

Electrolytic Defluoridation Technique in Sustainable Manner for Removal of Flouride in Groundwater

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Abstract: This study focus on groundwater quality of which is a high concentration of fluoride problem. Groundwater is the major source of drinking water in both urban and rural in Prakasham District. Markapuram town is located in Prakasham district suffers from fluoride problem due to lime quarries present in that location. These causes serious health problem to the people who are living in this area. The samples of ground water are collected from various locations and tests had been conducted. The water samples were analyzed for chemical parameters pH, Electrical Conductivity, Total dissolved solids, Total hardness, Fluoride, Calcium and magnesium. It is found that drinking water of the region was slightly acidic in nature. The concentration of fluoride in the water samples ranged between 4 and 6 mg/L. Water samples contains fluoride more than the permissible limit as per BIS 10500-2012. The fluoride content should be controlled by the defluoridation technique. We suggest electrolytic defluoridation technology and design details of electrolytic defluoridation plant in Markapuram Prakasham district, A.P.

Index terms: Defluoridation, electrolytic, fluoride, solar energy, ground water.

I. INTRODUCTION

Fluoride is described as the double edged sword, fluorine is a fairly common element of the earth's crust present in the form of fluorides in no. of minerals and rocks. The excess fluoride in drinking water causes harm full effects dental fluorosis and skeletal fluorosis. The WHO guidelines suggested that the optimum fluoride concentration in drinking water should be below 1mg/l for warm climatic conditions and 1.2mg/l for cooler climates .Around the world the highest fluoride concentration found in natural water was 2800mg/l recorded in river nakuru in Rift valley in Kenya. According to UNICEF no. of people affected due to fluoride is 10 millions. In India 15 of 32 states and union territories were identified by UNICEF as endemic for fluorosis. 50-100% of districts are affected in Andhra Pradesh, Gujarat, and Rajasthan. To control the fluoride level we have to do the deflouridiation. There are different techniques for the removal of fluoride in drinking water. The deflouridation techniques are:

- Chemical precipitation-Nalgonda technique, electrolytic deflouridation.
- Absorption technique -Activated alumina, ion exchange, absorbants.
- Ion separation - reverse osmosis, electro dialysis.

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By establishing the water defluoridation plant in the rural areas of south Africa, where the water has heavy content of fluorine in it .By using activated aluminum process for the removal of fluorine and supply the water from the water defluoridation plant to the` rural areas in South Africa and decrease the diseases caused through the fluorine water[1]. The fluorine in drinking water can also be removed by using natural soil in which the process will take in the form of absorption technique for the removal of the fluorine. When we pass the water through that natural soil it will absorb the fluorine content in that sample. By doing like this we can improve the efficiency of the water that we can use for drinking [2]. That fluorine can also be removed by using the natural absorbents such as ragi powder, orange peel powder brick powder, etc. by using those absorbents we will pass the water sample through that absorbents. At last after the passage of water we can the improved the efficiency of water sample we has taken [3]. Water containing fluorine can be removed by using different techniques and those techniques should be communicated and educated to the public, by doing like this we can bring the awareness in public for removing the fluorine in the drinking water by doing like this we can reduce the diseases cause through fluorine[4].

A. Health impacts of fluorine

Dental fluorosis:

An irreversible toxic effect on the tooth forming cells. At a fluoride concentration of 3.5 mg/l, over 90% of children of age group 8-15 years developed dental fluorosis. Fig. 1 indicates dental fluorosis.



Fig. 1: Dental fluorosis

Skeletal fluorosis:

Skeletal fluorosis is a condition associated with prolonged accumulation of fluorine resulting in fragile bones having low tensile strength. Skeletal fluorosis affects children well as adults. Fig. 2 indicates the skeletal fluorosis.



Fig. 2: Skeletal fluorosis

In India there are so many states that are affected due to the fluorine content in the ground water the below figure shows the affected states. Fig. 3 indicates the fluoride content in states of India.

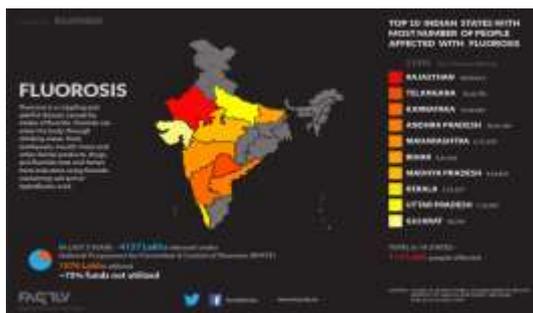


Fig. 3: Fluoride content in states of India

Here in this paper we are focusing mainly on defluoridation of water in sustainable manner by using electrolysis technique by utilizing solar energy which is renewable energy. We are using this technique because other techniques such as Absorption, ion exchange, precipitation techniques will remove fluorine water in small scale but electrolysis defluoridation technique will remove fluorine large scale in the sustainable manner and also it gives more efficiency than the other techniques. an also it requires less maintenance and also it takes less time to purify the water .

So for these reasons we are proposing this electrolytic defluoridation technique in a sustainable manner by using solar energy.

B. STUDY AREA

Markapuram is located at 15.736° N, 79. 2691°E in Prakasam district. There are 21 Villages Markapuram mandal. According to 2011 census Population of Markapuram mandal is 71092, after forecasting population of Markapuram mandal is 90854 (approximately) in 2018. Here fluorosis is the major problem in that region due to the presence of fluoride in the ground water. Samples are taken from different areas of that region and conducted several tests for various chemical parameters and they were compared with the Beuro of Indian standards [10500-2012] and found that content of fluoride in ground water in that region is high as compared to Indian standards. Fig. 4 indicates area of Markapuram.



Fig. 4: Area of Markapuram

II. RESEARCH SIGNIFANCE

The present study aims to control the fluoride problem in the Markapuram mandal and to propose the electrolytic defluoridation technique in a sustainable manner by using the solar energy which is renewable energy. By doing this we can supply drinking water to the people of Markapuram mandal which is use full for the future generation also.

III. MATERIALS AND METHODOLOGY

The materials used in this electrolytic defluoridation plant proto type are as follows:

- The solar panels of [12volts] which produce 10 watts.
- 2 Aluminum electrodes as reactors.
- Water tank capacity of 8liters.
- AC to DC power converter supply unit charge converter.

IV. SAMPLING OF WATER

The sampling of water has been carried out from various points of Markapuram town. Water samples are collected from different locations and the samples are examined.

Table I: Geographical coordinates of the sample collected sites

S.No	Site Code	Sample collected sites	Latitude	Longitude
1.	S1	Akkacheruvu	15.739	79.2643
2.	S2	Bondala Padu	15.731	79.2681
3.	S3	Sivaram Puram	15.738	79.2769
4.	S4	Jamma Pallu	15.742	79.2765
5.	S5	Idupur	15.740	79.2612
6.	S6	Rayavaram	15.734	79.2608

As shown in table the samples are collected from different regions of the Markapuram mandal and conducted the color disk test and compared the samples. Fig. 5 indicates color disk kit.





Fig. 5: Color disk kit

V. METHODOLOGY

For the removal of the fluoride in the drinking water there several techniques and in this paper we focus on the electrolytic defluoridation technique in a sustainable manner. Here for explaining the process of electrolytic defluoridation technique we prepared a prototype.

In this is first we have to place a water tank of capacity 8 liters, and pour the water sample in Markapuram region which contain fluoride in that water, next take 2 aluminum electrodes and place them in the water tank and now take a solar panel of capacity 12v which will produce 10 watts of current , connect that solar panel to the aluminum electrodes in which solar panel will produce the DC power supply.

Here we start the supply of the current to the aluminum electrodes from the solar panel next the electrolysis process will takes place. During electrolysis anode gets ionized and fluoride is removed by complex formation and settling. At last after the electrolysis the fluoride present in that water will form to sludge and that sludge will come to the top of the water tank , and then the water settled down is collected and then that water will be used as the drinking water .

VI. RESULT AND DISSCUSSION

Table II: Fluoride content in the samples

Samples	Fluoride content in taken samples
S1	6.5
S2	8.5
S3	5.5
S4	7
S5	8
S6	11

The Fig. 6 represents the fluoride content in samples that we had collected from the different areas of Markapuram region.

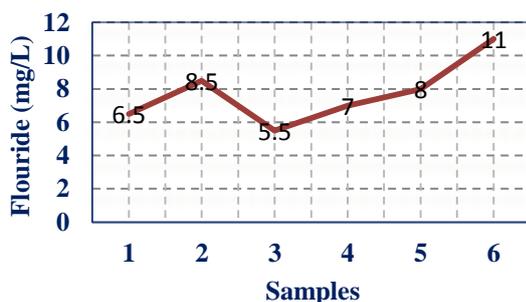


Fig. 6: Fluoride level in taken samples

The above prototype the fluoride content in the drinking water has been removed up to 90%. So that the efficiency of drinking water has been improved.

In the above study we are going to propose a electrolytic defluoridation technique for the removal of the fluorine content in the ground water of the Markapuram in Prakasam district.

According to 2011 census the population of the Markapuram is 71092.this population is increasing year by year by 25% and we are proposing this plant design for 30 years so we have to design for the increasing population for the 30 years also.

For checking the population increase for next decades we have to use the population fore casting technique in that we have to follow the geometric increasing method.

VII. GEOMETRICAL INCREASE METHOD:

This method is suitable because the Markapuram have a rapid growth of population since it belongs to municipality.

Table III: Forecasting population

YEAR	POPULATION	INCREASE D POPULATION	%OF INCREASED POPULATION
1991	45563		
2001	58462	12899	28.31
2011	71092	12630	21.60

$$P_n = P_o (1+r/100)^n$$

$$P_{2021} = 71092(1+0.247)^1 = 97821$$

$$P_{2031} = 71092 (1+0.247)^2 = 1, 05,437.869$$

$$P_{2041} = 71092 (1 + 0.247)^3 = 1, 37,854.2237$$

Per Capita Demand = 135/lit/day/person.
Water demand = 1, 37,854x135 = 18.610x10⁶LD

- Here we had check the population for next 3 decades i.e., 2041.
- By using the geometric increasing technique the population of 2041 is 137854.2237.
- According to Beauru of Indian Standards water required for each person for his daily activities is 135 liters per day.
- So water required for the population of the 2041 is 18.610x10⁶ liters.
- And the cost required to construct the water plant is, according to NEERI the cost required to construct a plant of 1000 liters is 25 rupees
- Now the cost for 18.610x10⁶ liters is 465270 rupees.
- This is the cost required for the construction of the water treatment plant for design period of 30 years.

Here the initial cost is getting high so government has to encourage by providing some of the investment to construct the plant. By using this electrolytic defluoridation plant in a sustainable manner by using solar energy which is renewable will give us the more efficiency than the other techniques which are used for defluoridation of water and

this technique will be used for the future generations also and it requires some less maintenance than compared to other techniques.

From the above prototype the fluoride content in the drinking water has been removed up to 90% so that the efficiency of drinking water has been improved.

VIII. CONCLUSION

From the above study we conclude that electrolytic defluoridation technique is better than compared to other techniques used for defluoridation of water for removing the fluorine in the drinking water.

But in practice to install this electrolytic defluoridation technique by using solar energy it requires high investment and low maintenance and also requires separate land for installation but it will give the more efficiency than other techniques.

So government should release funds and invest on the electrolytic defluoridation technique for solving the fluoride problem in drinking water in sustainable way by using solar energy, which will decrease the diseases occur due to fluoride.

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