

Defluoridation of Groundwater using Corn Cob and LECA Balls

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Abstract:

Fluoride accounts for about 0.3 g/kg of the Earth's crust and exists in the form of fluorides in a number of minerals. Any water resource having fluoride concentration above permissible limit 1.5 mg/l (WHO Standards) requires treatment before usage. When the fluoride ion exceeds the permissible limit it causes dental fluorosis and then skeletal fluorosis. In this study, we have collected groundwater sample from 4 different locations (selected on the basis of fluoride existence) in TamilNadu and defluoridated them using our proposed technique which uses corncob (agriculture waste) and leca balls (Cheap Factory made) as adsorbents. Results shows that proposed technique can be practised for defluoridating the water sources for the removal of excess fluoride content. Notably, our proposed technique does not involve any use of chemicals.

Keywords – Defluoridation, Corn Cob adsorbent, LECA Balls, Serial filtration, Fluorosis, Green Technique.

I. FLUORIDE DEPOSITION IN TAMILNADU

Tamilnadu is one of the 19 states with high fluoride contamination in drinking water, this varying from 1.0 to 48 mg per litre as against the World Health Organization's permissible limit of up to 1.5 mg per litre. Report says that patients from Salem, Ariyalur, Srivilliputhur, Trichengode, Namakkal and Dindigul are mostly affected by dental fluorosis and skeletal fluorosis, disease that weaken the teeth and cause joint pain. People in these areas use untested groundwater directly which is high in fluoride. Fluoride monitoring is carried out at 1286 observation wells in the state by the Tamilnadu water supply and drainage board twice a year before and after the monsoon. About 121 blocks in 19 districts have high fluoride concentration in groundwater.

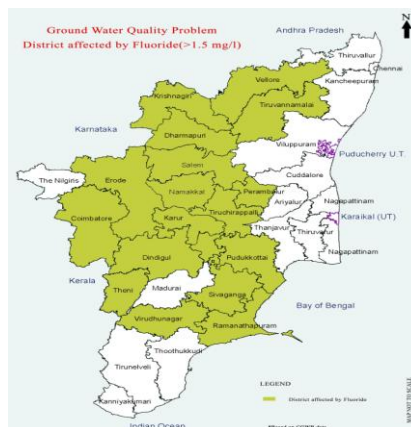


Fig 1.1: Fluoride Affected Districts of Tamilnadu

II. HEALTH EFFECTS OF EXCESS FLUORIDE INTAKE

- The toxic effects of high fluoride intake are due to the fact that it is a direct cellular poison, which binds calcium and interferes with the activity of proteolytic and glycolytic enzymes.
- Enamel fluorosis can develop only in children, as it results from intake of high levels of fluoride during the period of tooth development. It is characterized by the appearance of white areas in the enamel and in this form is considered an aesthetic issue. In the more severe form, reduced mineralization of the enamel results in stained and pitted teeth.
- In skeletal fluorosis, fluoride accumulates progressively in the bone over many years. Early symptoms includes stiffness and pain in the joints. There is an elevated risk of skeletal effects at fluoride intakes above 6 mg/day.

Table 2.1: Fluoride in Drinking Water and Health Effects

Fluoride content in mg/L	Corresponding health effects on human health
< 0.5	Dental caries
0.5 – 1.0	Safe limit
1.0 – 3.0	Dental fluorosis
3.0 – 4.0	Stiff and brittle joints
>4.0	Deformities in knees

III. MATERIALS AND METHODS

A. Collection of Bore Well Samples

Totally 4 samples/location were collected from 4 different locations say Dharmapuri, Theni, Dindigul and Virudhunagar according to the fluoride existence in Tamilnadu. (Source: India Water Portal) All the samples were collected in a pre-cleaned and sterilized polyethylene bottle of one liter capacity. On the arrival to the laboratory it was preserved at 4°C.

B. Materials

Corncob: Corncob was collected from the local agricultural field in Sithurajapuram, Sivakasi, India and was washed with distilled water and then dried in sunlight for one day. Properties of corncob are:

- The corncob has both absorbent and abrasive properties.
- The chaff is on the outside, pith is the soft sponge center and the tough woody ring is from inside.
- The chaff and pith provide absorbency while the woody ring has major abrasive properties.
- It is a durable and renewable resource and 100% environment friendly.

LECA Balls: Lightweight Expanded Clay Aggregate (or) expanded clay is a light weight aggregate made by heating clay to around 1200°C in a rotary kiln. LECA balls have been bought through online service Amazon for Rs.280 (Delivery charge Rs.100) per 3litres pack. Properties of LECA balls are:

- Cleaner than bark-odorless with no mold or mildew.
- Excellent capillary properties.
- Low salt content
- No breakdown or decay
- Cost effective – can be used over.

C. Filter Frame

We have prepared a serial filtration frame such a way that it can adopt layers of different filter media in a single portable laboratory setup.



Fig 3.1: Serial Filter Frame

We have used Corncob pieces, Corncob powder, Corncob charcoal and LECA balls in consecutive filter layers respectively from top to bottom. Each layer is provided with quantitative filter paper also called as ash-free filter paper for better filtration.



Fig 3.2 Filter Materials

D. Analysis for Fluoride

We have analyzed the collected groundwater samples with the help of District Water Testing Laboratory of Virudhunagar (TWAD Board) for the accurate measurement of Fluoride content.

IV. RESULTS AND DISCUSSION

Initially we have tested all the four groundwater samples for fluoride presence. According to the parameter values obtained, we then used only

two samples (Virudhunagar and Theni samples) for filtration because of higher fluoride values.

Table 4.1: Fluoride Presence before treatment

BIS 10500 : 2012	Accept able Limit	Result			
		372 06	372 07	372 08	372 09
Chemical Examinati on	1.0	1	1.2	0.8	1.5
Fluoride as F mg/L					

37206-Dharmapuri; 37207-Theni; 37208-Dindigul; 37209-Virudhunagar

Table 4.2: Fluoride Presence after treatment

BIS 10500 : 2012	Accept able Limit	Result			
		-	372 07	-	372 09
Chemical Examinati on	1.0	-	0.2	-	0.4
Fluoride as F mg/L					

37207-Theni; 37209-Virudhunagar

For sample collected from Theni, we have achieved 83.33% removal efficiency and for sample collected from Virudhunagar, we have achieved 73.33% removal efficiency.

V. SUMMARY AND CONCLUSION

- From the results, it is clearly seen that our proposed Defluoridation technique provides a great difference in Fluoride level in samples before and after treatment.
- Since we have not used any chemical for fluoride removal and produces non-hazardous wastes, our proposed Serial filtration with Corncob and LECA balls can be termed as a Green Technique for Defluoridation.
- When implemented in large scale, our technique will be a very cost effective and green methodology for defluoridating the drinking water.
- The effect of serial filtration on some basic parameters like pH, Color and Turbidity can be studied for further development of the proposed technique.

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