ANALYSIS OF SOME PHYSICOCHEMICAL PROPERTIES OF EFFLUENTS AND RAW WATER FROM CHALLAWA TEXTILE INDUSTRY, KANO STATE, NIGERIA

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ABSTRACT

Assessment of some physicochemical properties and raw water of Challawa Textile Industry Kano, State, Nigeria revealed that some of the effluents are highly impacted at the discharge point than the upstream and downstream; for instance, the pH, 11.14mg/l, total solids (TS), 520mg/l and total dissolved solids (TDS), 500mg/l but restored to normal downstream to 7.15, 170mg/l, 40mg/l respectively. However, the chromium (Cr), 0.74ppm copper (Cu) 0.43ppm and zinc (Zn) 6.33ppm contents of water from the effluents recipient river were greatly increased to levels much higher than are considered safe to the environment and human health

Keywords: Physicochemical properties, Effluents, Raw water, Textile Industry

INTRODUCTION

Rapid growth of industries during the past 200 years has resulted in a significant increase in the quantities of effluents released into the soil and aquatic environments (Sethy *et al.*, 2011).

Industrial activities among other things are a major source of environmental pollution; Water ecosystem for example is majorly affected by various industrial activities such as mining, cement production, soap and detergent productions and textile manufacturing (Venkatesharaju *et al.*, 2010). Developing and especially densely populated countries like Nigeria has most of its water bodies contaminated by industrial effluents as river water is considered means of industrial effluent disposal (Kayode, 2010). Waste water treatment is not given the necessary priority it deserves; therefore, industrial waste and domestic sewage are discharged into receiving water bodies without treatment. The consequence of this is increased river pollution, loss of aquatic life and uptake of polluted water by plants and animals which eventually gets into human body resulting in health-related problems. The situation is compounded by the fact that the common man in most of these countries does not have access to portable water and in many instances; raw river water is used as source of drinking. (Suriptono and Newman, 2000).

Textile industries use a lot of water in their various manufacturing stages (i.e. scouring, bleaching, mercerizing, dyeing, printing and final finishing) and hence they generate a lot of waste water. Effluents released from these operations usually contain a significant amount of pollution load, as hundreds of dyes and auxiliary chemicals are used in the most complex stages of wet processes (i.e. dyeing and printing) and this is usually discharge into water bodies half treated or untreated (Jamaluddin *et al.,* 2009).

In this research work some physicochemical properties of effluents and raw water from African Textile industry in Challawa linked to Challawa River was analyzed in which some of the physicochemical properties were above the permissible limits both in the effluents, downstream and upstream while some normalized downstream

MATERIALS AND METHODS

Assessment of heavy metals and physicochemical parameters of the textile effluent and treated water samples

Standard methods for the assessments of heavy metals and physio-chemical contents of effluent and water samples was used in this study as described in details below.

UV-Visible Spectroscopic Analysis

A PC based UV-Vis spectrophotometer was used for the determination of concentration of samples. The system was switched on and warmed up to 30 minutes and thoroughly clean quartz cuvettes were used. One cuvette was used as reference and the other one was used for compound whose absorbance was measured at maximum wavelength. To get the relationship between concentration and absorbance of the compound, a calibration curve was used. Calibration solutions were made from standard solutions of known concentration. The absorbance was being plotted against concentration of the calibrated samples. These calibration curves were store in the system and the concentration of the unknown sample was calculated directly from the absorbance.

Temperature

Temperature (Celsius) was measured on site using procedure provided in the HACH conductivity/TDS/temperature Meter (model 44600.00) manual.
The electrode of the meter was immersed into each sample long enough to permit accurate and stable reading and the temperature icon on the meter was pressed. The temperature value in Celsius was displayed on the screen of the meter and the reading was recorded.

pH

The pH was measured on site using a Hanna instrument p^H 210 microprocessor PH meter. The electrode of the pH meter was rinsed thoroughly first with distilled water. To standardize the pH meter to a pH 7.0 as instructed in the manual, it was immersed into a buffer solution. The pH meter was adjusted using a screw 7.0 pH meter. The electrode was then removed and inserted into each of the textile effluent and water samples and the pH of the samples was taken after some few seconds.

Electrical conductivity

Electrical conductivity (micro siemens per meter μS/m) was measured on site using procedure provided in HACH conductivity/TDS/temperature Meter (model 44600.00) manual as described below.

The textile effluent and water samples were gently shaken to mix. The electrode of the meter was rinsed thoroughly first with distilled water. The electrode of the meter was then immersed into each of the sample long enough to permit accurate and stable reading and the electrical conductivity icon on the meter was pressed. The electrical conductivity values in micro siemens per meter (μS/m) was displayed on the screen of the meter and was recorded.

Dissolved oxygen (DO)

Dissolved oxygen is important in water systems for its effect on other chemicals in the water; it oxidizes, organic and inorganic matter altering their chemical and physical states and their capacity as a nuisance to the consumers (APHA, 1992). The type of life in a natural water depends on the amount of DO present. Most micro-organisms use free DO for respiration APHA, (1992). The level of the dissolved oxygen in the textile effluent and water samples was measured on site using procedure provided in HACH DRELL/2400 manual as described below: The textile effluent and water samples were gently shaken to mix. The electrode of the meter was rinsed thoroughly first with distilled water. The electrode of the meter was then immersed into each of the sample 10-40 min hours enough to permit accurate and stable reading and the dissolved oxygen icon on the meter was pressed. The dissolved oxygen value in mg/l was then displayed on the screen of the meter and recorded.

Biological oxygen demand (BOD)

Biological oxygen demand (BOD) is the amount of oxygen required by microorganisms to stabilize biologically decomposable organic matter in water under aerobic condition, the BOD test is widely used to determine (1) the degree of pollution in water bodies at any time and their purification capacity, (2) the pollution load of waste water and (3) efficiency of water treatment plant.

The BOD was determined following the method of Ademoroti, (1996). The textile effluent and water samples were pre-treated with 0.5M acid (HCl) or 1M alkali (NaOH) to a pH 7. Using a volumetric flask, 60ml (20%) of the textile effluent was transferred into two separate 300 ml BOD bottles and covered with a glass stopper. The BOD bottles were labelled DO_1 and DO_5 representing the initial dissolved oxygen of day 1 and final dissolved oxygen of day 5 after incubation respectively. The BOD bottles containing the samples were then filled to the brim with dilution water. The BOD bottles were gently covered using a stopper without leaving any air bubble inside the bottle. The initial dissolved oxygen (DO_1) was measured and recorded on that same day using procedure provided in HACH DRELL/2400 manual as described above. The second BOD (DO_5) will be incubated for five days in the dark at 20^0C in a cooled incubator. After the incubation period, the final dissolved oxygen content was measured and recorded. The BOD of the textile effluent and water samples was calculated using the formula;

$$BOD\ (mg/l) = (DO_1 - DO_5) \times \frac{\text{volume BOD bottle used}}{\text{Volume of sample used}}$$

Measurement of chemical oxygen demand (COD)

COD is the quality of oxygen required by bacteria during biodegradable and transformation of oxidized organic matter and oxidazable inorganic matter

COD can be determined when the sample is refluxed with excess potassium dichromate with sulphuric acid in the presence of HgSO4 to remove any interference due to nitrate and AgSO4 as catalysts. The excess potassium dichromate remaining un-reacted is then titrated with standard solution of ferrous ammonium sulphate.

COD can be calculated as:

$$COD = \frac{(V1 - V2) * N * 100}{x}$$

Where:

V1, V2 = volume of ferrous ammonium sulphate. X = volume of the sample used. N = number of mole of ferrous ammonium sulphate.

Total solids

Total solids in the samples were determined by following the procedure described by APHA, (1992): 100 ml of the sample was filtered using 0.5 mm Whatman filter paper and placed in a pre-weighed crucible dish. The dish and the content were then dried to complete dryness in an oven for 2 hours at 103^0C. After dyed, the crucible dish was then transferred into a desiccator and allowed to cool for 1 hour 30 minutes. The initial weight of the empty crucible dish was subtracted from the weight of crucible after drying to give the weight of total residue. The total solids were then calculated using the formula below:

$$\text{Total solids} = \frac{\text{weight of total residue}}{\text{Volume (ml) of sample used}} \times 1000\ (mg/l)$$

Total dissolved solids

Total dissolved solids (mg/l) were measured on site using procedure provided in the HACH conductivity /TDS /temperature Meter (model 44600.00) manual.

The samples were gently shaken to mix. The electrode of the meter was rinsed thoroughly first with distilled water. The electrode of the meter was then immersed into each sample for 10 – 40 min long enough to permit accurate and stable reading and the total dissolved solids icon on the meter was pressed. The total dissolved solids a value in mg/l will be displayed on the screen of the meter and recorded.

Assessment of Cr, Cu and Zn contents of the raw effluent and water samples

Determination of chromium, copper and zinc in the samples will be carried out using acid digestion method as described by Abida *et al.,* (2009); Thippeswany *et.al.,* (2012). The procedure is as follows; 20 ml of the effluent and water samples was heated in a beaker on a hot plate for 20 minutes.9 ml of Hydrochloric acid (HCl) and 3ml of nitric acid (HNO_3) was added into the sample in the ratio of 3:1 for 15 minutes. A brownish fume was formed after which the sample was removed from the heat and allowed to cool. The samples were then filtered using a Whatman's no. 1 filter paper. The filtrates were diluted up to 50ml with distilled water and transferred to a 50 ml plastic container. The samples were then analyzed for heavy metal content using Schemadzu atomic absorption spectrophotometer (AAS) model AA 6800.

Physicochemical properties of textile effluents and water from Challawa River

Results of analysis revealed that, some of the physicochemical properties of water samples from Challawa River into which the raw textile effluents are discharged and profoundly impacted at the discharge points. For instance, the pH, total solids (TS) and total dissolved solids (TDS), Nitrate, sulphate and to a lesser extent phosphate content of water samples collected at the discharge point were much higher than both upstream and downstream samples (Table 1). However, the marked increase in the total solids (TS) and total dissolved solid (TDS) as well as the nitrate and sulphate that resulted from the entry of the effluents at the discharge point were restored to normal level downstream the river (table 2).

RESULTS

Table 1: Physicochemical properties of textile effluent samples from Challawa River

Parameter Assessed	Samples			
	Effluent (A) Not treated	Effluent (B) Partially treated	Effluent (C) Discharge point	Permissible limit
pH	11.81	11.65	11.14	6.0-9.0
Temperature (O^C)	26.30	26.30	26.35	<40
Electircal Conductivity (µs/cm)	3.07	2.72	0.78	2.0
Turbidity (NTU)	8.80	6.35	5.35	5
Total Dissolved Solids (mg/l)	1520	1360	500	500
Total Solids (mg/l)	1530	1420	520	200
Total soluble solids (mg/l)	1.22	1.05	0.35	30
Biochemical Oxygen Demand (mg/l)	39.25	35.85	28.45	30
Dissolved Oxygen (mg/l)	3.40	3.23	3.05	10
Nitrate (mg/l)	24.59	18.55	22.15	20
Sulphate (mg/l)	74.00	73.50	43.50	500

Phosphate (mg/l)	43.50	40.80	32.00	5.00
Chromium (ppm)	1.71	0.52	0.25	0.50
Copper (ppm)	2.30	0.56	0.49	0.10
Zinc (ppm)	6.34	5.91	5.61	<1

Table 2: Physicochemical properties of water samples from Challawa River

Parameter Assessed	Water samples		
	Upstream (A)	Downstream (B)	Permissible limit
pH	7.31	7.15	6.0-9.0
Temperature (O^C)	26.25	26.40	<40
Electircal Conductivity (µs/cm)	0.12	0.08	2.0
Turbidity (NTU)	8.25	9.15	5
Total Dissolved Solids (mg/l)	110	40	500
Total Solids (mg/l)	120	170	200
Total soluble solids (mg/l)	0.08	0.15	30
Biochemical Oxygen Demand (mg/l)	29.45	35.48	30
Dissolved Oxygen (mg/l)	1.95	2.50	10
Nitrate (mg/l)	9.25	4.35	20
Sulphate (mg/l)	15.50	13.00	500
Phosphate (ppm)	23.3	37.7	5.00
Chromium (ppm)	0.61	0.74	0.50
Copper (ppm)	0.44	0.43	0.10
Zinc (ppm)	6.24	6.33	<1

DISCUSSION

It was observed that, the Chromium (Cr), Copper (Cu) and Zinc (Zn) contents of water from the effluent recipient river were greatly increased to levels much higher than are considered safe to the environment and human health (Table 1 and 2). On the other hand, the temperature, electrical conductivity, dissolved oxygen (DO) and biological oxygen demand (BOD) of water from the recipient river was not drastically altered by the entry of the effluent even at the discharge point (Table 1). However, the dissolved oxygen (DO) level of water from the recipient river was much lower than is expected of water source meant for domestic uses.

CONCLUSION

The physicochemical properties from the Challawa River are impacted at the discharge point. Some of the properties restored to normal downstream while some are unaffected both from the discharge point to the upstream and downstream of the river while some are considered beyond the permissible limits.

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