Development of an Efficient Method for Hardness Removal from Groundwater

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Introduction

Hardness is one of the persistent issues in Sri Lanka related to water quality.It can lead to kidney problems while excess intake of magnesium influences on bowel diseases and laxative effect. Hardness in water is a result of dissolution of limestone - both sedimentary and crystalline - as well as calcium bearing minerals. It can also occur locally in groundwater from chemical and mining industry effluent or excessive application of lime to the soil in agricultural areas. Water hardness has spread almost all over the country. Approximately 75% of Sri Lanka has been affected by water hardness problems. Mainly Jaffna peninsula and several provinces including North Central, Central, Northwestern, Eastern provinces and some areas of Southern province experience water hardness problems (Dissanayake et al, 1985).

Even though, temporary hardness can be removed by boiling there are no efficient methods for removal of permanent hardness in groundwater domestically. Carbonate precipitation is suitable for industrial water softening. But domestically it cannot be applied easily and practically it is not possible. Therefore people tend to consume hard water without any treatment.

The present work aims at identifying and characterizing a suitable low-cost material for water hardness removal.

Methodology

Bentonite clay was used as a hardness removing material. Three experimental methods with different treatments were conducted during this study. Acid treatment, potassium dihydrophosphate treatment and Sodium sulphate treatment of bentonite were conducted. Four different concentrations of HCl solutions were used for acid treatment. Other two treatments were done by varying concentrations of the potassium dihydro phosphate and sodium sulphate of each of the four samples. The entire treated sample was centrifuged. 12 samples were then filtered through treated bentonite columns and hardness was measured with EDTA titrimetric method. Finally hardness was measured in hard water passed through the raw bentonite and natural hard water sample to find out the initial hardness in natural water.

Results and Discussion

Calculated hardness values are shown in Table 1. It suggests that the efficiency of hardness removal by Sodium sulphate treated bentonite is higher than the other two. Figure 1 shows the average efficiency of each treated bentonite type. Mainly Na_2SO_4 treated bentonite shows the higher efficiency than the KH_2PO_4 treated bentonite. Hardness removing efficiency of Na_2SO_4 is higher than that of KH_2PO_4 due to replacement of H ions on hydroxyl groups. It is absorbs energy and decreases the absorption capacity. But in Na_2SO_4, there is no any energy transformation and it is already bound sulphate groups in the layer and performs the adsorption phenomena directly. It is shown in Figure 2. The higher efficiency of removing hardness through

Na_2SO_4 has obtained at 150 mg/l concentrated bentonite sample. Raw bentonite also has water softening capability. It has enhanced by treating with those reagents to obtain more effective

removal of hardness. Final results have not approached standard hardness limits. The reason is the interferences of heavy metals which replace Magnesium and Calcium ions and include into the calculated hardness values.

Table 1. Hardness, Efficiency of Removing Hardness Calculations.

	Total Hardness (as CaCO3)	Hardness Removing Efficiency (%)
Synthetic Hard water sample	1808.23	0.0
Boiled natural water sample	1544.67	14.6
Raw Bentonite	1341.16	25.8
0.1M HCl treated Bentonite	1134.31	37.3
0.25M HCl treated Bentonite	1266.10	30.0
0.5M HCl treated Bentonite	715.62	60.4
1.0 HCl treated Bentonite	1316.14	27.2
50mg/L KH_2PO_4 treated Bentonite	1384.53	23.4
100mg/L KH_2PO_4 treated Bentonite	683.92	62.2
150mg/L KH_2PO_4 treated Bentonite	612.19	66.1
200mg/L KH_2PO_4 treated Bentonite	787.35	56.5
50mg/L Na_2SO_4 treated Bentonite	618.87	65.8
100mg/L Na_2SO_4 treated Bentonite	1125.97	37.7
150mg/L Na_2SO_4 treated Bentonite	523.78	71.0
200mg/L Na_2SO_4 treated Bentonite	785.68	56.5

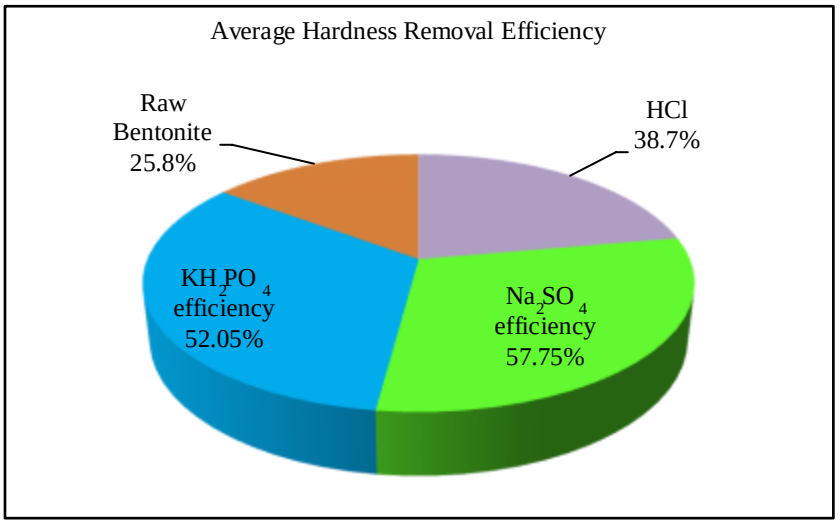

Figure 1. Average hardness Removal Efficiency.

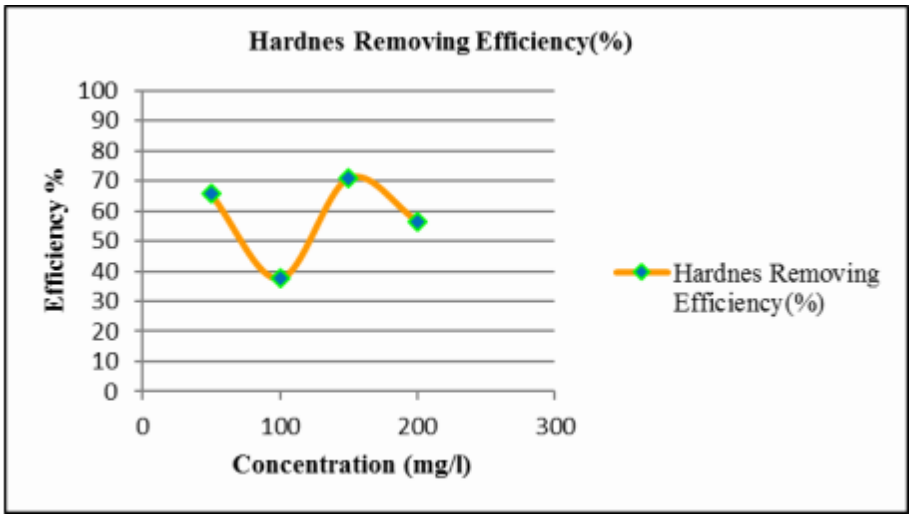

Figure 2. Average hardness removal Efficiency of Na_2SO_4 treated bentonite vs concentration.

Conclusions

In this research it is found out the bentonite can remove hardness and treating with Na_2SO_4 is more effective to remove hardness than the pristine bentonite. Modification slightly decreased the specific surface area of the pristine bentonite clay. Sulphate modified bentonite clay gave higher adsorption capacity for both metal ions.

References

Dissanayaka, C.B., Weerasuriya, S.V.R., 1985. Geological classification of ground water of Sri Lanka, Department of geology, University of Peradeniya, ,Sri Lanka

Olu-Owolabi, Bamidele I., Emmanuel, I., Unuabonah, 2010. Kinetic and thermodynamics of the removal of Zn^{2+} and Cu^{2+} from aqueous solution by sulphate and phosphate-modified Bentonite clay, Journal of Hazardous Materials, 184, 731–738.

Ozcan A.S., Erdem B., Ozcan A., 2005. Adsorption of acid blue from Aqueous solutions on to BTMA activated bentonite, colloid and surfaces, 266, 73-81.