International Journal of Innovative Environmental Studies Research 10(3):82-90, July-Sept., 2022

© SEAHI PUBLICATIONS, 2022 www.seahipaj.org ISSN: 2354-2918

The Physico-chemical Quality Analysis of Industrial Waste Water Discharged by a Cement Factory in Gboko, Benue State – Nigeria

Mwekaven, S.S.,[1*] Atser Seza[2], Iko Wanen[3], Swande, P.I[4], Yange, T[5]. and Gundu, E.G.[6]

[1,2,3,4,5]Basic Sciences Department, Akperan Orshi Polytechnic, Yandev, Benue State, Nigeria

[6]Forestry Department, Akperan Orshi Polytechnic, Yandev, Benue State, Nigeria

ABSTRACT

Waste water released by industries into the environment is one of the major sources of environmental pollution and can cause serious environmental degradation and deterioration. This study was therefore undertaken to assess the physico-chemical quality of waste water discharged by a cement factory in Gboko, Benue State - Nigeria. Samples of the industrial waste water were collected in clean bottles at four different points and then mixed to have a single sample which was transported immediately to the Laboratory of the Centre for Energy Research and Development Nsukka for analysis. The bottles were first rinsed with the appropriate sample prior to sample collection and subsequent mixture. Temperature and pH which are parameters with low stability were measured on the site using thermometer and pH meter. Result of the analyzed physico-chemical parameters shows that temperature, pH, Total Dissolved Solids (TDS), iron, cadmium, chromium, copper, lead, nickel, zinc, oil and grease, tin, manganese and selenium were within the effluent limitation guidelines in Nigeria for all categories of industries. However, values for Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), mercury, cyanide and arsenic were found to be above the limits of the National Environmental Protection Regulations Act 1991. This revealed the nature of the waste water as been inadequately treated. Long term exposure to this industrial waste water may be detrimental to human health. A reliable and extensive monitoring system of the waste water quality to ensure it comply with regulatory standards and provision of portable water for the rural community to make them discontinue from the use of the industrial waste water for domestic and agricultural purposes is therefore considered necessary to enhance environmental protection and maintenance of good health.

Keywords: Industrial waste water, environmental pollution, physico-chemical parameters, regulatory standards.

INTRODUCTION

Industrialization is a vital tool to a nation's socio-economic development as well as its political stature providing ready employment opportunities for a good percentage of her population (Siyanbola *et al*., 2011; FEPA, 1991). Despite the importance of industrialization, various devastating ecological and human disasters which have continuously occurred over time implicate industries as major contributors to environmental degradation and pollution problem of various magnitudes (Abhinay *et al*., 2017; FEPA, 1991). Rapid industrial development has increased hazardous wastes generation several folds. Cement production in the world especially in developing countries including Nigeria is increasing steadily due to high demand for infrastructure and housing. By-products in form of effluents and gaseous waste from cement plants are also increasing as production is stepped up (Ipeaiyeda and Obaje, 2017).

Ideally, industrial wastes should be properly treated before been discharged into the environment. Environmental guidelines and standards have been set by regulatory bodies to monitor the quality of waste water released by industries. However, with the prevailing hard economic situation and the zeal to minimize cost as well as lack of enforcement of a reliable and extensive monitoring system for industrial emissions, industrial wastes are been released into the environment untreated or partially treated thereby causing serious environmental degradation and deterioration (Tolulope *et al*., 2019; Abhinay *et al*., 2017). Some industries do not even have well established waste treatment facilities and simply adopt the use of substandard treatment methods that partially treat the waste and in some instances, forego the waste treatment process (Dube *et al*., 2010). Consequently, the waste not properly treated reaches the nearby water bodies (Emongor *et al*., 2005).

The release of this industrial waste water into the environment is one of the major sources of environmental pollution which is an eminent problem in the global context creating a remarkable impact on the receiving water bodies (Chris-Otubor and Olorunfemi, 2015; Tolulope *et al*., 2019). Industries do not adequately consider the functionality of their waste treatment plant so as to accommodate basic treatments. As such, the indiscriminate discharge of solid, liquid and gaseous wastes into the land and water bodies by industries remain the only way of disposing off their waste (Siyanbola *et al*., 2011). Surface water which is one of the major sources of water supply for domestic use and agricultural purposes now become a cheap recipient of industrial effluents (Iwuozor and Emuobosa, 2018). The industrial wastes and emissions may contain toxic and hazardous substances such as heavy metals and organic chemicals most of which can be detrimental to human health (FEPA, 1991). The occurrence of heavy metals in industrial effluents and municipal sewage constitute a major source of the heavy metals entering aquatic medium (Ipeaiyeda and Obaje, 2017). Industrial effluents are been continuously added into surface water bodies thereby posing a serious threat to aquatic life, livestock and humans. This may even cripple the natural biotic organisms to extinction (Kumar, 2013). Toxic substances may also accumulate in aquatic life, one of our important sources of food. Consumption of such polluted water and/or its aquatic life threatens human public health (WHO, 2008). Many people have contracted different diseases due to consumption of contaminated water or its aquatic life resulting to severe health impairment or even death. Rural communities especially during the dry season, sometimes directly use industrial waste water for domestic activities including irrigation purposes due to advantageous presence of potassium, nitrogen, phosphorus and other essential elements that enriches the soil (Siyanbola *et al*., 2011).

Water is one of the fundamental, indispensable and essential natural resources needed for the existence of both plants and animals including humans (Magarde *et al*., 2009; Tolulope *et al*., 2019). Despite its abundance in nature occupying 71% of the earth surface, water is becoming more and more unfit and dearer to mankind due to unwise use, neglect and mismanagement such as the indiscriminate disposal of wastes into surface water bodies (Taiwo *et al*., 2005; Magarde *et al*., 2009). Water pollution plays a significant role in the occurrence of global 'water crisis' by reducing the quantity of fresh water resources available to man as well as the ecosystems. The availability of fresh water is becoming hampered nowadays partly due to municipal and industrial pollution (Ipeaiyeda and Obaje, 2017). Globally, 2.1 billion people are deprived of accessibility to clean water and about 4.5 billion have no access to adequate sanitation (https://www.unicef.org/media/media-96632.html). According to UN report, by 2025, two-third of the world's population could face water stress. The scarcity of water could be in the form of physical scarcity where water availability is limited and demands are not met or it could be in the form of economic scarcity, where although water is available, there are no means and infrastructure to provide water of required quantity and quality (Tolulope *et al*., 2019). Water pollution by industrial effluent has become a question of considerable public and scientific concern.

Industrial waste water released by a cement factory in Gboko, Benue State - Nigeria flows into a receiving surface water body popularly known as Ngo River which serves as the main source of water supply to the rural community. More worrisome is the direct utilization of the industrial waste water by villagers for agricultural activities such as cultivation/irrigation of crops and vegetables as well as

domestic activities such as cooking, washing of clothes/utensils and bathing primarily due to lack of knowledge and portable water. Monitoring of the nature and quality of the industrial waste water to ensure it comply with regulatory standards is considered necessary to enhance environmental protection and maintenance of good health of the populace.

This study was therefore undertaken to assess the physico-chemical quality of industrial waste water discharged by the cement factory in Gboko, Benue State - Nigeria.

MATERIALS AND METHODS

Study Area

The cement factory is located at Tse - Kucha in Mbayion Clan, centre of the region Gboko, along km 72 Makurdi - Gboko Road. Tse – Kucha which is found within Gboko Local Government Area of Benue State is a clustered settlement area inhabited by villagers who are predominantly farmers and company staff. Gboko aside been a Local Government Area, is also a major and fast growing commercial town in Benue State of North Central Nigeria. It lies on longitude $9^{0}0^{1}18^{11}$ E and latitude $7^{0}19^{1}30^{11}$ N with a total area of 1835km^{2} and population size of over 500,000 people whom are mostly Tiv (Akpen *et al*., 2018). It is the traditional capital of the Tiv tribe with the official residence of the Tor-Tiv who is the paramount traditional ruler of the Tiv people that spread across Benue, Taraba and Nasarawa States. Gboko experiences two major seasons in a 12 month calendar year, the wet season (April - October) and the dry season (November – March). Annual average rainfall of 1400mm and daily average temperature ranges between 21^{0}C - 38^{0}C have been reported (https://www.worldweatheronline.com/gboko-weather/benue/ng.aspx). The vegetation is characterized by herbs, shrubs and trees which yield timber and provide a suitable habitat/shade for animals.

Sample Collection

Samples of the industrial waste water were collected in clean bottles carefully washed and rinsed with tap water then allowed to dry. The clean dried bottles used for sample collection were first rinsed with the appropriate sample before final collection. Samples were taken at four different points and homogenized to have a single sample. The sample was then transported immediately to the Centre for Energy Research and Development Nsukka for analysis.

Sample Analysis

Parameters with extremely low stability such as temperature and pH were measured on the site using thermometer and pH meter respectively. Other parameters were analyzed in the laboratory of the Centre for Energy Research and Development Nsukka using standard procedures and equipment.

RESULTS

Result of the assessed physico-chemical parameters of the industrial waste water is presented in the table below;

Parameters (unit)	**Waste water**	**FEPA Standard**
Temperature (^{0}C)	28	<40
pH	7.7	6-9
Biochemical oxygen demand (mg/L)	57	30
Total suspended solids (mg/L)	383	30
Total dissolved solids (mg/L)	594	2000
Iron (mg/L)	0.37	20
Cadmium (mg/L)	0.036	<1
Chromium (mg/L)	0.23	<1
Copper (mg/L)	0.032	<1
Lead (mg/L)	0.15	<1
Mercury (mg/L)	2.00	0.05
Nickel (mg/L)	0.41	<1
Zinc (mg/L)	0.10	<1
Cyanide (mg/L)	1.36	0.1
Oil and grease (mg/L)	0.24	10
Arsenic (mg/L)	1.58	0.1
Tin (mg/L)	0.092	10
Manganese (mg/L)	0.00	5
Selenium (mg/L)	0.076	<1

Diagrams showing the industrial waste water discharged by the cement factory and its utilization for domestic and agricultural purposes such as cooking, bathing, washing of clothes/cooking utensils and irrigation of crops/vegetables is presented in plates as shown below;

Plate 1: Fetching the waste water for washing cooking utensils

Plate 2: Fetching the waste water for bathing

Plate 3: Fetching the waste water for irrigation and domestic activities

Plate 4: Fetching the waste water for agricultural activities

Plate 5: Irrigated crops/vegetables

Plate 6: Utilization of the waste water for washing clothes

Plate 7: Eroded spots close to the waste water discharge point

Plate 8: Discharged waste water flowing down to the Ngo River

DISCUSSION

Physico-chemical analysis of the industrial waste water showed some variations in certain parameters when compared to the approved standard set by the Federal Environmental Protection Agency. Result of the assessed physico-chemical parameters of the industrial waste water revealed that temperature, pH, Total Dissolved Solids (TDS), iron, cadmium, chromium, copper, lead, nickel, zinc, oil and grease, tin, manganese and selenium were within the effluent limitation guidelines in Nigeria for all categories of industries. However, Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), mercury, cyanide and arsenic were found to be above the limits of National Environmental Protection (Effluent Limitations) Regulations (FEPA, 1991). Several studies conducted have highlighted this similar problem (Iwuozor and Emuobosa, 2018; Chris-Otubor and Olorunfemi, 2015; Tolulope *et al*., 2019*;* Emodi, 2015; Siyanbola *et al*., 2011).

The BOD value of the waste water 57mg/L exceeded the FEPA approved limit of 30mg/L for discharge into surface water and 50mg/L for land water. BOD directly affects the amount of Dissolved Oxygen (DO) in rivers and streams. The greater the BOD, the more rapidly is oxygen depleted in the stream or river. This means less oxygen is available to higher forms of aquatic life. This becomes hazardous for the survival of aquatic biota in the receiving stream or river (Iwuozor and Emuobosa, 2018).

TSS value of 383mg/L recorded was far above FEPA limits of 30mg/L, depicting high level of TSS in the industrial waste water. In terms of water quality, high levels of TSS will increase water temperatures and decrease dissolved oxygen (DO) levels. This is because suspended particles absorb more heat from solar radiation than water molecules. This heat is then transferred to the surrounding water by conduction. The decrease in water clarity (high turbidity) caused by high TSS value can also affect the ability of fish to see and catch food due to reduced light penetration and the ability of algae to produce food and oxygen is also lowered (Emodi, 2015). Fish gills can even clog either killing them or reducing their growth rate.

Mercury value of 2.00mg/L for the industrial waste water was found to be higher than the set limits by FEPA 0.05mg/L. High levels of mercury in drinking water can damage the brain, kidneys and developing foetus. Effects on brain functioning may result in irritability, shyness tremors, changes in vision or hearing and memory problems. Mercury is one of the most serious and global pollutant threatening our Nation's water because it is a potent neurological poison in fish, wildlife and humans (Dawe, 2006).

Cyanide value for the industrial waste water was 1.36mg/L above the set standard by FEPA 0.1mg/L. Cyanide may be harmful and toxic affecting individuals who have regular long term consumption of surface water. However, cyanide in water may be stably bounded to metals such as iron (Chang, 2008).

The value of arsenic 1.58mg/L for the industrial waste water was also found to be higher than the FEPA set limits of 0.1mg/L. Long - term exposure to arsenic is usually related to increased risks of cancer of the

skin, lungs, bladder and kidney as well as other skin changes such as hyperkeratosis and pigmentation changes. These effects have been demonstrated in many studies using different designs. It has also been associated with cardiovascular disease and diabetes. In early childhood, exposure has been linked to negative impacts on cognitive development and increased deaths in young adults (Mvungi *et al*., 2003). This result indicates the inadequate treatment of the industrial waste water discharged by the cement factory into the Ngo River.

CONCLUSION

Environmental pollution is one of the chief causes of sicknesses in our society. Unfortunately, industrial waste water discharged by the cement factory has their final destination in Ngo River which serves as the main source of water supply to the surrounding rural community. More worrisome is the direct utilization of the industrial waste water for irrigation of crops/vegetables and human consumption including domestic activities such as cooking, washing of clothes/ utensils and bathing primarily due to lack of knowledge and portable water. Result of the assessed physico-chemical parameters of the industrial waste water revealed the nature of the waste water as been inadequately treated. Long term exposure to this industrial waste water may be detrimental to human health. Those who rely on the receiving water body or the industrial waste water itself as their primary source of domestic water are posed with high health risks. Therefore, a reliable and extensive monitoring system of the waste water quality to ensure it comply with regulatory standards and provision of portable water for the rural community to make them discontinue from the use of the industrial waste water for domestic and agricultural purposes is considered necessary to enhance environmental protection and maintenance of good health.

REFERENCES

Abhinay, M.S., Sanjila, N., Gunjan, B. (2017). An Assessment of Physicochemical Parameters of Selected Industrial Effluents in Nepal. *Journal of Chemistry Volume* 2017, Article ID 3659561, 9 pages.

Akpen, G.D., Kphoghol, I.S., Oparaku, L.A. (2018). Quality Assessment of Sachet and Bottled water Sold in Gboko Benue State, Nigeria. *Nigerian Journal of Technology* 37(1):241.

Chang, H. (2008). Spatial analysis of water quality trends in the Han River basin, South Korea. *Water Research*, Vol. 42, No. 13, pp. 3285–3304.

Chris-Otubor, G.O. and Olorunfemi, P. (2015). Evaluation of Some Industrial Effluents in Jos Metropolis, Plateau State, Nigeria. *African Journal of Environmental Science and Technology* Vol. 9(6), pp. 566-572.

Dawe, P. (2006). A Statistical Evaluation of Water Quality Trends in Selected Water Bodies of Newfoundland and Labrador. *Journal of Environmental Engineering and Science*, Vol. 5, No. 1, pp. 59–73.

Dube, T., Makaka, C., Sibanda, Z. (2010). An Assessment of the Effect of Industrial and Sewage Effluent on Aquatic Invertebrates: A Case Study of a Southern Urban Stream, Zimbabwe. *Journal of Sustainable Development* 3(2):210.

Emodi, E.E. (2015). Comparative Analysis of Effluent Discharged from Emene Industrial Area of Enugu, Nigeria, with National and International Standards. *Civil and Environmental Research* Vol. 7, No. 9.

Emongor, V., Kealotswe, E., Koorapetse, I., Sankwasa, S., Keikanetswe, S. (2005). Pollution Indicators in Gaberone Effluent. *Journal of Applied Sciences* 5:147-150.

Federal Environmental Protection Agency (1991). National Environmental Protection (Effluent Limitation) Regulations.

https://www.unicef.org/media/media_96632.html. Retrieved 2021.

https://www.worldweatheronline.com/gboko-weather/benue/ng.aspx. Retrieved 16th January, 2021.

Ipeaiyeda, A.R. and Obaje, G.M. (2017). Impact of Cement Effluent on Water Quality of Rivers: A Case Study of Onyi River at Obajana, Nigeria. *Cogent Environmental Science* Volume 3, Issue 1.

Iwuozor, K.O. and Emuobosa, E.G. (2018). Physico-Chemical Parameters of Industrial Effluents from a Brewery Industry in Imo State, Nigeria. *Advanced Journal of Chemistry Section A* 1(2):66-78.

Kumar, P. (2013). Environmental Effect/Impact Assessment of Industrial Effluent on Ground Water. *Oriental Journal of Chemistry* 29(3):382.

Magarde, V., Iqbal, S.A., Pani, S., Iqbal, N. (2009). Environmental Impact Assessment of Industrial Effluents on Water Quality of Betwa River Discharged from Mandideep Industrial Area in Madhya Pradesh. *Current World Journal of Environmen*t 4(2):327-334.

Mvungi, A., Hranova, R.K., Love, D. (2003). Impact of Home Industries on Water Quality in a Tributary of the Marimba River, Harare: Implications for Urban Water Management. *Physics and Chemistry of the Earth*, Vol. 28, No. 20-27, pp. 1131–1137.

Siyanbola, T.O., Ajanaku, K.O., James, O.O., Olugbuyiro, J.A.O., Adekoya, J.O. (2011). Physico-Chemical Characteristics of Industrial Effluents in Lagos State, Nigeria. *G. J. P&A Sc and Tech.* 1:49-54.

Taiwo, A.M., Gbadebo, A.M., Awemoso, J.A. (2010). Potability Assessment of Selected Brands of Bottled Water in Abeokuta, Nigeria. *Journal of Applied Sciences and Environmental Management* 14(3):47-52.

Tolulope, E.A., Temilola, O., John, O.O., Joshua, N.E. (2019). Physico-Chemical Analysis of Wastewater Discharge from Selected Paint Industries in Lagos, Nigeria. *International journal of Environmental Research and Public Health* 16:1235.

WHO, (2008). Guidelines for Drinking Water Quality. Third Edition Incorporating the First and Second Addenda Volume 1.