Determination of Borehole Water Quality in Rivers State University

CYRUS ASEIBICHIN
Chemical/Petrochemical Engineering, Rivers State University

Abstract- Access to have a safe and potable water remains a significant challenge in many institutions of higher learning in Rivers State, Nigeria. Despite the importance of water for human consumption, recreation, and other uses, the provision of quality borehole water in these institutions has not been adequately handled. Hence, this research work to investigate the quality of borehole water in some specified institutions in River's state, in other to curtail possible negative effects of contaminated waters in the sub-region which will affect man and its environment pursuant to the threats posted by inadequate and poor treatment of a borehole water.

Indexed Terms- Borehole water, E. coli, contamination, water supply

I. INTRODUCTION

Water is crucial for all known forms of life and moves through a cycle of evaporation, precipitation and runoff (Gedneyet al., 2006). Water needs to be available at almost every moment of existence, but the availability of water in space and time is limited by environmental factors such as climate, geography of an area and physical conditions. A few other factors that could affect the availability of water are the efficiency by which it is conserved and used and the affordable technological solutions which permit its exploitation. An estimated two billion people do not really have access to potable water supply. Water being a basic need of every living thing, makes it necessary to ascertain its quality in relation to its effects on the consumer. Accordingly, standards and guidelines in water quality stem from the need to protect human health (Kiely, 2007).

Contamination of water has increasingly become an issue of serious environmental concern (Akpoveta et al., 2011). The habit of indiscriminate waste disposal, poor agricultural practices, septic tanks, pit latrines and graves near boreholes and poor well construction contribute to borehole water contamination (Sunnudo-Wilhelmy et al., 1999). These account for the presence of coliform bacteria in borehole water and lead to possible diseases if consumed without any form of treatment. Contaminated water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio. Among these water-related diseases, diarrhoea has a higher death possibility percentage (Singh et al., 2003). The calls for adequate treatment of water used for domestic purposes to prevent these deadly diseases, led to this research that is specifically centred in the institutions of higher learning in River's state.

II. LITERATURE REVIEW

Groundwater: This refers to the water present beneath the earth's surface filling the pores and cracks present in the rocks. It is usually present in soils that can retain it. It accounts for around 1.7% of the total water present on the planet. The depth at which the pores and cracks in the rocks and soil become completely saturated with water is called the water table. Groundwater makes up around 22% of the water that we use. It has mostly agricultural, municipal and industrial use. In India, about 90% of extracted groundwater is used for irrigation (USGS Ground water, 1999). The main source of ground water is infiltration. The infiltrated water after coming in contact with soil moisture deficiency drain deeply and becomes ground water. Maintenance of ground water resources is a must to every home that consumes water (Gbadebo, A.M. et al., 2010). Ground water pollution is a growing environmental problem, especially in developing countries. The urbanization process hinders the groundwater quality, due to impact of domestic and industrial waste disposal. This result to the aquifer deterioration, since some of the waste products, including sewage and cesspool may be discharged directly into the aquifer system (Reddy, P.J.R., 2008). Water soluble wastes and other materials that are dumped, spilled or stored on the surface of the land or in sewage disposal pit can dissolve by precipitation, irrigation waters or liquid wastes and eventually percolate through the soil in the unsaturated zone to pollute the groundwater (AIRBDA, 2014)

Surface Water: This is the water that is present on the earth's surface in rivers, streams, lakes, oceans, glaciers etc. Due to its ease of access, surface water provides around 78% of the freshwater used by inhabitants. Oceans contain 96.5% of the total water present on earth and glacier contains around 1.7%. Surface water pollution has a great potential than ground water contamination, the environmental implications of climate change have been a serious threat to surface water quality, with human activities seen as the most significant cause of the worsening of surface water quality in many nations and areas throughout the world (Weiler, M., et al. 2022).

Borehole Water: Borehole water resources are primarily groundwater, there is always a potential of impurity. Ground water is composed of numerous impurities and hazardous components. Prove of the increment in impurity is provided by the Government of Canada, which suggest that this increment results from a large and growing number of toxic compounds used in industries and agriculture (USGS, Groundwater, 1999).

Borehole Location: Refers to the specific geographic site or institution where the borehole water is sourced. This includes the physical address, surroundings, and environmental conditions of the area. In this study, the locations are limited to five institutions in Rivers State, Nigeria: Rivers State University. Each location has its unique geology, hydrology, and environmental characteristics that may influence the quality of the borehole water (Bridget, R. Scanlon et al.,2010).

According to the EPA, possible substrates can include:

- Microorganisms like Viruses, Fungi, Archaea, etc
- Fluorine in excess quantity
- Naturally occurring and Organic chemicals
- Heavy metals

Borehole is created by breaking through the ground to reach the aquifer. This is carried out via an efficient system of water pipes or submersible pumps, casings and Caps, which work together like lid and protect water quality. Water drawn up is then sent to an underground pressure tank installed in houses. Most drilled boreholes don't go dry (USGS, 1999). They may be prone to issues only if the pump intake is not fitted deep enough to enable a future reduction in the water table. Similarly, dug boreholes may be only subject to drying issues if placed too close to the surface or in an area with low permeability, sediments and rocks which doesn't allow a possible amount of water to seep into the aquifer. (SA Clan water, 2023)
A water borehole is constructed using a drilling rig, either rotary or percussion. These rigs are capable of penetrating much further into the water table than excavating by hand. Boreholes are generally much narrower and deeper than traditional wells as a result of modern techniques. Due to the increased depth, a water borehole can provide a consistent and reliable source of water. As part of the drilling process, steel or plastic casing is used to prevent the walls of the borehole from collapsing, as well as stopping contaminations. In some instances where the ground is self-supporting, a liner is not required (USGS Ground water, 1999).Once constructed; a water borehole can finish above or below the ground. However, the Environment Agency and environmental health guidelines recommends that, if the water is to be supplied for drinking, the borehole head works (which prevent surface contamination of the water), should be finished above the ground (USGS Ground water, 1999). With modern drilling techniques, water boreholes have overtaken water wells as a reliable source of clean water. Although installation costs can seem high, the water can be put to many uses and can therefore save money over time. A properly constructed borehole is a great way of accessing good quality water, and with suitable treatments the water can usually be made clean and safe for drinking (Well Drillers Association, 1940).

Testing for E. coli in water typically involves collecting a water sample and using a membrane filtration technique. The sample is filtered, and the filter is then placed on a culture medium that is selective for E. coli. After incubation, the colonies formed are counted and reported as colony-forming units (CFUs).

A simplified example of how to calculate the number of E. coli in a water sample:

1. Collect and Prepare the Sample: Collect the water sample in a sterile container. If necessary, dilute the sample with sterile, deionized water.
2. Membrane Filtration: Filter a known volume of the water sample through a membrane filter that retains bacteria.
3. Incubation: Place the filter on a selective medium for E. coli and incubate at the appropriate temperature for a specified time.
4. Counting Colonies: After incubation, count the number of colonies that have formed on the filter.
5. Calculations: Use the following formula to calculate the number of CFUs per 100 mL of the original water sample:

CFUs per 100 mL $= \frac{Number\ of\ colonies}{Volume\ of\ water\ filtered\ (mL)} \times 100$

For example, if you filtered 10 mL of water, and after incubation, you counted 50 colonies on the filter, and there was no dilution:

CFUs per 100 mL $= \frac{50}{10} \times 100 = 500 CFUs$

This means there are 500 CFUs of E. coli per 100 mL of the water sample.

There are documents that provide comprehensive guidelines for testing E. coli in water, including quality control measures, equipment, reagents, and step-by-step instructions. Accurate testing and calculation are crucial for assessing water safety and quality. (Manisha Garg: Generation Time, of Bacteria, 2018)

III. METHODS

Sample Collection

Collection and Preparation of the Sample

The water samples will be collected from boreholes in River's state institution of Higher learning which include River's state university. From their respective borehole tap, well labelled accordingly. Points where randomly picked during this period.

Preparation of Borehole Water

The water samples were collected using well-labelled plastic bottles. This is because plastic do not dissociate into water thereby reducing chemical interference in the analyses. An air space of 2.5cm was left in the water bottle to create space for oxygen, so that organisms in the water samples do not die before testing in the laboratory. The water was sent immediately to the laboratory in an insulated bag to prevent external factors like high temperatures from changing some of the water parameter.

Plate 1. Sample harvested from Borehole water.

The samples collected were stored in the refrigerator at 4°C to preserve its chemical properties prior to analyses.

- Determination of Physio-chemical Property of the Samples

Physio-chemical parameters such as pH, total Chlorine, Conductivity, turbidity, temperature, hardness, Total suspended solids, Total dissolved solids, Dissolved oxygen, Chemical oxygen demand, iron were all measured.

IV. RESULTS

The physiochemical parameter of water samples from borehole water location from institution of higher learning in River's state presented in table 1 shows that pH, turbidity, chlorine, Total hardness, conductivity, Iron, Total dissolved solids (TDS), Total suspended solids (TSS) were all below limits with a range of varying values, in comparison with the WHO standard.

Table 1. Physicochemical properties of Borehole water in River's state University

S/N	Parameters	Unit	RSU	Standard (WHO)
1	pH	-	4.90	6.5-8.5
2	Turbidity	NTU	0.61	5.0
3	Total hardness (as Caco3)	mg/L	18.1	100
4	Electrical Conductivity	µs/cm	6.54	1000
5	Temperature	˚C	27.2	Ambient
6	Chlorine (max)	mg/L	Nil	100
7	Iron (max)	mg/L	Nil	0.3
8	Total suspended solids (TSS)	Mg/L	1.35	100
9	Total dissolved solids (TDS)	Mg/L	0.1	250-500
10	Dissolved oxygen (DO)	Mg/L	6.77	5.0-10.0
11	Chemical oxygen demand (COD)	mg/	3.5	5.0

CONCLUSION

This study has shown that the chlorine, iron and turbidity of the boreholes located in Rivers state University was not up to the recommended limits by World Health Organization (WHO). In contrast, the temperature, total dissolved solid, total suspended solids, and total hardness and chemical oxygen demand of the water were within the WHO limit. Also, the Electrical conductivity of the borehole water were far Below the WHO limit. The pH values of the various institutions were seen to be very low and acidic, indicating that the water is not suitable for drinking. The results from this study indicate that water from the boreholes is lacking good treatment which is far apart from the WHO standards.

REFERENCES

[1] United States Geological Survey, USGS (1999). Groundwater: U.S. Geological Survey General Interest Publication Reston, Virginia, 1999 revision.

[2] Kiely, G. (2007). Environmental engineering. Special Indian Edition. McGraw-Hill Companies, Inc., New York, pp265266.

[3] Akpoveta, OV, Okoh, BE. & Osakwe, SA. (2011). Quality assessment of borehole water used in the vicinities of Benin, Edo State and Agbor, Delta State of Nigeria. Current Research in Chemistry, 3: 62-69.

[4] Sunnudo-Wilhelmy, SA. & Gill, GA. (1999). Impact of the clean water Acton the levels of Toxic Metals in Urban Estuaries the Hundson River Estuary Revisited. Environ. Sci. Technol., 33: 3471-3481.

[5] Egwari, L. and Aboaba, O.O. (2002). Bacteriological quality of domestic waters, Rev. Saude Publica, 36(4): 513520.

[6] William, L. (2014). Assessment of borehole water quality and consumption in Yei county South Sudan.A thesis submitted in partial fulfilment of the requirements for the award of Master of Science degree in environment and natural resources Makerere University.

[7] SA, Clean Water. (2023). How Borehole Water works: Publishedby Cameron MC Millan. Available at https://www.sacleanwater.com/How-borehols-work-7-Thing.

[8] Well Drillers Association. (1940).Boreholes and well. Available at htpps://www.welldrillers.org/boreholes-wells.

[9] Manisha Garg, Generation Time of Bacteria: With Mathematical Expression. Available at https://www.biologydiscussion.com/bacteria/generation-time-of-bacteria-with-mathematical-expression/55137.

[10] Quanti – Tray: (2020). E. coli Analysis in Wastewater by Quanti-Tray, Method 9223 B.

http://www.ohiowea.org/docs/E_Coli_QuanitTray.

[11] Environmental Protection Agency, U.S (2010). Method 1103.1: Escherichia coli (E. coli) in Water by Membrane. Available at https://www.epa.gov/sites/default/files/2015-08/documents/method.

[12] ISO 9308-1: Testing for E. coli and Coliforms in Drinking Water. Available at https://www.rapidmicrobiology.com/news/iso-9308-1-testing-for-e-coli-and-coliforms-in-drinking-water.

[13] Wisconsin, DNR. (2020). E. coli Test Method Help Sheet. Available athttps://dnr.wisconsin.gov/sites/default/files/topic/LabCert/E.-coli-Test-Method-Help-Sheet.

[14] Bridget .R. Scanlon, J. B. Gates. (2010): Quality of soil water and ground water in southern high plains, Texas.

[15] Singh, S. & Mosley, L. M. (2003). Trace metal levels, in drinking water on vitilevu, Fiji island, south pacific, *Journal of natural science 21, 31-34.*

[16] Gbadebo, A.M. and Akinhanmi, T.F. (2010). Gender issues in Management and uses of Ground water Resources: A Case of Abeokuta Metropolis. *Journal of Applied Science in Environmental Sanitation, 5, 191-199.*

[17] Uhl, A., Hahn, H.J., Jager, A., Luftensteiner, T.,Siemensmeyer, T., Doll, P., Noack, M.,Schwenk, K., Berkhoff, S., Weiler, M., et al. Making waves (2022): Pulling the plug-Climate change effects will turn gaining into losing streams with detrimental effects on groundwater quality. Water Res. 220, 118649.

[18] Reddy, P.J.R., (2008). A Textbook of Hydrology. University Science Press, New Delhi. Available at https://www.scirp.org/journal/paperinformation?paperid=69142.