Efficiency of coagulation processes for the treatment of flood affected water with special reference to turbidity and total solids

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Abstract

Groundwater is created by infiltration of precipitation, surface runoff, or water stored in surface bodies, including rivers and lakes, to an aquifer. Ground water quality is important as it is the main factor determining its suitability for drinking, domestic, agricultural and industrial purposes. Pollution reaches groundwater in several ways. Rainwater and runoff may contact contaminated soil while filtering down into groundwater. Turbidity, total solids, electrical conductivity, and pH are considered as some of the important parameters in water quality.

This study was designed to determine the efficiency of optimal alum concentration on the treatment of the flood affected ground water in Sithandi G. N. Division of Eravur Pattu D.S division at Batticaloa District. The total numbers of 15 wells were selected randomly from the Sithandi village to analyze the ground water samples. Severely polluted well was selected based on the questionnaire survey during the period of November 2015 to January 2016. Samples were collected to analyze the water quality parameters such as turbidity, total solids, electrical conductivity, and pH. Collected water samples were treated with Ammonium alum ($(NH_4)Al(SO_4)_2$) at different concentration (control, 2.5 mg/l, 5 mg/l, 7.5 mg/l, 10 mg/l, and 12.5 mg/l) with three replicates. It was found that the turbidity reduction was effective at the concentration of 5 mg/l alum.

Key words: *Groundwater, Coagulation, Alum, Turbidity.*

Introduction

Water is the most precious, cheapest and the least regulated natural resource in the world. It is a renewable resource and there are no substitutes for water (Panabokke, 2007). Groundwater use has fundamental importance to meet the rapidly expanding urban, industrial and agricultural water requirement, especially in arid areas where surface waters are scarce and seasonal. Ground water is an important source for

drinking water, and it plays an important role in the ecological functions performed by various ecosystems.

Coagulation is one of the efficient processes for the treatment of turbidity of water. From the historical point of view, the processes of coagulation were designed primarily for reducing turbidity, then the reduction of organic matter has become a goal of coagulation, due to the impact that organic constituents have on water bio stability (Volk *et al*., 1994). In this context, this study was designed to determine the efficiency of Ammonium alum on the treatment of groundwater which was polluted by seasonal flood.

Materials and Methods

This study was carried out at Sithandi of Eravur Pattu D.S division at Batticaloa. The total numbers of 15 wells were selected randomly in this village. Questionnaire survey was carried out during the period of November 2015 to January 2016. Severely polluted well was selected based on the questionnaire survey for sampling. Samples with three replicates were collected to analyze the water quality parameters such as turbidity, total solids, electrical conductivity, and pH. These samples were analyzed at the laboratory of Agricultural Engineering, Faculty of Agriculture, Eastern University, Sri Lanka.

Collected water samples were treated with Ammonium alum at different concentration such as T_1 (control: without alum), T_2 (2.5 mg/l), T_3 (5 mg/l), T_4 (7.5 mg/l), T_5 (10 mg/l), and T_6 (12.5 mg/l) with three replicates. Alum was added to the water samples and the samples were mixed for 1 min in 200 rpm, then for 20 min in 40 rpm by using shaker and allowed 20 min to settle (Jar test). After the coagulation process water samples were filtered by using whatsman No: 1 filter papers. Data were analyzed by using the statistical software of SAS 9.1.3, Minitab 15 and MS Excel version 2013. The mean values of parameters were compared with World Health Organization (WHO) standard for drinking water.

Results and Discussion

Turbidity

The changes in turbidity with different concentration of alum on groundwater in two weeks interval is shown in figure 1. Turbidity was decreased as alum concentration increased. The treatment T_2 (2.5 mg/l) significantly reduced the turbidity than T_1

(control). Madsen *et al.,* (1987) also reported that the turbidity was decreased due to destabilization mechanism could be adsorption and charge neutralization by increasing concentration of alum.

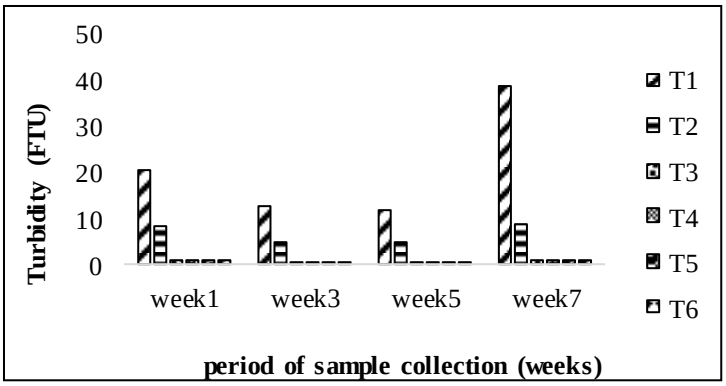

Figure 1: Changes in turbidity with different concentration of alum

Total solids

Figure 2 shows the changes in total solids with different concentrations of alum in two weeks interval. There was fluctuation in reduction of total solids. However, reduction was observed with the treatment of alum. The amount of total solid was reduced with the treatment of alum due to coagulation process neutralize or reduce the negative charge on the particles and particles bringing together to form large size particles by Flocculation. This in turn enhances the settling of total solid (James *et al.,* 2004).

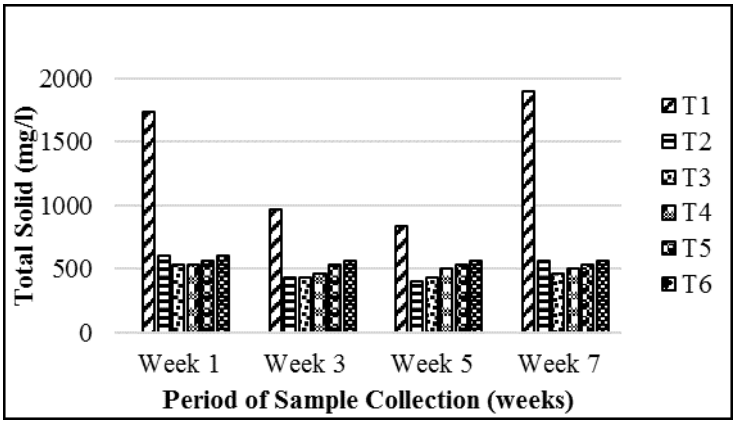

Figure 2: Changes in total solids with different concentration of alum

pH

The changes in pH with different concentration of alum on groundwater in two weeks interval is shown in figure 3. In most cases, pH was decreased as the alum concentration increased. Egbuikwem and Sangodoyin, (2013) also reported that the alum drastically reduced the pH with increasing concentration of alum. When one

mole of alum is added to water two moles of aluminum hydroxide are formed and precipitated as seen in Equation, it leads to the reduction of pH of the water.

$Al_2 (SO_4)_3.14H_2O \rightarrow 2Al (OH)_3 + 6H^+ + 3SO_4^{2-} + 8H_2O$

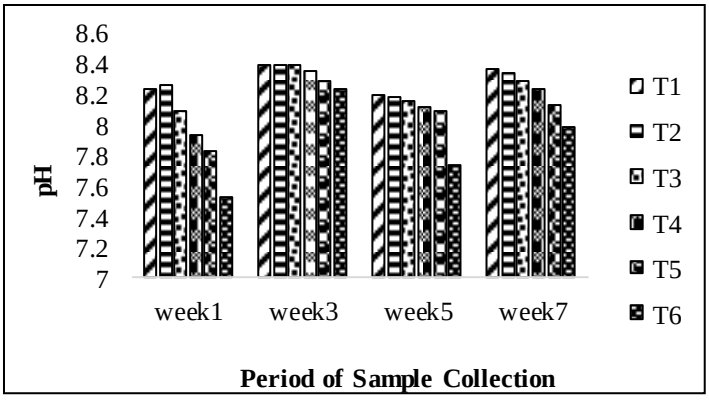

Figure 3: Changes in pH with different concentration of alum

Electrical conductivity

The results shown in figure 4 is the changes in electrical conductivity with increasing alum concentrations on groundwater in two weeks interval. Electrical conductivity was increased in all treatments as alum concentration increased. Electrical conductivity of a solution depends on the concentration of all the ions present in the solution. The most mobile cation is the hydrogen ion (H^+). When the addition of alum into water it lead to increase H^+ ion and it causes to lower the pH (Amfo-Otu *et al.,* 2014). Some residual dissolved Al is remained in solution by addition of alum into the water. It causes to increase the electrical conductivity of the water. This is supported by the findings of Egbuikwem and Sangodoyin, (2013) who found that alum increased the electrical conductivity of polluted water with increasing concentration.

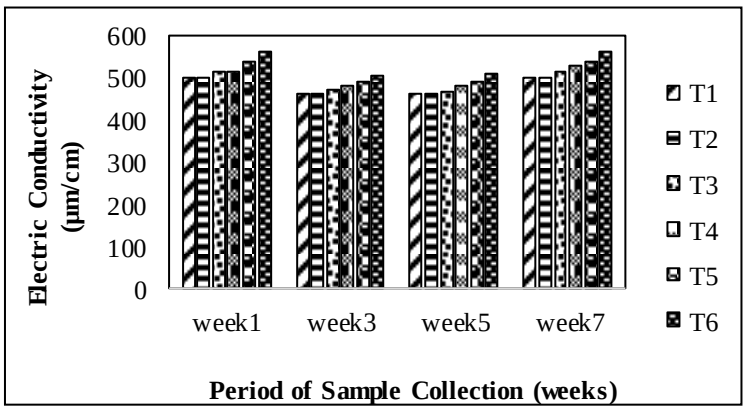

Figure 4: Changes in electrical conductivity with different concentration of alum

Conclusions

This study was provided information on flood affected well water quality and optimal alum concentration required to treat the ground water which is polluted by seasonal flood in Sithandi village. The higher mean values of these parameters (pH, turbidity, total solids and electrical conductivity) of groundwater at Sithandi village during the study period were obtained.

This study was mainly focused on turbidity and total solids. This study showed that there was significant reduction in turbidity, and total solids with the treatment of alum. 5 mg/l of alum concentration was considered as optimal concentration for the treatment of groundwater of Sithandi village although other treatments of alum concentration treated well because of lower concentration with considerable efficiency. Therefore, 5 mg/l of alum concentration could be considered as the optimal alum concentration to treat the flood affected groundwater at Sithandi village.

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