Physico-Chemical Studies of Yantinka Wastewater in Jos North Local Government Area, Plateau State.

Henry, M. U.

Department of Science Laboratory Technology, Federal College of Forestry, Jos.

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Abstract- Wastewater before and after the spot of discharge of effluents at Yantinka was analysed for the physico-chemical parameters like temperature, pH, specific conductivity, total hardness, magnesium hardness, chloride, sulphate and some heavy metals like Mn, Fe, Zn, Cu, Cd, Cr, Ni, Pb using standard method of analysis. Result of the analysis showed temperature range of 21.00°C,-23.50°C, pH range of 7.80-8.18, and conductivity range of 205-610µs/cm with the highest after the spot of discharge, total hardness range of 252 - 260 mg/l, $CaCO_3$, TDS range of 64-135mg/dm^3. Wastewater before the spot of discharge had concentrations of 6.432 ppm for Fe which exceeded the WHO permissible limit. Mn, Cd, Ni and Pb were not detected in the wastewater. Water after the spot of discharge had concentrations of 295mg/l for chloride and 20.40ppm for Fe which exceeded the permissible limit of WHO. The waste water after the spot of discharge had higher concentrations of the parameters analyzed.

Index Terms- Wastewater, Heavy metals, Concentration, Physico-chemical parameters, Specific conductivity.

I. Introduction

Pollution of surface water occurs when too much of an undesirable or harmful substance flows into a body of water, exceeding the natural ability of that water body (Jambeck, et al., 2015). Water pollution is the contamination of water bodies, usually as a result of human activities (Moss, 2008). Water pollution occurs when contaminants are introduced into the natural water body. In defining pollution, the intended use of the water is considered, how far it departs from the norm, its effect on public health or ecological impacts. Water pollutants include excessive amount of heavy metals, certain radioactive isotopes, fecal coliform bacteria, phosphrous, nitrogen and sodium. The quality of water determines the potential use as the major uses of water today are for agriculture, industrial processes and domestic (household) supply. Water for domestic supply must be free from constituent pesticides, pathogens and high concentration of heavy metals (EPA, 2005).

Waste water is any water that has been adversely affected in quality by anthropogenic influence (Tilley et al., 2014). It comprises of liquid waste discharged by domestic residences, commercial properties, industries, agriculture and can encompass a wide range of potential contaminants and concentrations. In most common usage it refers to the municipal waste water that contains a broad spectrum of contaminants resulting from the mixing of waste water from different sources. Waste water can come from different sources like human waste usually from lavatories: feces, used toilet paper, wipes urine and other bodily fluids also known as black water as well as wash water (personal, floors, dishes), grey water or also known as sullage. Rainfall collected on roofs and hardstanding also form a part of this. Others are highway drainage, urban rainfall, run-off from roads, car-parks, roofs, side-walks or pavements (contains oils, animal feces, liter, fuel residues, rubber residues, metals from vehicle exhaust). Surplus manufactured liquids from domestic sources (drinks, cooking oil, pesticides, lubricating oil, paint and cleaning liquids) also constitute waste water as well as septic tank discharge and sewage treatment tank discharge (Burton and Pitt, 2001). This work is intended to assess the level of pollution of Yantinka wastewater by metal works. The pollution level will be determined by assessing the wastewater quality before and after the spot of discharge for the physico-chemical parameters like temperature, pH, conductivity, total hardness, dissolved and suspended solids, chlorides, calcium, manganese, sulphate, copper, zinc, nickel, cadmium, lead, manganese, iron and chromium according to the standard analytical methods for the examination of water and wastewater (Eaton and Clesceri,2005).

II. MATERIALS AND METHODS

SAMPLING

Wastewater samples were collected from Yantinka waste water in the month of January 2019. Water samples were collected in polythene bottles that were' previously washed with detergent and then soaked in 50% concentrated nitric acid (HNO_3) and finally rinsed several times with distilled water and the waste water before sampling. The wastewater was collected before and after the spot of discharge of effluents, labeled properly, dated and transported to the laboratory. The samples were stored at room temperature and an immediate analysis was made using standard methods (APHA, 1995).

The temperature and pH of the waste water samples were determined by using a thermometer and digital pH meter (model 550). Specific conductivity was measured using digital conductivity meter (model 430). Total dissolved solids and suspended solids were determined gravimetrically by filtering 200ml of water through watchman filter paper No. 42. Total hardness was determined by EDTA method. The heavy metals (Copper, Zinc, Nickel, Cadmium, Lead, Manganese, Iron and Chromium) concentration in the wastewater were determined by standard analytical methods (APHA, 1995).

III. RESULTS AND DISCUSSION

Table 1 Physical parameters of the wastewater before and after the spot of discharge.

Parameters	Before spot of discharge	After spot of discharge
Temperature (ºC)	21.00 ± 0.02	23.50 ± 0.01
pH	8.18 ± 0.03	7.85 ± 0.05
Conductivity (µs/cm)	601 ± 0.08	205 ± 0.12
Total solids (mg/l)	445 ± 1.32	228 ± 1.08
Suspended solids (mg/l)	310 ± 1.00	164 ± 1.46
Dissolved solids (mg/l)	135 ± 1.28	64 ± 1.33

Triplicate determination

Table 2 Chemical parameters of the wastewater samples

Quality parameters	Water before spot of discharge	Water after spot of discharge
Total hardness (mg/l)	260 ± 0.15	225 ± 0.34
Calcium hardness (mg/l)	147 ± 0.14	163 ± 0.20
Magnesiumhardness(mg/l)	97 ± 0.30	105 ± 0.14
Chloride (mg/l)	95 ± 0.02	295 ± 0.06
Sulphate (mg/l)	185 ± 0.43	240 ± 0.38

Triplicate determination

Table 3 Heavy metal concentration in water before and after the spot of discharge (ppm)

Parameters	Water before spot of discharge	Water after spot of discharge
Mn	ND	1.13 ± 0.02
Fe	6.42 ± 0.09	20 .40 ± 0.01
Zn	0.18 ± 0.05	0.29 ± 0.02
Cu	0.11 ± 0.05	0.16 ± 0.01
Cr	0.05 ± 0.01	0.04 ± 0.03
Cd	ND	ND
Ni	ND	ND
Pb	ND	ND

Triplicate determination

The water temperature before the spot of discharge of effluents was 21.00°C while the temperature of water after the spot of discharge was 23.50 °C. The low temperature value recorded for both water before and after the spot of discharge may be due to the cold dry winds prevalent in the early hours of the day. However, temperature levels of the water samples were within the World Health Organization's recommended range of 10°C to 50°C (WHO, 2006). pH measurements of the water showed the pH value of water before spot of discharge to be 8.18 while the pH value after the spot of discharge was 7.85. This pH value showed slight level of alkalinity. The moderately alkaline pH value observed in the water could be due to the presence of substances which are alkaline generated from the metal works in the area. pH value of the water before spot of discharge showed slight deviation from the neutral pH of 7.0. However, the pH values of the water were within the WHO (1993) recommended ranges of 6.0 - 9.0 for portable water and 5.5 - 8.5 for agricultural uses.

Conductivity measurements of the waters range from 215µs/cm to 610µs/cm in water before and after the spot of discharge respectively. The conductivity of an aqueous solution is known to be particularly sensitive to variations in dissolved solids. A large conductance is an indication of highly mineralized water. The high conductivity value shown by water after the spot of discharge could be due to the high concentration of dissolved solids (135mg/l). These solids are capable of dissociating into ions thereby imparting conducting characteristics to the water. Conductivity value for water before the spot of discharge (215µs/cm) is a manifestation of the level of total dissolved solids in the wastewater (64mg/l). However, both waters had conductivities that fell within the WHO recommended range of 8-10,000µs/cm. The total dissolve solid (TDS) for the wastewater range from 288mg/l in water before the spot of discharge to 445mg/l in water after the spot of discharge. The relatively high concentration of total dissolved solids in water after the spot of discharge could be attributed to contribution through deposition of waste and metal scraps in large quantities into the water which latter decompose and corrode. This is evident in the distance of the water from the settlements and the metal works. The water had concentration of total dissolved solids that were within the WHO recommended permissible limit of 1000mg/l

Total hardness determination showed water after the spot of discharge to be a of a higher concentration value (260mg/l) while the total hardness of water before the spot of discharge was 252mg/l. The high concentration of total hardness after the spot of discharge might be due to the type of liquid waste emptied from the metal drums that are fabricated in the area which later found its way into the wastewater. It might also be due to the presence of carbondioxide in water which could have been released by decaying organic matter. Carbondioxide is known to enhance the ability of water to dissolve aluminium silicate, calcium carbonates and magnesium carbonate. The relatively high concentration of total hardness (260mg/l) of the water sample after the spot of discharge could also be due to a contribution of hardness producing substances from effluents discharge into the water such as calcium and magnesium carbonates. Although no health - based guideline value has been proposed for hardness by WHO (1993). Hardness of less than 75mg/l could have adverse effect on mineral balance.

Calcium hardness determination showed a lower concentration of 47mg/l in water before the spot of discharge while calcium hardness concentration of water after the spot of discharge had a higher concentration value of 163mg/l. The higher concentration of calcium in water was also manifested in the concentration of the total hardness, since calcium is the principal cation responsible for hardness of water. The concentration of calcium in the wastewater was however more than 15mg/l typical of most naturally occurring surface water. This could be due to the nature of refuse dump generated in the vicinity of the study. Calcium is usually in the range of 5- 500mg/l, as $CaCO_3$ (Tessema, 2015). The calcium concentration of the wastewater fell within this range.

Magnesium hardness ranged from 97mg/l in water before the spot of discharge to 105mg/l in water after the spot of discharge of effluents. The high concentration of magnesium in water after the spot of discharge could be due to the metal scraps and containers which when thrown into the wastewater rust with time thereby releasing metal ions into the water. It could also be due to the fluids that come with some of the metal containers which when emptied, found its way to the wastewater. The concentration of magnesium in the wastewaters however exceeded the WHO recommended maximum desirable limit of 30mg/l.

Chloride levels in the water samples ranged from 95mg/l in water before the spot of discharge to 295mgcl/dm^3 in water after the spot of discharge. The relatively high chloride concentration of 295 mgcl/dm^3 after the spot of discharge could be due to the effects of effluents dumped in the wastewater. The value of chloride ion concentration (295mg/l) after the spot of discharge exceeded the WHO permissible limit of 250mg/l while the chloride ion concentration before the spot of discharge (95mg/l) was within the WHO recommended value.

Sulphate ion determination of water after the spot of discharge has a higher concentration of 240mg/l while the sulphate ion concentration of water before the spot of discharge was 185mg/l. The high concentration of sulphate ion in the water might be due to the nature of effluents discharged into the wastewater. Sulphate though one of the least toxic anions, high concentration in drinking water is known to cause catharsis, dehydration and gastro-intestinal irritation. It also imparts taste to the water. However, the sulphate ion concentration in the water did not exceed the recommended permissible limit of 250mg/l (WHO, 2006).

Manganese content in water after the spot of discharge was 1.13ppm while the manganese content of water before the spot of discharge was beyond the detectable limit of the instrument used. The high concentration of manganese after the spot of discharge could be due to chemical such as gasoline and runoffs from the dumpsite in the vicinity of the study. This is evidence by the proximity of the metal works to the wastewater. The manganese content of the water after the spot of discharge showed a lower value of 1.13ppm when compared to the manganese value of 42.77ppm reported for water (Nagamani, 2015). Manganese may become noticeable in tap water at concentrations greater than 0.05mg/l by imparting colour, odour and taste to the water (Hassan, 2008). It may be found in deep wells at concentration as high as 2 -3 ppm (Slyvia et al, 2013). The manganese content of the water after the spot of discharge was within the WHO recommended value of 5.0mg/l.

The concentration of iron in water before and after the spot of discharge was 6.43ppm and 20.40ppm respectively. The high iron content in water after the spot of discharge could be ascribed to the run-offs from the meal works in the area. It could also be due to the metal containers thrown into the wastewater which corrode with time releasing metal ions into the water. At iron concentrations below 0.3ppm, there is no noticeable taste in water but turbidity and colour may develop. Laundry and sanitary wares are also known to be stained at iron concentration above 0.3ppm (Wu et al., 2011). The concentration of iron in the water was high and exceeded the WHO permissible limit of 0.1 ppm

Zinc content of water before and after the spot of discharge was 0.18ppm and 0.29pp. The Zinc values reported in this study was lower than the values (7-15 ppm) reported for surface water (Nagamani, 2015). However, the Zinc concentration in the wastewater was below the WHO maximum tolerable limit of 3.0ppm in drinking water.

Copper concentration in water before and after the spot of discharge were 0.11 ppm and 0.16ppm. Copper is required by the body for proper nutrition but high doses of copper causes liver damage or anemia.(Elarina et al., 2014). The high content of copper after the spot of discharge could be due to the corrosion of copper pipes and scrap in the refuse dumps which are eventually eroded into the water. The concentration of copper in both watery did not exceed the WHO maximum limit of 2.0ppm.

Chromium concentration in the water before and after the spot of discharge range from 0.005 ppm to 0.012ppm respectively. The concentration of chromium in water after the spot of discharge was higher than that before the spot of discharge. The high content of chromium after the spot of discharge could be due to the activities of the metal work and the type of metal waste generated in the study area. Trivalent chromium is slightly soluble in water and is considered essential in man and animals for efficient lipid, glucose and protein metabolism (Wijayawardena et al., 2016). However, the chromium content of both water did not exceed the WHO maximum permissible limit of 0.05ppm.

Cadmium, Nickel and lead could not be detected in the wastewaters before and after the spot of discharge. This could be due to their presence in concentrations below the detection limit of the instrument used.

IV. CONCLUSION

Water bodies are polluted and contaminated if the concentration of certain physico-chemical, biological and organic parameters in such water exceed the maximum permissible limit recommended by World Health Organization. Results of the physico-chemical parameters in Yantinka wastewater showed that wastewater before the spot of discharge had a low pollution level as all the parameters assessed were within the WHO permissible limit except for Fe which exceeded the permissible limit while the wasterwater after the spot of discharge had a high pollution level as the concentrations of chloride, manganese and iron exceeded the WHO permissible limit.

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AUTHORS

First Author – Henry, M. U.
Department of Science Laboratory Technology, Federal College of Forestry, Jos.
E mail: henry_ime@yahoo.com.