnut Shell Adsorbent

Groundnut Shells were collected, have washed with tap water and dried in sun light for two days. Then dried shells dried again in the hot oven at 100°C for 24 hours. These groundnut shells get crush in mixer and sieved-. Then, the powder of groundnut shells being stored in some container for next use

2) Preparation of Soya chunk Adsorbent

Soya Chunks been collected and dry in sun for two days. This Soya Chunks be grind in a mixer and sieved. Then the powders of Soya Chunks be keep in a container for future utilization.

3) Preparation of Stock Solution

For equipped a regular sodium fluoride stock solution, we dissolve 0.2210gms dry sodium fluoride (NaF) in distilled water and diluted to 1000 ml(100 mg/l). Again, not diluted 100 ml of these stock solution to 1000 ml distilled water(10 mg/l).
1ml = 0.010 mg F.

B. Preparation of Reagents

1) SPANDS solution

Dissolves 958 mg SPANDS [Sodium 2-(Parasulfophenylazo) -1,8- dihydroxy-3, 6 naphthalene desulphonated, also called 4,5-drihydroxy -3-(Parasulfophenylazo) -2,7 - napthalenedisulfonic acid tri sodium salt] in distil watered ant's dilute to 500 ml This solution is stables for at least 1 year if protecting from the direct sunlight.

2) Zirconyl-acid Reagents

Dissolved 133 mg zirconium chloride hexahydrate, ZrOC13.8H20, in approximately 25 mL distilled water Adding 350 mL concentrated HCl and diluting to 500 milliliters with distilled water.

3) Acid Zirconyl-SPADNS Reagent

Mix equalled size of SPADNS solutions and zirconyl-acid reagent. The combined reagent are stabled for almost 2 years.
Spectrophotometer providing light path of 1 cm at 570nm was utilized for analysis.

4) Preparation of standard calibration curve

Fluoride standards were prepared within the range of 0 to 1.40 mg/l through diluting quantities of standard fluoride solution in 50 ml distilled water. Pipette 5.00 ml each of SPANDE'S solution and zirconium acid reagent, or 10.00 ml mixed acid-zirconium-SPANDES reagent, to each standard and mix goodly. Contamination should be not be avoided. Spectrophotometer is to be set to zero absorbance with the reference solution and absorbance readings of standards obtained. An encompassing curve of the milligram's fluoride-absorbance relationship was plotted.

C. Tests on Adsorbent

1) pH

The pH scale is logarithmic, corresponding to the negative of the base 10 logarithm of the molar concentration (measured in moles per litre) of hydrogen ions in a solution. More exactly, it is the negative of the base 10 logarithm of the hydrogen ion's activity. At 25 °C, acidic solutions have a pH less than 7, while basic solutions have a pH greater than 7. The pH's neutral value is temperature dependent, falling below 7 as the temperature rises. The pH might be less than zero for very strong acids and greater than 14 for very strong bases**.**

- Procedure
- Add 10gm of sample to 100ml of distilled water.
- Transfer the sample to a beaker and shake it for 15 minutes at 80 rpm.
- After holding the sample for 15 minutes, the solution is filtered using Whatman paper.
- Use a digital pH metre to test the pH of the resulting filtrate.

- Results:
- pH of soya chunk powder - 6
- pH of groundnut shell powder – 5

2) Electrical conductivity

Electrical conductivity is a measurement of a material's capacity to carry electrical current. Electrical conductivity is also called specific conductance.

- Procedure
- Add 10 gramme of sample to 100 ml of distilled water.
- Transfer the sample to a beaker and shake it for 15 minutes at 80 rpm.
- After holding the sample for 15 minutes, the solution is filtered using Whatman paper.
- Use an electrical conductivity meter to test the resulting filtrate.

- Results:
- Conductivity of soya chunk powder – 5795µS
- Conductivity of groundnut shell powder – 2490µS

3) Specific gravity

Specific gravity is the ratio of a material's density to that of a reference substance; in other words, it is the ratio of a substance's mass to that of a reference substance for the same volume. The apparent specific gravity of a material is the weight of that volume divided by the weight of an equal volume of the reference substance. The reference substance for liquids is almost always water at its densest (4°C or 39.2°F); for gases, it is air at room temperature (20°C or 68°F). Nonetheless, both the sample and the reference must have their temperatures and pressures indicated. Pressure is almost always one atm.

- Procedure
- Wash and dry the density bottle.
- Weigh the empty bottle and cork (W1).
- Collect 5-10 gramme of cooled soil sample in a desiccator. Transfer it to a bottle. Calculate the weight of the bottle and dirt (W2).
- Fill the bottle with soil and distilled water, then weigh it (W3).
- Fill an empty bottle with water and weigh it (W4).

Specific gravity is calculated as

$$\frac{W2-W1}{(W4-W1)-(W3-W2)}$$

= 30-25/(76-25)-(78-30)

= 1.67

Results:

Specific gravity of soya chunk powder =1.67

Specific gravity of groundnut shell powder =0.83

4) Bulk density

Bulk density is a feature of powders, granules, and other "divided" solids, particularly mineral components (soil, gravel), chemical substances, ingredients, foodstuffs, or any other quantities of corpuscular or particulate material. It is defined as the mass of numerous particles of the substance divided by the total volume occupied. The total volume consists of particle volume, inter-particle void volume, and internal pore volume. Bulk density is not a material's intrinsic feature; it can vary based on how it is handled.

- Weighed a 25 mL specific gravity container without a cork.
- Fill the bottle with sample up to the neck edge, tap it 20 times, and weigh.
- Bulk density is calculated by dividing the sample's weight by its volume.

Bulk density $= \frac{W2-W1}{V}$

$=62-25/50 \quad = 0.74$ gm/ml

Results:
Bulk density of soya chunk powder is 0.74 gm/ml
Bulk density of groundnut shell powder is 0.38 gm/ml

D. Procedure of work

1) Study of pH

To investigate the influence of pH on fluoride adsorption onto groundnut shell powder and soya chunk powder, the dose of groundnut shell and soya chunk was held constant at 2g/100 ml, while the pH of the samples was varied using 0.1N HCl and 0.1N NaOH from 4 to 8. Fluoride concentrations were 5 mg/l in all liquids used in the experiment. Adsorption tests were conducted at room temperature. The samples were shaken for 120 minutes at 90 rpm (this speed allowed them to mix and attain equilibrium), then left in the beaker for 24 hours. After 24 hours of checking the fluoride concentration on the spectrophotometer, colour development is to be done by adding 10 ml of acid zirconyl-SPANDS reagent to 50 ml.

2) Study of adsorbent dose

The effect of adsorbent amount on equilibrium adsorption for each fluoride was investigated using groundnut shell and soya chunks weighing 0.5, 1, 1.5, 2, and 2.5g in five sets of 100 ml water containing 5 mg/l of fluoride concentrations each, at pH 6 for soya chunk and 7 for groundnut shell. The samples were shaken at 90 rpm at room temperature for 120 minutes and then left for 24 hours. The water samples were then filtered through Whatman filter paper and analysed for fluoride levels. The identical technique was followed with both adsorbents.

3) Study of initial concentration

The effect of the initial concentration on the equilibrium adsorption of each fluoride was examined using soya chunk and activated groundnut shells at 5, 10, 15, 20, and 25 mg/l in five sets of 100 ml water at pH 6 and 7, respectively. The samples were shaken at 90 rpm at room temperature for 120 minutes and then left for 24 hours. The water samples were then filtered through Whatman filter paper and analysed for fluoride.

4) Study of contact time

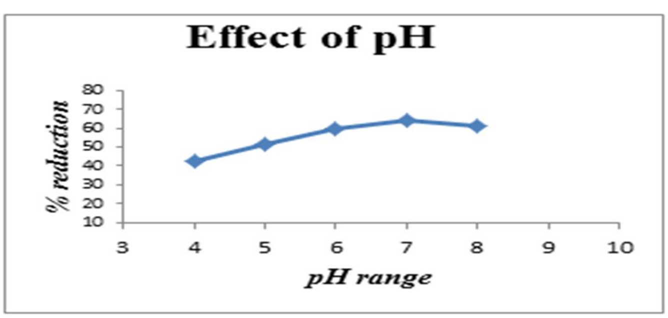
The effect of contact time on fluoride equilibrium adsorption was examined using groundnut shell and soya chunk for 20, 40, 60, 80, and 100-minute contact times in five sets of 100 ml, each containing 5 mg/l of fluoride at pH 6. The samples were shaken at 90 rpm at room temperature for 120 minutes and then left for 24 hours. The water sample was then filtered using Whatman filter paper and analysed for fluoride levels, and the same procedure was repeated with groundnut shell powder

IV. RESULTS AND DISCUSSION

A. Groundnut Shell Powder

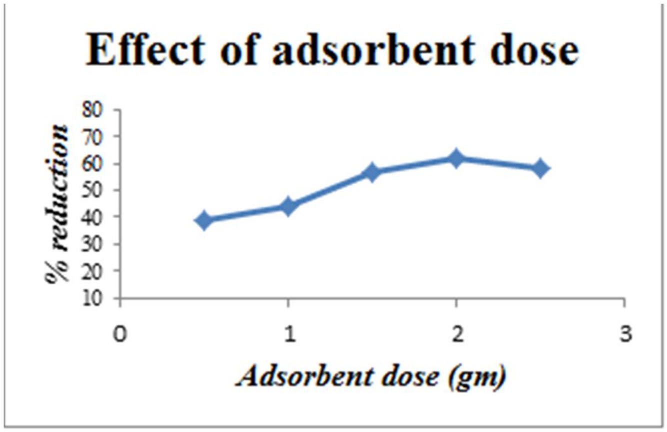
1) Effect of pH

The influence of pH on adsorption was investigated by altering the pH value from 4 to 8. The graph demonstrates that the adsorption of fluoride ions increases from pH 4 to 7, then decreases. At pH 7, the highest adsorption occurs, with fluoride ions being removed at 64.42% efficiency.



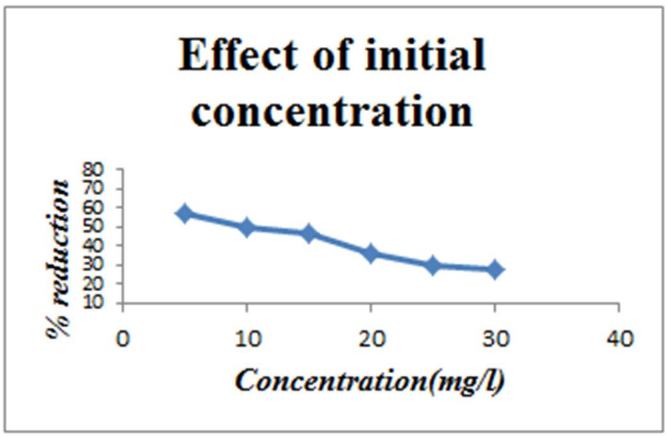
2) Effect of adsorbent dose

The effect of adsorbent dose on adsorption was investigated by altering the dose between 0.5 and 2.5 gm. The graph demonstrates that the adsorption of fluoride ions increases from 0.5 gm to 2 gm, and then decreases slightly. The highest adsorption occurs at a dose of 2 gm, resulting in 61.88% fluoride elimination.



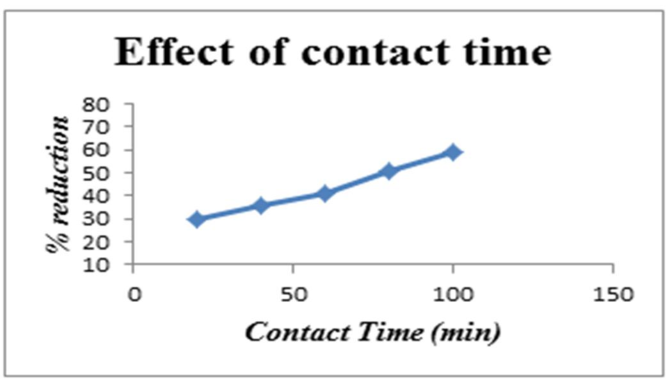
3) Effect of initial concentration

The effect of initial ion concentration on adsorption was investigated by increasing the concentration from 5 to 30 mg/l. The graph shows that the adsorption of fluoride ions is decreasing from 5 to 30 mg/l. The highest adsorption occurs at a concentration of 5 mg/l, with 57.5% clearance.



4) Effect of contact time

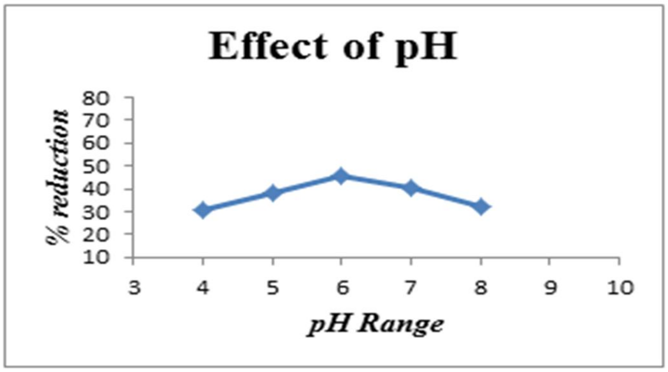
The effect of contact time on adsorption was investigated by altering the duration from 20 to 100 minutes. The graph shows that the adsorption of fluoride ions increases from 20 to 100 min. At 100 minutes, the greatest adsorption occurs, with fluoride ions being removed by 58.76%.



B. Soya chunk powder

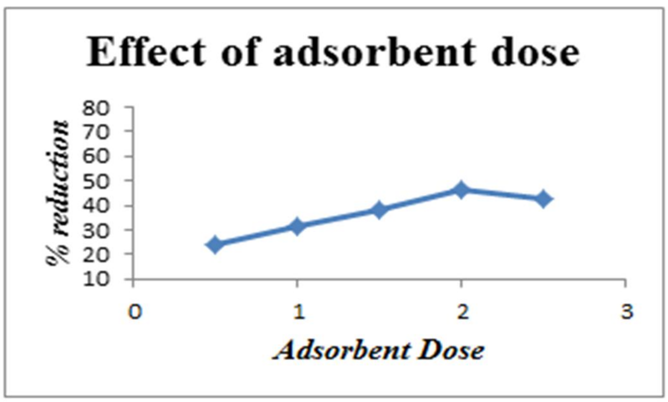
1) Effect of PH

The influence of pH on adsorption was investigated by altering the pH value from 4 to 8. The graph demonstrates that the adsorption of fluoride ions increases from pH 4 to 6, then decreases. At pH 6, the highest adsorption of fluoride ions occurs, with a removal of 45.66%.



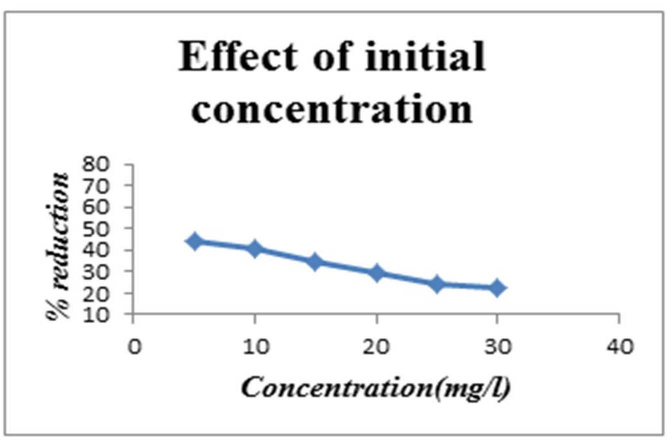
2) Effect of adsorbent dose

The effect of adsorbent dose on adsorption was investigated by altering the dose between 0.5 and 2.5 gm. The graph demonstrates that the adsorption of fluoride ions increases from 0.5 gm to 2 gm, and then decreases slightly. The highest adsorption occurs at a dose of 2 gm, with 46.5% fluoride ion elimination.



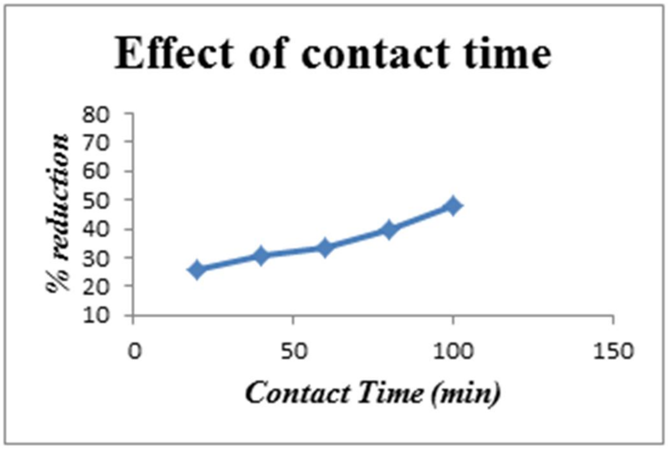
3) Effect of initial concentration

The effect of initial ion concentration on adsorption was investigated by increasing the concentration from 5 to 30 mg/l. The graph shows that the adsorption of fluoride ions is decreasing from 5 to 30 mg/l. The highest adsorption occurs at a concentration of 5 mg/l, with a clearance rate of 44.4%.



4) Effect of contact time

The effect of contact time on adsorption was investigated by altering the duration from 20 to 100 minutes. The graph shows that the adsorption of fluoride ions increases from 20 min to 100 min. For soya chunk powder, the highest adsorption occurs at 100 minutes, with 48.2% elimination.



V. CONCLUSION

1) Groundnut shell powder reduces fluoride ions by 55% to 65% for all optimal values, while soya chunk powder reduces them by 40% to 50%.
2) Soya chunk and groundnut shell have the highest percentage of fluoride ion elimination at pH 6 and 7, respectively.
3) Increasing adsorbent dosage led to higher % removal, with a maximum of 2 g for groundnut shell and soya chunk.
4) Adsorption decreased with increasing initial fluoride ion concentration. Both adsorbents achieve their highest percentage removal at an initial concentration of 5mg/l.
5) For both adsorbents, the maximum percentage removal occurs after 100 minutes of contact time.

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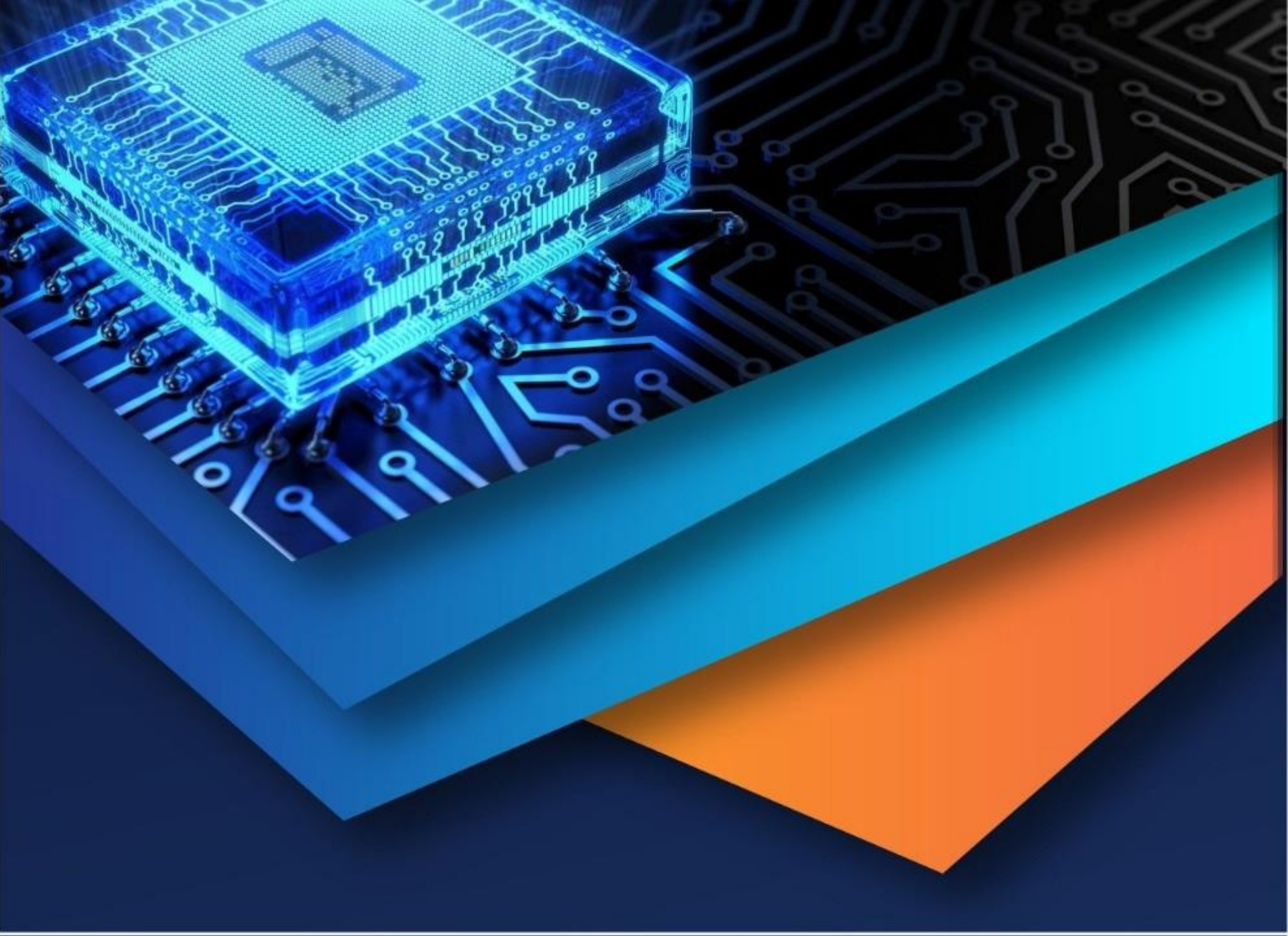

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