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Assessment of water quality of Ikpoba River, Benin City using d.c. conductivity

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Abstract

The* d.c. *conductivity of Ikpoba, River was measured with a view to ascertaining the quality of the water. The* d.c. *conductivity of Ikpoba River ranges from* 400*μs/cm* - 500*μs/cm. This was compared to that of a popular brand of bottled water in the city which has a d.c conductivity of 180μs/cm* (Table 3). *The measurements show that a lot of ions are present in the river water. The origin of such ions is believed to be by-products of organic wastes deposited in the river by some industries located along its banks.

1.0 Introduction

Pollution is defined by Ahonkhai [2] as an undesirable change in physical, chemical or biological characteristics of air, land and water Environmental contamination is commonly expressed as a concentration of pollutant per unit volume or mass of air, water or soil. Due to pollution and other factors only 0.3% of the water resources of the world is available for general use. 70% of the earth's surface is water World Water Council [11], 97% is contained in oceans hence salty and unsuitable for drinking and irrigation of the remaining 3% of fresh water only 0.3% is found in lakes and rivers, the rest being frozen.

Part of the reason for this work is that water is a critical element of poverty in its many dimensions (Asian Development Bank, [3]). Indicators are developed to show the efficiency of water use to meet different demands. A generic example of a Current Water Adequacy (CWA) indicator for a current use *i* is

$$CWA_i = \frac{QCA_i}{TQ_i} \tag{1.1}$$

where QCA_i = current quantity of water allocated for use *i* and TQ_i = quantity of water needed to meet target level for use *i* .

If $CWA_i = 1$, it means that the current allocation for use *i* is perfectly matched to current needs.

A target sufficiency ratio (TSR) indicates whether current in flows are sufficient to meet current target levels. It is calculated as follows:

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$$\text{TSR} = 1 - \frac{\sum_i TQ_i}{I} \qquad (1.2)$$

where I = inflow.

If TSR is negative it means that current inflows are insufficient to meet all targets.

Industrial pollutants (Henry and Gary, [6]) include detergents, solvents, cyanide, heavy metals, mineral and organic acids, fats, salts, sulphides, ammonia and so on. Water carries wastes away from all stages of industrial processes. Water pollution by industrial wastes has become a threat to the continued existence of plants and animals and may threaten the quality of human life. A group of pollutants called heavy metals have been identified as the cause of health problems (Bernard, [12]). Heavy metals enter the water by many routes. The transmission of heavy metals to human consumers follows the food chain. Organic matter like dead leaves, human wastes and animal wastes also cause water pollution. In time organic matter gets broken down by micro-organisms if there is ample oxygen in the water. This depletes the dissolved oxygen supply in the water (Paul and Roughgarden, [7]). Further breakdown proceeds anaerobically. This leads to the production of variety of poisonous gases including hydrogen sulphide and methane (Ademoroti, [1]). Other products of the breakdown of organic matter are nitrates, phosphates, and sulphates. This can lead to the appearance of slimy green scum on the water. This worsens the quality of the water (Thomas, [9]).

Ikpoba River is one of the sources of drinking water by the in habitants of Benin City. Some industries in the city also use the river as outlets for their effluent wastes. In addition, animal and human wastes find their way easily and often into the water. These pose threats to the quality of the water and the need to evaluate the water quantitatively is the reason for this study. This quantitative evaluation is done through the measurements of the dc conductivity of different samples of water from the river.

The conductivity of a solution depends on the quality of dissolved salts present. It is a measure of the water's capacity to carry electricity current, which is, directly proportional to the concentration of the ionized substances in the water.

2.0 Method

Samples from Ikpoba river were taken at three different points of the river. A sample was taken from the sewage system in the city. The last sample was taken from the University of Benin pure water factory. The samples were labeled as follows;

Sample A : was from under the bridge across Ikpoba River

Sample B: was from Ikpoba River running beside the School of Dentistry, University of Benin.

Sample C: was from the dump site of a brewery on Ikpoba river.

Sample D: was from the sewage system in the city.

Sample E: pure water from a borehole water factory owned by the University of Benin.

Table 2.1: Analysis of some physical parameters

Sample	Colour	Odour
A	Colourless	Odourless
B	Colourless	Odourless
C	Slightly yellowish	Beer odour
D	Brownish	Mud odour
E	Colourless	Odourless

Table 2.2: Analysis of suspended solid

Sample	Suspended solid	Dissolved solid	Total
A	0.030g±0.001g	0.021g±0.001g	0.051g±0.001g
B	0.079g±0.001g	0.182g±0.001g	0.261g±0.001g
C	0.078g±0.001g	0.262g±0.001g	0.340g±0.001g
D	0.107g±0.001g	1.882g±0.001g	1.989±0.001g
E	0.075g±0.001g	0.544g±0.001g	0.619g±0.001g

The apparata used were, a plastic funnel, glass wool, filter paper and a retort stand with clamp. The filter used in each case was weighed before being folded in the funnel. 100ml of each water sample was poured into the filter inside the funnel. This was done slowly in order to avoid over flow from the filter paper into the funnel. The wet filter paper was allowed to dry before drying in an oven at 105^0C. The weighing of the filter paper was repeated several times and the averaged weight was recorded.

3.0 Analysis of the total solid in the water samples

The apparata used were a 100ml beakers, oven and a weighing balance. Each beaker was weighed before pouring 50ml of water sample into it. The beakers containing the water samples were transferred into the oven and heated at 110^0C until the water had evaporated to dryness. Each beaker was weighed again and the weight of the solid deduced.

Consequently the dissolved solids in the samples were estimated as follows:

To measure the conductivity of the water samples, a Jenway conductivity meter, model number 3020 and serial number PZ2431021 was used. The measurements obtained are summarized in Table 3.1.

Table 3.1: pH, conductivity and temperature measurements of the water samples

		Parameters	
Sample	**pH**	**Temperature (^0C)**	**Conductivity $\mu s/cm$**
A	6.45 ± 0.01	25.9 ± 0.1	400 ± 0.1
B	6.09 ± 0.01	25.7 ± 0.1	500.0 ± 0.1
C	6.29 ± 0.01	25.6 ± 0.1	400 ± 0.1
D	6.7 ± 0.01	25.5 ± 0.1	110.0 ± 0.1
E	6.8 ± 0.01	25.7 ± 0.1	180.0 ± 0.1

The concentration of some ions were measured. The reagents used were, Erichrome black T. solution, 0.1 EDTA solution, 2.5N NaOH and Ammonium chloride buffer solution.

10ml of each water sample was in each titration. 1ml of NaOH and drops of Erichrome black T were used in the determination of the concentration of Ca^{2+} ions, while ammonium chloride buffer was used in the case of Mg^{2+} ions.

To estimate the concentrations of chloride ions, the reagents used were0.0141N $AgNO_3$ and 5% potassium chromate solution. 50ml of each water sample was used. 0.0141N Ag NO_3 was titrated against the water sample. 5% potassium chromate solution was used as the indicator.

Table 3.2: Summary of the measurements of concentrations of ions

Sample	Colour	Chloride $Cl^- \times 10^{-6}$	Calcium $Ca^{2+} \times 10^{-3}$	Magnesium $Mg^{2+} \times 10^{-3}$	Sodium $Na^+ \times 10^{-6}$	Potassium $K^+ \times 10^{-6}$
A	Colourless	4.50 ± 0.02g	19.00 ± 0.02g	88.00 ± 0.02g	17.60 ± 0.02g	23.40 ± 0.02g
B	Colourless	4.80 ± 0.02g	1.60 ± 0.02g	0.02 ± 0.02g	18.70 ± 0.02g	24.90 ± 0.02g
C	Yellowish	43.00 ± 0.02g	35.30 ± 0.02g	3.80 ± 0.02g	16.80 ± 0.02g	22.30 ± 0.02g
D	Brownish	40.00 ± 0.02g	86.00 ± 0.02g	2.60 ± 0.02g	15.80 ± 0.02g	28.00 ± 0.02g
E	Colourless	6.00 ± 0.02g	27.00 ± 0.02g	7.00 ± 0.02g	26.30 ± 0.02g	35.10 ± 0.02g

4.0 Discussion and conclusion

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations. Organic compounds like oil, phenol, alcohol, and sugar do not conduct electricity well and so have low conductivity. Conductivity is also affected by temperature. The warmer the water, the higher the conductivity. For this reason, conductivity is reported at 25^0C (US Environmental protection (Agency, [10])

Distilled water has a conductivity range of 0.5 to 3*μs/cm*. The conductivity of rivers (Dezuane, [5]in the United States of America generally ranges from 50 to 1500 *μs/cm* Inland fresh waters for streams supporting good mixed fisheries have a range between 150 and 500 *μs/cm*. Conductivity outside this range may mean that certain species of fish may not survive there. The conductivity of pure water ranges from about 0.01*μs/cm* at O^0C to 0.8*μs/cm* at 100^0C. The conductivity of water from various sources as given by: the US Environmental Protection Agency [10] and Boyd [4] is as follows:

Table 4.1

1	Water type	Conductivity
2	Absolute pure water	0.055μs/cm
3	Distilled water	0.500μs/cm
4	Mountain water	1.000μs/cm
5	Most drinking water sources	500.000 – 800.000μs/cm
6	Sea water	56.000μs/cm
7	Maximum for portable water	1055.000μs/cm

The relation between conductivity and dissolved solids is approximately 2*μs/cm* = 1*ppm* (which is the same as 1*mg*/l) and 1*μs/cm* = 1*μmhos/cm*

From the dc conductivity measurements alone which range from 110*μs/cm* - 500*μs/cm* (Table 4.1) for the 5 samples of water used, one can say that Ikpoba river water is potable. The same can also be said of the water produced by the University of Benin. The industrial activities are yet to put the ecosystem of the river at risk. However, the dc conductivity of 400*μs/cm* - 500*μs/cm* (Table 4.1) obtained for the different points along the river suggests that the river water is polluted compared to mountain water with a normal dc conductivity of 1.0*μs/cm*.

Future harm to the river can be avoided with proper regulation of the industrial activities around the river.

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