
A Review on Industrial Effluents as Major Sources of Water Pollution in Nigeria

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Abstract

This review investigates the level of water pollution caused by industrial effluents in Nigeria with a view to provide useful information to the authorities on the management, control and investigation of pollution cases, water quality surveillance and forecasting water quality in the country. Literature on the subject matter was accessed through published and unpublished materials on the subject as well as browsing of related issues on the internet. The results show that industrial effluents account for several point sources of water pollution. While developed nations adopt stringent water quality requirements to control river pollution from point and non-point sources, the situation is different in most developing countries like Nigeria. Waste water treatment in Nigeria is not given the necessary priority it deserves and therefore, industrial wastes are discharged into receiving water bodies without treatment and the consequences of this include, among others, river pollution, loss of aquatic life, uptake of polluted water by plants, disease burden and shorter life expectancy. It is recommended that the federal, state and local authorities in Nigeria should ensure that industrial wastes, particularly effluents, are pre-treated before discharging then into the environment.

Keywords

Industrial Effluents, Pollution, Water Quality

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1. Introduction

Nigeria is the most populous country in Africa with a population of over 150 million people. The country is endowed with generous resources of water bodies. The span of water bodies within the country is estimated at 900km². This water provides resources for fishery, transportation, irrigation, recreation and domestic use. Different regulations put in place to protect the marine environment and other water bodies in Nigeria have not been effective in controlling the

indiscriminate dumping of effluent into open water bodies. These effluents contain substances that range from chlorides, phosphates, oil and grease, nitrates, heavy metals, among others [1]. The levels of the concentrations in these effluents, especially of heavy metals, have been found to be above acceptable and permissible levels [2, 3 and 4].

Industries are the major sources of pollutants in all environments and various levels of the pollutants are discharged into the environment either directly or indirectly [5]. For example, discharged effluents from industries have

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been found to be carcinogenic [6], while other chemicals present are poisonous to humans and toxic to aquatic life [7, 8]. Effluents from industries were found to alter the physical, chemical and biological nature of receiving water bodies [9].

It was reported that effluent from Kaduna textile industries contains oil and grease, ammonia and sulphides which are potential pollution sources; they concluded that the air quality of the area covered by the entire Kaduna river basin could be negatively affected by both the gaseous emissions and particulates which could be released from the effluents [10]. The deterioration of water quality due to industrial effluent and municipal sewage discharge has been documented in literature. The contamination of Cauvery River in India by heavy metals (lead, chromium, zinc) was reported and it was attributed to agricultural, industrial and other anthropogenic activities around the river [11]. High level of mercury (Hg) was found in amphibians and vertebrates and reptiles which revealed a strong influence from industrial effluent [12]. The characteristic qualities of five textile industries effluent in Kaduna Nigeria was analyzed and high level of chemical oxygen demand (COD), total suspended solids (TSS), ammonia (NH₃), Biological oxygen demand (BOD) and sulphide (S²⁻) that exceeded the Federal Environmental Protection Agency (FEPA) limit by several fold was reported [10]. The characteristics of selected effluents from industries in Ikeja, Lagos Nigeria, were analyzed and it was reported that the concentration of effluent discharged is on the high side exceeding the maximum recommended limit [13]. Also high blood lead levels were reported among Nigerians due to exposure to the environmental pollutant which can get in to the human body through various sources [14].

Furthermore, the characteristics, as well as the pollution implications of effluents from five tannery industries in Kano metropolis in Kano State Nigeria were analyzed and it was discovered that effluent quality discharged by the tanneries differed significantly. Chromium concentrations varied between 1.02 ± 0.13 to 1.56 ± 0.06 mgL⁻¹ which are above the limits set by Nigeria Industrial Standard [15] and World Health Organization [15] of 0.05 mgL⁻¹ as shown in table 1. Effluents from Hafawa Enterprises Tannery and Unique Leather Finishing had significantly high lead concentrations, while Great Northern Tannery was found to be a potential source of iron contamination [17]. Effluents samples from tanneries and textile industries located in Challawa, Bompai and Sharada Industrial Areas of Kano were analyzed and the physico-chemical parameters (BOD, COD, DO), anions, trace elements and heavy metals were observed to be higher than the limit set by WHO for the discharge of tanneries and textile effluents into river. They concluded that based on the high levels of the above parameters, regular monitoring of pollutants in the tannery and textile effluents are necessary to

ensure proper discharge of these effluents into receiving rivers (Salanta, Challawa and Bompai). A study on water quality of Ogun River in which industrial effluents from Lagos and Abeokuta are discharged was conducted and it was reported that the levels of turbidity, oil and grease fecal, coliform and iron were very high in all the sampling sites [18].

Table 1. Upper Permissible Limit of some Physico-Chemical parameters and heavy metals in Nigerian Drinking water.

Parameter	Unit	Max Permissible Value
pH	-	6.5-8.5
Conductivity	μS/cm	1000
Turbidity	NTU	5.0
Color	TCU	15
Total Dissolve Solid	mg/L	500
Mercury	mg/L	0.001
Arsenic	mg/L	0.01
Cadmium	mg/L	0.003
Lead	mg/L	0.01
Iron	mg/L	0.01
Cyanide	mg/L	0.01
Copper	mg/L	1.0
Chromium	mg/L	0.05

Source: Nigerian Industrial Standard, Nis 554: 2007

Although the findings related to industrial pollution of water resources have been disturbing, the category of pollution that has received much attention in Nigeria is sewage pollution of potable drinking water [1]. This type of pollution has engaged the attention of bodies such as the UNICEF, established in Nigeria in 1952, and Water Aid, which began work in Nigeria in 1995 to assist with the water and sanitation needs of the country by working with the water and sanitation units (WASU) of local government councils to deliver water and sanitation services to the poor. However, about 60 percent of the Nigerian populace both rural and some urban dwellers still obtain domestic water, including drinking water, from ponds, streams and shallow wells. This condition justifies the concern for increases in the level of pollutants in both surface and ground water whose sources could be traced to industrial effluents and domestic sewage, thus making water pollution monitoring very vital [18].

Presently, very little, if anything, has been done on an integrated level concerning industrial pollution abatement in Nigerian waters [1, 2, 3 and 20]. The federal government of Nigeria only started to give attention to the abuse of the environmental in Nigeria after the discovery of an Italian Ship dumping toxic waste in Nigeria at Koko in May, 1988 giving rise to the establishment of the Federal Environmental Protection Agency (FEPA) later that year. The establishment of FEPA was also followed by the publication of "National Guidelines and Standards for Environmental Pollution" which focused mainly on industrial pollution. This body became part of the Federal Ministry of Environment which was established in September 1999. This review investigates the level of water

pollution caused by industrial effluents in Nigeria with a view to provide useful information on the management and control of industrial water pollution as well as to provide techniques for the investigation of pollution causes, water quality surveillance and forecasting.

2. Water Bodies as Sink for Industrial Effluents

In Nigeria, cities like Kaduna, Lagos, Kano and Aba depend very much on their rivers for water supplies. However, the rush by African countries to industrialize has resulted in the discharged of partially treated or raw wastes into the surrounding water bodies since the development of treatment facilities has not kept pace with the rate at which the wastes are generated by the industries [21].

River Asa run through industrial area in Ilorin, Kwara state, and the river flow through the town of Ilorin that resulted in the contamination of the river water due to continuous discharge of industrial effluents [22]. Physico chemical and bacteriological properties of water from dug well close to River Asa was investigated; the water was colored and turbid with thin film oil present at the surface. The content of TSS was very high making it unsafe for drinking. The high conductivity values suggested that dissolved solid are mostly mineral salts. Also all the water samples examined contained faecal coliform (*E. coli*) and high population of heterotrophic bacteria, which is consisted with World Health Organization [16] report that open dug wells are contaminated, with levels of at least 100 faecal coliforms per 100ml [23]. The high bacterial count is suggestive of presence of organic matter [22].

The industrial discharge, therefore, constitute a large portion of the flow of the rivers during the dry season, with the result that the water quality of the rivers is further deteriorated. Indeed, many water bodies in Nigeria experience seasonal fluctuations; leading to higher concentration of pollutants during the dry season when effluents are least diluted [9]. The uses, for which the rivers are employed, involving body contact, expose the users to serious hazards due to the bacterial situation. A few specific industries and their effluents in Nigeria are discussed below:

3. Tannery Industrial Effluents as Source of Water Pollution

The direct discharge of effluents from tanneries into bodies of water has become a growing environmental problem. Most of these waste waters are extremely complex mixtures containing inorganic and organic compounds [24]. The tannery operation consists of converting the raw hide or skin

into leather, which can be used in the manufacture of a wide range of products. Consequently, the tanning industry is a potential-intensive industry. Chemical impurities mostly comprise of the following dissolved substances:- inorganic salt cations such Fe^{2+} , Zn^{2+} , Cu^{2+} , Ca^{2+} , Na^+ , e.t.c., anions such as SO_4^{2-} , NO_3^- , PO_4^{3-} , organic parameters such as dissolved oxygen (DO), total dissolved solids (TSS)[25]. Toxic metals especially Chromium and Iron are carried by waste water flow from tanning industries to rivers, streams and lakes, and resulted in pollution of the water bodies with regards to the physico chemical properties [26].

Indeed, tannery waste-water, for example, has a biochemical oxygen demand of 250-300 mg/L which is 10 times the strength of domestic waste water. This means that 1m^3 of tannery effluent pollutes a river to the same degree as 10m^3 of raw domestic effluent. In the tannery industry, the production of 1 ton of hides per day requires water consumption of 50m^3 . This quantity of water is equal to the daily water consumption of 250 urban people [28]. The levels of effluent samples from tanneries in Kano industrial area of Challawa were analyzed, Bompai and Sharada and reported that all tanneries are the major sources of high chromium, sulphate, and nitrate and dissolved oxygen. This indicates the sources of contamination of River Challawa which is the major sink of these effluents [27].

Another study conducted reveals that untreated waste-water from Challawa and Sharada industries which are being discharged into Challawa river is the major factor responsible for its contamination and thus regular monitoring is needed since the river is used for various purposes including irrigation, fishing and domestic water supply [29].

Eighty-eight (88) samples of the ground water were studied near industrial effluent discharges in Enugu (Nigeria) in order to evaluate how potable it is. The parameters of interest were common waste-derivable chemical constituents such as nitrate (NO_3^-), chloride (Cl^-) and sulphate (SO_4^{2-}), and indicator microorganisms, like *Escherichia coli*. The study showed that about 22% of the samples had concentrations of NO_3^- higher than the WHO permissible level (45mg/L) while 80% of the samples analyzed to test the bacteriological quality of the ground water showed evidence of sewage and industrial effluent contaminations. The identification of the *E. coli* in the water indicates faecal contamination [30]. Improvement in the management of both domestic and industrial wastes would improve the quality of both surface and ground water hence, the necessity for the reduction or rather elimination of water pollution.

4. Textile Industrial Effluents as Source of Water Pollution

Textile industries are multi-chemical utilizing concerns of

which dyes of various types are of importance. During the dyeing process a substantial amount of dyes and other chemicals are lost in the waste water [31].

Textile industry can be categorized in to three *viz.*, cotton, woolen and synthetic depending upon the raw material used. The water consumption depends upon the processing operations employed during the conversion of raw fiber to textile. Textile industries are major sources of these effluents due to the nature of their operations, heavy metal contamination of an area was linked to industrial effluent [32]. It was reported that the negative impacts from Kaduna textile mills effluents could be felt as far as all the regions covered by the Kaduna river basin, the main receptor of these effluents [10]. This justifies that industrial effluents are the major sources of water pollution.

Textile industries have considerable negative effects on the water quality of the sampled textile effluent Lagos, and as such, the stream is polluted and the water is not good for human consumption and domestic use. Zero values of DO observed at these sampling points showed that the stream was heavily polluted and may not likely support aquatic lives. Metal values of the stream were generally low. The study also revealed that the values of most water parameters were higher than international permissible standards in drinking water, thereby; rendering the stream polluted and unfit for domestic, agriculture and industrial purposes [33]. Isolates of *Bacillus* was also discovered in the textile effluent [31].

5. Palm Oil Effluent as a Source of Water Pollution

Palm oil mill effluent is an important source of inland water pollution when released into local rivers or lakes. In Nigeria palm oil is processed both locally and industrially in the oil palm belt stretching from Cross River to Lagos state. Beside the main product; that is, the crude palm oil (CPO), the mill also generates many by-products and liquid wastes, which may have a significant impact on the environment. Palm oil mill effluent (POME) is one of the major sources of pollutants produced during oil processing [34].

The Palm oil mill effluent (POME) is generated from three major sources namely; sterilizer condensate, hydrocyclone waste and separator sludge. On an average 0.9-1.5 m³ of POME is generated for each tone of crude palm oil produced. POME is rich in organic carbon with a biochemical oxygen demand (BOD) of higher than 20g/L and nitrogen content around 0.2 g/L as ammonia nitrogen and 0.5 g/L total nitrogen [35].

In a study carried out in Nigeria, the characteristic problem associated with Palm oil mill effluents are high level of pH, dark color, BOD, COD and suspended solids (SS). High value

of COD also indicates the recalcitrance of chemicals that have escaped biodegradation. When these chemicals present in water bodies are used by both plants and animals, bioaccumulation can results in their systems. However, majority of sinks for POME are rivers and streams and thus serves as a source of water pollution [34].

6. Soap and Detergent Industrial Effluent as Sources of Water Pollution

Alkyl sulphonates (AS) are anionic surfactants widely used in household and personal cleansing applications. At a concentration above 106µg/L, it is toxic to aquatic animals [36]. However, industrial effluents from soap manufacturing industries are known to contain complex chemicals most of which are very toxic and capable of destroying the microbial habitats in a serious adverse way. For example, characterization of the composite waste-water from both soap and food processing plants indicated that the waste is highly contaminated with organic compounds as indicated by COD and BOD values [37].

In a study to assess the seasonal variation in bacterial heavy metals biosorption in a receiving river Eziama in Abia state as affected by industrial effluents, [9] observed an overall seasonal variation of heavy metals such as lead, zinc and manganese in the rainy seasons. Moreover, effluents from the soap manufacturing plant contained significant concentrations of oil and grease amounting to 563 mg/L. The inefficiencies of waste treatment processes involved do not treat properly the waste being generated and thus the discharged effluents remain the source of water pollution in rivers as in the case of Kaduna State Nigeria [10].

7. Brewery and Soft Drink Effluents as Sources of Water Pollution

Waste water from brewery industry originates from liquors pressed from grains and yeast recovery and has the characteristic odour of fermented malt and is slightly acidic [9].

Brewery effluents, high in carbohydrate; nitrogen and the cleaning and washing reagents, have been proved as water pollutants [34]. Also, high bacterial counts were discovered in Ikpoba River in Benin City Nigeria receiving a brewery industrial effluent [38]. Similar results were reported on the effect of brewery discharged into Eziama River, Aba, Nigeria [9]. Therefore, the above justifies that brewery effluents are sources of water pollution.

On the other hand, analysis of waste water in the accumulation pond and final discharge point of the Nigerian Bottling Company Plc in Owerri, Nigeria was carried out to determine their bacteriological and physico-chemical characteristics. Species of organisms isolated included *Staphylococcus*, *Bacillus*, *Lactobacillus* and *Streptococcus*. Others include *Klebsiella*, *Escheria*, *Proteus* and *Serratia*. However, species of *Lactobacillus* and *Proteus* were isolated from the final discharge point only [39]. Therefore, the presence of the above microorganisms implies that effluent from soft drink processing companies are sources of water pollution.

8. Conclusion and Recommendation

The release of untreated effluent affects the natural water bodies' flora and fauna of the ecosystem and increases the effect to human health and environment [40]. In Nigeria, most of the portable water used for domestic, agricultural and industrial purposes is channeled from rivers and ground water. The quality of these water bodies cannot be guaranteed due to constant disposal of industrial effluents.

Presently, very little, if anything, has been done at integrated level concerning industrial pollution abatement in Nigerian waters. Moreover, there is very little or no institutional memory in Nigeria on the influence of industrial waste on human health, thus, a detailed campaign should be put in place, elucidating the mechanism of water pollution especially with regard to these toxic industrial effluents.

To provide a holistic approach toward water pollution abatement, prevention at the source is the best alternative. Having identified these major water pollution sources in this review, government should as a matter of urgency, adopt legal, administrative and technical measures to eliminate or lessen the undesirable effects of industrial effluents in Nigerian water bodies. Imposition of direct charges on industrial effluents by the regulating agency, as well as continuous monitoring and surveillance is imperative in order to ensure the protection of Nigerian water resources from further degradation as a result of pollution.

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