Characterisation of Textile Wastewater Discharges in Nigeria and its Pollution Implications

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Abstract

Wastewater discharges from two textile industries in Lagos (Nigeria) were analysed for their pollution characteristics such as temperature, pH suspended solids (SS), total solids (TS), permanganate value (PV), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). For the first textile industry the range of values for the above named characteristics were: 29.10 - 33.500C, 9.25 - 11.18, 506.50 - 663.20mg/l, 5157.50 - 6930.30mg/l, 528.70 â??” 728.60mg/l, 646.10 â??” 880.00mg/l, and 2190.00 â??” 2984.00mg/l. Also the second industry had values ranging from 31.40 â??” 41.800C, 9.22 - 11.60, 455.60 â??” 684.90mg/l,5099.20 â??” 7624.10mg/l, 469.60 â??” 746.40mg/l, 584.30 â??” 885.00mg/l and 2012.13 â??” 2960.00mg/l. The study revealed that the textile wastewaters were untreated and contained high amounts of pollutants. These pollutants are discharged daily into nearby receiving surface waters. There is need to prioritize action to minimize rapid depletion of dissolved oxygen in the receiving water so as to prevent ?oxygen sag? in the water there also need to protect the quality and portability of the receiving surface water so as to reduce its adverse health implications on consumers in the surrounding environment.

Index terms— textile wastewater, textile industries, characterisation, pollution, treatment, disposal.

1 Introduction

extile industries produce large volumes of wastewater daily. The wastewater contains organic and inorganic substances which can cause pollution of the environment if discharged indiscriminately **??**Ademoroti,1996a). In a developing country like Nigeria, indiscriminate dumping of untreated wastes is still the current practice. Both domestic and industrial wastewaters are discharged into rivers, streams, drainage systems etc. As a result of this practice, pollutants enter the groundwater, rivers and other water bodies causing adverse effects an ecological systems (Uwidia and Ademoroti,2012; **??**widia,2011). Ultimately, such water which ends up in our households could affect the aesthetic quality of portable water and pose threats to public health on the side of consumers (Miroslav and Vladimir, 1999).

The wastewater generated in the textile industry depends on the raw materials used and the volume of water required.

Textile generally go through three or four stages of production processes from raw cotton, raw wool and synthetic materials to the final product. This includes yarn fabrication, fabric formulation, wet processing, and textile fabrication. An example of fibres obtained from natural source is wool while fibres from chemical substances i.e. synthetic fibres are nylon and polyester. They are made from petroleum. Some of the steps in processing fibres into textile goods include pretreatment, dyeing, printing and finishing operations. These production processes not only consume large quantities of water but also produce large volumes of wastewater, large amount of energy and substantial waste products (Babu et al, 2007;Wynne et al, 2001).

Most of the wastewater generated is during the wet processing stage which include slashing/sizing, bleaching, mercerizing, and dyeing and finishing. Little or no wastewater is generated during fiber preparation, weaving, knitting, and textile fabrication processes.

Wastewater from printing and dyeing units is often rich in colour, containing residues of reactive dyes and chemicals and requires proper treatment before being released into the environment (Azymezyk et al, 2007;Pala and Tokat 2002). Textile wastewater exhibit very high toxicity. The toxic effects of dyestuffs and other organic compounds, as well as acidic and alkaline contaminants, from industrial establishments on the general public are widely accepted. Due to increased awareness of worldwide environmental issues, there has been a great interest in ecologically friendly, wetprocessing textile techniques in recent years **??**Padama, et al 2006).

Although wastewater disposal has become a significant cost factor, it is an important aspect to be considered in running textile industries. Characterization of such wastewaters is pre-requisite for the investigation of pollution potential and necessary treatment options.

2 II.

3 Objectives of Study

The aim of this study was to determine some pollution characteristics of textile wastewater obtained from textile industries in Nigeria assess the pollution level and possibly make useful recommendations on the treatment and disposal.

4 Materials and Methods

5 a) Source of Textile Wastewater

The study was carried out on two textile industries manufacturing mostly cotton fabrics. Each textile factory consists of various departments, each of which carries out different operations and produces one type of wastewater or another.

Both industries have three major departments that are directly involved in the manufacture of the products.

First is the spinning department, where the fibres are spurn into yarns.

Second is the weaving department, where the yarns are converted to grey fabrics for further processing. The third is the wet processing department. This sector enhances the aesthetic as well as technological properties of the textile materials. It consists of de-sizing, bleaching, mercerizing, dyeing, and finishing and prints work. The wet processing departments accounts for the bulk of textile wastewater generated in these industries. One industry was larger than the other. The first and larger industry had an average annual production of about 140-160thousand metric tons and the average wastewater generated perday was 4.2x10 6 litres. For the second industry the average annual production was 130-150 thousand metric tons while the average wastewater generated per day was 3.9 x10 5 litres.

Wastewater from both factories contains acids used in de-sizing, dyeing bases like caustic soda used in scouring and mercerization. It also contains oxidants e.g hydrogen peroxide and peracetic acid for bleaching and other oxidative applications.

Also present in the wastewater are organic compounds like dyestuff, optical bleachers, furnishing chemicals, synthetic polymers for sizing and thickening surface-active chemicals used as wetting and dispersing agents; and enzymes for de-sizing and degumming.

All these wastes are contained in the wastewater from each factory passed into an effluent tank and then channeled through a drainage system for disposal. The textile wastewater samples were collected from the pipe conveying all the wastewater out of the factory works into a stream.

Samples were obtained on hourly basis for 11 hours beginning at 7am and ending at 6pm. The day for

6 Cleaning and ginning

Carding and spinning

7 Cotton yarn

Slashing, weaving, desizing, rinsing, scouring

8 Bleaching and rinsing

9 Mercerizing

Rinsing, washing, dyeing, printing

10 Finishing

11 Raw picked cotton

This was done so that the total exercise might account for the cyclic and intermittent variations occurring at the work site.

Each sample was collected in clean well labelled plastic bottles and kept in the refrigerator maintained at 4 0 C. For each sampling the rate of flow was measured. At the end of each sampling period, the samples were mixed together in volumes proportional to the rates of flow. This mixture was the composite sample that was analyzed for the pollution characteristics.

All together twenty four (24) composite samples (twelve from each textile industry) were obtained and used for analysis at an interval of once a week.

The two industries were chosen due to the similar fabrics they produce so as to obtain detailed account of the pollution characteristics studied.

12 c) Methods of Analysis

The sample were analyzed as described in the Standard Methods for the Examination of Water and Wastewater (APHA, 2005); Standard Method for Water and Effluents Analysis **??**Ademoroti, 1996) and Bureau of Indian Standards (BIS, 2005).

Where analysis was not immediately possible, they were preserved by refrigeration at 4 0 C.

13 IV.

14 Results and Discussion

Results of the analysis carried out in both industries are as shown in Tables **??** and II. The result show mean values obtained for the pollution characteristics in both factories. . This is significant. It is a reflection of the amount of oxygen required to synthesize both organic and inorganic solids present in the textile wastewaters. Suspended solids provide information on the amount of BOD present in the wastewater. The total solids include both organic and inorganic solid constituents dissolved or suspended in the wastewater.

The PV values (528.70 -728.60mg/l ; 469.60 -746.40mg/l) shows the magnitude of organic and inorganic substances readily available for oxidation in the textile wastewaters(Uwidia and Ademoroti,2012). The high BOD values obtained (646.10 -880.00mg/l ; 584.30 -885.00mg/l) show that the wastewaters have high pollution strength. COD values (2190.00-2984.00mg/l ; 2012.13 -2960.00mg/l) were about three times higher than BOD. The remarkable increase in COD levels compared with BOD also indicates that significant levels of toxicants e.g. heavy metals may be possibly present in the wastewater. **??**Chavan,2001).

All these must have contributed towards toxicity in the wastewater which makes it necessary for its characterization in order to access the pollution level.

Industrial processes generate wastewater containing heavy metal contaminants. Most of these heavy metals are non-degradable into non toxic end products which could be harmful to the environment **??**Sekhar et al,2003). It therefore becomes necessary to reduce their concentration to acceptable levels using the necessary wastewater treatment process before discharging them into the environment. This will help reduce the detrimental effect of polluted water and general pollution of the environment caused by such discharges.

V.

15 Conclusion

Results obtained from the analysis show that the textile wastewaters studied contained substantial pollution load. Such polluted wastewater poses threat to the environment.

Treatment in a wastewater treatment plant with optimization of the basic operating conditions is currently in practice. Combined treatment processes would be necessary to reduce the pollution load and avoid adverse pollution effect of the textile wastewaters on both the affected surface waters and the surrounding environment.

2

Figure 1: 2 Global

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SamplingTemp		pH	SS (mg/l)	TS (mg/l)	PV (mg/l)	BOD 5 (mg/l)	COD (mg/l)
Code			mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
1	30.10	9.57	506.50 ± 0.21	5157.50 ± 0.24	609.70 ± 0.46	646.10 ± 0.33	2190.00 ± 0.80
2	33.40	10.44	514.80 ± 0.14	5302.50 ± 0.64	528.70 ± 0.35	654.80 ± 0.29	2236.66 ± 0.12
3	31.80	10.48	561.30 ± 0.15	6080.40 ± 0.27	627.10 ± 0.12	715.30 ± 0.08	2404.80 ± 0.18
4	29.80	9.67	583.90 ± 0.75	5601.20 ± 0.22	622.40 ± 0.13	730.50 ± 0.08	2468.31 ± 0.59
5	30.70	9.36	563.40 ± 0.85	5857.90 ± 0.55	658.50 ± 0.34	726.90 ± 1.73	2546.00 ± 0.70
6	30.60	9.58	569.30 ± 0.14	6188.70 ± 0.31	626.40 ± 1.13	729.00 ± 1.16	2456.80 ± 0.30
7	29.90	11.18	596.70 ± 0.39	6109.70 ± 0.23	723.80 ± 3.49	804.00 ± 0.13	2725.63 ± 0.66
8	32.60	10.21	606.30 ± 0.45	6148.30 ± 0.39	623.40 ± 0.25	779.30 ± 0.35	2650.00 ± 1.19
9	30.90	10.48	616.10 ± 0.12	6205.10 ± 0.12	714.30 ± 0.20	829.40 ± 0.08	2858.00 ± 1.01
10	31.00	9.48	629.40 ± 0.65	6643.40 ± 0.32	669.50 ±17.19	790.00 ± 0.73	2660.23 ± 0.52
11	29.10	10.33	623.90 ± 0.49	5997.90 ± 0.83	680.40 ± 0.17	802.80 ± 0.25	2706.14 ± 1.00
12	33.50	9.25	663.20 ± 0.66	6930.30 ± 0.66	728.60 ± 0.17	880.00 ± 0.95	2984.0 0.81

Figure 2: Table 1 :

2

Sampling Code	Temp	pH	SS (mg/l) mean ± SD	TS (mg/l) mean ± SD	PV (mg/l) mean ± SD	BOD 5 (mg/l) mean ± SD	COD (mg/l) mean ± SD
1	36.10	10.20	455.60 ± 0.14	5144.30 ± 0.24	535.30 ± 0.16	628.50 ± 0.10	2123.55 ± 0.05
2	36.90	10.80	457.20 ± 0.07	5099.20 ± 0.53	506.30 ± 0.11	602.30 ± 0.35	2025.36 ± 0.18
3	37.30	9.80	456.80 ± 1.08	5056.30 ± 0.06	469.60 ± 0.28	584.30 ± 0.21	2012.13 ± 0.63
4	35.60	10.65	574.20 ± 0.77	6349.20 ± 0.65	621.40 ± 0.09	740.00 ± 1.06	2512.00 ± 0.79
5	33.00	11.60	499.50 ±29.52	5831.80 ± 0.59	613.80 ± 0.76	725.00 ± 2.90	2650.00 ± 1.29
6	41.80	9.22	525.40 ± 0.27	5450.40 ± 0.27	584.70 ± 0.23	665.20 ± 0.10	2265.00 ± 0.33
7	38.40	10.12	573.45 ± 0.33	5726.50 ± 0.16	604.90 ± 0.23	751.00 ± 0.72	2620.00 ± 0.58
8	40.70	11.15	624.30 ± 0.25	6884.40 ± 0.32	657.30 ± 0.11	789.10 ± 0.09	2645.00 ± 1.12
9	37.30	10.12	587.30 ± 4.72	6236.40 ± 0.22	652.40 ± 0.06	835.30 ± 0.23	2950.12 ± 0.19
10	31.40	9.82	658.10 ± 16.4	7624.10 ± 1.04	734.50 ± 0.15	860.00 ± 1.22	2892.00 ± 0.67
11	39.40	9.79	665.30 ± 0.39	6530.30 ± 0.51	729.80 ± 0.41	843.40 ±12.79	2865.09 ± 0.38
12	36.30	10.40	684.90 ± 0.96	6970.50 ± 0.22	746.40 ± 0.36	885.00 ± 1.07	2960.00 ± 0.84

Most of the pollution characteristics measured from both industries had high values, indicating high pollution level. Wastewater temperatures from both factories ranged between 29.00 -33.50 0 C and 31.40 -41.80 0 C.

High values recorded for the various pollution characteristics may be linked to the various chemicals employed during processing and the nature of the raw materials for example, different enzymes, deterge dyes, acid sodas and salts used during processing

The pH values (9.25 -11.18; 9.22 that the wastewaters were typically alkaline. Alk increases with wastewater strength. High alkalini quite objectionable .It is an indication that the wastewaters have the capacity to neutralize acids

Figure 3: Table 2 :

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