Removal of Fluoride from Drinking Water using Gypsum

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Introduction

Excess amount of fluoride in drinking water causes detrimental health impacts such as dental and skeletal flurosis. According to the World Health Organization (WHO), the maximum acceptable concentration of fluoride in drinking water is 1.5 mg/L (Darchen *et al*, 2010). According to Sri Lanka Standards desirable and permissible levels of fluoride is 0.6 mg/L and 1.5 mg/L respectively. In tropical countries like Sri Lanka, the lowering of the fluoride regulatory limits in drinking water is required due to high consumption of water by the people living in the regions with high natural fluoride concentrations. Therefore, excess fluoride in drinking water must be removed to the permissible level. There are several techniques available to remove excess fluoride from drinking water based on adsorption, precipitation, ion exchange and membrane separation. (Dou *et al*, 2012). However, most of these methods are highly specialized and cost intensive in that they cannot be implemented successfully at community level. In this research we propose to utilize gypsum, a ubiquitous mineral in nature, to mitigate excess fluoride from drinking water based on precipitating common ion effects.

Materials and Methodology

Industry grade gypsum was obtained from Holcim Lanka Limited. It was cleaned and ground into powder and separated into different particle sizes through mesh sizes 500 µm, 250 µm, 125 µm and 63 µm. Varying amounts of gypsum were added to definite 10 ppm fluoride solutions. Gypsum – fluoride suspensions were thoroughly mixed for 24 h and the residual fluoride concentrations in solutions were measured. The fluoride removal ability was determined as a function of particle size of gypsum. In these experiments gypsum of different particle sizes were selected. Fluoride removal efficiency by gypsum was also evaluated as a function of pH. The pH variations were done using 0.01N nitric acid and 0.01N sodium hydroxide solutions. In all cases, SPADNS method was used to determine the residual fluoride concentrations.

Results and Discussion

As shown in Figure 1, the residual fluoride concentration in solution decreased with the addition of gypsum. When gypsum content is in excess, the residual fluoride concentration has decreased showing an optimal value at 2.50 g gypsum. For other experiments, 2.50 g of gypsum was used. According to the results shown in Figure 2, the residual fluoride concentration decreases with the particle size of the gypsum and the maximum fluoride removal is obtained with the gypsum particles having diameter below 63 µm. As illustrated in Figure 3, the pH for maximum removal of fluoride was around 6.

Conclusions

Gypsum can be used to lower the fluoride content in drinking water. The particle size effect on fluoride removal efficiency is a result of increased specific surface area. Optimal pH of fluoride removal was around 6.

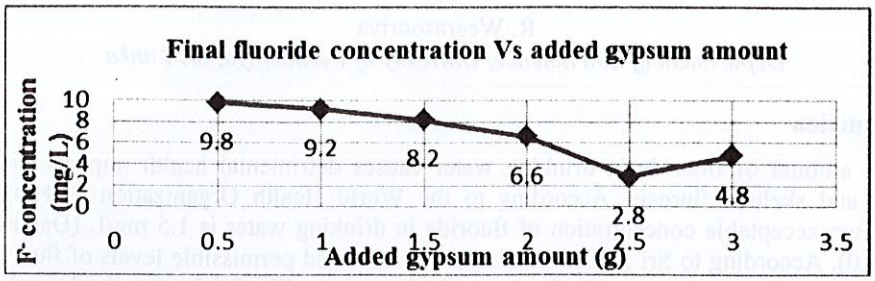

Figure 1: Variation of residual fluoride concentration as a function of gypsum content

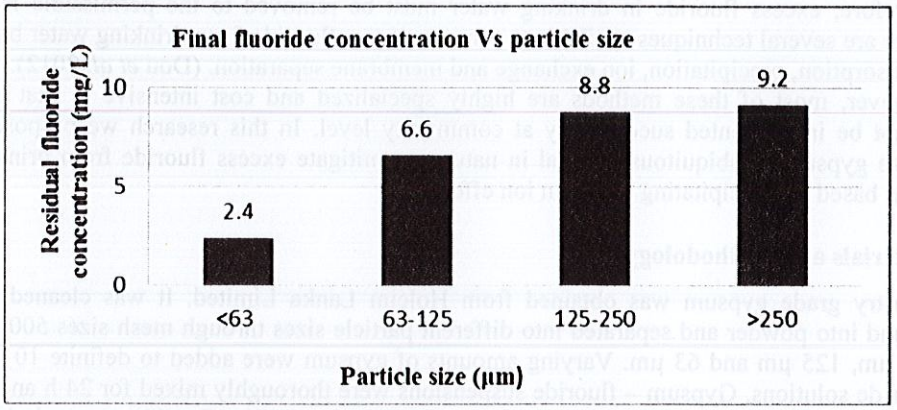

Figure 2: Variation of residual fluoride concentration with gypsum particle size

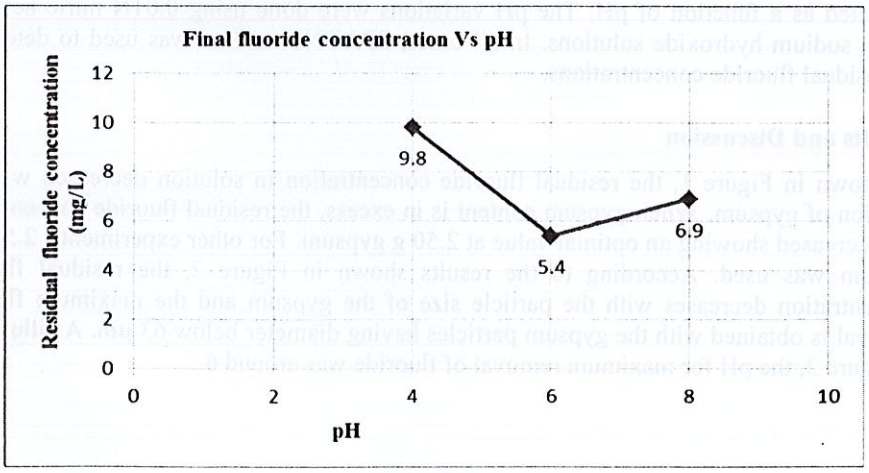

Figure 3: Variation of residual fluoride concentration with pH

References

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Dou, X., S.Yang, D. Mohan, and C.U.P. Jr., 2012. Remediating fluoride from water using hydrous zirconium oxide, *Chemical Engineering Journal* 198, 236–245.