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Assessment of Wastewater Quality from Supercor Industries Limited, Bauchi, Nigeria

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Abstract: Wastewater from Supercor Industries Limited, Bauchi, an Asbestos roofing sheets production company was subjected to laboratory investigation by determining the physical, chemical and biological parameters of effluent discharged from the industry. The results obtained showed an average alkalinity result of 660 mg/L, total suspended solids average value of 621 mg/L. The calcium and magnesium content were found to be 1231 and 954 mg/L, respectively. Chloride content was 270 mg/L while the field temperature and pH values were 27.5°C and 8.5, respectively. The turbidity of the wastewater sample was at 226 NTU. Results obtained showed that the wastewater quality meets the national standards for disposal into surface watercourses with causing adverse effects on the biological life. The use of the surface water without treatment could have health risk for the community members that depend on the watercourse for domestic use. It was recommended that the effluent should be recycled by treatment to meet standards for specified use.

Key words: Wastewater, surface water, effluent, industry, standard, production company

INTRODUCTION

Water is used as a solvent during industrial processes as a medium for chemical reactions or for washing products and machines. The water is discharged finally as wastewater, the composition of which differs according to the usage and the nature of the industrial processes operated.

Industrial wastewater has various content of mineral and organic compounds. The nature and concentration of their pollutants are functions of the industry, type and size of the facility, process conditions, specific water consumption per production unit and the on site treatment method if any. The industrial wastewaters usually have various proportions of suspended solids, dissolve organic and inorganic solids, BOD, alkalinity and acidity. Pretreatment is frequently required for industrial wastewater before disposal into surface waters as they contain mostly greases, oil resins, gasoline, petroleum products and other minerals in concentration that would inhabit biological growth if discharged before treatment into the environment as communities depend on surface waters for domestic use. Many community members can be dissatisfied with quality of water due to environmental activities as shown by research (Baino-Salingay *et al*., 2017).

Industrial wastewater will either be discharged directly into the receiving water body (if they meet necessary standard) or else are discharge in to municipal sewer. These wastes have some effect in the normal life of a stream or normal functioning of sewage and sewer treatment plant itself if they are discharge directly in the receiving water.

The discharge of wastewater from domestic municipal and industrial sectors directly into water bodies without proper treatment is major cause of surface and ground water pollution. Anonymous (2007) states that "The discharge in harmful quantities of any hazardous substance into the air or upon the land and the waters of Nigeria or at the adjoining shorelines is prohibited, except where such discharge is permitted or authorized under any law in force in Nigeria''. The presence of contaminants from industrial wastewater may reduce yield from crops when the water is used for irrigation. The contaminants are also harmful to the aquatic living organism. The contaminant on the soil surface may interrupt human daily activities and bring adverse effect to the growth of plant as well as human health (Shakeri and Moore, 2010; Anonymous, 2017).

Wastewater is an undesirable element to life and the environment, especially based on regions termed environmentally sensitive areas which could be

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categorized into natural heritage, disaster risk and life support areas (Asmawi *et al*., 2016) as pollutant from chemical and biological wastes constitutes a hazard to public health and animal life. Also, part of the wastewater contributes a wide variety of chemicals detergents, soaps, fats, grease of various kinds and pesticides (Mara, 2004). Industrial wastewaters usually have higher material content than domestic wastewater and differ in their content of minerals and organic compounds which tends to relate to specific industrial plant and processes. The industrial waste can be very toxic predicative and if not treated to a certain safe degree before subsequent discharge into the sewer system which serves the entire community or into the receiving water may cause a lot of damage to life especially aquatic life if not treated to meet international standards (WHO., 2008).

Turbidity in water is caused by suspending organic and inorganic matter (Anonymous, 2009). The major problem with turbidity is a esthetic but in some cases suspended matter can carry pathogens with it.The most important physical characteristics of waste water is its totals solid content which is composed of floating matter, settle-able matter, colloidal matter and matter in solution. Other physical characteristics include odour, temperature, density, color and turbidity (Anonymous, 2009).

Analytically, the total solid content of a wastewater is defined all the matter that remains as residue upon evaporation at 103-105°C. Some of these very solids, especially suspended solids and though very small in size are occasionally recognizable.

Temperature of wastewater is commonly higher than that of the water supply because of the addition of warn water from household and industrial activities. Temperature affects both biological and chemical used in the industrial processes, the temperature of wastewater disposed off must meet standards (WHO., 2008). Also found in wastewater are pathogenic organisms (disease-causing micro-organisms) which may be discharged by human beings who are infected with disease or who are carriers of a particular disease or animals. The principal categories of pathogenic organism found in wastewater are bacteria, viruses, protozoa and helminthes (Cairncross and Feachem, 1993). BOD is one of the most effective parameters in the control of water quality as this measure the amount of oxygen that is needed to be able to stabilize organic materials contained in the water (Ohanu *et al*., 2012).

Alkalinity is the ability to react with hydrogen ions of water mainly caused by Carbonates (CO^{-3}) and Bicarbonates (HCO^{-3}). Nitrates (NO^{-3}) are very soluble salts, derived from Nitrogen which can be found in food and drinking water. The physical, chemical and biological parameters of the wastewater effluent discharged from the Supercor Industries Limited Bauchi was investigated to assess and to determine the strength of the waste.

MATERIALS AND METHODS

The wastewater sample in carrying out the experiments was obtained from Supercor Industries Limited within Bauchi metropolis. The sample is mainly mixture of fiber pulp, calcium, process of Asbestos cement roofing sheets (corrugated and flat sheets) and Asbestos cement pipes. The sample was collected as effluent from the discharge of the factory to the environment.

Laboratory investigation was carried out using the American Public Health Association Standards Methods for Examination of Water and Wastewater (APHA, 1999).

Total solid determination: Total solids include both suspended and dissolved species as noted and their determination involves filtration and evaporation of the sample. Solid may affect water or effluent quality adversely in a number of ways. Water with high dissolved solid generally are of inferior palatability and may induce an unfavorable physiological reaction in the transients consumer, however, highly mineralized waters also are unsuitable for many industrial application. Solid analyses are important in the control of biological and physical treatment processes. Total solid is the term applied for the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven of a defined temperature (103-105°C). It is determined as follows:

Total solid determination

Procedure:

- A clean evaporating dish was ignited at 550°C in a muffle furnace for 1 h
- The dish was cooled, weighed and kept it in a desiccator's
- 50 mL of the sample was carefully transferred into the dish and evaporated to dryness on a steam bath
- The evaporated sample was placed in an oven and adjusted at 103°C and dry it for 1 h
- The process was repeated at 103°C until constant weight is obtained
- The total solid was (mg/L) = (A-B)×106)/mL sample where:
- A = The weight of residue+dish
- B = Weight of dish

Determination of total dissolved solids: A total dissolved solid is the remaining materials or substances in the sample after filtration of the suspended solids, so that, upon evaporation of the water, the solids could be retrieved.

Equipment: Waste water sample, distilled water, filter paper, funnels, evaporating dish, oven, steam bath or hot plate, desiccators, measuring cylinder, conical flasks and weighing machine and waste water sample.

Procedure: A clean dry glass beaker 150 mL capacity kept at 103°C in oven for 1 h was taken. Appropriate identification mark was put on it, the beaker was weighed and the weight was noted. 100 mL of sample was taken and filter through a double layered filter paper and the filtrate was collected in a beaker. The beaker was placed in an oven maintained at 103°C for 24 h. The beaker was cooled after 24 h and weighed. The process was repeated until constant weight is gotten. The weight of the solid was determined by subtracting the weight of the clean beaker determined in Step 1 above. Total Dissolved Solid (TDS) is calculated as:

$$\text{Total Dissolve Solid (TDS) mg/L} = \text{Mg of solid in the beaker} \times 1000 \text{ volume of sample}$$

Alkalinity: Alkalinity in wastewater results from the presence of hydroxides, carbonates and bicarbonates of which the most common are calcium and magnesium bicarbonates. Alkalinity is measured volumetrically by titration with standard acid and the result expressed in terms of equivalent calcium carbonate, $CaCO_3$.

Equipment: Pipette, burette, conical flasks, measuring cylinder, methyl-orange indicator, 0.02 Nsulphuric acid, H_2SO_4, waste water sample.

Procedure for determining alkalinity of waste water:

- 500 mL of distilled was taken in a 100 mL standard flask
- 20 mL of concentrated 0.1 normality sulphuric acid was pipette and added slowly along the sides of the standard flask
- The volume was made up to 1000 mL mark to make the strength of the solution to be 0.02 N
- 1g of phenolphthalein was weighed and added to 100 mL of 95% ethyl alcohol (100 mL of distilled water)
- The burette was rise with 0.02 N sulphuric acid and the solution was discarded
- The burette was filled with 0.02 N sulphric acid and it was adjusted to zero. The burette was fix to stand
- A measuring cylinder was used to measure 100 mL of sample and was poured into a 250 mL of conical flask
- A few drop of phenolphthalein indicator was added to the contents of conical flask
- The colour of the solution turned pink. The colouris changed due to alkalinity of hydroxyl ions in the water sample. It was titrated against 0.02 N sulphuric acid until the pink colour disappeared. This indicates that all the hydroxyl ions are removed from the water sample
- The titter Value (V_1) was noted. The value of the titration is 0.5 N, this value is used in calculating the phenolphthalein alkalinity
- The titration was carried out till the solution become red, the entire Volume (V_2) of Sulphuric acid is noted and it is used in calculating the total alkalinity

Metals: Flame transient spectrometry was used for this test. In this, the sample was aspirated as a must of fire droplets in to a flame in which the solvent is evaporated and the residual solute then vaporized and partially covered to other constituents atoms. As a result of the high temperature of the flame, their atoms are excited and it tint light at wavelength characteristics of the elements. The emitted radiation is a measure of the contestation radiation of the determinant in the sample standard solution of the metals of known concentrations were aspirated into the flame and their corresponding absorbance obtained which was then corrected with these of the standard solutions of the metals to deduce its concentration.

In this determination, the pony plate method was used. This is aimedat determining the quantity of a given sample of wastewater.

Equipment: Petri dishes, distilled water, pipette incubator test tubes, auto clare creature media water samples.

Reagents for culture media:

- Yeast extract 3 g/L
- Peptone 7 g/L
- Sodium chloride 5 g/L
- Oxide agar 31.5 g/L
- Bile salt 31.5 g/L
- Lactose 10 g/L
- Neutral red 0.03 g/L
- Crystal violet 0.002 g/L

Sterilization: All glass wares pipettes, beakers, petri dishes were steadied in hot air over at 160°C for about 2 h and all media were sterilized in an auto clave at 120°C for 15-20 min.

Procedure: The 10 mL of distilled water was placed in test tube and a serial dilution with 1 mL of sample was made 0.1 mL of the serially diluted sample was drawn from the test tube and pour into petri dish 10 mL of the culture media was added and stirred gently to insure even spread of the media. All these were done with core to avoid external contamination by always covering the petri dish quickly. The petri dish containing the mixture was then incubated at 37°C for 24 h after which the colonies formed in the petri dish were counted.

RESULTS AND DISCUSSION

Temperature: Generally, temperature of wastewater is usually higher than that of water supply because of the heat generated in the industries. Depending on the temperature of the environment which in turn depends on time/season, the field temperature of wastewater could be high or low, the average temperature of wastewater sample was high at 27.5°C. The high temperature of wastewater causes decrease in the dissolved oxygen concentrations coupled with increase in the rate of biochemical activities accompanying increase in temperature. Standards require a maximum temperature of 40°C to be disposed into surface waters (Table 1-3).

Hydrogen ion concentration (pH): Hydrogen ion concentration (pH) is a term used rather universally to express intensity of the acid or alkaline condition of a solution or more precisely, the hydrogen-ion activity. It is

Table 1: Physical parameters

Sample No.	Temperature (°C)	Hydrogen ion concentration (pH)	Total dissolved solids (mg/L)	Total suspended solids (mg/L)
1	28.0	8.0	500	400
2	26.0	8.7	700	800
3	26.0	8.2	900	800
4	24.0	8.6	500	800
5	27.0	8.7	500	600
6	28.0	7.9	580	400
7	29.0	8.2	700	800
8	27.0	9.3	800	900
9	30.0	8.3	800	400
10	30.0	9.1	800	310
Mean	27.5	8.5	678	621

Table 2: Chemical parameters

Sample No.	Chloride Cl (mg/L)	Turbidity (NTU)	Electrical conductivity (µsec/cm)	Calcium Ca^{2+} (mg/L)	Magnesium (Mg^{2+})	Total alkalinity ($CaCo_3$) (mg/L)
1	100	400	1000	800	800	470
2	400	230	1400	1600	1000	860
3	400	200	1800	1400	1200	700
4	200	400	1000	1600	800	800
5	300	100	1000	1200	800	600
6	100	200	1000	1400	900	710
7	200	230	1400	1400	1000	720
8	250	200	1800	1000	1000	540
9	375	200	1800	1200	1000	600
10	375	100	1140	710	1040	600
Mean	270	276	1334	1231	954	660

Table 3: Industrial effluent standards

Parameters	Standard values	Method of examination
pH value	5.5-9.0	pH m
Total Dissolved Solids (TDS)	Not >3,000 mg/L depend on receiving water or type of industry under consideration of PCC but not exceed 5,000 (mg/L) Not >5,000 mg/L exceed TDS of receiving water having salinity of >2,000 mg/L or TDS of sea of discharge to sea	Dry evaporation 103-105°C
Suspended Solids (SS)	Not >50 mg/L depending on receiving water or type of industry or water treatment system under consideration of PCC but not exceed 150 (mg/L)	Glass fibre filter disc
Temperature	Not >40°C	Thermometer during the sampling
Colour and odour	Not objectionable	Not specified
Sulphite as H_2S	Not >1.0 (mg/L)	Titrate
Cyanide as HCN	Not >0.2 (mg/L)	Distillation and pyridine barbituric acid method
Fat, oil and Grease (FOG)	Not >5.0 mg/L depending on receiving water or type of industry under consideration of PCC but not exceed 15.0 (mg/L)	Solvent extraction by weight
Formaldehyde	Not >1.0 (mg/L)	Spectrophotometer
Phenols	Not >1.0 (mg/L)	Distillation and 4 aminoantipyrine method

Table 3: Continue

Parameters	Standard values	Method of examination
Free chlorine	Not >1.0 (mg/L)	Iodometric method
Pesticides	Not detectable	Gas-chromatography
Biochemical Oxygen Demand (BOD)	Not >20 (mg/L) depending on receiving water or type of industry under consideration of PCC but not exceed 60 (mg/L)	Azide modification at 20°C, 5 days
Total Kjedahl Nitrogen (TKN)	Not >100 mg/L depending on receiving water or type of industry under consideration of PCC but not exceed 200 (mg/L)	Kjedahl
Chemical Oxygen Demand (COD)	Not >120 mg/L depending on receiving water type of industry under consideration of PCC but not exceed 400 (mg/L)	Potassium dichromate digestion
Heavy metals		
Zinc (Zn)	Not >5.0 (mg/L)	
Chromium (Hexavalent)	Not >0.25 (mg/L)	
Chromium (Trivalent)	Not >0.75 (mg/L)	
Copper (Cu)	Not >2.0 (mg/L)	Atomic absorption
Cadmium (Cd)	Not >0.003 (mg/L)	Spectrophotometry direct aspiration or plasma emission spectroscopy inductive coupled plasma
Barium (Ba)	Not >1.0 (mg/L)	
Lead (Pb)	Not >0.2 (mg/L)	
Nickel (Ni)	Not >1.0 (mg/L)	
Manganse (Mn)	Not >5.0 (mg/L)	
Arsenic (As)	Not >0.25 (mg/L)	Atomic absorption spectro-photometry; hydride generation or plasma emission spectroscopy; Inductive Coupled Plasma: ICP
Selenium (Se)	Not >0.02 (mg/L)	
Mercury (Hg)	Not >0.005 (mg/L)	Atomic absorption cold vapour technique

important in almost every phase of hydrogen-ion difficult to treat, this alteration is necessary before discharge into natural waters. The average hydrogen ion concentration (pH) of the wastewater sample was 8.5. A pH range of 5.5-9.0 may be disposed off to surface waters.

Solids: In the realm of wastewater, the total solids determination is one of importance. The data used to evaluate the strength of industrial as well as other wastewaters. They are also used for the purpose of determining the loading on treatment units and routinely as a measure of the effectiveness of these units. The average total solids-total dissolved and suspended of the sample tested was 678 and 621 mg/L, respectively. Total dissolved solids range of 3000-5000 mg/L is required for disposal.

Turbidity: Turbidity values for the wastewater samples varied between 100-400 NTU with an average value of 276 NTU. Turbidity values also gives an indication of the presence of coliform bacteria in the wastewater samples.

Conductivity: The electrical conductivity of the samples from the industrial regions was found to range from 100-420 μ/cm indicating an average of 92.33 μsec/cm.

The increase in the conductivity of the samples from industries areas can be argued to be because of the increase in soluble salts which resulted from the use of asbestos in the areas.

CONCLUSION

Production of wastewater in every community is a continuous process which calls for proper disposal of generated wastewater from its sources based on required treatment:

The result obtained from this investigation shows a field temperature of 27.5°C and an average hydrogen ion concentration (pH) of 8.5 which are within the standard for disposal into surface waters.

Alkalinity results of 660 mg/L average was found. Dissolved and suspended solids values were also with the standard requirement for disposal into surface waters. Calcium and magnesium values at 1231 mg/L and 954 mg, respectively and chloride value of 270 mg/L. However, no guidelines for safe disposal into surface waters are given for these parameters. The turbidity of the wastewater sample at an average of 276 NTU.

RECOMMENDATION

It is recommended that the effluent should be recycled by treatment to meet standards for specified use.

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