Impact Factor 4.574

ISSN 2349-638x

Refereed And Indexed Journal

AAYUSHI INTERNATIONAL INTERDISCIPLINARY RESEARCH JOURNAL (AIIRJ)

Monthly Journal

VOL-V ISSUE-VI June 2018

Address
- Vikram Nagar, Boudhi Chouk, Latur.
- Tq. Latur, Dis. Latur 413512 (MS.)
- (+91) 9922455749, (+91) 8999250451

Email
- aiirjpramod@gmail.com
- aayushijournal@gmail.com

Website
- www.aiirjournal.com

CHIEF EDITOR – PRAMOD PRAKASHRAO TANDALE

Aayushi International Interdisciplinary Research Journal (AIIRJ)
Vol - V Issue-VI JUNE 2018 ISSN 2349-638x Impact Factor 4.574

Study of Heavy Metal Removal From Ground Waters By Rhizofiltration in Comparison With Some Traditional Methods.

B. M. Tayde,
Department of Applied Science,
Padm.Dr.V.B.Kolte College of Engineering, Malkapur,
S.G.B. Amravati University

B. B. Wankhade
Department of Chemistry,
Vidnyan Mahavidyalaya, Malkapur,
S.G.B.Amravati University

Abstract:

Heavy metals have long been recognized as one of the most important pollutants in the waters because of their toxicity, mutagenic and carcinogenic effects in animals. In the present work ground water samples were collected from different villages of Purna river basin, samples were treated by two traditional methods viz Lime-Soda process and Ion Exchange process and by advance Rhizofiltration method. Samples were analysed physico-chemical parameters and some heavy metals like Cu, Fe, Cd, Pb, Mn, Zn Cr, and Ni. Heavy metals are assessed before and after treatment. The result of the study reveals that Rhizofiltration is potential technique for removal of heavy metals from ground water.

Key wards: Ground water, Rhizofiltration, Heavy metals.

I. INTRODUCTION

Water plays a vital role in the development of communities; hence a reliable source of water is essential for the existence of both human and animals 1].Ground water is one of the major sources of drinking water in the study area hence it is important to assess the groundwater quality with respect to physico chemical parameter and heavy metal contamination 2] Ground water has been traditionally considered to be pure form of water because of its filtration through soil and its long residence time on the ground. However ground water is not as pure as traditionally assumed as water is an excellent solvent and it can contain lots of dissolve chemicals 3]. Heavy metal contamination of ground, stream and river water ecosystem is a worldwide environmental problem 4] and between the wide diversity of contaminants affecting water resources, heavy metals receive particular concern considering their strong toxicity even at low concentrations 5]. Some heavy metals like Fe, Zn, Cu, Mg have been reported to be of bio importance to man. In very small quantities, even Cr and Ni are required in the body. However, some other metals like As, Cd, Pb has been reported to have no known importance in human biochemistry and physiology, and consumption even at very low concentrations can be toxic. Even for those that have bio importance, dietary intakes have to be within regulatory limits as excesses may result in poisoning or toxicity. Heavy metals are also known to be toxic to both humans and other living forms, with their accumulation over time causing damage to the kidney, liver and reproductive system in addition to cancer 6]. During last few years, it is reported that the patients affected by water pollutants are facing serious health problems like kidney failure, hair loss and cardiovascular damage. If the population use untested and untreated water for drinking this could be probably the cause of so many water borne diseases 3].

Heavy metals are considerable environment concern due to their toxicity and accumulative behaviour; hence it is not advisable to consume polluted water without subjecting it to proper and effective treatment. Generally, issues in the environmental pollution of heavy metals in ground water resources is very scanty [7], hence the objective of this study is to assess heavy metal concentration in ground water resources across Purna river basin. In the present work the ion exchange process (IEP, lime soda process (LSP) and Rhizofiltration (RF) techniques were used for the remediation of presence of metal ions in contaminated water.

II. Material And Method

Sampling:

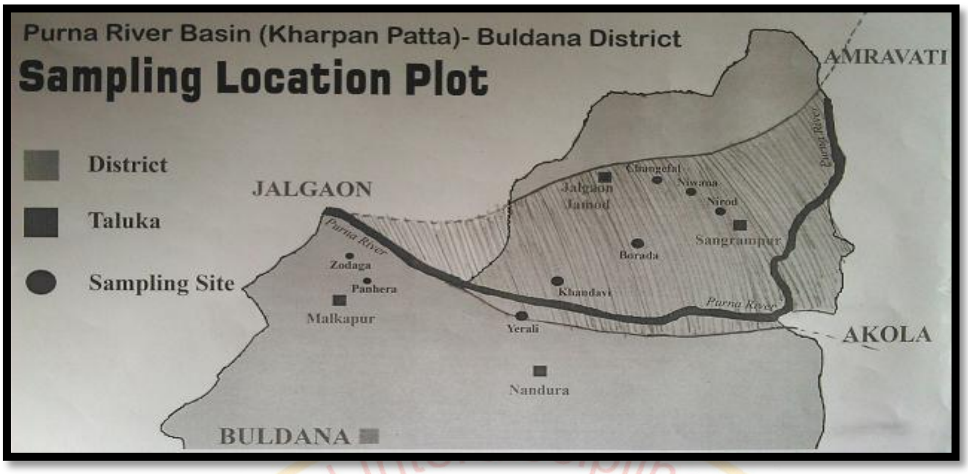

Figure 1: Sampling Location Plot.

In the present work the ground water samples were collected from saline track of Buldana District, Maharashtra, India, in winter season January 2017 for the determination of physico-chemical parameters and heavy metals by standard methods. Samplings of ground water were done by standard methods [8]. Sampling was done in winter season in the month of January 2017. Special precautions were taken during the collection of samples. Before collecting the samples, at each sampling location water samples were collected in two pre-cleaned containers for duplicate measurement. The bottles were rinsed three times with the ground water sample of the particular location and collected the final sample to avoid the contamination. Nine villages where kidney failure patients are reported and the main source of drinking water is groundwater were selected as target area. Those villages are Jalgaon, Borada, Khandavi, Yerali, Zodaga, Panhera, Changefal, Niwana and Nirod of Buldana District. The parameters were determined at research laboratory and metal ion at Central Instrumentation Cell S.G.B. Amravati University Amravati before and after LSP, IEP, and RF processes. The details of sampling locations have been summarized in **Table -1.**

In the present work the presence of metal ions in contaminated water can be removed by ion exchange, Lime-soda and Rhizofiltration process. Ion exchange resins are insoluble, cross-linked, long chain organic polymer with a micro porous structure and the functional group attached to the chain responsible for the ion-exchange properties. Resin containing acidic functional group (-COOH, $-SO_3H$ etc.) are capable of exchanging H^+ ions with other cation present in moving water phase. The contaminated water is passed through cation exchange column, where cations like Ca^{2+}, Mg^{2+} and heavy metal ions are removed from water.[9] In Lime Soda Process, the soluble metal salts in contaminated water are chemically converted into insoluble compounds by adding calculated amount of lime [$Ca(OH)_2$] & soda [Na_2CO_3] [10].

Rhizofiltration is defined as the use of plants, both terrestrial and aquatic; to absorb, concentrate and precipitate contaminants from polluted aqueous sources with low contaminant concentration in their roots.[11-12]. In this work, Brassica Juncea (Indian mustard) is chosen as a test plant for rhizofiltration as the condition to grow mustard plant in target area is suitable. Further it accumulates high level of heavy metals in both shoot and root [1]. B. Juncea seedlings can be naturally grown in farm. After 30 to40 day's mustard plants were collected from farm then wash with distilled water and dipped in water sample for 2 days (48 hr.) after 48 hours sample were collected and analysed for Metal ion before and after LSP, IEP and Rhizofiltration treatment.

Table:1 Details Of Sampling Locations

SR.NO	SAMPLE NO.	SAMPLE LOCATION
1	S-1	JALGAON
2	S-2	BORADA
3	S-3	KHANDAVI
4	S-4	YERALI
5	S-5	ZODAGA
6	S-6	PANHERA
7	S-7	CHANGEFAL
8	S-8	NIWANA
9	S-9	NIROD

III. Result And Discussion

The results of the study are tabulated in Table number 2 and are compared with water quality standards given by WHO and other agencies.

The concentration of heavy metal such as Cu, Fe, Cd, Pb, Mn, Zn, Cr & Ni mg/l in the groundwater sample S1 to S9 were assessed before and after LSP, IEP and RF. From the result it is reveals that the concentration of heavy metal in ground water reduces to certain level after the treatment of lime soda, ion exchange and rhizofiltration treatment.

Table: 2 AAS analysis of water sample for heavy metal before treatment (BT), after Lime soda process (ALSP), Ion exchange process (AIEP) and Rhizofiltration (ARF).

Sr. No.	Element	Process	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	WHO Guideline
1	Cu	BT	0.138	0.134	0.144	0.149	0.140	0.136	0.137	0.146	0.141	2mg/dm3
		ALSP	0.129	0.122	0.133	0.134	0.131	0.129	0.129	0.133	0.131	
		AIEP	0.119	0.117	0.129	1.118	0.123	0.121	0.117	0.119	0.124	
		ARF	0.099	0.094	0.100	0.093	0.098	0.095	0.091	0.098	0.093	
2	Fe	BT	0.164	0.162	0.168	0.166	0.162	0.164	0.167	0.165	0.163	50mg/dm3
		ALSP	0.157	0.156	0.157	0.157	0.155	0.155	0.156	0.157	0.154	
		AIEP	0.142	0.139	0.140	0.141	0.139	0.141	0.140	0.141	0.139	
		ARF	0.119	0.115	0.118	0.121	0.199	0.122	0.125	0.117	0.119	
3	Cd	BT	0.041	0.040	0.044	0.042	0.046	0.044	0.047	0.045	0.043	0.003 mg/dm3
		ALSP	0.036	0.035	0.036	0.034	0.032	0.034	0.037	0.036	0.038	
		AIEP	0.029	0.029	0.027	0.024	0.027	0.025	0.029	0.027	0.029	
		ARF	0.016	0.015	0.016	0.018	0.015	0.016	0.018	0.015	0.017	
4	Pb	BT	0.051	0.049	0.053	0.054	0.051	0.057	0.052	0.050	0.055	0.01 mg/dm3
		ALSP	0.044	0.046	0.041	0.042	0.047	0.040	0.044	0.041	0.046	
		AIEP	0.029	0.022	0.026	0.025	0.027	0.026	0.028	0.027	0.025	
		ARF	0.018	0.013	0.015	0.014	0.013	0.018	0.015	0.019	0.016	
5	Mn	BT	0.046	0.043	0.042	0.044	0.042	0.045	0.042	0.041	0.045	0.4 mg/dm3
		ALSP	0.037	0.033	0.036	0.037	0.036	0.033	0.033	0.029	0.037	
		AIEP	0.026	0.024	0.026	0.025	0.024	0.025	0.024	0.022	0.024	
		ARF	0.019	0.019	0.017	0.018	0.018	0.017	0.018	0.016	0.017	
6	Zn	BT	0.056	0.050	0.048	0.052	0.049	0.053	0.051	0.054	0.055	0.01-0.05 mg/dm3
		ALSP	0.039	0.037	0.034	0.038	0.032	0.035	0.039	0.037	0.034	

		AIEP	0.025	0.026	0.027	0.024	0.028	0.026	0.025	0.039	0.025	
		ARF	0.011	0.011	0.016	0.017	0.019	0.013	0.017	0.031	0.012	
7	**Cr**	**BT**	0.039	0.041	0.037	0.039	0.040	0.041	0.039	0.043	0.039	0.05 mg/dm3
		ALSP	0.031	0.031	0.029	0.029	0.031	0.032	0.030	0.032	0.031	
		AIEP	0.024	0.020	0.021	0.022	0.021	0.019	0.021	0.025	0.022	
		ARF	0.011	0.012	0.014	0.017	0.014	0.015	0.013	0.015	0.14	
8	**Ni**	**BT**	0.047	0.052	0.049	0.050	0.048	0.049	0.053	0.050	0.054	0.07 mg/dm3
		ALSP	0.039	0.037	0.039	0.036	0.038	0.035	0.037	0.039	0.033	
		AIEP	0.031	0.032	0.030	0.029	0.031	0.028	0.031	0.028	0.029	
		ARF	0.019	0.021	0.018	0.015	0.016	0.19	0.020	0.022	0.019	

Copper (Cu):

Copper is both an essential nutrient and a drinking-water contaminant [14]. In the present study concentrations of copper are well below the WHO Guidelines for drinking water quality. Measured values are shown in Table 2 For all Nine samples the concentration of copper decreases after LSP and IEP and RF. The concentrations of copper ion in ground water for various locations were given in Figure 1. Even though copper is an essential element inhuman diet but human eats and drinks copper approximately 1.00µg per day. It is also occur naturally in plants and animals. If the concentration of copper exceed beyond the permissible limit, then the immediate health effects are vomiting, diarrhea, stomach cramps and nausea. The effects are much higher in children under one year old than adults. However, long term exposure which is more than 14 days to copper in the drinking water can cause serious problems like kidney and liver damages in infants [15].

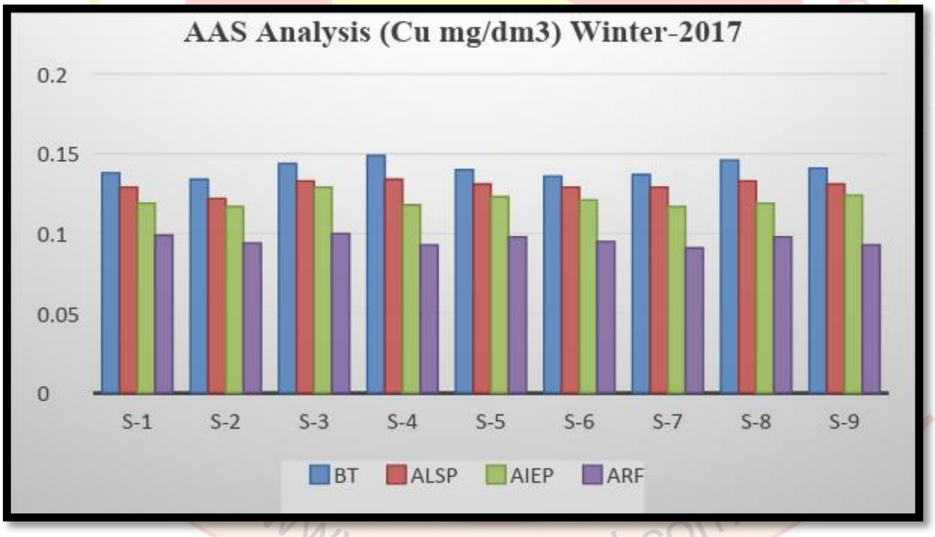

Figure: 1

Iron (Fe):

Iron is the fourth most common element in the earth‘s crust [16]. Iron is an essential element in human nutrition, particularly in the iron (II) oxidation state. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status and iron bioavailability and range from about 10 to 50 mg/day [19]. In the present study concentrations of Iron are well below the WHO Guidelines for drinking water quality. Measured values shows in Table 3, the comparison levels of iron before and after LSP, IEP and RF treatment is shown in Figure 2.

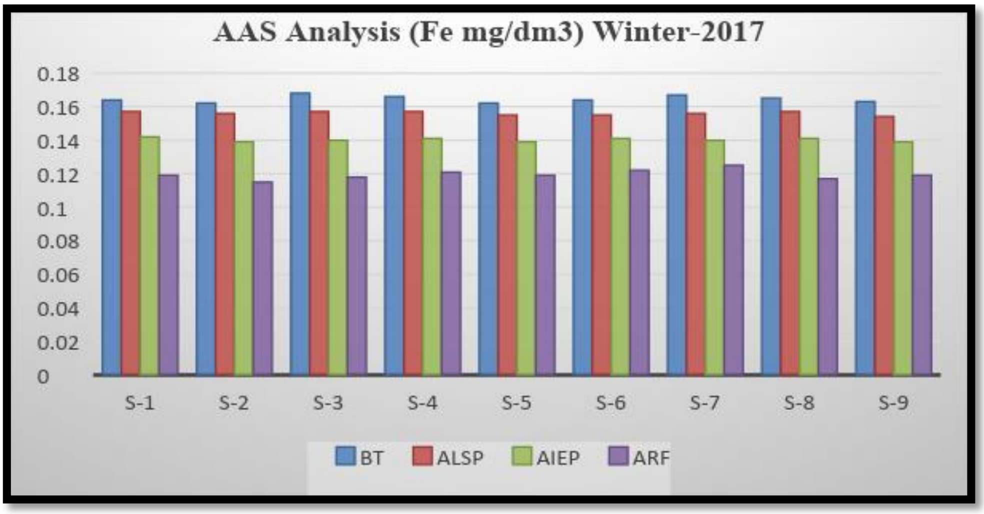

Figure: 2

Cadmium (Cd):

Cadmium is released to the environment in waste water, and pollution caused by contamination from fertilizers [14]. Generally, cadmium is found naturally in small quantities in water. Cadmium can be released to drinking water from the corrosion of some galvanized plumbing and water main water piping materials. The permissible limit for cadmium in drinking water no exceed than 0.003Mg/L as per WHO. In the present work it is observed that the concentration of Cadmium is beyond the limits laid down by WHO guideline for all samples. The measured values are shown in Table 3, for all samples the concentration of cadmium decreases after LSP and IEP, but it shows significant decrease in Cd Concentration after RF as shown in Figure 3.

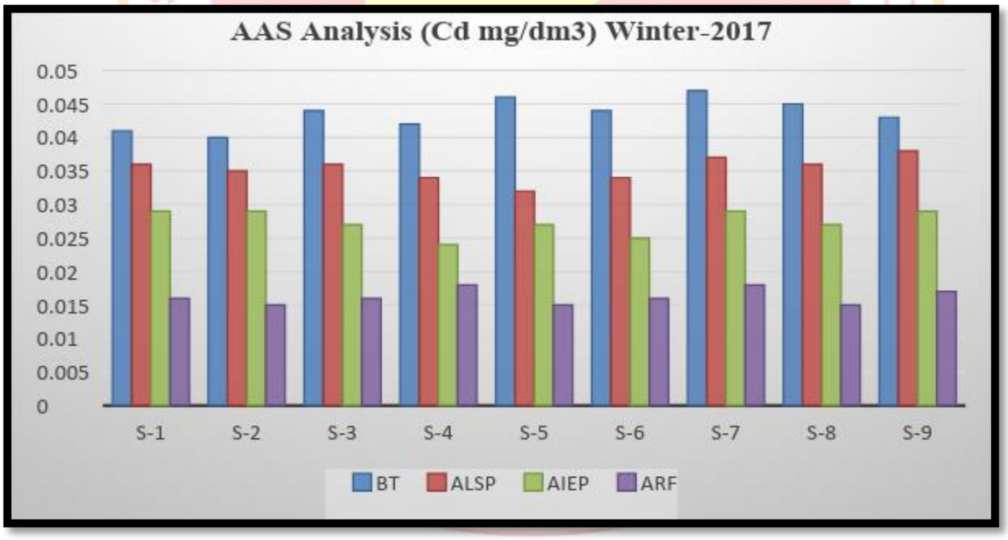

Figure: 3

Lead (Pb):

Lead is common heavy metal found in industrial effluent, particularly in developing countries. The main source of Lead are mining and smelting activities. Lead is toxic to many organs of human body including heart, kidneys, reproductive and nervous system [18]. The permissible limit of Lead in Drinking water is 0.01Mg/L as per WHO guideline. In the present work it is observed that the concentration of Cadmium is beyond the WHO guideline for all samples. The measured values shows in Table 3, from the graph it reveals that there is a decrease in concentration of Pb after

LSP,IEP but after RF treatment concentration of Lead is decreases near to the permissible limits, which is shown in figure 4. Exposure to lead is very dangerous for young children compared to an adult. This is because young children's growing rate is much higher than an adult. Lead can accumulate in human body over some time and cause serious damage to brain, kidney, nervous and red blood cells. For infants, large amount of lead can cause delays in physical and mental development [19].

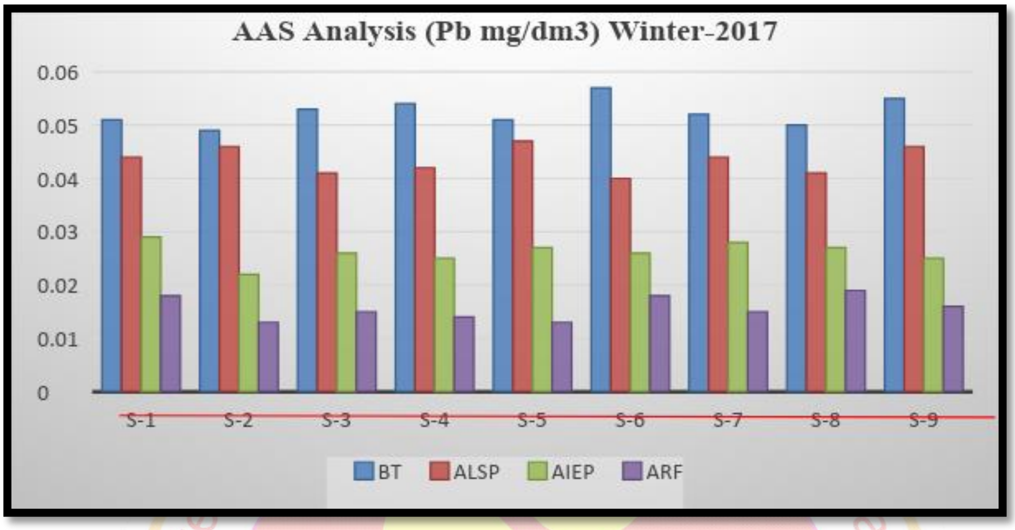

Figure: 4

Manganese (Mn):

Manganese occurs in the natural waters in both the dissolved and a suspended form with the anaerobic ground water often contains higher levels of dissolved Manganese. Manganese is an essential element for human beings [20]. Manganese is present in all tissues of the body, the highest levels usually being found in the liver, kidney, pancreas and adrenals [21]. As per WHO guideline the permissible of Lead in drinking water is 0.4mg/l.[14] In the present study concentrations of Manganese are below the WHO Guidelines for drinking water quality. Measured values shows in Table 3, the comparison levels of Manganese before and after LSP, IEP and RF treatment is shown in figure 5.

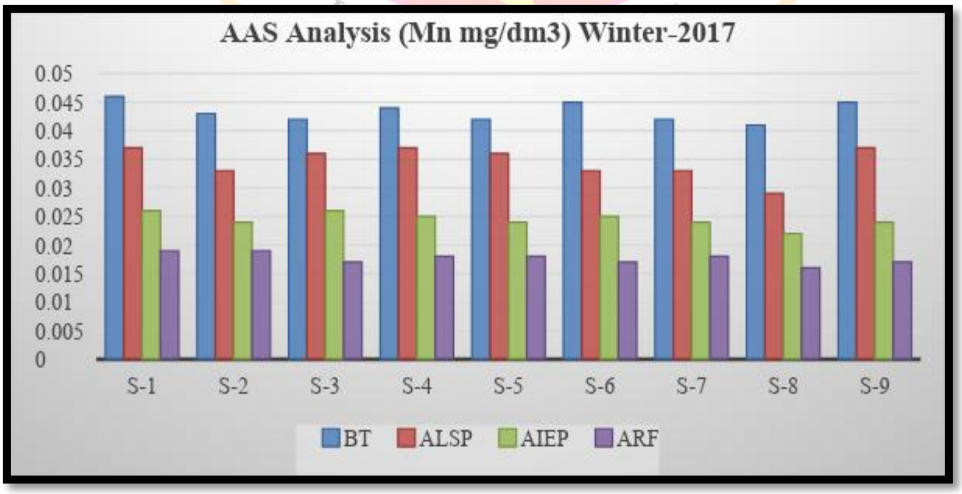

Figure: 5

Zinc (Zn):

Zinc is an essential and beneficial element in the human metabolism. It is necessary for the functioning of the various enzyme systems including alkaline phosphatase, carbonic anhydrase, alcohol dehydrogenase etc. [22]. Although levels of zinc in surface water and groundwater normally do not exceed 0.01 to 0.05 mg/l, respectively [1]. Too little zinc can cause slow wound healing and skin sores, decreased sense of taste and smell, loss of appetite and damage in immune system. In the present study concentrations of Zinc were beyond the WHO Guidelines for drinking water quality for some samples. Measured values shows in 3. The comparison levels of Zinc before and after LSP, IEP and RF treatment is shown in figure 6. The concentration of Zn decreases significantly after rhizofiltration.

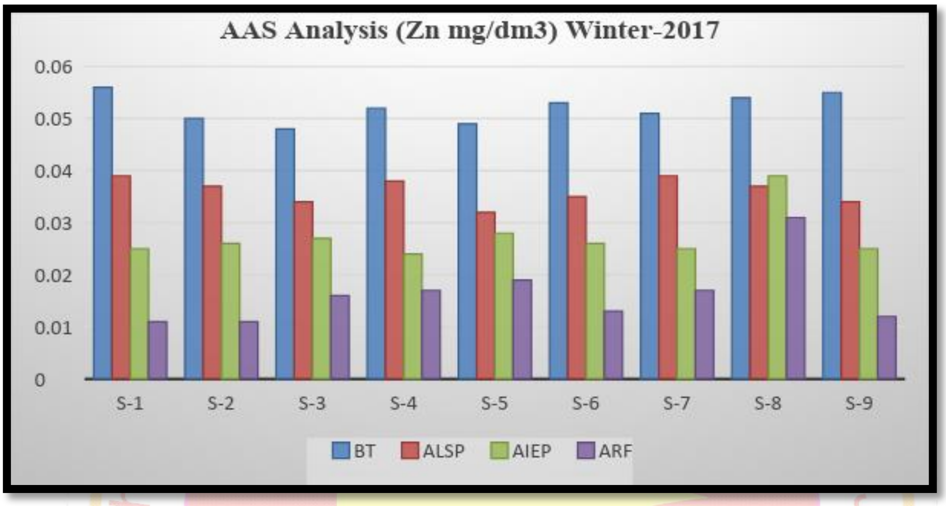

Figure: 6

Chromium (Cr):

Chromium is an important industrial metal used in diverse products and processes [23]. Chromium is found naturally in rocks, plants, soil and volcanic dust, humans and animals and anthropogenic sources of chromium-6 in drinking water are discharges from steel and pulp mills, and erosion of natural deposits of chromium-3. The maximum allowable limit for chromium as per WHO guidelines is 0.05 mg/L. Chromium concentration levels in all studied samples were below then WHO Standards. The concentration levels of chromium in all the samples are shown in Table 3 and the comparison levels of Chromium before and after LSP, IEP and RF treatment is shown in figure 7.

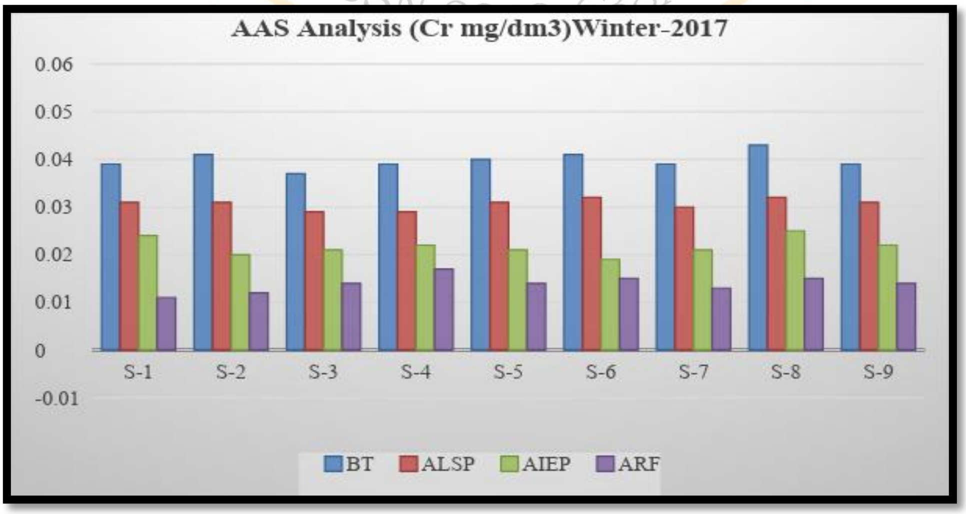

Figure: 7

Nickel (Ni):

Nickel is primarily found combined with oxygen or sulphur as oxides or sulphides that occur naturally in the earth‘s crust and used in a wide variety of metallurgical processes such as electroplating and alloy production as well as in nickel-cadmium batteries [24].maximum allowable limit for Nickel as per WHO guidelines is 0.07mg/L. Concentration levels of Nickel in all studied samples were below then WHO Standards. The concentration levels of Nickel in all the samples are shown in Table 3 and the comparison levels of Nickel before and after LSP, IEP and RF treatment is shown in figure 8.

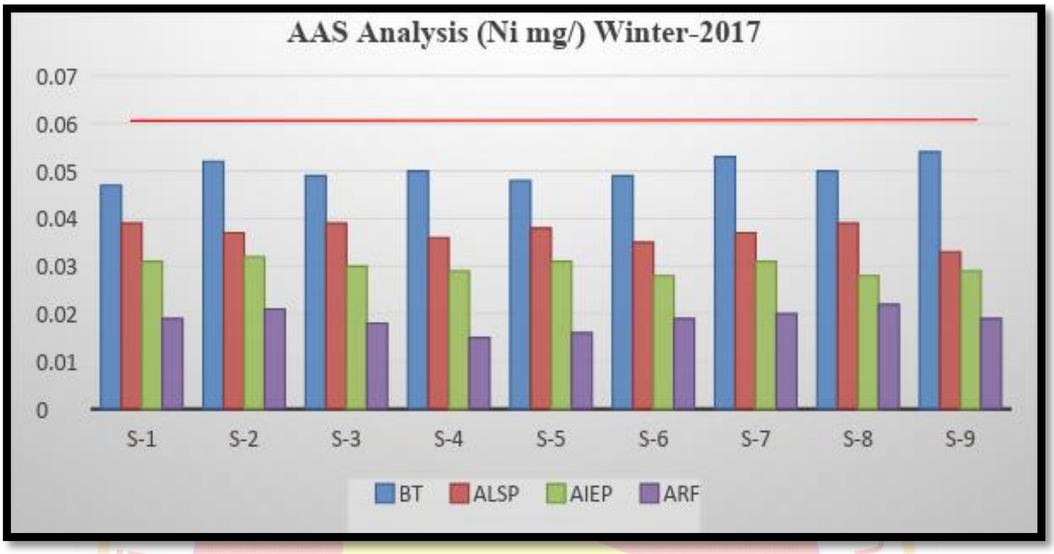

Figure: 8

IV. Conclusion

Heavy metals like Cd, Pb exceed the limits laid down by WHO for all samples. From the result it is clear that after LSP and IEP concentration of heavy metal decreases up to certain level of all metal ions .But it shows significant decrease in concentration of metal ions after RF treatment for all samples. From the result it is clear that the quality of water is poor and not good for drinking and domestic use. It is, therefore, strongly recommended that the ground water needs treatment to reduce metal ion concentration. From the result it reveals that Rhizofiltrtion is very useful and eco-friendly technique to reduce metal ion concentration in ground water as compared to Lime-soda and Ion exchange process.

References:

1] B. G. Kolo & M. Waziri, International *Journal of Basic and Applied Chemical Sciences*,Vol 2(3), pp18-20, 2012.
2] O. V. S. Raju , P.M.N. Prasad, V. Varalakshmi & Y. V. Rami Reddy, *International Journal Of Innovative Research In science Engineering And Technology*,VOL.3 ISSUE-2,2014.
3] O. M. Collins & U. Ugbune, *Sky Journal of Soil Science and Environmental Management*, Vol 2(3), pp 31-33, **2013**.
4] C. O. Ehi-Eromosele & W. O. Okiei,*Resources and Environment*, Vol.2(3): 82-86, 2012.
5] Z. Es'haghi, M. Khalili, A. Khazaeifar & G.H. Rounaghi, *Electrochimica Acta*, Vol.56 (9), 3139-3146, 2011.
6] A. Z. Hussain & K .M. M. Sheriff, *Journal of Chemical and Pharmaceutical Research*, Vol. 5(3), pp73-77 2013.
7] O. M. Collins & U. Ugbune, *Sky Journal of Soil Science and Environmental Management*,Vol 2(3), pp31- 33,2013.
8] P. Trivedi, A. Bajpai& S. Thareja, Nature and Science, **,** 1(6), 91, **2009.**

9] D. Franceska, *National Field Manual for the Collection of Water-Quality Data* - chapter A4, U.S. Geological Survey TWRI, Book 9, 2006.
10] S. S. Dara, *Experiments &Calculation Engineering Chemistry*, S Chand Publication and company Ltd, 2011.
11] *A State-of-the-Art report on Bioremediation, its Applications to Contaminated Sites in India, Ministry of Environment & Forests*, Government of India, 2011.
12] M. Ghosh & S.P.Singh Applied *Ecology & Environmental Research,* 3(1): 1-18.
13] P. Trivedi, A. Bajpai & S. Thareja, *Nature and Science*, , 1(6), 91, 2009.
14] World Health Organization *Guidelines for drinking-water quality* – 4 edition, 2011.
15] S. NALATAMBI. *Sunway Academic Journal 6*
16] R. M. Cornell, U. Schwertmann, *The Iron Oxides: Structure, Properties, Reactions, Occurrence and Uses. VCH*, New York, pp. 28–29, 1996.
17] P. Trivedi, A. Bajpai & S. Thareja, *Nature and Science*, 1(6), 91, 2009.
18] V. Hanuman Reddy, P. M. N. Prasad, A. V. Ramana Reddy & Y. V. Rami Reddy *Scholars Research Library*, Der Pharma Chemica, 4(6), pp2442-2448, 2012.
19] O Hutzinger, *The Handbook of Environmental Chemistry and Water Pollution*(5).*Berlin:Springer-Verlag*,1995.
20] World Health Organization*, Task Group on Environmental Health Criteria for Arsenic Environmental Health Criteria 18*, Geneva, pp. 1. 1981.
21] I.H. Tipton & M. J. Cook, Trace *elements in human tissue. Part II. Adult subjects from the United States. Health Physics*, 9:103–145. (1963)
22] A.F. Parisic & B.L. Vallee, *American Journal of Clinical Nutrition*, 22, 1222, 1969.
23] J. O. Nriagu & E. Nieboer *Production and Uses of Chromium.IN: Chromium in the Natural and Human Environments*, Vol. 20 81-104. 1988.
24] K.K. Das, S.N. Das & S.A. Dhundasi, Nickel, its adverse health effects & oxidative stress, *Indian J Med Res* 128, pp 412-425,2008.