Removal of Fluoride from Water Using Low Cost Filter Materials with Various Combinations

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Abstract— **Fluoride content in ground water is now a global problem, which affects more than 21states of India. Most of Ground water in the West Bengal and Eastern states are contaminated with Fluoride. Clean water use being a prime concern in many communities of developing country. Fortunately, efficient and cheap water purification systems are being utilized and tried to be accessed worldwide for easy access to clean water. The present work is deals with the usage of low-cost material such as rice husk ash, quartz sand etc., for removal of fluoride from water with various combinations which is benefit to human society for purification of water**

Index Terms— **Fluoride; Ground water; low-cost material; Rice husk ash; Quarzite**

I. INTRODUCTION

Ground water is undoubtedly the most essential resource for mankind's survival and development. Water pollution has become an inevitable and yet serious problem for human consumption. Fluoride exists fairly abundantly in the earth's crust and can enter groundwater by natural processes. Fluoride in drinking water has an intense effect on teeth and bones. Up to low level Fluoride concentration 1–1.5 mg/l, this gives strengthens the enamel. Concentrations of Fluoride in the range of 1.5–4 mg/l result in dental fluorosis whereas with prolonged revelation at still higher fluoride concentrations 4–10 mg/l result dental fluorosis progresses to skeletal fluorosis. Concentrations of high fluoride in groundwater more than 30 mg/l, occur widely, in many parts of the world [1-3].

Examining the concentration of fluoride in different areas might help to ascertain proper preventive measures. Due to the effects of fluoride on human health, Fluoride concentration level in water supplies have been the subject of various recent studies [4].

The fluoridation discusses things to see the dynamics of science and power. To time the dominant description has been that water fluoridation is safe and effective; with advocates state the strong scientific support and the endorsement of the practice by major dental and public health bodies as evidence of its effectiveness [5].

Among the unit operations in water treatment adsorption occupies a significant position. Operations of adsorption exploit the capacity of certain solids preferentially to build up specific substances from solution onto their surfaces [6]. Sorption, which is a general term introduced by McBain [7], it includes discriminating transfer to the surface, and for into the bulk of liquid. In a general adsorption method, the adsorbed solutes are referred to as adsorbate and the adsorbing agent is the adsorbent.

Activated alumina is a granular form of aluminium oxide (Al_2O_3) having high internal surface area, usually in the range of 200-300 m^2/gm. This high surface area helps a very large number of sites where adsorption can occur. Activated alumina has been widely used for removal of fluoride from drinking water [8, 9].
The studies reveal that chloride and sulfate ions have slightly effect on the fluoride removal capacity of activated alumina but bicarbonates have a considerable effect on fluoride removal efficiency of activated alumina [10].

In addition to activated alumina, clays and soils spent bleaching earth, rare earth oxides, fish bone charcoal and bone char were studied as adsorbents for fluoride removal from water [11-13].

The studies deal the removal of fluoride by fresh leaves powder obtained from neem, pepal and khair trees. The result proved that low-cost bio-adsorbent could be effectively used for the fluoride removal ions over a wide range of initial fluoride ion concentrations and the removal efficiencies decrease with high initial fluoride concentration [14]

From various literature surveys, fixed-bed column studies for removal of fluoride from water are still in the very infancy. Column study is compared with other adsorption studies in tabulated form, which revealed that column study is better, easy, simple, economical and feasible for industrial for removal of various contaminations from water [15].

The present study deals with the removal of fluoride from water using natural materials like rice husk, rice husk ash, quartz sand which has more adsorbing capacities by column operations.

II. MATERIAL AND METHODOLOGY

A. Material

The following various adsorbent materials collected, preserved and prepared for experimental process. The fluoride solution is prepared by 22mg of sodium fluoride (NaF) in 10ml of distilled water.
The pH of water is maintained with in ranges of drinking water (pH- 6.5 -8.5)

1) Rice Husk:
The rice husk was obtained from a local mill was
sieved through IS Sieves of 150 microns and 300 micron size which has a geometrical size of 212 microns was used in all experiments. The apparent density of rice husk is 0.4 to 0.7g/cm3.

Fig. 1 Rice Husk

2) Rice Husk Ash:
The rice husk ash can be prepared from dried rice husk Packed in a tin container with multiple pores were kept in a muffle furnace at 3000 C for 3hours.The black husk obtained is rice husk ash.

Fig. 2 Rice Husk Ash

3) Quartz Sand
Silica is good adsorbent of fluoride and it is more in sand,the quartz sand manly composed of silica and quartz. Sand is sievedto obtain size less than 100 microns and were washed several times with deionized water. Finally, the sand was dried in oven at 2500c for 12 hours.

Fig.3 Quartz sand

4) Activated Silica Gel
The activated silica is prepared by washing of rice husk and dried. Then carbonization is done at constant temperature. The rice husk ash is formed. This rice husk ash is added with sodium hydroxide, after carbon and filtrate is formed. To this filtrate add sulphuric acid and water, now precipitated silica is formed.

Fig. 4 Activated Silica Gel

B. Methodology

The principal involved in the study was a adsorption of fluoride ion while passing through the alternate beds. The fluoride ion having negative charge is adsorbed to the alternate beds of coagulants having positive charge, there by reduction in fluoride ion concentration is observed.

Column bed was prepared with three different mediums rice husk, rice husk ash, quartz sand packed one above another with a required thickness shown in figure 5. Each layer is separated by a filter paper. The influent aqueous fluoride solution is allowed to pass through the beds at constant flow in down flow manner. Samples were collected from the exit of the column at regular time intervals and analyzed for residual fluoride concentration.

Experiment procedure is repeated by various depths and with various detention time intervals. Same procedure is to be continued for individual coagulants with varying depths and time. Comparing both the combination removal efficiency and individual removal efficiency and fetching out the optimum removal efficiency of the natural coagulants.

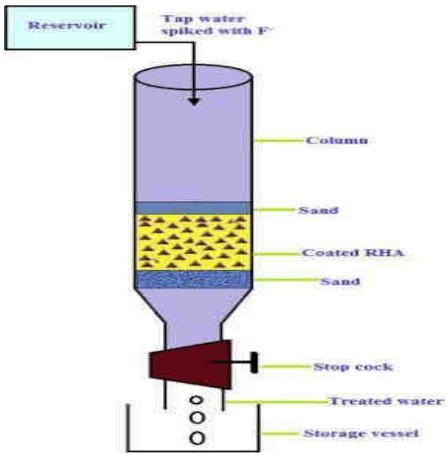

Fig 5 Column Study

III. RESULTS AND DISCUSSIONS

The results of study of the column with various combination of material such rice husk, rice husk ash, quartz sand represented the following paragraphs.

A. Study at different contact time
The coagulants rice husks, rice husk ash, quartz sand were placed in a column one above the other. These are placed for the constant depth of 10 cm of equal proportions and influent fluoride concentration of 10 ppm solution is allowed to pass through it for various detention times shown in table 1.

Table 1 Removal of Fluoride at different contact time

Time (min)	Initial fluoride Concentration (ppm)	Final fluoride Concentration (ppm)	Removal efficiency (%)
20	10	6.0	40
40	10	5.0	50
60	10	4.3	47
80	10	3.7	63
100	10	3.3	67
120	10	3.0	70
140	10	2.9	71

An examination of data presented in table 1, revealed that Fluoride concentration decreased with increase different time treated with combination of coagulants. The Fluoride value decreased from 6.0 ppm to 2.9 ppm. The treatment is effective at contact time 120 min in reducing fluoride Concentration. The decreasing trend of Fluoride values might be adsorption of coagulant material.

B. Study at different depth with constant time

The coagulants were placed in a column one above the other. These are placed for the constant depth of 10 cm, 15 cm and 20 cm of equal proportions and influent fluoride concentration of 10 ppm solution is allowed to pass through at constant time 120 min shown in table 2 .

Table 2 Removal of Fluoride at different depth

Depth	Initial Fluoride (ppm)	Final Fluoride (ppm)	Removal efficiency (%)
10	10	3.1	69%
15	10	2.0	80%
20	10	1.8	82%

Critical scanning of data showed in table 2 indicates that treated Fluoride concentration values decreased with different depth of filter bed. The Fluoride value decreased from 69% to 82%. The decreasing trend of Fluoride values might be adsorption of coagulant material volume increase with increase depth.

C. Study at different pH with constant depth and time

The coagulants were placed in a column one above the other. These are placed for the constant depth of 15 cm of equal proportions and influent fluoride concentration of 10 ppm solution is allowed to pass through at constant time 120 min at different pH shown in table 3.

Table 3 Removal of Fluoride at different pH

pH	Initial Fluoride (ppm)	Final Fluoride (ppm)	Removal efficiency (%)
2	10	1.4	86
4	10	1.6	84
6	10	1.7	83
8	10	1.8	82

Critical analysis of data presented in table 3 indicates that treated water with different pH, Fluoride Concentration increased with increase ph value. The optimum decrease Fluoride concentration is found at pH 2 with constant depth 15 cm and time 120 minutes.

CONCLUSIONS

The study revealed, with natural coagulants such as rice husk, rice husk ash, quartz sand can be used for the effective removal of fluoride using column operation studies. As contact time increases the removal efficiency increased up to around 70%. The depth of bed increases at constant time the Fluoride concentration decreased up to 82%. From this study the optimum decrease Fluoride concentration was found at pH 2 with constant depth 15 cm and time 120 minutes.

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