Available online at www.elixirpublishers.com (Elixir International Journal)

Pollution

Elixir Pollution 122 (2018) 51842-51845

Awakening to Reality

Elixir ISSN: 2229-712X

The Influence of Modern Industrial Wastewater Treatment Technique as a Sure Way to Water Economy, Recycling and Re-Use.

Ike, C. C.[1], Emeka-Ike, P. C[2] and Nwogu, O. G.[3]

[1]Department of Biological Sciences (Microbiology Programme), College of Basic and Applied Sciences, Rhema University, P.M.B. 7021, Aba, Abia State, Nigeria.

[2]Department of Food Science and Technology, Imo State University, P.M.B. 2000, Owerri, Imo State, Nigeria.

[3]Department of Food Science and Technology, Abia State Polytechnic, P.M.B. 7166, Aba, Nigeria.

ARTICLE INFO

Article history:
Received: 28 August 2018;
Received in revised form:
16 September 2018;
Accepted: 26 September 2018;

Keywords
Wastewater,
Biological treatment,
Sedimentation,
Clarification,
Sludge.

ABSTRACT

Modern wastewater treatment technique is effective in removing inherent contaminants in influent, which leaves the effluent with permissible minimum regulatory standards that would support the demand for water economy, recycling and re-use. Most industrial wastewater (untreated) entering a water body represents a heavy source of environmental pollution. It affects the water quality as well as microbial flora and aquatic lives. With competing demands on limited water resources, awareness of issues involved in water pollution, has led to considerable evaluations concerning environmental effects of industrial effluents discharged into aquatic environments. Effluents rich in decomposable organic matter constitute high level of organic pollution that promotes growth of significantly high coliforms and other microbial forms leading to eutrophication. Finally, this could pose serious health issues to users especially when discharge into water bodies, but could be remedied in the recent times with the advent of modern wastewater treatment techniques.

Introduction

Nigeria is the most populous country in Africa with a population of over 160 million people; the country is endowed with generous resources of water bodies. This water provides resources for fishery, transportation, irrigation, recreation and domestic use (Ekiye & Luo, 2010). There are different regulations put in place to protect the marine environment and other water bodies in Nigeria. However, they have not been effective in controlling the indiscriminate dumping of effluent into open water bodies.

Inability to effectively and efficiently manage huge amount of wastes generated by various anthropogenic activities particularly in developing countries has created serious problems in our environment. Industrial effluent contamination of natural water bodies has emerged as a major challenge in developing and densely populated countries like Nigeria (Sangadoyin, 1995). Streams and river systems are the primary means for disposal of waste, especially the effluents, from industries that are near them. These effluent from industries have a great deal of influence on the pollution of the water body and, can alter the physical, chemical and biological nature of the receiving water body (Sangadoyin, 1991). Increased industrial activities have led to pollution stress on surface waters (Ajayi and Osibanji, 1981). The manner at which industrial effluents are being disposed into the environment (water bodies) like rivers, streams etc are becoming worrisome.

Over the years, in many African countries a considerable population growth has taken place, accompanied by a steep increase in urbanization and industrialization. This has led to tremendous increase in discharge of wide diversity of pollutants to receiving water bodies (Saad *et al.*, 1985). The discharge of industrial effluents into receiving water bodies in Nigeria invariably resulted in the presence of high concentrations of pollutant in the water. The pollutants have been present in concentrations, which may be toxic to different organisms. The effluents also have considerable negative effects on the water quality of the receiving water bodies and as such, they are rendered unsafe for human use (Kanu and Achi, 2011). The consequences of these negative effects are of great health concern (Nwokorie and Ike, 2016; Osibanji *et al.*, 2011). One of the most important factors of water pollution is the microbial contamination, especially with pathogenic microorganisms. Enteric pathogens are typically responsible for several waterborne sicknesses (Sabae, 2004). However, these water bodies as in most developing countries like Nigeria serve as major source of water for domestic uses. The inhabitants depend on this available source for their daily drinking water and other activities like washing of clothes, bathing etc (Sangadoyin, 1995).

Ideally, effluents from industries are to be properly treated before being discharged into the environment. In Nigeria, the case is different as there are many sharp practices by industrialists in managing effluent. The problem of pollution has attracted much attention–nationally and internationally, and in Nigeria, National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 to promulgate laws and monitor standards related to industrial discharges. Therefore, this study is targeted at assessing the influence of modern wastewater treatment technique as a sure way to water economy, recycling and re-use.

Wastewater classification

Wastewater generally refers to liquid wastes that has not undergone treatment, and sometimes are discharged into the

Tele:
E-mail address: chrismacaug@yahoo.com

environment. Wastewater can be classified into the following: industrial wastewater, municipal wastewater, sanitary wastewater, storm wastewater, and non-contact cooling water. With very few exceptions, all problems associated with wastewater discharges have environmentally acceptable solutions. The technology for achieving any desired level of effluent quality is already developed and in most cases, well proven. The impact of industrial wastewater discharges on the environment and human population can pose serious health hazards (Crites and Tchobanoglous, 1998; DOA, 1987).

The hydrologic cycle: The cycle of water in nature allows water to be used repeatedly. Plants evaporate water into the atmosphere through evapo-transpiration and draws water from the surface or underground. Water vapor is condensed from the atmosphere in the form of precipitation which falls to the ground (storm wastewater) and either flows as runoff to surface waters (streams, rivers, lakes and eventually oceans) or infiltrates the ground to feed groundwater aquifers (DOA, 1987).

Water uses: There are two types of water uses:

Direct water use: Water supplies are required for domestic, commercial, industrial and agricultural uses. Domestic uses include water for drinking and food preparation, washing, waste transport, lawn sprinkling, fire fighting. Commercial water uses include recreational, wild life habitat and so on. Industrial uses include process water, cooling water and cleaning water. Then, agricultural water use is for irrigation and other livestock watering and waste disposal.

Indirect water reuse: This is commonly practiced when wastewater from one community is discharged into receiving water body and subsequently used as a water supply by another community. Due to the natural assimilation of wastes by receiving water body, this type of water reuse has become acceptable (Crites and Tchobanoglous, 1998; Ajayi and Osibanji, 1981).

Types of receiving bodies for discharges

Water usage generally results in production of wastewater requiring disposal. Liquid wastes from industrial sources are ultimately disposed into receiving water bodies or onto land. These wastes are usually disposed of by discharge to surface waterways. Below are some examples of receiving bodies:

Surface discharges: Federal, State, and local governments have placed restrictions on wastewater discharge quality in order to control the detrimental effects of contaminants. Typically, the quality of the receiving stream or body of water is taken into consideration along with the intended use of the water following the wastewater discharge. Stream offers abundant dilution, careful attention is given to the fate of the various constituents as they are discharged and their effects on the aquatic environment. However, inadequate discharges might result in severe environmental nuisance including oxygen depletion, color and turbidity, algae blooms, and public health problems to users. Non-degradable constituents and toxic materials were eliminated from wastewaters prior to discharge to streams, as their fate thereafter is unknown and uncontrollable. The after effect of these might be lethal to man, fish and can cause sub-lethal effects on aquatic organisms (Nwokorie and Ike, 2016; Kanu and Achi, 2011; Ekhaise and Ayansi, 2005).

Land discharges: Wastewater discharged to land were to be considered on a constituent by constituent basis in order to make sure that no land is irreversibly depleted/ polluted from potential use. Land application of wastewater require intimate mixing and dispersion of the waste into the upper zone of the soil-plant system with the objective of assimilation of all constituents by mechanisms such as microbial decomposition, adsorption, immobilization, and plant recovery. Adequately designed land application systems avoid groundwater or surface water contamination from leachates, air pollution, and other aesthetic nuisance in the application area. Assimilative capacities of each wastewater constituent were carefully established in order to make sure none are exceeded (Warner, 2008).

Wastewater treatment

There are various treatment methods depending on the intended use of the effluent. These include primary treatment, secondary treatment and tertiary treatment (ECC, 2008; WTM, 1999)

Primary treatment:

Primary treatment phase:

Primary treatment is a physical process designed to remove materials that will settle out. The influent is first passed through series of screens to remove certain objects such as straws, crown cork, small stones, trash and other floating materials. Coarse static screen removes debris and coarse biodegradable materials from the waste stream and stabilize the wastewater. Also installed alongside the coarse static screen is a safe cleaning fine screen which has scrappers and brushes that scrapes other tiny particles that comes in with the influent. Skimmers are used to remove floating oil and grease into tanks. The wastewater flows to the equalization tank.

Equalization tank: At the end of the screening phase, the wastewater enters the equalization tank where the pH of the influent is equilibrated to neutrality by online dosing of either hydrochloric acid or sodium hydroxide depending on the pH value of the influent. This is necessary to create optimal pH condition for the degrading aerobic microorganisms employed in the biological treatment phase of the secondary treatment. If the pH of the wastewater is alkaline (8-14), hydrochloric acid solution is used in the neutralization while if the pH is acidic (1-6), then sodium hydroxide solution is used in the neutralization to achieve an optimum environment (6.5-7.5) for the growth of organic degrading microorganisms. This pH range is suitable for most aerobic degrading microorganisms. Also installed in the equalization tank is a blower that constantly supplies the needed oxygen that supports the growth of these aerobic microorganisms. There is need to monitor the pH constantly to avoid deviations, as failure may lead to death of the degrading organisms and subsequent foul odour. Usually there is an online pH meter installed to augment the laboratory analysis. Equalization can be broken into two types; flow equalization and concentration equalization. Flow equalization utilizes a tank with variable levels to provide temporary storage of peak flows, while concentration equalization reduce variations of pollutant concentrations, allowing more effective downstream treatment.

Secondary treatment:

Biological treatment phase:

In biological treatment, there are two biological tanks with adjoining two trickling filter towers to aid aeration, pre-sedimentation, sedimentation and final clarification. Nutrient deficiency is a common problem in wastewater. The high concentration of biochemical oxygen demand (BOD) results in a high ratio of BOD to other nutrients. This imbalance in nutrient ratios that are needed by microorganisms for synthesis, metabolism, and organic removal can stimulate filamentous growth, resulting in sludge bulking and solids dewatering difficulties. The need to add urea arises when wastewater from the plant is poor in nitrogen. The urea dosing required daily is determined by analyzing the influent wastewater. Urea dosing involves nitrification which is the addition of nitrogen. Addition of nitrogen (N) and phosphorus (P) in sufficient quantities to achieve a BOD:N:P ratio of approximately 100:5:1 is recommended to provide optimal conditions for BOD removal and solids settling. Nitrogen is available to biomass in the form of ammonium (NH_4^+) or as nitrate (NO_3^-). Ammonia is typically added in the form of either anhydrous ammonia, urea, or ammonium salts (ammonium sulfate, ammonium chloride, or ammonium nitrate). Phosphorus must be present in the form of soluble orthophosphate in order to be combined with biomass. It is generally added in the form of either phosphoric acid, sodium phosphate, or ammonium phosphate. Phosphoric acid is phosphorus additive of choice as it is really available at most factory facilities.

Pre-sedimentation, and Sedimentation:

After primary/ preliminary treatment, wastewater undergoes pre-sedi mentation and sedimentation by gravity in a basin or tank (pre-sedimentation tank cum 1st stage biological treatment and sedimentation tank cum 2nd stage biological treatment) to produce near quiescent conditions. In the facility, under calm conditions settleable solids and most suspended solids settle to the bottom of the tank, while the supernatant water is collected over the weirs in the overflow launders. The settled sludge is collected into the sludge tank with the aid of mechanical collectors such as underwater scrapper and submersible pumps. Two trickling filter towers were present which aided in providing sufficient aeration other than the blowers. There is turbulence as wastewater goes up into these towers. However, the turbulence in the wastewater is gradually reduced until it comes to a still as it passes through the first and second sedimentation tanks. In the 1st and 2nd biological treatment stage, there is conversion of organic matter and other constituents in the wastewater to gas and cell tissue. The installation of a blower helps in the supply of air for the process. Microorganisms are attached to the inert packing materials of the trickling filter to form biofilm, which aids in the biodegradation of organic waste as wastewater flows over the attached biofilm.

Activated sludge:

The settled sludge is collected with the aid of mechanical collectors such as underwater scrapper. The sludge is collected by this underwater scrapper to the center of the tank from where it is taken to the sludge tank with the help of two submersible pumps that are installed in the sludge pumping pit to the side of the sedimentation tank. Activated sludge is returned from sludge tank when sedimentation is not efficient and clear water is farfetched. The return activated sludge (RAS) is an agent of flocculation and sedimentation for an efficient wastewater treatment process. The excess sludge is collected and pumped into the sludge thickener tank. Temporary thickening is achieved and the sludge is mixed with polyelectrolyte substance for dewatering at the belt filter press. The harvested sludge could be used as manure by farmers.

Tertiary treatment:

Clarification and final treatment phase:

The clarification tank is an extension of the sedimentation tank. Further settling of solids and suspended solids to the bottom of the tank takes place, and clear effluent is achieved while chlorination to reduce bioloads and annihilate pathogenic microbes takes place.

The online chlorine dosing is monitored as residuals were not permitted by standards in discharged effluent as same water is used in sustainig fishes in fishpond to ascertain if the water could support aquatic life. After the effluent has met permissible minimum standards for industrial effluent discharge, the effluent would either be used in lawns watering and toilets flushing or be discharged into receiving water body. Also, effluent from wastewater treatment plant can further be subjected to multiple barrier treatment process to achieve recommended potable water standards as in the case of re-use in factories (NESREA, 2009; ECC, 2008; WTM, 1999).

Conclusion and Recommendation

Man in his bid to survive has exploited the environment of its natural resources. Unavoidably, in developing countries like Nigeria, the environment receives immeasurable quantities of untreated liquid wastes from industrial activities. Most industrialists are even far from thought on treatment of their various industrial wastes (Ekiye and Luo, 2010, Ekhaise and Ayansi, 2005).

Consequently, pollutions from different untreated industrial effluents have remained the principal source of aquatic pollution in Nigeria and other developing countries. This unchecked hostility to nature by industrialists has left our immediate environment in a highly manifesting potential hazard (Crites and Tchobanoglous, 1998).

Having considered the hostile practices and need for a sustainable water economy, there is need for the establishment of modern wastewater treatment operations in every industrial facility as it is the only sure way to water economy, recycling and re-use. Therefore, industrialists and industries are encouraged to align with the new trend of wastewater treatment operations in order to achieve the permissible minimum standards for every discharged effluent, so as to avert possible sanctions and litigations from regulatory agencies.

References

Crites, R., & Tchobanoglous, G. (1998). *Small and decentralized wastewater management system*, McGraw Hill Publishing, San Francisco, pp 112-154.

Department of the Army – DOA, (1987). Technical Manual - *Evaluation Criteria Guide for Water Pollution Prevention, Control and Abatement Programs."* Published by Department of the Army, Washigton, DC, pp 11-31, 67-98 & 99-104.

Euro Contruction Company – ECC, (2008). *Nigerian Bottling Company Wastewater Treatment Plant Operational and Maintenance Manual*. Published by Euro Contruction Company, Athens, Greece, pp 1-39.

Ekiye, E. and Luo, Z. (2010). Water quality monitoring in Nigeria: Case study of Nigerian industrial cities. *Journal of American Science*, **6(4):** 22 – 28.

Ekhaise, F. O. and Ayansi, C. C.(2005). Influence of breweries effluent discharge on the microbiological and physiochemical quality of Ikpoba River, Nigeria. *African Journal of Biotechnology*, **4**: 1062 – 1065.

Kanu, I. and Achi, O.K. (2011). Industial effluents and their impact on water quality of receiving river in Nigeria. *Journal of applied technology in environmental sanitation*, **1(1)**: 75 – 86.

NESREA, (2009). *National Environmental Standards for Effluent Limitations and Regulation (Food, Beverages & Tobacco Sector) Regulations*, Published by The Federal Government Printer, Abuja, Nigeria, pp 1211- 1248.

Nwokorie, C. C., and Ike, C. C. (2016).The Physico-chemical and Microbial Contamination of Discharged Effluents on the

Receiving Water Body. A Study of Brewery "A" in South-Eastern Nigeria. *International Journal of Scientific Engineering and Applied Science (IJSEAS),* 2(5):208-216.

Osibanji, O., Dase, A. P. and Gbadebo, A. M. (2011). The impact of industries on surface water quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. *African Journal Biotechnology*, **10**:696-702.

Saad, M. A. H., McComas, S. R. and Eisenreich, S. J. (1985). Metals and chlorinated hydrocarbons in surficial sediments of three Nile Delta Lakes. *Journal of Water, Air and Soil Pollution*, **24**: 27-33

Sabae, S. Z. (2004). Monitoring of microbial pollution in the River Nile and the mpact of some human activities on its waters. *Proceeding of 3rd International Conference on Biological Science,* **3**: 200-214.

Sangadoyin, A. Y. (1995). Characteristics and control of industrial effluent. *Genres ted pollution environmental management and health*, **6(4)**: 15 – 18.

Sangadoyin, 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.

Warner, D. L. (2008). *"Deep Well Disposal", in Industrial Waste Disposal,* Ross, R. D. (ed), Van Nostrand Reinholds Co., New York, pp 245-260.

Water Technology Manual– WTM, (1999). *Standard methods for the examination of water and wastewater*. 20th Edition. Published jointly by American Public Health Association, American Water Works Association and Water Environment Federation, Washington DC. pp 5- 672.