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Effects of Storage Containers (Plastics and Galvanized Iron) on Physicochemical Qualities of Water

Jesse D. Bwala[1],0naiwu Ighodaro[2], Oluwaseun Doofan[3],Chikezie, Ada Okey[4], Esimi J.S.[5]

[1,3,4&53]*Department of Agricultural and Bioenvironmental Engineering Technology, Federal Polytechnic Nasarawa, Nasarawa State, Nigeria*

[2]*Department of Civil Engineering Technology, Federal Polytechnic Nasarawa, Nasarawa State, Nigeria*

Abstract: *Water, a single most important resource to mankind constitutes 70% of the earth's surface and 75% of our body. This resource is very important, yet, fresh water is limited, and potable water is scarce. This is why there is a tendency to store this limited resource to ensure water security, both for domestic and industrial purposes. This paper tries to compare water stored in galvanized and plastic tanks over a period of three months. Three sets of water samples (20 liters each) were obtained from the same source (dug well-ground water). One was used as control and the other two were stored in plastic and galvanized tanks respectively. After three months the water in the plastic and galvanized tanks were analyzed for their physical and chemical/geochemical characteristics. The results were then compared to the results obtained from the control sample. The three results were then compared to world health organization (WHO) and National Agency For Food And Drugs Administration Control (NAFDAC) limits for potable water. The results obtained showed a general deterioration of both samples but the water sample from the galvanized tank deteriorated more.*

Key words: *Water, Security, Plastic, Galvanized, WHO standards.*

Introduction

Water is stored for a variety of reasons which include covering of peak demand, smooth out variation in supply, provide water security in case of supply interruption or disaster. There may be various other reasons for water storage (Perlman 2010) Water security is the capacity of a population to ensure that they continue to have access to potable water, it is an increasing concern arising from population growth, drought and climatic changes etc, (Wikipedia 2011)

The most important reason may be to provide water security for domestic. municipal and industrial uses. Water could be seen every where but potable water is scarce hence if available must be stored for future use.

To ensure water security especially in drought-stricken areas, water is often stored for very long periods to last out the drought periods.

One important factor in water storage is the material for the construction of the storage facility. These materials range from wood, concrete, plastics, and galvanized iron etc. The materials must be chemically pure so as not to pollute the stored water, hence it is imperative to ascertain the level of contamination of the construction material for the storage facilities on the stored water (Harter, 2003). For this study plastic and galvanized steel tanks are put under scrutiny.

Plastics are synthetic polymers derived from petroleum and are composed of hydro - carbons which means that the basic elements in plastics are hydrogen and carbon. Other elements that make up plastics include oxygen, nitrogen, chlorine, fluorine (Volume library 2001)

Plastics are characterized by low strengths, low stiffness (modulus of elasticity) which is less than one tenth that of metals except reinforced plastics. Plastics have a tendency to creep-change in dimensions under prolonged loading.

Plastics are sensitive to temperature changes they lose strength at higher temperatures Thermal expansion of plastics is about ten times that of metals (Griskey, 2009)

All these deficiencies are overcome by the addition of suitable fillers and compounds. Pure plastics are not used for any plastic products.

Some of the element added to reinforce plastics includes silicon in silicones and sodium in lonomers. With these fillers in place, plastics are made into a variety of products including tanks. (Volume library 2001)

Galvanizing is a process of coating a base metal iron steel with a thin layer of zine to protect it from corrosion. The product is galvanized iron steel which could be made into several products including water tanks. The presence of zinc slows down corrosion considerably but does not stop it completely. (Microsoft encarta 2009)

Materials and Methods.

Materials.

Three water samples were drawn from the same well (dug well-ground water) located near the Department of chemical Engineering, The Federal Polytechnic Nasarawa, (Table 1). Each sample was 20 liters. One sample was stored in a covered plastic container, the second sample was stored in a galvanized iron tank. The third water sample was taken for immediate analyses (control).

The instruments utilized in the study include

(a) Digital Atomic Absorption Spectrophotometer, (AAS),(HACH DR/2000 model.
(b) HANNA instrument pH meter model H198229.

Methodology

After three months (90) days the samples in the galvanized iron and plastic tanks were taken to the laboratory for analyses. The same parameters measured in the fresh water sample were measured for these samples, they include, Total dissolved solid (TDS). Total suspended solid (TSS), Taste, Odour, Temperature, Colour, pH, Nitrate, Chloride, Iron and Zinc.

(a) Digital Atomic Absorption Spectrophotometer (AAS) (HACH) DR/2000 model.

This equipment measures the concentrations of various elements and acid radicals in water. The reagents are the standard solutions of the element whose concentration is being determined and the water sample.

(b) HANNA instrument H meter model H1.98129. This instrument measures pH. To use this instrument, it is first calibrated using a pH buffer solution. This instrument was also used for measuring TDS (total dissolved solid). A higher TDS means that there are more cations and anions in the water. With more ions in the water, its electrical conductivity increases (Harter 2003). By measuring the electrical conductivity of water, we are indirectly measuring its TDS concentration. At a high TDS concentration water becomes saline. Water with TDS above 500mg/l is not recommended for drinking (WHO,2004).

Table 1: Condition of Well

S/N	Sample No.	Source	Duration of Storage	Remark
1	Sample No. 1 (Control sample)	Bore hole water (ground water)	Sample (ground water)	The well was partially covered and the container is closed.
2	Sample No.2 (Plastic container samples	Bore hole water (ground water)	The water was stored for 3 months period	The well was partially covered. The container is fully covered up to that duration
3	Sample No.3 (Galvanized iron container sample)	Bore hole water (ground water)	The water was stored for 3 months period	The well was partially covered. The container is fully covered throughout that duration of time

Detailed results are shown in Table 2. from the analyses the following were observed, temperature, odor and taste were the same for all the samples. There were no changes. H values changed but not significantly. The water samples became more alkaline with plastic container showing more alkalinity.

The following parameters showed significant increases in values, electrical conductivity. Total Dissolved Solids (TDS), Colour, Total Suspended Solids (TSS), Nitrate (NO), Zinc (Zn) and Chloride (CI). Nitrate and chloride are used in plastic manufacture, zine is utilized in galvanized iron. Iron (Fe) and turbidity showed reduction in values.

Discussion

The result showed that the values of temperature, odor and taste did did Nitrate not change in any of the samples and they all fall within NAFDAC/WHO limits

The pH values, changed but not significant. The samples became more alkaline but the values are still within acceptable limits.

Total Dissolved Solid (TDS), Colour, Total Suspended Solids (TSS), Nitrate (NO), Zinc (Zn), Chloride (CI), these showed significant increases in values but these values still fall within acceptable limits, Table 2.

The values of iron (Fe) and turbidity showed reduction in values. This means less iron (Fe) in the stored water samples but the value of Fe from the water in the plastic container showed slightly higher values. Turbidity in both samples has very close values (9 & 10). This showed that the water samples became clearer as they stayed longer but they are still higher than the acceptable value (5).

Electrical conductivity values increased but not significantly, even the value of the control sample is well above the NAFDAC/WHO acceptable limits, the Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) increased significantly but within acceptable limits. The Nitrate (NO), Zinc (Zn) and Chloride (Cl) increased even though within acceptable values but the increases are significant because it showed the containers as not being very safe especially the galvanized iron tank for long storage durations.

The strange observation was the reduction in iron in the samples but this may be explained by the increase in alkalinity, iron is more soluble in acidic environments (Mason 1966). It is possible that the iron precipitated with increase in alkalinity and added to the increase in Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). This may also be the reason for the increase in the electrical conductivity values.

Another significant observation is the increase in the value of Zinc (Zn) in the galvanized iron container sample. Pauling and Pauling (1975) indicated that Zn in moist air is oxidized and become coated with a tough film of zinc carbonate Zn,CO, (OH): This may be the reason for the increase in Zn in the galvanized iron tank sample S3. The Zine that was used to galvanize the iron container may have been oxidized to give the high values.

Table 2: Result of the Analysis

PARAMETER	SI	S2	S3	NAFDAC/WHO STDS
Temp. ^{0}C	26	26	26	-
Ph	7.26	7.57	7.31	6.8 -8.5
Electrical conductivity us/cm	231	231	249	120
T.S.D. mg/l	115.5	121	124.5	500
Colour (true). Pt.co	65	17	16	50
Turbidity NTU	18	9	10	5
T.S.S mg/l	13	46	65	200
Odour	Uni.obj.	Uni.obj.	Uni.obj.	Uni.obj.
Taste	Uni.obj.	Uni.obj.	Uni.obj.	Uni.obj.
Nitrate.(NO_3). Mg/l	12.76	32.56	37.84	45
Iron, Fe (T) mg/l	0.08	0.04	0.04	0.30
Zinc. Zn. mg/l	2	2	6	15
Chloride, Cl mg/l	11.20	18.30	18.60	250

Keys:
S1 - Control (Sample)
S2 - Plastic Container (Sample)
S3 - galvanized iron container (sample)
NTU - Nephelometric Turbidity Unit
Pt. Co.- Platinum Cobalt Unit
T.D. S - Total Dissolved Solids
T.S. S - Total Suspended Solids

The metals Fe and Zn are of nutritious value to man, animals and plants but within limited values. If the critical values are exceeded, they become toxic and can give rise to haemochromatosis and diarrhea but if there is a deficiency of these metals in human nutrition, anemia and stunted growth may occur (Sellinus & Frank 2000, Brunnel, et.al, 2007).

Excess of chloride and nitrates in drinking water could be hazardous to health especially to children. (Dissanayake 2005). These two increased in both the plastic and galvanized tanks, but the increases did not exceed the WHO recommended limit.

Conclusion

In conclusion water in both containers deteriorated but that of the galvanize diron container deteriorated more, within the period under investigation.

There may have been reactions between water and the containers, especially the iron and the trapped air. This makes it imperative that materials for manufacture of water storage facilities must be thoroughly analyzed to avoid possible contamination of the stored water.

The galvanized iron is not suitable for water storage for a long time especially where there are long drought periods.

Recommendation

Plastic containers are better for water storage but both should not be used for water storage for very long periods. As water storage is imperative in ensuring water security, further research should be carried out to improve the water storage construction materials

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