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Use of Marble Slurry Powder Waste for Defluoridation: A Case Study of Jaipur City

Naresh Kumar*, Nidhi Bansal and Sanjay K. Sharma

*Green Chemistry and Sustainability Research Group, Department of Chemistry,
JECRC University, Jaipur-303905, **INDIA**

Email: nareshamansharma@gmail.com

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ABSTRACT

Large number of people are in rural areas are dependent on ground water for drinking purpose. The present study investigates the study of fluoride in the level of groundwater of different area in jaipur city of Rajasthan state and collecting from bore wells and hand pump. In the current research paper by employing SPANDS method, fluoride ion concentrations in water were determined spectrophotometrically at 570 nm. First and then marble slurry powder was used as adsorbents in defluoridation of water. In this paper, dose of adsorbents, contact time and concentration of fluoride ions will be discussed with their interdependence.

Keywords: Fluoride, marble slurry powder, Analysis of study area.

INTRODUCTION

The presence of fluorine in drinking water, are permissible limits of 0.5–1.0 mg L^{-1}, is beneficial for the production and maintenance of healthy bones, teeth and excessive intake of fluoride causes dental or skeletal fluorosis. The chronic disease manifested by mottling of teeth in mild cases, softening of bones and neurological damage in severe cases [1- 5]. Many countries have regions and the water contains more than 1.5 mg L^{-1} 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 [6 - 8]. Precipitation of fluoride with calcium and aluminium salts[9]has been used to remove fluoride from industrial wastewater. Then, aluminium salts are used to reduce the fluoride concentration [10]. The solubility of CaF2 is theoretically 8 mgL^{-1} fluoride at stoichiometric concentrations of calcium; and when a large dosage of calcium is used, the concentration of fluoride in water and the pH of treated water is at a relatively high value, resulting in a supplementary difficulty of eliminating excess chemicals [11].

Adsorption is another technique, in which fluoride is adsorbed onto a membrane, or a fixed bed packed with resin or other mineral particles. Many techniques have been reported, like reverse osmosis, electrodialysis, Donnan dialysis, ion exchange, limestone reactor and activated alumina column [12]. The efficiency of this technique mainly depends on adsorbents and ion exchange, electrodialysis and membrane processes are effective and can remove the fluoride to a suitable level, but they are expensive and require

frequent regeneration of resin beads or membrane and cleaning of the scaling and fouling [13]. A large number of materials have been tested, such as activated alumina [14] , amorphous alumina [15], calcite [16], clay [17], zeolite, charcoal [18], red mud [19]. However, with fluoride concentration decreasing, a lot of adsorbents lose the fluoride removal capacity [20], the lowest limit for fluorine reduction and adsorbents is greater than 2 mg/, therefore, they are not suitable for drinking water, especially, only work at an extreme pH value, such as activated carbon which is only effective for fluoride removal at pH less than 3.0 [21].

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 [22]. Though fluoride is an essential constituent for both humans and animals, it can be either beneficial or detrimental to human health depending on the level of fluoride in drinking water [23]. In India, the problem is common in places such as Andhra Pradesh, Tamilnadu, Karnataka, Kerala, Rajasthan, Gujarat, Uttar Pradesh, Punjab, Orissa and Jammu and Kashmir [24].
Free fluoride level in drinking water was identified at 3.02 mgL^{-1} in Kadayam block of Tamilnadu [25]. 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 mgL^{-1} [26]. Many natural and low cost materials such as red mud[27, 28], zirconium impregnated coconut shell carbon [29], cashew nut shell carbon[30], ground nut shell carbon and clays[31] have been used as adsorbents for fluoride removal from drinking water.

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 km^2) and subdivided in 33 districts. The capital city is Jaipur.

Geographical Details of Jaipur: Geographical area of Jaipur district is 11,117.8 Km^2. 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 on the extreme northeast, Alwar and Dausa districts on the east, Sawai Madhopur district on the 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.

Jaipur City has a humid subtropical climate, receiving over 650 millimetres (26 inches) of rainfall annually but most rains occur in the monsoon months between June and September. 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). During the monsoon there are frequent, heavy rains and thunderstorms, but flooding is not common. 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. There are however occasional cold waves that lead to temperatures near freezing, Jaipur is the 10th largest city of India according to census of 2011. 47.49% People live in rural areas, 52.51% live in urban areas. The Study Area (Jaipur City) is divided into four different zones for convenience of the present study is zone- I

MATERIALS AND METHODS

Materials: The apparatus was washed with nitric acid and distilled water before use. First, a stock solution of 100 mg/L was prepared by dissolving an appropriate amount of sodium fluoride (NaF) in distilled water and desired concentrations of solutions were prepared from stock solution. Naturally occurring and abundantly available low-cost material marble slurry powder was obtained from a local kiln. The marble

slurry powder was washed several times with distilled water and dried in an oven at 105 ºC for 12 h. The dried material was sieved to obtain particles, of size 300 μm, for the present study.

Experiment: Adsorption method was conducted to study the effect of controlling parameters like contact time, the adsorbent dosage of marble slurry powder. The experiment was conducted at room temperature. 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 from various places of the zone - I of Jaipur city was studied for defluoridation under the feasible optimized conditions to check the suitability of the marble slurry powder adsorbent under field conditions. The physicochemical properties of ground water samples were determined before and after treatment by marble slurry powder.

RESULTS AND DISCUSSION

On physicochemical characterization of the water samples from various location of Zone – I 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 table1.

Physicochemical characterization of water samples from Zone - I of Jaipur city: Ground water samples from Zone- I of 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	**Ramniwash Garden**	9.6	9.4	0.69	0.72	446	475	150	140	140	146	110	105	1..689	0.616
2	**Adrash Nagar**	9.4	9.1	0.36	0.40	233	250	110	105	60	68	70	70	1..397	0.297
3	**M.D. Road**	8.3	8.2	2.40	2.90	1545	1720	50	45	540	560	650	540	1.668	1.501
4	**Ghatgate**	8.1	8.0	1.80	2.00	1140	1205	40	37	100	112	400	335	1.576	1.423
5	**Galtagate**	9.5	9.3	0.46	0.52	299	330	140	135	120	129	70	60	1..691	0.598
6	**Ramganj**	9.8	9.6	0.50	0.58	323	348	160	150	130	140	90	70	1.656	1.516
7	**Sanganeri Gate**	9.4	9.2	0.37	0.42	235	265	110	105	50	57	60	50	1..969	0.817

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 main Ramganj site (9.8) and minimum at Galtagate site (8).

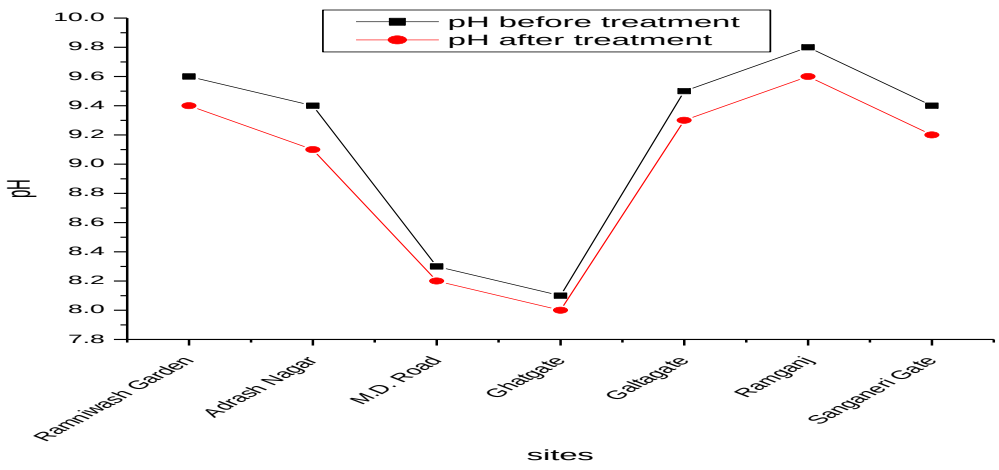

Fig 1: Comparison of pH before and after treatment with marble slurry Powder

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 Sawai Mansingh hospital (2.11mho^{-}) and lower level found at lalkothi (0.58mho^{-}).

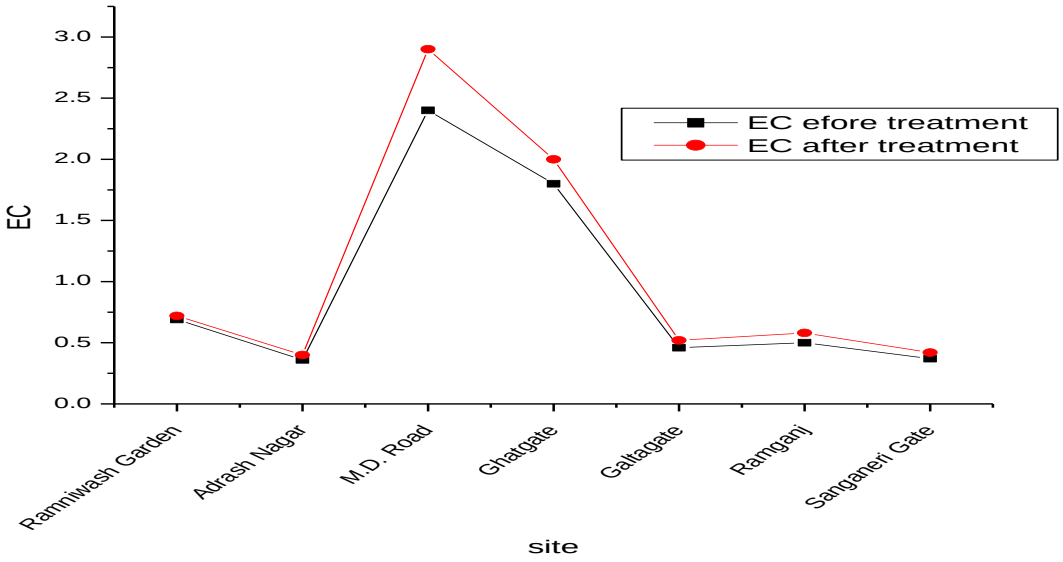

Fig.2: Comparison of total electric conductivity (EC) before and after treatment with marble slurry Powder

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 Sawai Mansingh hospital (1373mg L^{-1}) and lower level found at Lal Kothi (310mg L^{-1}).

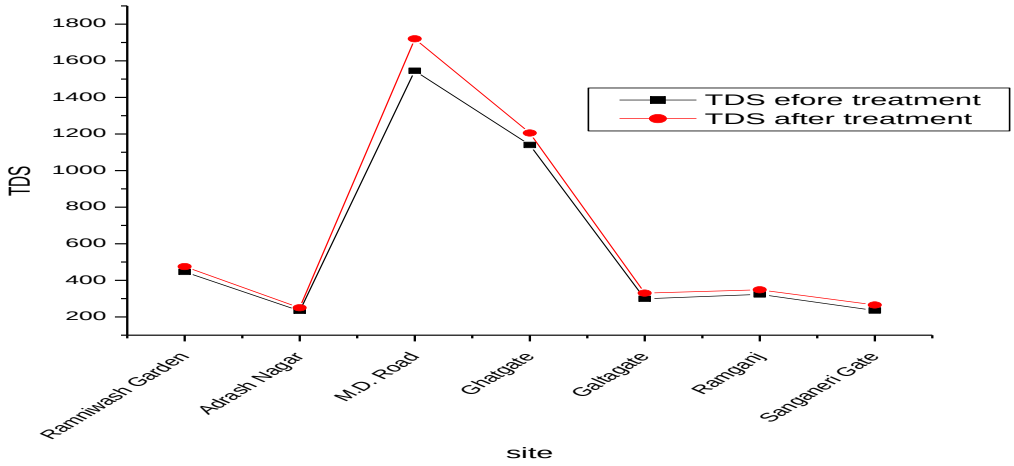

Fig.3: Comparison of total dissolved solid (TDS) before and after treatment with marble slurry Powder

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 main Ramganj site (160mg L^{-1}) and lower level at Galtagate site (40mg L^{-1}).

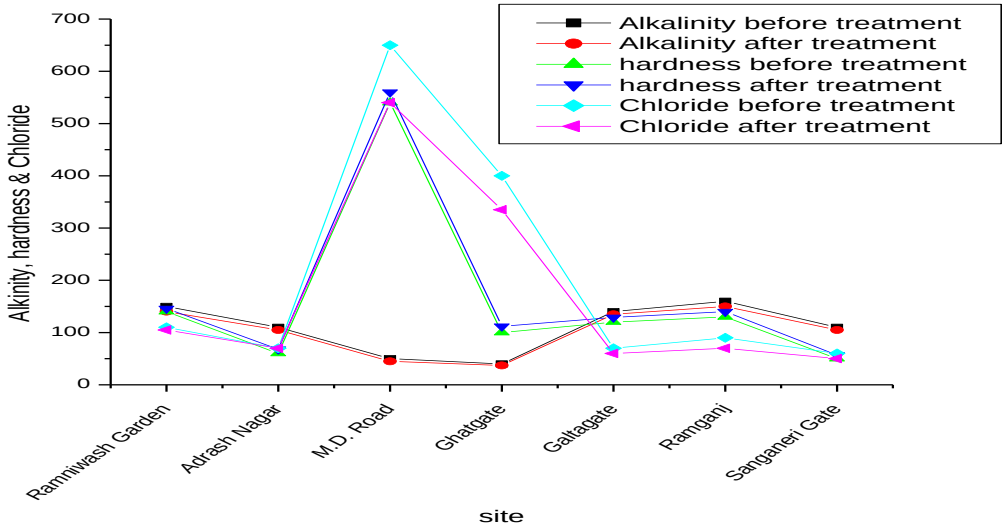

Fig4: Comparison of total alkalinity, hardness and chlorides ions before and after treatment with marble slurry Powder

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 M.D. Road (540mg L^{-1}) and lower level of Sanganeri gate (50mg L^{-1}).

Chloride Ions: Chloride ion concentration is determined by silver nitrate titration method. The chloride concentration range is from 40mg $L^{-1}$to 430 mg L^{-1}. The maximum chloride ions are present at the M.D. Road site (mg L^{-1}) and lower level at the Sanganeri gate site (40 mg L^{-1}).

Fluoride: The studies on the initial fluoride concentration were conducted by SPADANS method using an adsorbent dose of 2.0 g100 mL^{-1}, and contact time of 15 min. 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 M.D. gate (1.668 mg L^{-1}) and lower level found at Adarshnagar (1.397mg L^{-1}).

APPLICATIONS

The marble slurry powder method is suitable for defluoridation in water samples.

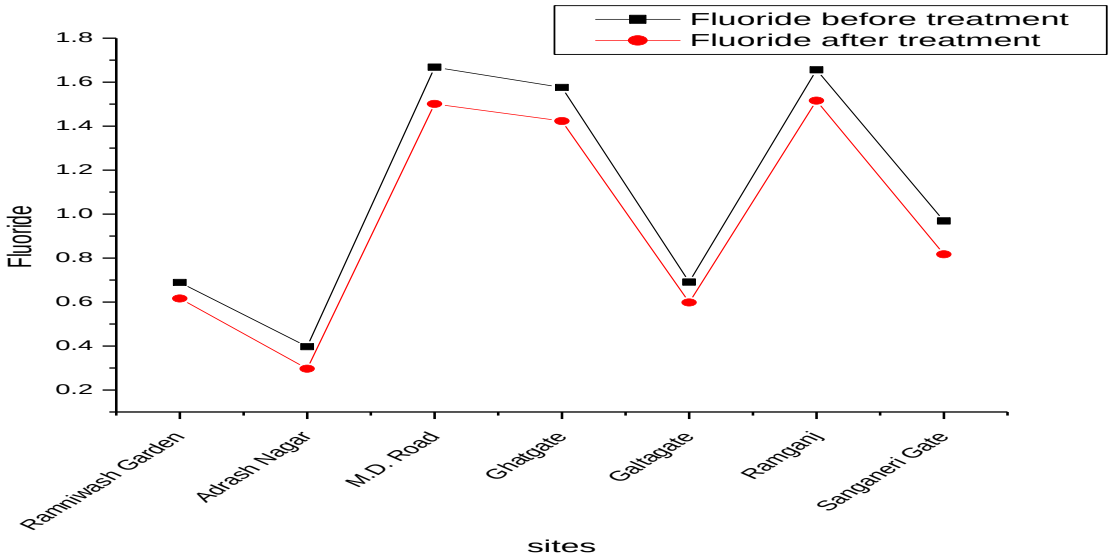

Fig 5: Comparison of fluoride before and after treatment with marble slurry Powder

REFERENCES

[1] Y.Wang and E. J. Reardon, "Activation and regeneration of a soil sorbent for defluoridation of drinking water," *Applied Geochemistry*, **2001**, 16(5), 531-539.
[2] H. L. Lounici, D. Addour, H. Belhocine, S. Grib, B. Nicolas and N. Mameri, "Study of a new technique for fluoride removal from water,." *Desalination*, **1997**, 114(3), 241-251.
[3] M.A. Srimurali, Pragathi and J. Karthikeyan, "A study on removal of fluorides from drinking water by adsorption onto low-cost materials," *Environmental pollution*, **1998**, 99(2), 285-289.
[4] M. Hichour, F.Persin, S. Jacqueline, and G. Claude, "Fluoride removal from waters by Donnan dialysis," *Separation and Purification Technology*, **1999**, 18(1), 1-11.
[5] Z. Amor, M. Suad, T. Mohamed, B. Bernard, M. Nabil Mameri, E. Azzeddine, "Optimization of fluoride removal from brackish water by electrodialysis," *Desalination*, **1998**, 120(30), 263-271.
[6] S.M. Hasany, H.C. Munawar. "Sorption potential of Haro river sand for the removal of antimony from acidic aqueous solution," *Applied Radiation and Isotopes*, **1996**, 47(4), 467-471.
[7] D. Cohen and M. Herbert Conrad, "65,000 GPD fluoride removal membrane system in Lakeland, California, USA," *Desalination*, **1998**, 117(1-3), 19-35.
[8] S. Saha, "Treatment of aqueous effluent for fluoride removal," *Water Research*, **1993**, 27(8), 1347-1350.
[9] C.L Yang, D. Robert, "Electrochemical generation of aluminum sorbent for fluoride adsorption," *Journal of hazardous materials*, **2002**, 94(3), 239-252.
[10] C. Castel, M. Schweizer, M. O. Simonnot, M.Sardin, "Selective removal of fluoride ions by a two-way ion-exchange cyclic process," *Chemical Engineering Science*, **2000**, 55(17), 3341-3352.

[11] M. Hichour, F.Persin, M. Jean, S. Jacqueline, G. Claude, "Fluoride removal from diluted solutions by Donnan dialysis with anion-exchange membranes," *Desalination*, **1999**, 122(1), 53-62.
[12] Pervov, G., Eugene V. Dudkin, Oleg A. Sidorenko, Victor V. Antipov, Sergei A. Khakhanov, Roman I. Makarov, "RO and NF membrane systems for drinking water production and their maintenance techniques," *Desalination*, **2000**, 132(1-3), 315-321.
[13] J.L. Shupe. Fluorides: Effects on Vegetation, Animals and Humans, Paragon Press, Inc., 1983.
[14] Y.H. Li, W. Shuguang, C. Anyuan, Z. Dan, Z. Xianfeng, X. Cailu, L. Zhaokun, "Adsorption of fluoride from water by amorphous alumina supported on carbon nanotubes," *Chemical Physics Letters*, 2001, 350(5), 412-416.
[15] M. Yang, H. Takayuki, H. Nobuyuki, M. Haruki, "Fluoride removal in a fixed bed packed with granular calcite," *Water Research*, **1999**, 33(16), 3395-3402.
[16] M. Mahramanlioglu, I. Kizilcikli, I. O. Bicer, "Adsorption of fluoride from aqueous solution by acid treated spent bleaching earth," *Journal of Fluorine Chemistry*, **2002**, 115(1), 41-47.
[17] Y. Çengeloğlu,K. Esengül,E. Mustafa, "Removal of fluoride from aqueous solution by using red mud." *Separation and Purification Technology*, **2002**, 28(1), 81-86.
[18] T. Majima, H. Takatsuki, "Fluoride removal from smoke-washing wastewater by using CaF2 separating method," *Water Purif Liquid Wastes Treatment*, **1987**, 28(7), 433-43.
[19] S. Ayoob, K.G. Ashok,"Fluoride in drinking water: a review on the status and stress effects," *Critical Reviews in Environmental Science and Technology*, **2006**, 36(6), 433-487.
[20] A. Pruss-Ustun, World Health Organization, "Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health," **2008**.
[21] A.K.Susheela, "Fluorosis management programme in India," *Curr. Sci*., **1999**, 77(10), 1250-1256.
[22] G. Alagumuthu, M. Rajan, "Monitoring of fluoride concentration in ground water of Kadayam block of Tirunelveli district, India, *Rasayan J. Chem*, **2008**, 4, 757-765.
[23] Y. Çengeloğlu, K. Esengül, E. Mustafa, "Removal of fluoride from aqueous solution by using red mud," *Separation and Purification Technology*, **2002**, 28(1), 81-86.
[24] Tor, D. Nadide, A. Gulsin, Y.Cengeloglu, "Removal of fluoride from water by using granular red mud: batch and column studies," *Journal of hazardous materials*, **2009**, 164(1), 271-278.
[25] R.Sathish, Sai, N. S. R. Raju, G. S. Raju, G. Nageswara Rao, K. Anil Kumar, C. Janardhana, "Equilibrium and kinetic studies for fluoride adsorption from water on zirconium impregnated coconut shell carbon," *Separation Science and Technology*, **2007**, 42(4), 769-788.
[26] G. Alagumuthu, M. Rajan, "Equilibrium and kinetics of adsorption of fluoride onto zirconium impregnated cashew nut shell carbon," *Chemical Engineering Journal*, **2010**, 158(3), 451-457.
[27] Tor. "Removal of fluoride from an aqueous solution by using montmorillonite," *Desalination*, **2006**, 201(1-3), 267-276.
[28] Y.H. Li, W. Shuguang, C. Anyuan, Z. Dan, Z. Xianfeng, X. Cailu, L. Zhaokun, "Adsorption of fluoride from water by amorphous alumina supported on carbon nanotubes," *Chemical Physics Letters*, **2001**, 350(5), 412-416.
[29] Y.H. Li, W. Shuguang, Z. Xianfeng, W. Jinquan, X. Cailu, L. Zhaokun, W.Dehai, "Adsorption of fluoride from water by aligned carbon nanotubes," *Materials Research Bulletin*, **2003**, 38(3), 469-476.
[30] L. Ruixia, J. Guo, H. Tang, "Adsorption of fluoride, phosphate, and arsenate ions on a new type of ion exchange fiber," *Journal of colloid and interface science*, **2002**, 248(2), 268-274.
[31] N.I. Chubar, V. F. Samanidou, V. S. Kouts, G. G. Gallios, V. A. Kanibolotsky, V. V. Strelko, I. Z. Zhuravlev,"Adsorption of fluoride, chloride, bromide, and bromate ions on a novel ion exchanger," *Journal of colloid and interface science*, **2005**, 291(1), 67-74.

AUTHOR ADDRESS

1. **Naresh Kumar**
Green Chemistry and Sustainability Research Group,
Department of Chemistry, JECRC University,
Jaipur-303905, India
Email: nareshamansharma@gmail.com