Comparative Analysis of Effluent Discharge from Emene Industrial Area of Enugu, Nigeria, With National and International Standards

EMODI EDMUND EMEKA
CENTRE FOR ENV. MGT. AND CONTROL, UNIV. OF NIGERIA, NSUKKA

Abstract
Effluent from industries particularly in developing countries are in most cases discharged into the adjoining environment, and water bodies being mostly affected. Some of these effluents are not well treated or not even treated at all before being discharged. This study analyses the effluent being discharged from Emene Industrial area, comparing it with the Nigerian and international discharged standards. Sample of the waste water was collected at the point where the waste is being discharged into Ekulu river. Laboratory analysis of the sample was carried out, using physiochemical and biological parameters. The results were statistically analysed, using Analysis of variance to show that at least one or more of the physiochemical and biological characteristics of the effluent at all selected standards differ significantly at 0.05 significant level. This manifested in the abnormal presence or concentration in the effluent of various parameters used in the analysis. This implies that the industrial effluents discharged from the area are either not properly treated or not even being treated at all before being discharged. Hence, they do not meet the National and International standards. This, definitely will impact negatively on the receiving Ekulu river. Enforcement of cost effective cleaner production technology among other measures have been recommended to ameliorate the situation.
Key Word: Analysis, Effluent, Compared, Nigeria, International

Introduction

Inability to effectively and efficiently manage vast amount of wastes generated by various anthropogenic activities particularly in developing countries has created one of the most critical problems in our environment. Of more importance is the manner in which industrial effluents are being disposed into the ambient environment, water bodies like fresh water reservoirs being mostly affected. With such activity, these natural resources are rendered unsuitable for both primary and secondary usages (Fakayode S.O 2005). The major sources of drinking water in Nigeria-inland water bodies and estuaries-have always been contaminated by the activities of the adjoining populations and industrial establishments (Sangodoyin, A Y. 1995).

River systems are the primary means for disposal of industrial effluents, and these have the capacity to alter the physical, chemical and biological nature of the receiving water body (Sangodoyin, A,Y. 1991). Of recent, there have been pollution stress on surface water bodies as a result of increased industrial activities (Ajayi S.O and Osibanji O, 1981). The consequences of this are of great magnitude to public health and the environment (Osibanji O, et at, 2011).

Ideally, effluents from industries are supposed to be properly treated before being discharged into the environment. In Nigeria, there are laws put in place to guide and regulate industrial discharge practices and environmental contamination generally. The federal environmental protection Agency (FEPA) established to check environmental abuses has had little or no impact on pollution control in our environment (Ezeronye, O.U and Amogu, N 1998).

This study, therefore compares the industrial effluent discharge from Emene industrial area of Enugu with the national (Nigerian) as well as the International (world Health Organization) discharge standards.

Comparative analysis was carried out to determine whether the physiological characteristic of the effluents discharged meet the national and international discharge standards, using the ANOVA table.

Literature Review

Assessing the nature of effluents, Kosaric (1992) opined that waste waters are generated by many industries as a consequence of their operation and processing. He classified waste effluents generated by selected industries as; oxygen consuming wastes generated by breweries, dairies, distillers, packaging houses etc, high suspended solids from coal washeries, iron and steel industries etc. high dissolved solids from chemical plants, tanneries, water softening, oily and grease from laundries, metal finishing, oil fields, coloured from pulp and paper mills, textile dye houses, palm oil mills etc. High alkaline from chemical plants, tanneries, textile finishing etc. and high temperature from bottle washing plants, power plant etc. Agedengbe et al (2003) noted that an important pollution index of industrial waste waters is the oxygen function measured in terms of chemical oxygen demand and biological oxygen demand while the nutrients status of waste water are measured in terms of nitrogen and phosphorous. However, Ezenobi et al (2004) added that PH, temperature and total suspended solids are other important quality parameters. The effluent total hardness concentrations of a chemical-biological treatment plant were found greater then the influents (Ogunfokowokan, 1998). The results are presented in terms of the relative flux as a function of time related to hydrodynamic conditions and pollution characteristics of water waste.

Tracing the source of industrial effluent through soap and detergent industry, El-Cohary et al (1987) observed that characterization of the composite waste water from both soap and food processing plants indicated that waste was highly contaminated with organic compounds as indicated by COD and BOD values. In a study to assess the seasonal variation in bacterial heavy metal biosorption in a receiving river as affected by industrial effluents, Kanu et al (2006) observed an overall seasonal variation of heavy metals such as lead and zinc in the rainy season as compared to other metals for dry season. The concentrations of heavy metals were also generally low in some sample and no similar trends were observed in the control samples. Except for iron and zinc, the concentrations of the heavy metals were relatively low. Moreover, effluent from the soap manufacturing plant contained significant concentrations of oil and grease amounting to 563 mg.$^{1-1}$.

According to Calamari (1985), process water in paper and board mills contain a lot of sugars and lignocelluloses, which support the growth of bacteria, mold and some yeast. Effluents from fertilizer plants contain a high concentration of potentially toxic wastes rich in ammonia and phosphorous which support the growth of algac, yeast and cyanobacteria. Celluloytic bacteria such as Klebsiella pneumonia and enterobacter have been isolated from spent water from the paper and pulp industries. The occurrence of these microbs in the effluent lead to excessive oxygen demand loading, and also disturb the ecological equilibrium of the receiving waters with much lose of aquatic life.

Waste water from brewery industry originates from liquors pressed from grains and yeast recovery, and have the characteristic odour of fermented malt and slightly acidic. (Kanu et al, 2006). Ekhaise and Anyasi (2005) were of the opinion that introduction of waste water high in organic matter and essential nutrients bring about changes in the microflora. They reported high courts of bacterial population in Ikpoba River in Benin City of Nigeria receiving a brewery industrial effluent. Similar results were reported by Kanu and Others in 2006 of the effect of brewery discharge into Eziama River Aba, Nigeria.

Onwuka et al (2004) studied eighty eight samples of the ground water near industrial effluent discharges in Enugu in order to evaluate its probability. The parameters of interest are common waste; derivable chemical constituents such as nitrates. The results showed that eight out of ten samples analysed tested that the bacteriological quality of the ground water showed evidence of sewage and industrial effluent contaminations. The identification of E. Coli in the water indicates faecal contamination. Improvement in the management of domestic wastes, such as the use of central sewer was suggested as a means of preserving the aquifer and consequently improving the quality of the ground water.

Ibekwe et al (2004) analysed the waste water in the accumulation pond and final discharge point of Nigerian Bottling company Plc. in Owerri, Nigeria to determine their bacteriological and physio-chemical characteristics. Species of organisms isolated include; staphylococcus, bacillus, lactobacillus, and streptococcus. Others were, klebsiella, Escherichia, proteus and serratia. Species of lactobacillus and proteus were isolated from the final discharge point only. Bacteria count after 72 hours was higher with a maximum count $6x10^7$ Cfu/ml in the final discharge point. The final discharge contained more dissolved solids which was double that of the accumulation pond. It was also found that the dissolved oxygen was slightly higher in the final discharge point than accumulation pond. Although, these findings were found to be within the permissible limits of effluent discharge specified by the federal ministry of Environment in Nigeria, the consequent long term bioaccumulation effects on microbial ecosystem were not reported.

The toxicity of benzene, hydroxylbenzene, chlorobenzene, methylbenzene and dimethylbenzene to four chemolithotrophic bacterial (Nitrosomonas Nitrobacter, thiobacillus and leptothrix) Isolated from the New Calabar water were investigated by Odokuma and Oliwe (2003). The static method of acute toxicity assessment was employed. Mortality within a period of five hours exposure to toxicant was the index of assessment. Toxicity of chemicals to the bacteria decreased in the following order. Phenol > xylem > benzene > chlorobenzene > toluene > xylem for Nitrobacter, phenol > chlorobenzene > benzene was for leptothrix. The toxicity of the chemicals to the test organisms decreased in the order, phenol > chlorobenzene > benzene > xylene > toluene. Sensitivity of the bacteria to the chemicals decreased in the order; Nitrosomonas > leptothrix >Thiobacillus > Nitrobacter. The toxicity generally decreased with increased methyl substitution in the case of Nitrobacter and Thiobacillus but increased with increased methyl substitution in the case of Nitrosomonas and leptothrix. Hydroxyl and halogenated substituted derivatives were more toxic than methyl substituted derivatives. These results indicate that wastes containing hysroxyl and chlorosustituted derivatives of benzene may pose greater toxicity problem to microbiota than wastes containing methyl substituted derivatives. The nitrification stage of the nitrogen cycle will also be greatly impaired in the presence of these groups of chemicals in a river.

Davis and Reilly (1980) asserted that palm oil mill effluent is an important source of inland water pollution when released without treatment into local rivers or lakes. Noting that palm oil mill effluent is generated from three major sources – sterilizer condensate, hydrocyclone waste and separator sludge -, Ma (2000) added that it contains various suspended components including all walls, organelles, short fibres, as spectrum of carbohydrates ranging from hemicelluloses to simple sugars, a range of nitrogenous compounds from proteins to amino acids, free organic acid and an assembly of minor organic and mineral constituents. Accepting the fact that palm oil mill waste water treatment system is one of the major sources of green house gasses due to their biogas emission, Wu el at (2009) were of the view that palm oil mill effluent has generally been treated by anaerobic digestion, resulting in difficulty in perceiving the magnitude of pollution being caused to the receiving waters by such discharges.

Assessing the danger in the use of water bodies as sink for industrial effluent Anetor et al (2003), exphasized that population explosion, hazardous rapid urbanization, industrial and technological expansion, energy utilization and wastes generation from domestic and industrial sources have rendered many water resources unwholesome and hazardous to man and other living resources. Some heavy metals contained in effluents have been found to be carcinogenic while other chemicals equally present are poisonous depending on the dose and duration of exposure. Undoubted, waste water from industries and residential areas discharged into another environment without suitable treatment could disturb the ecological balance of such an environment (Botkin and Kelly 1998). In Nigeria, cities like Kaduna, Lagos and Aba depend very much on their rivers. However, the rush by African countries to industrialise has resulted in discharge of partially treated or raw wastes into the surrounding bodies of water (Nwachukwu et al 1989).

Water pollution may derive natural processes such as weathering and soil erosion. In the vast majority of cases, however, impairment of water quality is either directly or indirectly the result of human activities (Dix, 1981) Stumm and Morgan (1981) identified point and non-point sources of water contamination. Point sources are discrete and readily identifiable and as a result they are relatively easy to monitor and regulate. Most sewage from urban areas and industrial waste waters are discharged from point sources. Non point sources, on the other hand are distributed in a different manner.

Davis and Walker (1986) were of the opinion that when a biodegradable organic waste is discharged into an aquatic ecosystem such as stream, estuary or lake, oxygen dissolved in the water is consumed due to the respiration of micro organisms that oxidize the organic matter. The more the biodegradable a waste is, the more rapid is the rate of its oxidation and the corresponding consumption of oxygen. Because of this relationship and its significance to water quality, the organic content of waste waters is usually measured in terms of the amount of oxygen consumed during its oxidation. In an aquatic ecosystem, a greater number of species of organisms are supported when the dissolved oxygen concentration is high. Meetens et al (1995) observed that oxygen depletion due to waste discharge has the effect of increasing the numbers of decomposer organisms at the expense of others. When oxygen demand of a waste is so high as to eliminate all or most of the dissolute oxygen from a stretch of a water body, organic matter degradation occurs through the activities of anaerobic organisms, which do not require oxygen.

According to Perry et al, (2007), nitrogen or phosphorus or both may cause aquatic biological productivity to increase, resulting in low dissolved oxygen and eutrophication of lakes, rivers, estuaries and marine waters. Mott and Associates (2001), stressed that many serious human diseases are caused by water borne pathogens. In developed countries, the spread of water borne disease has been largely arrested through the introduction of water and sewage facilities and through hygiene. But in many developing countries, such diseases are still major causes of death especially among the young ones (Lamb, 1985).

Chino (1981) observed that heavy metals (Pb, Cu, Cd) are among the major toxic pollutants in surface water. These have been found to constitute a problem in streams or rivers abutted by catchments with factories dealing with tanning, smelting, welding, rennovation, manufacture and disposal of car batteries, petroleum and oil products. Cadmium is a non- essential element and is both bioavailable and toxic (Adriano, 2001). It interfers with metabolic processes in plants and can bioaccumulate in aquatic organism and enter the food chains. The basic long term effects of low level disease exposure to cadmium are chronic obstructive pulmonary disease and emphysema and chronic renal tubular diseases. Ingestion of high concentration of cadmium leads to nausea, vomiting and abdominal pain. About, three quarters of cadmium is used in battery (especially Ni - od batteries), and most of the remaining quarter is used mainly for pigment, coatings and plating and as stabilizers for plastics (Okonkwo, 2014). Cadmium derives its toxicological properties from its chemical similarly to zinc which is an essential micronutrient for plants, animals and humans. It is biopersistent and once absordbed by an organism, remains resident for many years although it is eventually excreted. The presence of copper, lead, zinc and cadmium in fish is of serious health concern to human consumers (Mdamo, 2001).

According to Salequuzznman et al (2008), the measure of the acid balance of a Solution (PH) changes can trip the ecological balance of the aquatic system and excessive acidity can result in the hydrogen sulfide. The PH of water affects the solubility of many toxic and nutritive chemicals; hence, the availability of the substances to aquatic organisms is affected. Mosley et al (2004), observed that water with PH > 8.5 indicates that the water is hard. Most metals become more water soluble and more toxic with increase in acidity. Toxicity cyanides and sulfides also increase with a decrease in PH. The content of toxic forms of ammonia to the untoxic form also depends on PH dynamics.

Examining the place of electrical conductivity in determining the quality of water, Tariq et al (2006), opined that it is a function of total dissolved solids known as ions concentration which determine the quality of water.

Mosley et al (2004), were of the opinion that electrical conductivity is a measure of how mush total salt (Inorganic ions such as sodium, chloride, magnesium, calcium) is present in the water. According to them, the more ions the higher the conductivity. Conductivity itself is not of human aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problem. If the conductivity of a stream suddenly increases, it indicates that there is a source of dissolved ions in the vicinity. Therefore, conductivity measurements can be used as a quick way to locate potential water quality problems. All natural waters contain some dissolved solids due to the dissolution and weathering of rocks and soils. Some, not the entire dissolved solids, however, act potentially unhealthy. Nadia (2006) noted that discharge of waste water with a high total dissolved solids level would have adverse impact on aquatic life, rendering the receiving water unfit for drinking and domestic purposes. It also reduces crop yield if used for irrigation, as well as exacerbate corrosion in water networks.

Nyanda (2000), was of the view that plant nutrients, particularly nitrogen and phosphorus are important determinants of the biological productivity of aquatic ecosystems. Industrial effluences, animal waste and sewage contain high levels of nitrogen and phosphor using – other major sources of fertilizer run off from urban and agricultural catchments. While the long term cultural entrophication accelerates, the natural successional progress of aquatic ecosystems towards a terrestrial system in the short term, problems arise due to cyclic occurrences of algal blooms and decay. In warm weather, nutrients stimulate rapid growth of algae and floating aquatic weeds. The water often becomes opaque and has unpleasant taste and odour (Katima and Masange, 1994). Apart from adding to nutrient content of water, addition of some forms of nitrogen and phosphorus will increase BOC and COD (Mahdieh and Amirohossein, 2009). Increased nitrogen levels adversely affect cold water fish more than warm water ones. The result of the study carried out by Barnes et al, (1998) on sedimentation and Georgia fishes revealed that nitrogen concentrations of 0.5 mg /1 liter are toxic to rainbow trout. Through discharge of waste water, while phosphorus ends up in surface waters near the factories that use it, phosphorus is generally the limiting nutrient in fresh water systems and any increase in phosphorus usually results in more aquatic vegetation.

Mathuhu et al (1997), found out that water pollution due to discharge of untreated industrial effluents into a body of water is a major problem in the global context. The problem of water pollution is being experienced by both developing and developed countries. Human activities give rise to water pollution by introducing various categories of substances or waste into a water body. The more common types of polluting substances include; pathogenic organisms, oxygen demanding organic substances, plant nutrients that stimulate algal blooms, inorganic and organic toxic substances (Cornish and Mensahh, 1999).

Material and Methods

The study involved the laboratory analysis of effluent collected at the point of being discharged into the Ekulu River.

Sampling bottles were sterilized in order to activate the micro organisms with the use of surgical glove so as not to add to the bacteria in the water. Sterilized cup was used to collect the samples into sterilized bottles. The samples were covered immediately in order to avoid contamination through air. The samples were placed in cooler to prevent increase in bacterial load and also to avoid depletion of the contamination due to oxidation and direct sunlight.

Spectrophotometer (DR. 20600 model) and glass comparators were used to determine colour. PH was determined using lovibond instruments and electronic meters. Mercury- in glass thermometer was used to determine temperature. Mettler Toledo MC 2006 conductivity meter was used to measure electrical conductivity. Turbidity levels were measured in Nephelometric units (NTU) using HACH 2100A turbidity meter. Alkalinity was determined by Titrametric method (using titration).Transmission spectrometer was used to determine sulphate. Titration of the samples with silver nitrate determined chloride. For nitrate, 1ml of sodium arsenic was added to the sample, shaken thoroughly, 5ml was separated from the Mixture in a test tube and 10mls of bruane sulphate added, then 10 mls of conc. Sulphuric acid was added and the remaining solution mixed and allowed to develop for about 1hr; the absorbance was then read with the aid of spectronic 20. To determine iron, a percentage of water was pipetted in a test tube, 5 mills of sodium acetate buffer was added, 5 mls of 0.023% of phenolphthalcin was added, it was allowed to develop for about 30 minutes, then with the aid of spectrophotometer absorbance was read. Copper was determined with the aid of spectrophotometer. In the determination of lead, 5 drops of 10% potassium cyanide was added to a measure of 10mls water, eventually spectrophotometer was used to measure adsorbance. Biochemical Oxygen Demand was determined by conventional methods according to association of Official Analytical Chemists (AOAC) 2002. In chemical Oxygen Demand determination, potassium dichromate was used in the test and oxygen used in oxidizing the water was determined.

The following parameters were used in the laboratory analysis of the samples; general appearance, colour, odour, turbidity, temperature, PH, total dissolved solid, total suspended solid, total solid, dissolved oxygen, COD, BOD, conductivity, iron, lead, copper, zinc, coliform, E. coli and total plate.

Comparative analysis was carried out to determine whether there are variations between the point of discharge result and the Nigerian and world Health organization discharge standard limits.

Data Presentation and Analysis

Sample of the effluent was taken to the laboratory and analysed. The analysis turned out the following result in the table 1 below.

The national (Nigerian) discharge standard limit as well as the International (World Health Organization) discharge standard limit are also presented in the table below.

Table 1: **WASTE WATER RESULT, NATIONAL AND INTERNATIONAL DISCHARGE STANDARD LIMITS**

S/N	Parameters	Units	Raw water Discharged	National discharge standard	International discharge standard
1	General Appearance		Light	Clear	Clear
2	Colour	unit	120	5.15	5.125
3	Odour	-	Little	Unobjectional	Absent
4	Turbidity	Ntu	510	10	10
5	Temperature	oC	29	Ambient	Ambient
6	PH		8.6	6.5-8.5	6.5-8.5
7	Total dissolved solid	Mg/L	653	500	500
8	Total suspended solid	Mg/L	82.5	0.75	0.75
9	Total solid	Mg/L	735.5	1000	1000
10	Dissolved oxygen	Mg/L	3.3	Minimum 4	6.4
11	C.O.D	Mg/L	41.8	30	30
12	BOD	Mg/L	45.1	6.0	4.0
13	Conductivity	N/CM	956.78	1000	1250
14	Sulphate	Mg/L	201	500	500
15	Nitrate	Mg/L	12	40	50
16	Phosphorous	Mg/L	1.3	3.5	3.5
17	Chlorides	Mg/L	500	250	350
18	Alkalinity	Mg/L	461	-	-
19	Iron	Mg/L	0.02	0.3	0.5
20	Lead	Mg/L	0.0026	0.01	0.1
21	Copper	Mg/L	0.001	1.0	1.0
22	Zinc	Mg/L	0.003	0.2	2.4
23	Coli form	CFU/ML	67	100/ml	100/m
24	E.coli	CFU/ML	+ve	-ve	-ve
25	Total plate count	CFU/ML	102	3/ml	3/ml

Source: Enugu state water corporation, water analysis laboratory

Comparative Analysis
Hypothesis
H_o: The physiological characteristics of the effluents discharged are the same with the National and International discharge standard limits.
H_i: At least one or more of he characteristics differs at level of significance $\propto$ =5%

ANOVA TABLE

Source of Variation	D.F	SS	Ms	F. ratio
Between treatment	3-1=2	1984225.597	999,112,799	10.5636
Within Treatment	71-3=69	6480374.264	93,918.468	
Total corrected	72-1=71	8464599.861		

Critical region: Reject Ho if F cal. > F tab if
Otherwise accepted

That is $F\ \mu,\ V_1,\ V_2$ = F 0.05 (2,69)
= (0.95, (2.69)
$F\ \mu\ (V_1,\ V_2)$ = 3.15

Decision: since the F calculated is greater than the F tabulated i.e 10.5636 > 3.15, then accept H_i, which means that at least one or more of the physiochemical characteristics of the effluents at all selected standards differ significantly at $\propto$ = 0.05 (5%).

Results and Implications

The analysis of the sample of the industrial effluent shows that there are differences in the physiochemical characteristics as compared with the national and international discharge standard limits. While the national and international discharge standard limits tend to tilt towards one side, there seems to be wide gap between both of them and the industrial effluent. The differences manifest various consequent implications.

The discharge standard limit prescribed by international organization (WHO) for, industrial effluent as it concerns odour is that the effluent be odourless. Nigerian standard is unobjectional, but the industrial effluent from Emene has little odour. This brings about contamination of the water body into which it is discharged, invariably making the water unfit for human consumption and for other domestic purposes.

While the international and the national discharge standard limits as regards turbidity tend to be 10 NTU in each case, the industrial discharged effluent has its turbidity as 510 NTU. This is very high indeed. High turbidity can significantly reduce the aesthetic quality of streams, lakes, having the harmful impact on recreation and tourism. It can increase the cost of water treatment for drinking and food processing. It can also harm fish and other aquatic lives by reducing food supplies, degrading spawning beds and affecting gill functioning. Besides, high turbidity diffuses sunlight and slows photosynthesis. Plants will begin to die in the process reducing the amount of dissolved oxygen and increasing the acidity. Both of these effects harm aquatic animals. Smith and Davies (2001), observed that if light level gets too low, photosynthesis may stop altogether and algae will die. Furthermore, high turbidity raises water temperature as the suspended particles absorb the sun's heat. Warmer water holds less oxygen, thus increasing the effect of reduced photosynthesis. In addition, some aquatic animals may not adjust well to the warmer water, particularly during the eggs and larval stages. Besides, high turbid water can clog the gills of fishes, stunt their growth and decreases their resistance to diseases. Also the organic materials that may cause turbidity can also serve as breeding grounds for pathogenic bacteria. Turbid water can clog industrial machines and interfere with making food and beverages.

The total dissolved solid has 500 mg/L as the discharge standard limit both nationally and internationally. But that of the industrial effluent is 653 mg/l, indicating that it is high. Water with high dissolved solids generally is of inferior palatability and may induce unfavourable physiological reaction in the consumer.

Effluent from the industrial discharge contains 82.5 mg/L of total suspended solid as against the 0.75 mg/L which stands as the discharge standard limit for both Nigeria and world Health organization. This depicts high level of total suspended solid. High rate of suspended solids in surface water can clog fish gills, either killing them or reducing their growth rate. They also reduce light penetration, and the ability of algae to produce food and oxygen. Again, when the water flow slows down am when it enters a reservoir, the suspended sediments settle out and drop to the bottom. This makes the water become clear, but as the sediment settles, it may smother the bottom dwelling, organisms, cover breeding areas and smother eggs. Besides, the suspended solids affect other parameters indirectly such as temperature and dissected oxygen; Because of greater absorbency of the particulate water, the surface water becomes warm, and this tends to stabilize the stratification (layering) in stream pools, embayment and reservoirs. This, in turn interferes with mixing, decreasing the dispersion of oxygen and nutrients to deep layers. Suspended solids also interferes with effective drinking water treatment. High sediment load interfers with coagulation, filtration and disinfection of turbid water. They also cause problems for industrial uses, interfer with recreational use and aesthetic enjoyment of water. Poor visibility can be dangerous for swimming and diving. Sediment deposition may eventually close up channels or fill up the water body converting, it into wetland. High rate of total suspended solids may cause the water to be corrosive, salty or brackish taste, resulting in scale formation and decreased efficiency of hot water heaters. The may equally contain elevated levels of irons that are above the primary and secondary drinking standards such as an elevated level of nitrate arsenic, aluminum, copper, lead etc. High total subtended solids also affect the quality of the water, interfering with washing clothes and corroding plumbing fixtures.

As the world health organization sets 6.4 mg/L as its discharge standard for dissolved oxygen, Nigeria has a discharge standard limit of a minimum of 4. Mg/L. However, the 3.3 mg/L discharged from the industrial effluents is less than the required national and international standards. Hence, certain living organisms in the water that depend on the intake of dissolved oxygen for survival will find it difficult to exist.

The phosphorous content of the discharged effluent is 1.3 mg/L contrary to the national and international standards both of which have 3.5mg/L as their discharge standards. Instances where phosphate is a growth limiting nutrient the discharge of raw or untreated industrial waste into a water body may stimulate growth of photosynthetic aquatic micro organisms in nuisance quantities.

The industrial discharge has its chloride level as 500mg/L, as against the 250 mg/l for the national and international discharge standards. Chlorides in water may have no adverse physiological effects, but a sudden increase above their background levels may indicate pollution.

Sulphate content of the industrial discharge is 201 mg/L while 500 mg/L is the discharge standard for both at national and international levels. Although sulphates are not normally considered serious problems in most water supplies, they can nevertheless, be troublesome if sulphate reducing bacterial are present. These bacterial are capable of reducing the sulphate radical to hydrogen suphide with the accompanying rotten egg odour.

Both at the national and international levels, there is zero tolerance for E. Coli as the discharge standards. On the other hand, the industrial effluent manifested the presence of E. Coli. It has been affirmed that E. Coli present in water bodies can bring about diarrhea, urinary tract infections, respiratory illnesses, pneumonia and the likes.

There are also variations in different other areas; while the discharge standards of both national and international for copper is 1.0 mg/L, industrial effluent discharge is 0.001. For zinc, it is 0.2 mg/L and 2.4 for national and international standards, while the industrial discharge is 0.003. Lead has 01 mg/L and 0.1 as discharge standard limits for national and international respectively, but the industrial discharge is 0.0026 mg/L. The national and international discharge standards for iron 0.3 mg/L and 0.5 mg/L respectively, and the industrial discharge is 0.02 mg/L. These variations in one way or the other exert influences on the water bodies that receive the industrial effluent.

Recommendations

The results obtained form the comparative analysis of the industrial effluent discharge show that it does not compare favourable with the national and international standards.

It is therefore recommended that careless disposal of industrial effluent be discouraged. There is need for industrialists in the area to install waste treatment plants with a view to properly treat wastes before discharging them into the surrounding environment. Where such facility is available, it is equally recommended that competent personnel be employed that will effectively and efficiently handle the treatment processes, making sure that the waste water discharge is in line with the discharge guidelines.

Introduction of cost effective cleaner production technology should be enforced. Industrialists should be encouraged to evolve site waste separation and reduction as well as recycling their waste water for use in some other areas in order to reduce cost of fresh water.

Federal Environmental Protection Agency and National Environmental Standards and Regulation Agency (Agencies Saddled with the Responsibilities of Protecting the Environment and Monitoring Environmental Quality in Nigeria) should rise to their responsibilities. They should impose levies or prosecute owners of industries that discharge their untreated or partially treated wastes into the surrounding environment. Such industries should also be made to take remediation measures to ameliorate the situation.

Conclusion

It has been revealed from the study that the effluents discharged from Emene industrial area of Enugu, Nigeria, are not properly treated or not even treated at all. This is depicted by the fact that the results obtained from the analysis of the sample from the industrial discharge did not compare favourably well with the Nigerian and World Health Organization Standards. There is a great variation in concentration of the parameters analyzed in the industrial discharged effluent, when compared with the national and the international standards.

Hence, the continous discharge of untreated or partially treated effluent into the surrounding environment may result in severe accumulation of the contaminants. This may be toxic to different organisms in that environment, and therefore should be discouraged for the sustainability of our environment.

REFERENCES

Agedengbe, K, Akinwole, A. O., and A.O. Babatunde (2003) Effluents Characteristics of selected industries in western Nigeria and Implications for re-use in Agricultural production. *Journal of Environs*. Extension. 4: 79-82.

Ajayi S.O. and O. Osibanjo (1981) Pollution Studies on Nigerian Rivers, water quality of some Nigeria Rivers. *Environmental Pollution Series* 2:87-95.

Aneter, J.I. Deniyi, F. A. and S. B. Olaleye (2003) Molecular Epidemiology: A Better Approach for early detection of Pathophysiologic Response to Environmental Diseases. *African Journal of Biomedical Research* 6: 113-118.

Botkin, D. B and E. A Kelly (1998) *Environmental Science Earth as a living Planet.* 2nd ed. USA John Willey.

Calamari, D. (1985) Review of the State of aquatic Pollution of west and central African Inland waters CIFA Occassional paper: (12) 26-32.

Chino, M. (1981): In "Kitagishi, K & Yamane, I. Eds: Heavy Metals Pollution in Solils of Japan". Japan Sci. COC Proc.

Cornish, G and Mensahh, A. (1999) Water quality and Peri-urban irrigation. Report OD/TN95HR Willing ford. UK.

Davis, B.R and K.F Walker (1986): *The Ecology of River Systems*. New York. John Wiley and Sons.

Davis, J.B. and P.J Reilly (1980) Palm Oil Mill Effluent – a Summary of Treatment Method. *Oleagineux.* 35-323-330.
Dix, H.M (1981) *Environmental Pollution.* Chichester. John Wiley.

Ekhaise, F.O. and C.C Anyansi. (2005) Influence of Breweries Discharge on the Microbial and Physiochemical Quality of Ikpoba River, Nigeria. *Afri Journal Biotechnology* 4: 1062-1065.

EL-Gohary, F.A, Abo-Elela, S.I. and H.I. Ali (1987) Management of waste water from soap and food industries*. Sci. Tech. Environ*. 66:203-212.

Ezenobi, N.O. and G.C. Okpokwasili (2004) Bacterial flora and Physiochemical Characteristics of Hospital Sewage in Port-Harcourt City, *Nigeria. Inter. Journal. of Environmental Studies*. 54 (2) 145-152.

Ezeronye, O.U. and Amogu, N. (1998) Microbiological studies of Effluents from Nigeria Fertilizer and paper Mill Plants. *International Journal of Environmental Studies.* 54:213-228.

Falcayode, S. O (2005) Impact Assessment of Industrial Effluent on Water Quality of Receiving Alaro River in Ibadan, Nigeria. *AJEM-RAGGEE*. 10: 1-13.

Ibekwe, V.I, Nwaiwu, O.I and J.O Offorbuike (2004) Bacteriological and physiochemical qualities of waste water from a bottling company in Owerri, Nigeria, *Global Journal environmental Science* 3: 51-54.

Kanu, I.A, Achi, O.K. Ezeronye, O.U and E.C. Anyanwu (2006) Seasonal variation in heavy metal biosorption in water samples from Eziama River near soap and brewery industries and environmental health implication. *International Journal of Environmental Science and Technology*. 3(1) 95-102.
Katima, J. and Masanja. E. (1994) Environmental Impact auditing for Tanzania Chemicals limited NEMC Report.

Kosaric, N. (1992) Treatment of Industrial Waste waters by Anacrobi Processes: a New Development in recent advances in Biotechnology. Vardar-Sukan, F, and Sukan, S.S. (eds) Netherlands. Academic Publishers.

Lamb, J.C. (1985): *Water Quality and its Control.* New York. John Wiley and Sons.

Ma, A.N (2000) Environmental Management for Palm oil industries. *Palm Oil Dev*. 30, 1-9.

Madamo, A. (2001): Accumulation of nutrients and heavy metals in plants at Kagondo natural wetland (Draft Paper).

Mahdieh, E. and Amirhessein, M. (2009) *Water quality Assessment of Bertain River and its tributaries in Cameroon Highland*. Malaysia. World Applied Science Journal Tronh, Perak, Malaysia.

Mathuthu, S. Nwanga, K and Simero A. (1997) "Impact Assessment of Industrial and sewage effluents" Water quality of receiving marimba River. *Harare Journal*.

Meetens, H.C. Ndege, L.J., and H.J. Enserik (1995) *Dynamics in farming system: changes in time and space in Sukumaland, Tanzania.* Armsterdam. Royal Tropical Institute.

Mosley, L., Sarabject S. and Aalbersborg B. (2004) *Water Quality Monitoring in Pacific Island Counties*. Handbook for water quality. Suva-Fiji Island. The University of South Africa Pacific.

Mott, M and E Associates (2001): Management of industrial and Municipal effluents. *LVEMP Report*, 2001.

Nadia, M.A. (2006) "Study on Effluents from selected sugar Mills in Pakistan". *Sustainable Development Policy Institute*. Islamabad, Pakistan.

Nwachukwu, S.U., Akpata, T.V, and M.E Essien (1989) Microbiological Assessment of Industrial Sewage of Agbara Industrial Estate in Ogun State. *International Journal of Ecology and Environmental sciences* 15: 109-115.

Odokuma, L. and O.S. Oliwe (2003) Toxicity of Substituted Benzene Derivatives to four Chemolithotrophic Bacteria Isolated from the New Calaber River *Global Journ. Environ. Sci*. 2(2) 72-79.

Ogunfowokan, O.A and A.O Fakankun (1998) Physiochemical Characteristics of Effluents from Beverage Processing Plant in Ibadan, Nigeria. *Journal of Applied Science in Environmental Sanitation* 5 (4) 353.

Okonkwo, U (2014) "Impact of Effluents on surface water in Enugu Metropolis", A case study of Emenite Industries Nig. Limited. Unpublished B.Sc project at N.O.U.N.

Onwuka, O.S, Uma, K.O and H.I. Ezeigbo (2004) Portability of shallow ground in Enugu town, South Eastern Nigeria. *Global Journal of Environ.Sc*. 3: 33-39.

Osibanjio, O. Daso, A.P and Gbadebo, A.M. (2011) The Impact of Industries on Surface Water Quality of River Ona and River Alaro in Ibadan, Nigeria. *Afric Journal Biotechnology* 10 (4)696.

Perry, R.H, Green, D. W and J.O Maloney (2007): *Perry's Chemical Engineers Handbook*. 7th ed. New York. McGraw-Hill.

Salequzzamma, M. Tariqul, I. Tasnuva, A. Kashem, M. and Mahedi, A. (2008) *Environmental Impact of Sugar Industry- a case study on Kushtia sugar Mills in Bangladesh*. Khulna. Green World Foundation.

Sandoyin, A Y (1995) Characteristics of Control Industrial Effluents – generated Pollution. *Environmental Management and Health* 6:15-18.

Sandoyin, A. Y. (1991) Ground water and surface water pollution by open refuse dump in Ibadan, Nigeria. *Journal of discovery and innovations*. 3(1): 24-31.

Smith, D. G and R.J. Davies-Colley (2001). "If visual water clarity is the issue, then why not measure it" New York City development of environmental protection Bureau of Water supply.

Stumm, W. and J.J Morgan (1981) *Aquatic Chemistry.* New York. John Wiley.

Tarig. M., Ali, M. and Shali, Z. (2006) "Characteristics of Industrial effluents and their possible impacts on quality of underground water". Soil Science of Pakinstan Dept. of Soil & Environmental Science. NWFP Agricultural University Pashawar.

Wu, T.Y., Mohammed, A.W. Jahim, J.M and N. Amuar (2009) A holistic approach to managing palm oil mill Effluent (POME); Biotechnological advances in the sustainable re-use of POME. *Biotechnology advances*. 4 40-51.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar