Comparative Analyses of Physico – Chemical Properties of In-Situ Concrete Lined and Ringed Shallow Wells Water

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Abstract **- The research examined the physico – chemical properties of a shallow well water lined with fresh concrete in Ado – Ekiti, Ekiti State. Two separate samples were collected and analyzed using standard method (s) of examination of water quality (ies) - one from the shallow well lined with in-situ concrete and the other from an old existing adjoined ringed well. Parameters studied included chemical and physical ones, which are pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Total Hardness, Chloride, Carbonate and Bicarbonate, Alkalinity, Calcium, Iron, Nitrate, Colour, Odour and Temperature. The physicochemical parameters of the old existing adjoined ringed shallow well water were within while most of the shallow well lined with in-situ concrete were beyond the permissible limits for potable water. However, remarkable reductions in the concentration levels of these parameters were observed when same sample were subjected to boiling and water guard treatment. Thus, the shallow well lined with in-situ concrete water should not be hurriedly used for domestic purpose. In case of urgency in demand for water, such shallow well water should be subjected to treatment.**

Keywords **- Pollution, groundwater, shallow well, in-situ concrete, physico – chemical parameters, treatment.**

I. INTRODUCTION

The demand for water of sufficient quantity and quality for human consumption, sanitation, agriculture and industrial uses should continue to intensify as the population increases. Groundwater is one of the major components of environmental resources that are under threat of either over exploitations or pollution, exacerbated by human activity on earth's surface [6].

Many areas of Ado Ekiti in Ekiti State do not have access to piped – borne water from municipal water treatment plants and where they do, it is grossly inadequate to meet the user's demands. As a result of this, many city dwellers are left with little or no alternative than to resort to self – exploration and exploitation of the underground water resources within their vicinity to meet the water demands by employing various means such as digging of shallow wells. It simply means that shallow wells were used as a major level of technological know – how in exploring underground water in Ado Ekiti area. There is no regulation guiding the construction and use of water wells. Therefore, home – owners build wells arbitrarily [2].

Well is a common ground water source readily explored to meet the community water requirement or make up shortfall. The various ways of lining a well are through the use of bricks, natural stones, concrete block, concrete rings and cast in – situ. The use of fresh concrete to line a shallow well caused major physical and chemical change in the quality of the water. The major effect caused is a phenomenon called Hardness of water. Hardness of water can be defined as a situation whereby soap cannot form lather readily with water. Water acquired hardness when it dissolved gypsum ($CaSO_4.2H_2O$) or limestone ($CaCO_3$) from the water surface over which the water flows. Gypsum is sparingly soluble in water but limestone is not. Worthy to note, gypsum and limestone are major raw materials for production of cement, which serves as a binding material during production of concrete [5].

When a fresh concrete is used to line a well, the constituent material mixed with water to cause hardness of water. Hardness of water can be temporary or permanent. Some of the physical effects noticed were the water taste, which was bitter because of the presence of excess alkali, the odour was very offensive and the presence of whitish particles was seen on the water, which is known to be an undissolved salt in the water. When a kettle or boiler is used to boil the water for some time, the inner surface becomes coated with a white fur – like layer. When fruits and vegetables are heated (cooked) in water, the amount of calcium ions in the water will influence the textural properties of the products. For example, calcium ions may form insoluble salts (calcium pectates) that are beneficial for maintaining firmness in cooked fruits and vegetables may become excessively tough. In this kind of condition, dried beans and peas would be difficult to rehydrate when cooked.

This piece of study examined and compared the physico – chemical properties of groundwater obtained from well lined with in-situ concrete and the ringed one. It would serve as source (s) of information for Civil Engineers and scientists concerning shallow well water in Ado Ekiti area.

A. Study Area

The study area is within Omisanjana area of Ado Ekiti, Ado – Ekiti Local Government Area (LGA) of Ekiti State, Southwestern part of Nigeria. It is around Latitude 7.6031° N and Longitude 5.2860° E as shown in Fig. 1. *The geology of Ekiti State where the study area is situated is of old plains broken by steep sided outcropping dome rocks and underlain by metamorphic rocks of the Precambrian basement complex of Southwestern Nigeria, which are very old. These showed serious changes in grain size and mineral composition. The rocks are quartz gneisses and schists consisting mainly quartz with small amounts of white mizageous minerals. They vary from very coarse-grained pegmatite to medium-grained gneisses in grain size and structure. They are strongly foliated and occur as outcrops. The soils derived from the basement complex rocks are mostly well drained, having medium to coarse in texture* [3], [4].

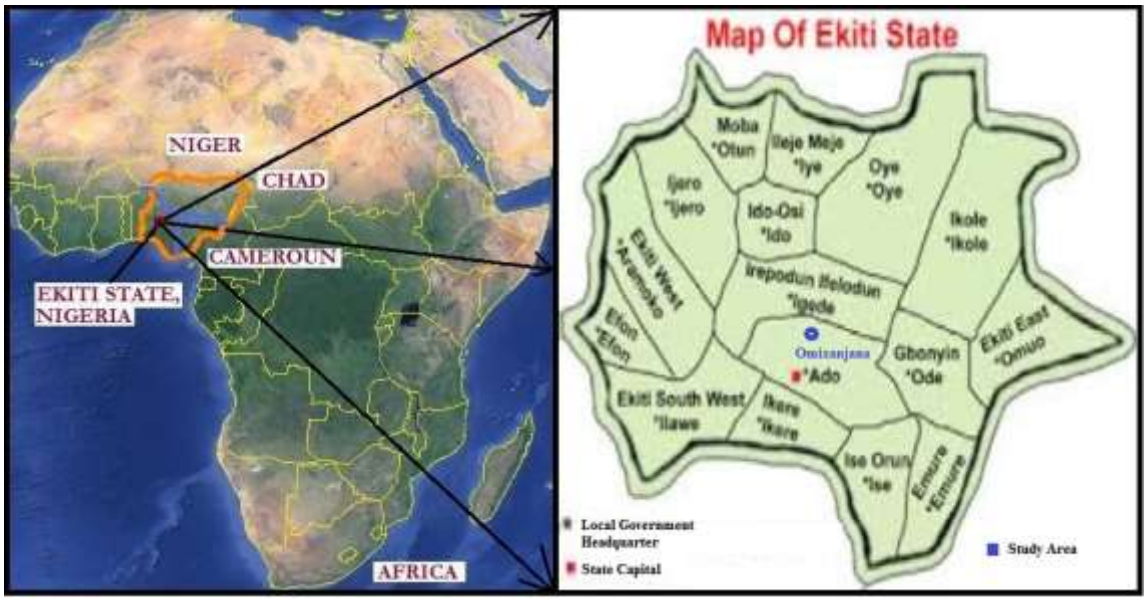

Figure 1: Location of the study area – Omisanjana area of Ado – Ekiti, Ekiti State

II. MATERIALS AND METHODS

Materials used for the sampling were two sterile plastic containers of 2 litres capacity, steel tape for the determination of depth, portable Hach Thermometer, ice packed cooler for sample storage. Water samples were collected from an insitu concrete lined well that was just seven days old and an existing adjoining ringed well from Omisanjana area of Ado – Ekiti, Ekiti State, Nigeria. The water samples were collected by dipping the 2 litres white plastic container into the wells. The containers were firstly washed with deionized water and then rinsed several times with the sample water before collection to avoid any contamination. Hach digital thermometer was used in taking the onsite temperature.

The containers were tightly capped to minimize contamination, escape of gases and labeled accordingly. Then stored in ice packed cooler for onwards transfer to the Water / Public Health Laboratory of the Department of Civil Engineering, the Federal Polytechnic, Ado Ekiti, Ekiti State. The analyses were carried out between 24 and 48 hours after collection in accordance with [1] standard methods. Physico – chemical parameters of in-situ concrete lined well water (Raw), after being subjected to boiling and sodium hypochlorite (i.e. water guard) samples were established. While only physico – chemical parameters of adjoining ringed shallow well water sample were determined.

III. RESULTS AND DISCUSSION

From Table 1, it is observed that the adjoining ringed shallow well water has chloride, conductivity, temperature and total hardness physico – chemical parameters that were beyond the [7] permissible limits for drinking water. While all the remaining physico – chemical parameters were within the permissible limits.

From Table 2, it is observed that there were sharp decrease in most of the parameters of the raw sample of in-situ concrete lined well water after being subjected to boiling as a form of palliative treatment measure and fell within the [7] permissible limits (except chloride and pH). Conductivity and temperature increased after boiling and were outside the [7] permissible limits. While turbidity and colour remained the same and were within the [7] permissible limits.

From Table 2, remarkable reductions in most of the parameters of the raw sample of in-situ concrete lined well water were observed after being subjected to water guard

treatment and fell within the [7] permissible limits (except calcium hardness and pH). Conductivity and temperature also increased after water guard treatment and were outside the [7] permissible limits. While turbidity and colour remained the same and were within the [7] permissible limits. Moreover, water guard treatment has more effects on the raw water when compared with the boiling treatment.

Comparatively, all the physico – chemical parameters of adjoining ringed shallow well raw water were better than that of in-situ concrete lined well raw water. Effects of treatments on the in-situ concrete lined well raw water parameters resulted in better water than adjoining ringed shallow well raw water.

Table 1: Summary of Results of Analyses of Adjoining Ringed Shallow Well Water

S/N	Parameter	Unit	Adjoining Ringed Well	WHO (2011) Limit
1	Iron	Mg/l	0.01	0.01
2	Calcium Hardness	Mg/l	47.50	75.00
3	Total Hardness	Mg/l	165.00	30.00 – 150.00
4	Nitrate	Mg/l	-	0.01
5	Magnesium	Mg/l	17.50	50.00
6	Chloride Cl^{2-}	Mg/l	482.12	200.00
7	Total Alkalinity	Mg/l	26.84	600.00
8	Bicarbonate Alkalinity	Mg/l	41.48	200.00– 600.00
9	Carbonate Alkalinity	Mg/l	-	200.00
10	Total Dissolved Solid	Mg/l	165.00	500.00
11	Total Suspended Solid	Mg/l	85.00	500.00
12	Total Solid	Mg/l	250.00	500.00
13	Conductivity	*u*S/cm	1.451	1.413
14	pH	-	7.80	6.50 – 8.50
15	Turbidity	NTU	5.00	6.00
16	Odour		Odourless	Odourless & Pleasant
17	Colour	TCU	5.00	<15.00
18	Temperature	^{0}C	26.30	25.00

Table 2: Summary of Results of Analyses of In-situ Concrete Lined Well Water

S/N	Parameter	Unit	Raw Water Sample	Sample After Boiling	Sample After Applying Water Guard	WHO (2011) limit
1	Iron	Mg/l	0.01	0.01	-	0.01
2	Calcium Hardness	Mg/l	180.00	68.00	84.00	75.00
3	Total Hardness	Mg/l	180.00	79.67	-	30.00 – 150.00
4	Nitrate	Mg/l	-	-	0.01	0.01
5	Magnesium	Mg/l	3027.00	11.66	17.50	50.00
6	Chloride Cl^{-2}	Mg/l	886.25	375.77	184.34	200.00
7	Total Alkalinity	Mg/l	1318.00	179.20	220.80	600.00
8	Bicarbonate Alkalinity	Mg/l	1012.00	170.80	219.60	200.00– 600.00
9	Carbonate Alkalinity	Mg/l	306.00	8.40	1.20	200.00
10	Total Dissolved Solid	Mg/l	355.00	120.00	95.00	500.00
11	Total Suspended Solid	Mg/l	115.00	30.00	18.00	500.00
12	Total Solid	Mg/l	450.00	150.00	113.00	500.00
13	Conductivity	*u*S/cm	1.46	1.57	1.47	1.413

14	pH	-	12.10	11.30	10.80	6.50 – 8.50
15	Turbidity	NTU	5.00	5.00	5.00	6.00
16	Odour		Slight Odour	Faint Odour	Faint Odour	Odourless & Pleasant
17	Colour	TCU	5.00	5.00	5.00	<15.00
18	Temperature	^{0}C	26.70	30.60	27.10	25.00

IV. CONCLUSION

The above study showed that when a freshly produced concrete was used to line a shallow well, the chemical properties of the concrete constituent materials altered the quality of the water produced beyond the permissible limits for drinking water. Thus, the water should not be hurriedly used for domestic purpose, though; there is possibility of quality improvement with time (if fetched). However, in case of urgency in demand for water, such shallow well water should be subjected to treatment.

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