FLUORIDE REMOVAL USING INDUSTRIAL WASTE: A CASE STUDY OF JAIPUR CITY

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ABSTRACT

'Green Chemistry' provides various tools and techniques including the ion-exchange, adsorption, reverse osmosis, precipitation and many more as some usual means of defluoridation. Batch adsorption studies were undertaken to assess the suitability of commercially available bricks powder used in fluoride-contaminated water. The effects of some of the major parameters of adsorption,viz, dose of adsorbent, contact time and initial adsorbate concentration on fluoride removal efficiency were studied and optimized. Maximum fluoride removal was observed to be 94% at optimum conditions. Freudlich as well as Langmuir isotherms were plotted and kinetic constants were determined.

Key Words: Fluoride, adsorption, Bricks powder, Freundlich isotherm, Langmuir Isotherm

INTRODUCTION

Many countries have regions and the water contains more than 1.5 mg/l of fluoride due to its natural presence in the earth's crust, or discharge by agricultural and industrial activities, such as steel, aluminium, glass, electroplating (Amor Z et.al,1998, Hasany SM, et.al, 1996, Cohen D, et.al, 1998). Precipitation of fluoride with calcium and aluminium salts (Saha S , 1993) has been used to remove fluoride from industrial wastewater. The chronic disease manifested by mottling of teeth in mild cases, softening of bones and neurological damage in severe cases (Wang Y, Reardon EJ,2001, Lounici H et.al,1997, Srimurali M et.al,1998, Hichour M et.al, 2000). Use of Marble Slurry Powder Waste for Defluoridation: A Case Study of Jaipur City (N.kumar et,al,2017.)

High fluoride levels in drinking water has become a critical health hazard of this century and induces intense impact on human health including skeletal and dental fluorosis (S. Ayoob; A.K. Gupta, 2006). Physico-chemical analysis of water of Jaipur city and its defluoridation by using brick powder and marble slurry powder: a green approach to utilize industrial wastes (N.kumar et,al,2016). Free fluoride level in drinking water was identified at 3.02 mg/L in Kadayam block of Tamilnadu (G. Alagumuthu , 2008). Fluoride survey in Nilakottai block of Tamilnadu and positive correlation between prevalence of dental fluorosis in children and levels of fluoride in portable water is 3.24 mg/L (G. Viswanathan et.al, 2008). Many natural and low cost materials such as red mud (Y. Cengeloglu et.al, 2002), (A. Tor et.al,2009), zirconium impregnated coconut shell carbon (R. Sai sathish et.al, 2007), cashew nut shell carbon (G. Alagumuthu et al, 2010), ground nut shell carbon (G. Alagumuthu , 2010) and clays (Ali Tor , 2006) have been used as adsorbents for fluoride removal from drinking water. Physico-Chemical Analysis of Ground Water of Difference Places in Jaipur City and its Defluoridation by using Marble Slurry Powder(N. Kumar et al, 2017).

Geographical Details of Rajasthan: Rajasthan is located in the north western part of the subcontinent. It is bounded on the west and northwest by Pakistan, on the north and northeast by the states of Punjab, Haryana, and Uttar Pradesh, on the east and southeast by the states of Uttar Pradesh and Madhya Pradesh, and on the southwest by the state of Gujarat. The Tropic of Cancer passes through its southern tip in the Banswara district. The state has an area of 132,140 square miles (3,42,239 km2) and

subdivided in 33 districts. The capital city is Jaipur.

Geographical Details of Jaipur: Geographical area of Jaipur district is 11,117.8 Km2. Total number of villages is 2380. It is situated in the east of Rajasthan state. It is bounded by Sikar district on the North, Haryana state is northeast, Alwar and Dausa districts are east, Sawai Madhopur district is southeast ,Tonk district on the south, Ajmer district on the west and Nagaur district on the northwest. East and North area of Jaipur district is surrounded by Aravalli hills. Temperature remains relatively high throughout the year, with the summer months of April to early July having average daily temperatures of around 30 °C (86 °F). The winter months of November to February are mild and pleasant, with average temperatures ranging from 15–18 °C (59–64 °F) and with little or no humidity. The Study Area (Jaipur City) is divided into four different zones for convenience of the present study area.

Method and Materials

3.1 Materials:- The glassware was washed off with nitric acid and distilled water before use. First, a stock solution of 100 mg F/L was prepared by dissolving appropriate amount of sodium fluoride (NaF) in distilled water and desired concentrations of working solutions were then prepared from stock solution. Naturally Abundantly available low cost materials like Bricks powder was obtained from a local kiln. The Bricks powder was washed several times with distilled water till clear water was obtained and it is dried in oven at 105 ºC for 12 h. The dried material was sieved to obtain particles, of size 300 μm.

3.2 EXPERIMENTAL

Fluoride concentration was estimated by SPADNS (Trisodium-4, 5 Dihydroxy-3-(p-sulfophenylazo) -2,7-naphthalene disulfonic acid) method using a spectrophotometer.

Ground water samples collected from various places of Zone – I of Jaipur city was studied for defluoridation under the feasible optimized conditions to check the suitability of the bricks powder adsorbent under field conditions. The physico-chemical properties of ground water samples were determined before and after treatment by brick powder.

On physicochemical characterization of the water samples collected from various location of Jaipur city. We observed interesting changes in the values of different parameter including pH, EC, TDS, total alkalinity, total hardness, chlorides ions, and fluoride, after using marble slurry powder as an adsorbent. The values before treatment and after treatment are summarized in Table-1

Physico-chemical characterized of water sample

Ground water samples collected from Jaipur city was studied for de-fluoridation with conditions to check the suitability of the marble slurry powder adsorbent under field conditions. The physicochemical characterization of ground water samples was determined with marble slurry powder. Fluoride was decreased with marble slurry powder

Table-1 The values before and after treatment are summarized in the table:

S. No.	Name of location	pH		EC		TDS		Total Alkalinity		Total Hardness		Chloride ion		Fluoride ion	
		Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)	Before Treat.	After Treat.(MP)
1	KhiriniPhatak	10.2	9.8	0.61	0.72	390	410	225	210	30	38	80	65	1.678	1.501
2	Ghotwara	9.6	9.4	0.42	0.51	268	286	125	110	75	80	70	55	0.465	0.412

3	**Dadika phatak**	9.8	9.6	0.33	0.38	212	250	165	150	45	50	40	30	.375	0.310
4	**Nadika phatak**	9.8	9.6	0.38	0.45	264	280	160	150	55	60	50	35	1.745	1.612
5	**Niwaru Road**	9.9	9.8	0.64	0.75	409	470	170	155	40	48	90	75	0.486	0.425
6	**Khatipura**	8.6	8.5	0.45	0.53	285	305	90	80	90	95	70	55	0.396	0.316
7	**Vaishalinager**	8.7	8.5	0.39	0.49	254	285	100	90	65	70	60	45	1.836	1.689
8	**Military area**	8.7	8.5	0.38	0.50	244	290	100	90	75	82	80	65	1.768	1.628

(i) pH

pH depends on H^+ ions concentration present in a ground water sample and it is an important indication of water quality. The pH is maximum in the main khirni phatak site (10.2) and minimum at khatipura site (8.6).

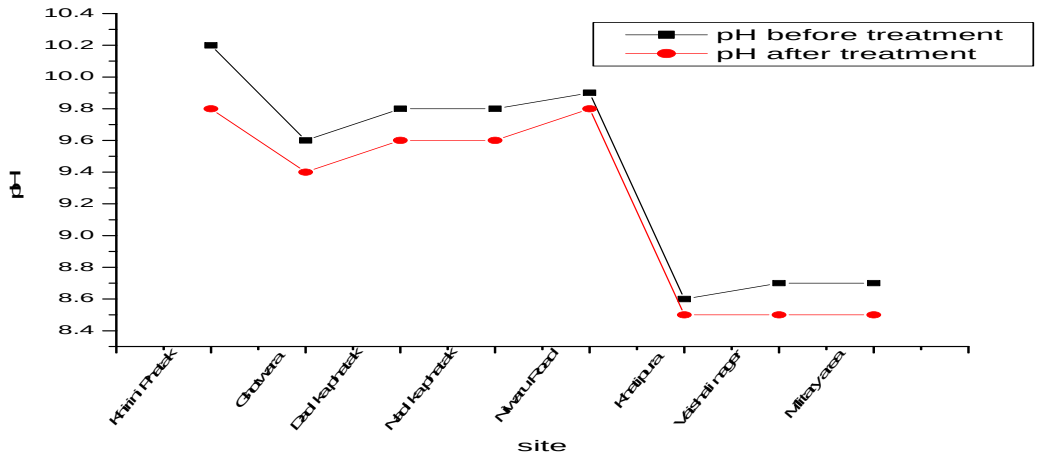

Fig.- 33: Comparison of pH before and after treatment with marble slurry Powder

(ii) **Electro Conductivity (EC)**

Electro conductivity depends on dissolved ion concentration and it is measured by the electro conductivity meter. The maximum electro conductivity is at the Niwaru Road site (0.64mho$^-$) and lower level found at Dadikaphatak (0.33mho$^-$).

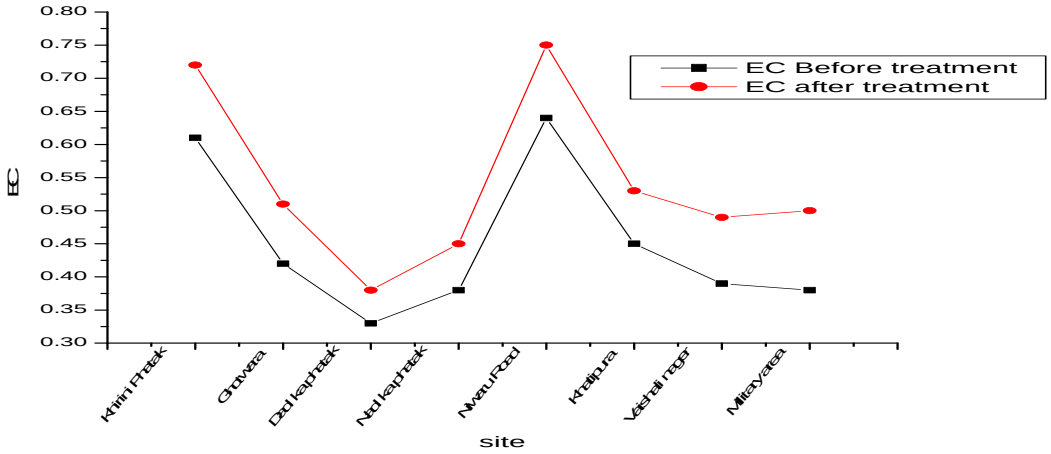

Fig.- 34: Comparison of total electric conductivity (EC) before and after treatment with marble slurry Powder

(iii) **Total Dissolved Solid (TDS)**

Studies of total dissolved solid (TDS) concentration were analyzed by gravimetric method. It consists of HCO_3^-, SO_4^{-2} and Cl^- of calcium, sodium and magnesium ions as a major part. It is found in maximum concentration at the Niwaru Road site (409ppm) and lower level found at Dadikaphatak site (212ppm).

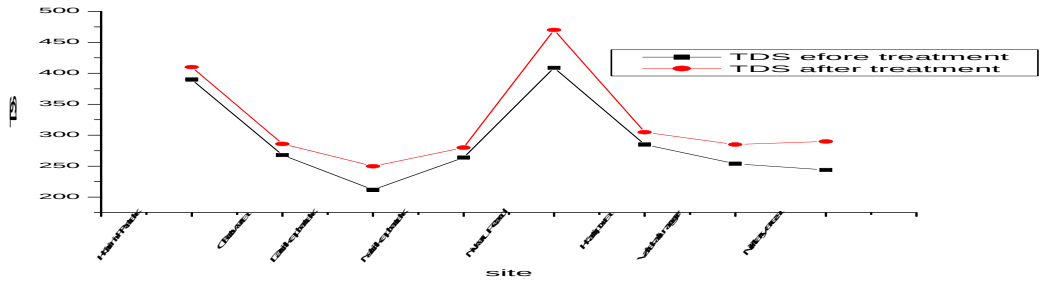

Fig.- 35: Comparison of total dissolved solid (TDS)present before treatment and after treatment with marble slurry Powder

(iv) Total Alkalinity

The alkalinity of ground water sample was determined by titration method and it depends on OH^- ions concentration. The alkalinity is found to be in maximum at the main khirni phatak site (225ppm) and lower level at khatipura site (90ppm).

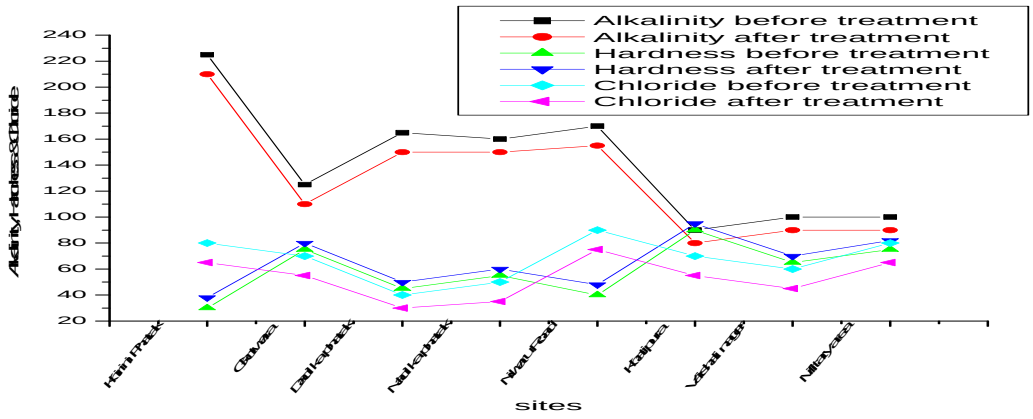

Fig.- 36: Comparison of total alkalinity, hardness & chlorides ions present before treatment and after treatment with marble slurry Powder

(v) Total hardness

The total hardness is determined by EDTA method and it depends on carbonate, bicarbonate of calcium magnesium salt, chlorides sulfate and heavy metal. It is maximum level at khatipura site (90ppm) and lower level of khirni Phatak (30ppm).

(vi) Chloride Ions

Chloride ion concentration is determined by silver nitrate titration method. The chloride concentration range is from 40 ppm to 90 ppm. The maximum chloride ions are present at the Niwaru Road site (90ppm) and lower level at the Dadi ka Phatak site (40ppm).

(vii) Fluoride

The studies on the initial fluoride concentration were conducted by SPAND method using an adsorbent dose of 2.0 g/100 ml, and contact time of 15 minutes. The fluoride is removed by adsorption method and comparison of fluoride in water sample before treatment and after treatment with marble slurry powder. The fluoride is found in maximum concentration at Vaishali Nagar (1.836ppm) and lower level found at dadi ka phatak site (.375ppm).

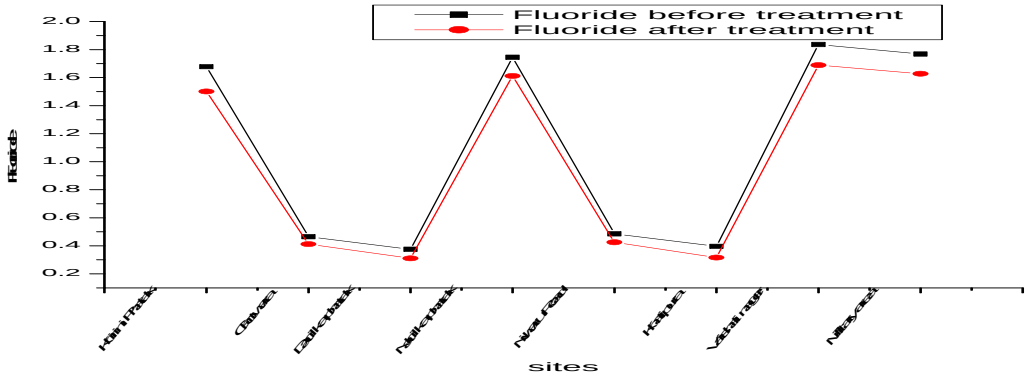

Fig.- 37: Comparison of fluoride present before and after treatment with marble slurry Powder

Conclusion

In the present study, marble slurry powder was used as adsorbents for removal of fluoride from various ground water samples of different fluoride concentrations. The maximum fluoride is present in vashali nager and lower level of fluoride is Dadi ka Phatak sites. Fluorides are measured by SPANDS method. The main conclusions that can be drawn from the above study are given as: adsorption of fluoride on marble slurry powder. Presence of others ions in groundwater did not significantly affect the defluoridation process thereby indicating that marble slurry powder is selective adsorbent for fluoride. High concentration of fluoride may also cause harm to the ecosystem and vegetation.

Acknowledgement

Author (NK) thankfully acknowledge the scholarship given by President, JECRC University for his Ph.D. work.

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