International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.11, pp 83-90, 2017

Removal of Heavy Metals from Well Water

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Abstract : Sustainability of good health depends upon the purity of water. However, groundwater may be exposed to contamination by various anthropogenic activities such as agricultural, domestic and industrial. Groundwater quality problem can be typically associated to high level of heavy metal concentration. The removal of heavy metals from drinking water was very essential across the globe. The study area, Chrompet, is completely contaminated due to industries present in the surrounding area. The presence of heavy metals such as Iron, Lead, Cadmium, and Zinc were high. The given study analyzes the adsorption efficiency of rice husk in the removal of heavy metal and concludes that treated rice husk gives comparatively better adsorption efficiency of heavy metals. The given study focuses on critical review of current available information on potential of untreated and treated groundwater with rice husk, tartaric acid, and desiccant silica gel for the removal of heavy metals. This study also focuses on removal of heavy metals using other forms technologies.
Keywords : Pollution, Heavy Metal, Concentration, Rice Husk, Adsorption.

I. Introduction

Water is vital to life on Earth. It is the only known substance that naturally exists in gas, liquid, and solid form within the relatively small range of air temperatures and pressures found at Earth's surface. It is life-sustaining and nourishing every plant, animal, and human cell on Earth and plays a major role in the complex processes of Earth's climate. Essentially all industrial processes generate by-products that become waste materials. Heavy metals, solvents organic compounds, and petroleum products account for most of the contaminants. Industrial Waste water, particularly in electroplating, metal finishing industries, tannery operators, chemical manufacturing and battery manufacturing industries is an important pathway for entry of metals in the environment. Water contamination with heavy metals is a very important problem in the current world. Occurrence of toxic metals in pond, ditch and river water affect the lives of people that depend upon water sources. The primary heavy metals of concern are arsenic, lead, cadmium, chromium, and mercury. For removal of heavy metals and metalloids many conventional techniques such as chemical precipitation, membrane filtration, ion exchange, etc have been used. But they are not suitable for high concentration of metals and also, not cost effective (Demirbas, 2008). Bio-adsorbents have emerged as one of the potential alternatives for removal of heavy metals and metalloids.

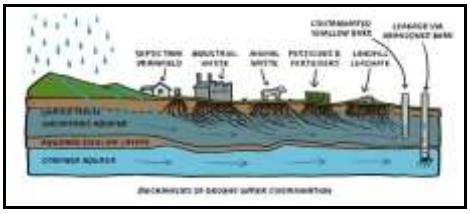


Fig.1: Reason for contamination of water

1.1 Literature Reviews

Nour T. Abdel-Ghanil (2014) observed that the inorganic species are persistent and non-biodegradable pollutants should be eliminated from water. Bio-sorption has emerged as an economical and environmental friendly method for the decontamination of polluted water. Nichole Lathan, et.al (2013) had used solid biomaterials such as charcoal or waste coffee and tea to remove heavy metals from contaminated aqueous solutions through adsorption. Omar E. Abdel Salam (2011) had done a case study on behavior of some low-cost adsorbents such as peanut husk charcoal, fly ash, and natural zeolite, with respect to Cu^{2+} and Zn^{2+} ions, has been studied to consider its application to the purification of metal finishing wastewater. K. Chandra Sekhar (2004) had done project by using the bark of Hemidesmus indicus, an extensively available plant biomass commonly called as Indian sarsaparilla was used as biomaterial for removal of lead from aqueous streams

1.2 Objectives of the Study

- To assess the level of heavy metal concentration in the water sample.
- To minimize the heavy metal concentration by an experimental study.
- To make the suitable review on available treatment technologies for heavy metals removal from underground contaminated water.

II. Materials And Methods

The main objective of this project is to remove the heavy metals concentration in contaminated water. The following will explain briefly about the material and methods used to remove the contamination.

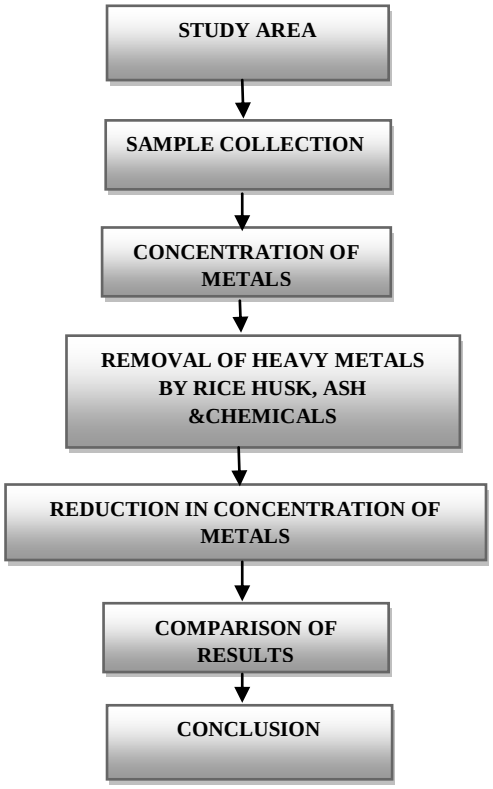


Fig .2: Flowchart of Methodology

2.1 Study Area and Sample Collection

Chrompet is a Residential Locality in the southern part of Chennai, India. It is located 16 kilometers from Egmore.

Fig.3: Samples collected from the study area

The extent of groundwater pollution is caused by tanning industries in Chrompet area located in south of Chennai, Tamil Nadu. This is due to the recharge of partially treated effluent, discharged by tanning industries into open drains. The sample is collected from three different areas from nearby Chrompet. The chosen areas are Ganapathipuram, Mummurti nagar, Periyar nagar.

3.2 Varieties of Sample

S1, S2, S3, S4, S5 and S6 denote all the samples collected respectively. The samples were collected from Ganapathipuram, Periyar Nagar and Mummurti Nagar. All these areas are located around Chrompet. The samples were tested in ocean research laboratory (ICPMS) of Sathyabama University.

Table.1: Area of the Collected Samples

Place	**Samples**
Ganapathipuram	S1 S2
Periyar Nagar	S3 S4
Mummurti Nagar	S5 S6

Heavy Metal Concentration	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
Iron	2.5	0.26	0.78	2.5	2.9	2.7
Magnesium	245	76	91	115.2	118.1	116.7
Cadmium	0.009	0.006	0.008	0.007	0.006	0.004
Lead	0.03	0.02	0.03	0.04	0.02	0.03

Fig .4: Sample collection

III. Experimental Study

3.1 Rice Husk

Rice husk is difficult to ignite and does not burn easily with open flame unless air is blown through the husk. It is highly resistant to moisture penetration and fungal decomposition. Rice husk has a high silica (SiO2) contents which means that it decomposes slowly when brought back to the field. Rice husk has a high average calorific value of a 3410 kcal/kg and therefore is a good, renewable energy source. Because of the high silica contents rice husk is very abrasive and wears conveying elements very quickly.

Adsorbent Preparation: The rice husk was obtained from Chrompet (local rice mill). It was sieved using mesh to get a desired adsorbent size of 30 micro meters and stored in an airtight container. Sieving was done to remove the dust and impurities present in it.

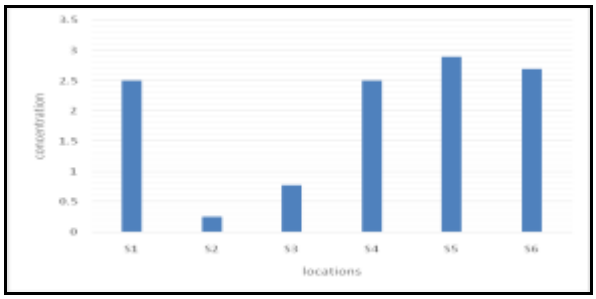


Fig .5: Concentration of Iron Content

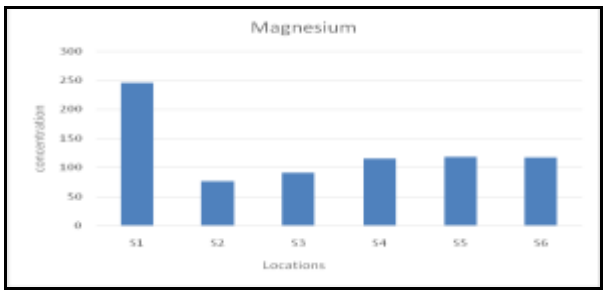


Fig .6: Concentration of Mg Content

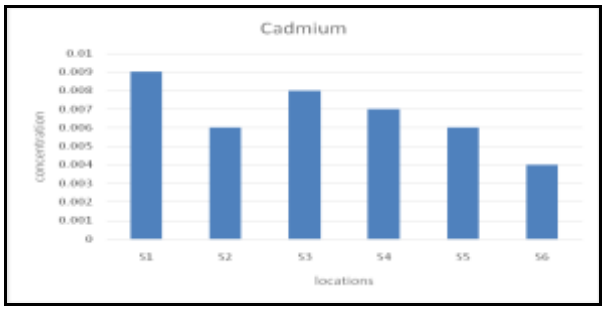


Fig .7: Concentration of Cd Content

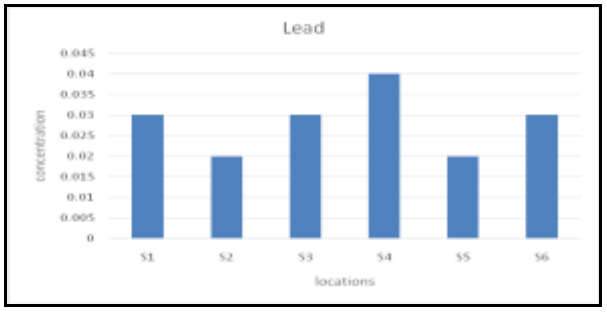


Fig .8: Concentration of Lead Content

3.3 Methods of Removal of Heavy Metals

Removal of heavy metal is done by using rice husk as adsorbent sample, varying the ratio of rice husk from 2g/l, 4g/l,6g/l,8g/l,10g/l and 12g/l with the contaminated water and made to determine adsorbent capacity of rice husk on heavy metals. This procedure is carried out in a beaker (1000ml) and test tubes. First sample collected in the required area and solution pH was adjusted with HCL or NaOH (0.01) pH is measured by following electrometric method using a digital pH meter. Then the samples were placed in 6 beakers up to level of 800ml-900ml. A known amount of adsorbent (Rice Husk) was added to samples and was agitated at 50-140 rpm agitation speed, allowing sufficient time for adsorption of 45-150 minutes at 28-30 degrees' room temperature. Then the sample can settle till clear water is seen on the surface. The sample is filtered and then the final concentration of metal is measured from the analysis using ICPMS. Thus, the initial and final concentrations of the sample were determined and the results are recorded.

Table .3: Concentration of Iron Content after Treatment

Sample id	Initial concentration (mg/l)	Final concentration(mg/l) after Treatment					
		2	4	6	8	10	12
S1	2.5	1.15	1.22	1.7	1.16	1.372	1.7
S2	0.26	0.11	0.1	0.07	0.10	0.138	0.17
S3	0.78	0.32	0.3	0.27	0.29	0.42	0.519
S4	2.5	1.2	0.89	0.62	1.0	1.34	1.66
S5	2.9	1.33	1.08	0.87	1.11	1.47	1.84
S6	2.7	1.13	1.00	0.94	1.06	1.41	1.67

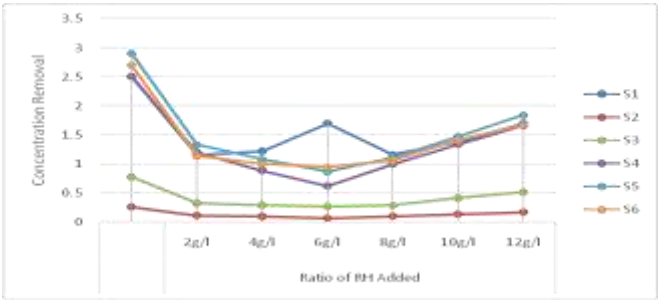


Fig .9: Final concentration of Fe after treatment

Table .4: Magnesium Content after treatment

Sample id	Initial concentration(mg/l)	Final concentration(mg/l) after Treatment					
		2g/l	4g/l	6g/l	8g/l	10g/l	12g/l
S1	0.009	0.0026	0.002	0.0026	0.0026	0.0046	0.005
S2	0.006	0.0026	0.002	0.0021	0.0023	0.0029	0.003
S3	0.008	0.0034	0.002	0.0024	0.003	0.004	0.005
S4	0.007	0.0032	0.003	0.0022	0.0027	0.0036	0.004
S5	0.006	0.0027	0.002	0.0017	0.0022	0.003	0.003
S6	0.004	0.0017	0.001	0.0014	0.0015	0.003	0.002

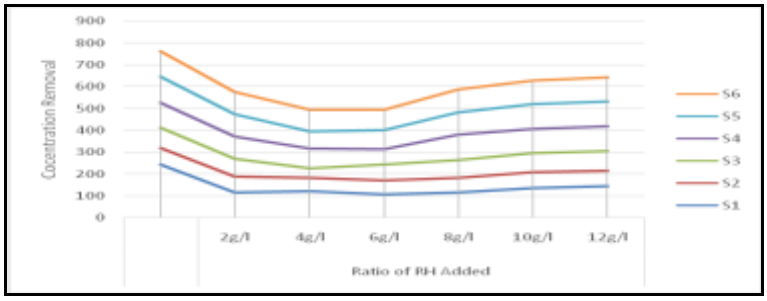


Fig .10: Final Concentration of Mg after treatment

Table .5: Cadmium Content after Treatment

	Initial conc (mg/l)	Final concentration(mg/l) after Treatment					
		2g/l	4g/l	6g/l	8g/l	10g/l	12g/l
S1	245	115	122	107	116	137.2	145.6
S2	76	73.8	60.	65.	69	72.4	71.8
S3	91	82	45	73.	81.6	86.8	88.6
S4	115.2	102	89	68	115.	112.	112.8
S5	118.1	103	80	87.	101.	112.	112.8
S6	116.7	101.4	100	94.	103.	108.	113

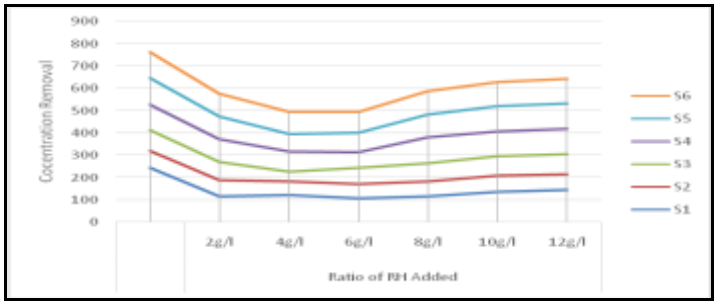


Fig .11: Final Concentration of Cd after treatment

Table .6: Lead content after treatment

Sample id	Initial concentration(mg/l)	Final concentration(mg/l) after Treatment					
		2g/l	4g/l	6g/l	8g/l	10g/l	12g/l
S1	0.03	0.009	0.006	0.009	0.008	0.02	0.02
S2	0.02	0.0084	0.006	0.005	0.008	0.01	0.01
S3	0.03	0.014	0.010	0.009	0.012	0.01	0.02
S4	0.04	0.018	0.014	0.013	0.015	0.02	0.03
S5	0.02	0.0094	0.009	0.002	0.007	0.01	0.01
S6	0.03	0.013	0.01	0.008	0.011	0.01	0.02

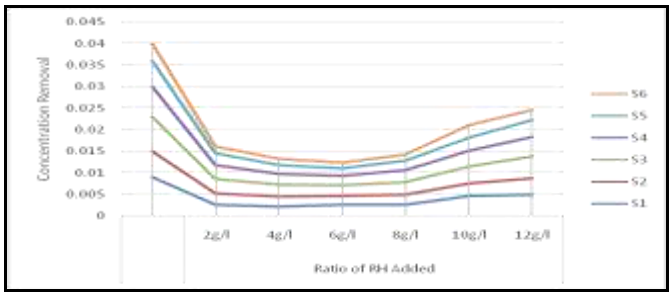
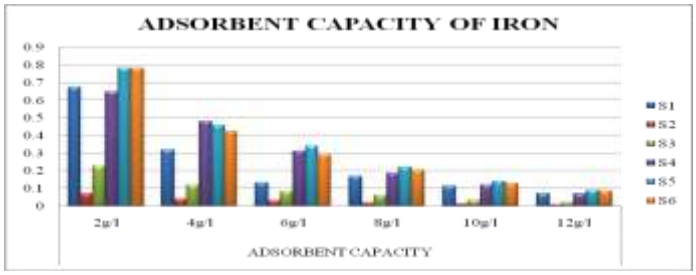


Fig .12: Final Concentration of Pb after treatment

3.4 Adsorption Isotherm

The initial and final concentration of the heavy metals had shown the rice husk worked effectively on the removal of heavy metal concentration. The adsorption capacity had been found using adsorption isotherm equation which is shown below:

Adsorbent capacity (q_i) = [(Co - Ct) V] / m
Where,
C_o is initial concentration (mg/L),
C_t is concentration at time *t* (mg/L),
V is the volume (L) of wastewater,
And m is mass of adsorbent (g).



3.5 Removal of heavy metals by using other technology

- Solid bio materials such as charcoal or waste coffee and tea have also been used to remove heavy metals from contaminated waste water up to 70%-100%, which is a suitable process to eliminate metals from ignored wastewater.
- Peanut husk, charcoal are some of the low-cost adsorbents which have the potential to remove heavy metals from underground water.
- A chemical reagent name LENNSORB 101 is also use in adsorption process as filters, which act as permeable barrier to remove heavy metals from underground water that is elimination to the proximity required point.
- Phyto technology can also be use as removal of heavy metal from polluted ground water, which involves using plants. It is also known to be the second most abundant material.
- Phyto filtration technology is a method which is used to remove heavy metal in high amount up to 90.5% with a plant namely Hemidesmus indicus.
- Chitosan a biological cationic polymer, which is recognized as versatile, is also an eco-friendly material that has been use for the removal of heavy metals from industrial wastewater.
- Chemical precipitation is one of the most widely used methods for heavy metal removal from inorganic effluent in industry due to its simple operation.
- Electrolytic recovery is one technology used to remove metals from wastewater streams. This process uses electricity to pass a current through an aqueous metal-bearing solution containing a cathode plate and an insoluble anode.
- Ion exchange can attract soluble ions from the liquid phase to the solid phase, which is the most widely used method in water treatment industry. As a cost-effective method, ion exchange process normally involves low-cost materials and convenient operations.

IV. Conclusion

In this study Chrompet is taken as study area, because of presence of tanneries and many other industries in the area. Due of the discharge of industrial waste in that area, the surface water and groundwater was highly affected. So, an attempt had been made for the removal of heavy metal in the contaminated water of the corresponding area. In this study, totally 6 samples were collected around the area and analyzed for the presence of heavy metal. It shows that the heavy metal like iron, magnesium, cadmium and lead were present in the samples with high concentration. The basic physicochemical properties were also above permissible limit.

V. References

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