

# REMOVAL OF FLUORIDE IN GROUND WATER BY ELECTRO-COAGULATION

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**Abstract** - Groundwater is considered to be vast resource of Indian sub-continent. From several years, Ground water has been exploited for domestic, agriculture and other uses like industries etc. Due to unplanned industrialization, urbanization has led to the untreated waste contamination for ground water. The level of the fluoride content is rapidly increasing in ground water due to certain expedition. The current study presents the adaptive method named electro-coagulation which helps in the removal of the fluoride from the water. From the research, it was studied that the complete removal of the fluoride from ground water possible to 99.5%. The purpose of this paper was to understand how the electro-coagulation method has been an effective and cheap method for the fluoride removal in ground water. The approach was to assemble the fundamental equations of the electro-coagulation in electrolysis of the ground water. Exceeding the level of fluoride content gave rise to skeletal fluorosis in the human body. The parameters that are undertaken are concentration of the fluoride, distance between the electrodes and pH and applied voltage where constituent of fluoride removed from the groundwater is examined in the study. It has been observed that at concentration of 1, 5, 10 mg/L of fluoride solution were prepared by mixing proper amount of sodium fluoride with tap water. At pH 5.5, the effective results are obtained and revealed that the removal capacity of the fluoride through electrodes that are kept at distance of 1 cm can obtain effective results.

**Key Words:** Electrocoagulation, groundwater, cost-effective treatment, Fluoride removal

## 1. INTRODUCTION

Fluoride is one of the most essential elements to the human body. It has been observed the consumption of the fluoride in the water should not exceed above 1.5mg/L. This leads to fluorosis problem in the human being. It has undertaken the range of the semi-arid area and source where the ground water is the only source for drinking water. Fluoride is encountered as important geochemical deposits in Indian sub-continent. There are different channels through which natural fluoride pollution occurs in the environment. It has been examined that the discharge of the wastewater from the industries would lead to heavy contribution in the water reserves especially in ground water. According to Central Pollution Control Board of India, maximum number of the fluoride constituent is directed from industrial wastewater which is around 15mg/l.

Fluoride removal from the contamination from the groundwater has been reluctantly done by using various processes such as adsorption, reverse osmosis, chemical precipitation and Nalgonda technique, ion-exchange and electro-coagulation. Each and every method has their operational importance and constraints.

Electrocoagulation is the method which utilizes wash water treatment and other processed water through radio frequency diathermy or electrolysis of short wave. This method has the ability to remove the contaminants from the water which are more difficult to remove by filtration or chemical treatment systems. A typical electro-coagulation unit consists of electrochemical cell which has been connected metal electrodes and gaining power from DC supply. The only difference observed in the electro-coagulation method is that they generate coagulant from the electrochemical dissolution at anode. Further, the sacrificial anode is however made up of aluminum metal where the aluminum hydroxide flocs are produced. However, the negative charged fluoride ions and precipitated out in the form of sludge.

### 1.1 WHAT IS GROUND WATER

The prominent role of the fresh water might direct on the component that is accessible in surface layer of the environment is the ground water. This water is rapidly decreasing with the increasing intensity of the populations and systematic measures. The significance of the research has directed on the relative groundwater and surface water resources might relate with the climate change in the business. The role of the ground water systems might direct on the knowledge of the issues that are currently being assembled upon the systems that are interlinked. The importance of the ground water has been a severe issue in the India. This might affect the continents and states on global basis if not cured.

### 1.2 IMPACT OF FLUORIDE

Fluoride has significant effects that are enlisted from the dependency of the total fluoride usages. This is commonly examined with the dosage level in the water. This pertinent to have adverse effect on the dental fluorosis and alter the range of appearances for the child's teeth through which the development of the tools and practices can be managed in the business practices. The public health is aesthetic with the effects of the fluoride. Thus, in april 2015, the pollution

board has standardized the level of drinking water and further the United States were changed to 0.7 ppm from 0.7-1.2 ppm and managed with the risk of dental fluorosis. As per the Cochrane review, the estimate range of the fluoride level to around 0.7 ppm. This can manage the percentage of participants with fluorosis. This would approximately upgrade to 12%. This might meet with the fluorosis level and meet with the increase of 40%. This would directly on the US mild or very mild dental fluorosis reported to 20% in the population, moderate to around 2% and more severe fluorosis in around 1%.

The tenure of the fluorosis unending risks is aged to expose between one to four years and are affecting the teeth to around eight years. The role of the fluoridated water and indirect response to the estimated risk from the sources are 40%. It can notably meet with the range of the remaining 60% preventions. The role of the water comparative resources would result in the every fluoridation to around 0.4mg/L. the ratio can be caused support of the aesthetic concern with the base of the every 6 people. It has been found that the people are facing this problem right from the birth and is profound in every 22 people. The term which is utilized can help in scaling up the standards with the range of the adolescents which are unaccepted. Thus, it can be measured with the services that are studied by the Britishers since 1996 and back down to 14 year olds. The industries basically utilize the increase in the unfluoridated range of the communities was mostly carried in the products made from it i.e. toothpaste. The consumption of the Fluoride directly on the systematic review where the formula is evident with the range of the distorted practices. The publication is usually being biased and is based on the evidence and formula to reconstitute the business which can be weakening with the cause of the fluorosis. The aftermath of the fluoride has been reduced and it has mainly due to the increase in the fluorosis problem in the people. In the U.S. it was accompanied by the reduction in the problem through different ways. They are usually done in infant's formulas, water, toothpaste, schedules with the fluoride supplements.

## 2. LITERATURE REVIEW

Sailaja et al (2014) has presented the level of Fluoride content in the drinking water. The people are prone to get skeletal fluorosis and affecting the health of the human being. It access to the present study directs on the iron and aluminum electrodes to which fluoride removal might provide the pH application and voltage and reaction time. The distance between the electrodes can directly on the reactivity and concentration of the high removal capacity. The variants of the fluoride from the aqueous solution might give rise to the concentration and working parameters where the applied Voltage and reaction time has represented the distance between the electrodes. The reactive area gives rise to the higher removal capacity. The concentrations at 1, 5 and 10 mg/L have involved the sodium fluoride with tap water. The pH variation can directly on effects to which the removal of the

efficiency can mark on the synthetic solution. The removal capacity for fluoride could be more productive and additionally managing the most additive form of the capacity that enhances the treatment rate. The effective surface area is found to be 40 cm<sup>2</sup>. This can result in the potential value and benefit with 40V potential electricity. The final distance between the electrodes is around 1 cm. henceforth; the final outcome predicts the surface range to which optimum fluoride dosage can be observed which is suitable for the fluoride removal. The dosage of the fluoride was observed to be 8 ppm. It means that the maximum fluoride removal is obtained at 30V. This presents the neutral balance of the pH with the increasing reactive surface. The Neutral pH would also provide the Fluoride removal at the increased with decrease level in the inter electrode distance.

According to Juarez et al (2014), the most effective method of reducing the organics in the water is electro-coagulation. It has even coupled with the electro-oxidation where the process is imparted with the iron and aluminum range of the solution. The pH is dependent on the effectiveness which is enriched at the range of 7. The density to which the applied balance has been undertaken is 60 mins and at density of 210 A/m<sup>2</sup>. The turbidity range decreased to 94.5% from 95.3%. Henceforth, the COD will also drop to 81%. This is highly observed with the reluctant forces of iron and aluminum electrodes from 84%.

As per Sandoval et al (2014), the fluoride removal has been an effective configuration for the drinking water. The electrocoagulation method leads to utilization of the aluminum anodes. It has been observed that the FTIR analysis, EDA-X and SEM equipments help in providing the information that flocs are slightly present in the water in the form of fluoride. The electro-coagulation leads to the removal of the 10 to 1 mg/l on the density of 4-6 m/Acm<sup>2</sup>. The 0.37kW has been provided in order to flow the rates of 0.91-1.82 cm/s ratio of the fluoride content in the water. It has been favored that the massive generation of the electrolytic gases is disfavored with the fluoride content in the water at  $j > 7$  mA/cm<sup>2</sup>. The investigation to the fluoride content has been undertaken place in the synthetic drinking water where the 10mg/L is the constituent value and inclusion of the sodium sulphate to around 0.5 g/L has managed the Fluoride measures in the water. The conductivity ratio reached to 410  $\mu$ S/Cm directly that the electro-coagulation has sacrificial anode. It has managed the EC test to quantify as per the WHO norms. The SEM, EDA-X and other analysis has been performed.

## 3. METHODOLOGY

The present study involves the chemicals including the Sodium Fluoride (NaF) which is an analytical grade for the study. The variables that are utilized to meet the concentration range from 1-10 mg/l. This can provide the solution which is prepared through mixing the right amount of the sodium fluoride with ground water. The pH is initially

the solution adjusted with the 5, 7 and 9 range. It has involved the sodium hydroxide (1N) as the solution experimentation along with this sodium hydroxide (1N) has been utilized in order to perform the batch reactor. The internal size of the cell is basically presented as follows:

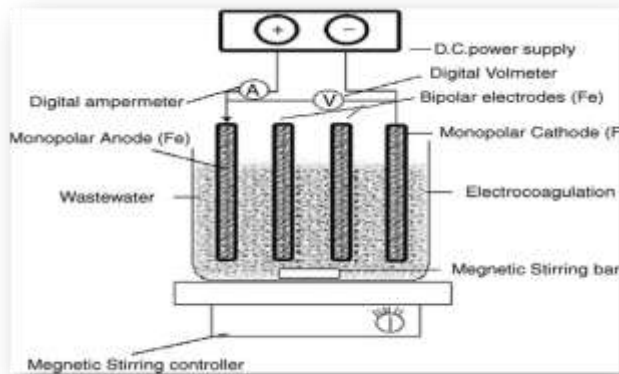


Fig -1: Schematic Diagram of electrocoagulation Process

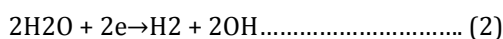
The active area of the electrode and other features totally present the concentration and range of the time intervals for the residual particles for the fluoride and managing the determined concentration using the spectrophotometric method which is standard method.

Consequently the chances of the electrocoagulation process presents the cathode and anode reactions for removing the fluoride by utilisation of the aluminum electrodes are demonstrated as follows

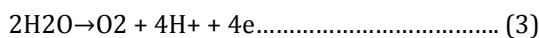
At the anode:



At the cathode:

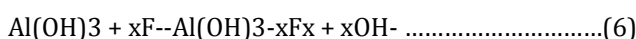
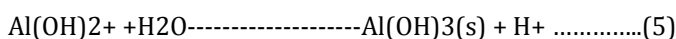
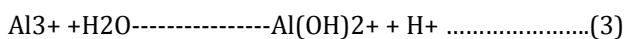


It can efficiently manage the high rate to the secondary reactions which helps in evaluating the oxygen level



The key range of the Aluminum level by electrolytic range to anode which can be foreseen through equation 1 and presenting the hydrolysis of the monomeric species.

According to the following sequence:



**4. RESULTS AND DISCUSSION**

An important parameter that has decided the removal of the pollutants in the initial concentration of the groundwater has been included in the study. So, right removal of fluoride efficiency decrease with increase in the concentration level of

the water for the same applied. It is an evident due to the amount of the metal oxides rocks formed might be insufficient in removal of the fluoride molecules at the higher initial fluoride concentration. The concentrations initially the fluoride molecule readily populated in the velocity of the sacrificial anode. But as the treatment time process increased diffusion resistance to the movement to the surface of the anode reduce the rate of the electro-coagulation.

Table -1: Effect of Fluoride concentration in ground water

Initial Conc. (ppm)	pH	Conductivity (µm)			TDS (ppm)		Turbidity (NTU)		Resistivity (Ohm)	
		Initial	Final	Final	Initial	Final	Initial	Final	Initial	Final
5	7	8.02	1812	1234.56	1002	654	1.93	0.82	0.623	1.102
10	7	8.11	1683	997.6	589	537	0.89	0.45	0.745	0.886
15	7	8.58	1173	778.12	668	423	1.23	0.93	0.704	2.011
20	7	8.67	1419	745.37	478	289	1.34	0.76	0.756	1.291
25	7	8.68	1301	613.9	447	245	2.13	0.73	1.034	1.543

**Effect of pH**

The different results of PH and color reductions varying pH are thanks to quality and quantity of hydroxide ions generated at particular pH. Variety of components like proteins, Carbohydrates, lignin are present in ground water. they need various functional groups with electric charge that react with Fe and its charged hydroxides, e.g. FeOH<sup>2+</sup> etc. the amount of electrode loss, formation of Fe<sup>2+</sup>, Fe<sup>3+</sup>, Fe(OH)<sub>2</sub>, Fe(OH)<sub>3</sub>, and monomeric and polymeric hydroxide species varied with pH. At pH < 8, protons within the solution get reduced to H<sub>2</sub>. Consequently, the proportion of the hydroxide ions produced is a smaller amount, resulting in lower pH removal efficiency. Maximum PH reduction 75% was obtained at pH and 5.53 Ampere current. The pH solutions are efficiently handled on the following parameters.

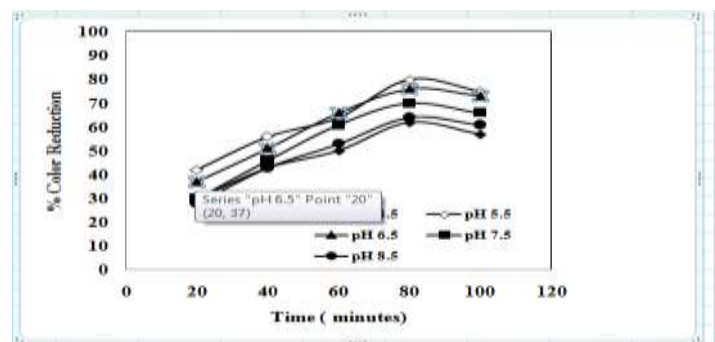
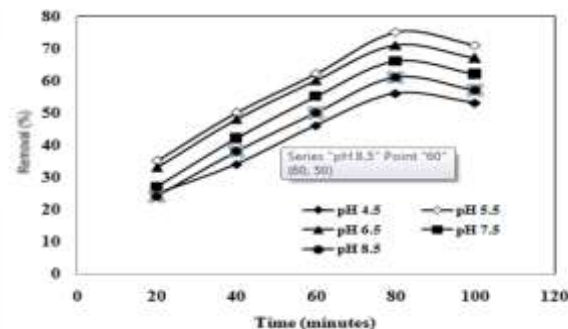


Chart -1 and 2: effect of pH on ground water by electrocoagulation method using SS304 electrode, pH= 8913 mg/dm<sup>3</sup>.



The key aspects of EC process come from the word electrolysis which has efficiently managed to gain the support of electrolytes. It is efficiently manages to enhance the conductivity of the across medium and managing the current of electrode that is positive and moves to cathode and negative ions to anode. It is certainly raise the anions are oxidized and cations are reduced.

	Chemical Precipitation	Activated Alumina	R.O.	Electro coagulation
Efficiency	Lowest	Low	Very High	Very High (Almost 100%)
Treatment Cost	10 – 12	10 - 14	60	8-10
Treatment Time	2 – 4 Hrs	Very Slow flow	Continuous	90 min
Water Recovery	High	High	50-60%	Very High
Regeneration/ Maintenance	Not Required	Regeneration + Backwash	Required	Not Required
Man Power	Requires manpower		Skilled Manpower	Unskilled Person
Sludge	Maximum	High	High	Lowest
Disinfection	No	No	Yes	YES

The electrochemical mechanism is a quite complex process which has possibly followed the mechanism of electro-coagulation and electro flotation. it has established the suspended emulsified or dissolved contaminates by introducing an electric current into aqueous medium that parallel metal electrodes connected in a monopolar or bipolar or dipolar range helps in carrying out the process. The different methods of the treatment of the fluoride in groundwater however the electrocoagulation is considered to be an eco-friendly and economical viable process that has been used in the study.

## 5. CONCLUSIONS

The electro-coagulation (EC) process proved to be an efficient method for the removal of fluoride from ground water. The experimental process that's accounted will help in providing the reduction details of the percent of the fluoride compound within the water and also provide crystal clear water for drinking. However, it's predicted that complete removal isn't possible. Electrocoagulation technology has achieved grade of applicability and hence examined as potential defluoridation technology.

It is highly compared with traditional flocculation-coagulation, electrocoagulation has the advantage of removing the tiniest colloidal particles and comparatively low amount of residue generation. In spite of getting numerous advantages, EC has some drawbacks like the periodic replacement of sacrificial anodes. Also it requires a

minimum conductivity reckoning on reactor design that limits its use with water containing low dissolved solids. Additionally the control of residual aluminium, technical and economical optimization of the method per the standard of water being treated must be taken into considerations. Although large numbers of studies are available in literature further studies are required to elucidate the potential and limitations of the method. so as to proportion the strategy, the longer term work should be focused on investigating the influence of assorted operational parameters including duration, energy consumption and initial fluoride concentration in addition as interference from factors like calcium ions in effluents.

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