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Effect of Aluminum Tetraoxosulphate (VI) hydrate (Alum) On Some Water Quality Parameters

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Abstract: The need to acquire portable water has long been realized by greater part of rural area population. However, the technology of purifying contaminated water is not accessible but there are options that are mostly accepted as better option of reducing the level of contaminants in polluted water. Once of such local technology involves the use of alum (aluminum sulphate). The present study was designed to investigate the effect of alum on turbidity, COD, pH, chloride content, sulphate content, alkalinity, total dissolved solid, ammonium and conductivity of contaminated water. Polluted water samples were collected from some local wells (designed to collect erosion water after rain). Analysis of the quality parameters before and after addition of alum indicated significant reduction in in all the analyzed parameters except chloride, salinity and alkalinity. Therefore, has the tendency to remove contaminants from water except salinity.

Key Word: Polluted water, purification, alum, water quality parameters

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1.0 Introduction

Lack of access to portable water is a global challenge especially in the rural areas. This is because global volume of waste and contaminated water is significantly higher than that of portable water (Eddy and Udo, 2006). Most natural sources of water, which were relatively portable have been heavily contaminated. Consequently, studies on methods of treating waste water for domestic and industrial applications are receiving global acceptability.

The use of alum as a coagulating agent and in decolorising polluted water with the aim of achieving the expected purity has become a common practice in the purification of water by rural women. This is done without the knowledge of the basic chemical composition of the alum and the water before and after the addition of the alum (Ranade and Bhandan, 2014). Alum is also useful in the treatment of industrial waste water.

Literature is not scanty on the effect of alum towards the improvement of the quality of domestic, industrial and Lake water. The effects of aluminum sulfate (alum) treatment on water quality in four lakes of the Minneapolis Chain of Lakes (MN, USA) were examined. Lakes Harriet and Calhoun (treated in 2001) and Cedar Lake and Lake of the Isles (treated in 1996) all showed initial water quality improvement based on surface water total phosphorus (TP), chlorophyll *a* (Chl-*a*), and Secchi disk depth.

Malect-Brown *et al*. (2010) described their study on the aapplication of low doses of alum for the treatment of wetlands to reduce elevated outflow winter phosphorus concentrations. They found that the application significantly improved the outflow water quality and that the growth of the plants was unaffected by the application of alum. Huser *et al*. (2011) also reported favourable results on the effective use of alum for the treatment of water and sediment in the Minneapolis Chain of Lakes. Malik (2018) conducted a study to investigate the effect of alum on the turbidity of muddy water and found that alum significantly reduces the turbidity of the muddy water and the removal efficiency varied with pH.

Water quality standards specify tolerance limit for water quality indices (physicochemical parameters, gross-organic pollutants, radionuclide organo-leptic properties and specific organic pollutants) as the standards for assessing the quality of water (FEPA, 1991; Konz, 2012). WHO (2011) guideline on water quality standards has outlined the permissible values for each of these parameters and in the assessment of the quality of water, observed parameters are compared with the desirable value/criteria (Richardson, 1999).

Alum (aluminum tetraoxosulphate (VI) is commonly used in several rural areas of Nigeria, with the aim of purifying dirty water. The practice is often done to obtained colourless water without recourse to the impact on the physicochemical quality of the water. Therefore, the present study is aimed at investigating the effect of alum on physicochemical quality of contaminated water.

The term water quality is defined by WHO (2011) as its fitness for its various usage. Ions in alum are K^+, Al^{3+} and SO_4^{2-} . Alum is soluble in water in all proportion therefore the assessment of its effect can be achieved by examination of the chemical composition of the water before and after the addition of the alum.

Arising from the excessive demand for portable water, especially among rural dwellers, it is necessary to search for purification or treatment methods that are easily accessible and cost effective. Hence the aim of the present study is to investigate the effect of alum on some quality parameter of contaminated water.

2.0 Materials and Methods

Contaminated water was collected from some local wells within Ikot Idem Udo village and were analyzed for pH, conductivity, total dissolve solid, chemical oxygen demand, hardness, phenolphthalein alkalinity, sulphate and chloride content. 0.5 g of alum were added to 100 ml of each of the water sample and the samples were allowed to stand for one hour at a pH of 6, after which the parameters were re-analyzed. The conductivity of the water was determined by using a conductivity meter. pH was determined using pH meter (Eddy, 2003). The phenolphthalein alkalinity and hardness were determined by titrimetric method (Rahmanian *et al*., 2015) while the chloride content of the water was determined by titration with standard silver nitrate solution using potassium chromate as an indicator (Hevdari and Bidgoli, 2012). COD was determined using titrimetric method (Odiongenyi *et al*., 2015).

The sulphate, ammonium and nitrate concentrations of the water were determined by spectrophotometric method (Ogoko, 2017). Water turbidity was measured using turbidity meter (Jia.*et al*., 2010)

3.0 Results and Discussion

The result of the physicochemical parameters of the water before and after the addition of alum is presented in Table 1.

The conductivity of the water sample after the addition of alum was observed to increases from 0.94 to 1.65 mS/cm. According to Eddy *et al.* (2004), conductivity of a solution depends on the number of mobile ions in the solution. Alum is soluble in water and is capable of dissociating to free cations and anions, which will lead to increase in conductivity of the water. Since there is a permissible range in which the conductivity of water is expected to lies for portable water (WHO, 2012).

Table 1: Mean physicochemical parameters of contaminated water before (raw) and after addition of alum (Raw + alum)

Parameter	Raw	Raw + alum
Colour	Brownish	Colourless
Conductivity (Ms/cm)	0.94±0.023	1.65± 0.029
pH	7.02 ±0.001	9.5 ±0.001
Total dissolve solid	360.01± 0.03	65.03± 0.02
Chemical oxygen demand (mg/l)	220.00 ±0.12	185 ±0.001
Turbidity (NTU)	350 ±0.034	65 ±0.032
Salinity (PSU)	51.01± 0.23	67.00±0.12
Phenolphthalein alkalinity	160 ± 0.51	1050 ± 0.49
Chloride mg/dm^3	40.24 ± 0.03	65.00± 0.02
NH_4^+ mg/dm^3	1.40 ± 0.29	0.31± 0.182
Total hardness as mg/dm^3 of $CaCO_3$	240.00± .512	102.00±0.32
SO_4^{2-} (mg/dm^3)	8.50 ± 0.93	13.19 ± 0.51

**** Results are presented as mean of triplicate analysis**

At significant level of conductivity, the salinity of the water may increase, leading to precipitation of some metal salts. Therefore, if excessive amount of alum is introduced into water, the conductivity may rise above the tolerance limit. The conductivity of natural water is due to ions such as chloride, sulphate, etc. A change in conductivity of the water may cause changes in other physicochemical parameters of the water.

The addition of alum increases the chloride content of the water from 40 to 65 mg/L. This gives an increment of 62.5%. According to FEPA (1991), excessive chloride concentration in water can increase the salinity of the water. Although chloride is needed by the body for the maintenance of electrolyte balance, excessive concentration could exert toxicity through its impact of increasing salinity (Likasiewicz *et al*., 2014). Concentration of ammonium in the water was slightly altered as a result of addition of alum. The change was from 1.40 to 0.31mg/l indicate a decrease in concentration, which could be attributed to the coagulation effect of the alum.

The alum was found to reduce the hardness of water from a mean value of 240 mg/dm^3 of $CaCO_3$ to. 2.60 $mg/dm^{3.}$ The favorable reduction in hardness may be attributed to the capacity of the added alum to coagulate $CaCO_3$ ions that are responsible for hardness of the water. Water may be soft, hard or very hard depending on the concentration of the constituents responsible for the hardness (Ahirran, 2008). The decrease in hardness is advantageous because it would allow for the use of the water for washing cloth and other materials (Eddy and Ekop, 2007). However, the concentration of tetraoxosulphate (VI) ion in the water was increase by 52.94 %, which may pose a threat to permanent harness if the calcium or magnesium content of the water is high. Tetraoxosulphate (VI) ion is regarded as a pollutant when its concentration in water is above the permissible limit (WHO, 2011). Hence the use of alum in excessive quantity may lead to the pollution of the water which would ultimately leads to toxicity. Symptoms of toxicity of tetraoxosulphate (VI) ion has been extensively discussed by Eddy (2003).

Deduction in COD and total dissolved dissolves solid of the water after addition of alum was also observed. Similar observations have been reported by Hashmi *et al*. (1999) and Guida *et al*. (2007).

4.0 Conclusion

Alum can improve the concentration of most contaminants in water and adjust the pH to alkalinity but also has the tendency of increasing salinity of the water. Therefore, alum is useful in adjusting some physicochemical parameters of water except chloride and salinity.

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Conflict of Interest

The authors declare no conflict of interest.