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A Steps Approach to EnvironmentalWaste Management: A Review of Treatment Systems

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ABSTRACT: Environmental deterioration by man, is attributable to Over–population, urbanisation and industrialization. The increasing amount of waste generated by this phenomena, undoubtable degrade the quality of land, air, water and food. The alarming increase of wastes generally and their improper management is a major risks to human health and the environment. In this study, the types of waste treatments, the method and processes of the treatment and the impacts of wastes on health and environment were highlighted. The results indicate that solid wastes and wastewater from industries, communities and households are serious health hazards and lead to the spread of infectious diseases.

Keywords: Waste, Treatment, Environment, Pollution, Management

I. INTRODUCTION:

Waste is a heterogeneous mass generated by human and animal activities fit for discarding. Waste can exist in solid, liquid and gaseous forms. Wastes have physical, chemical and biological constituents, which cause toxicity in the flora and fauna. They may be divided into hazardous and non-hazardous types, also biodegradable and non-biodegradable types. Waste generation cannot be totally eliminated, neither can waste recovery be completely achieved. In the later part of the 20th century, it became increasingly apparent that solid wastes discontinued to be a technical problem and turned into a management problem of significant magnitude Indu (2006).The type of waste management employed is influenced by the source and characteristics of the pollutant in the waste Adegoke (1989). Pollutant can come either by point sources or by diffuse sources. The point sources join the pollutant conveyance path at isolated and identifiable sites, these includes sewer networks, industrial and treatment plant effluents and their quality and quantities can be directly measured. In the other hand, the diffuse sources originates from the natural weathering processes of minerals, erosions and artificial sources such as fertilizers, pesticides, and so onFEPA(1991). Waste treatment is the cost effective stabilization of waste and the resultant residuals for control of public health and environmental hazards. Treatment involves pre-treatment, primary, secondary tertiary treatments. Wastes considered here for treatment are limited to solid waste and wastewater and their treatments are categorized into physical, chemical and biological methods of treatment. Solid waste refers to the range of garbage materials – arising from animal and human activities. Mostly generated from industrial, residential, and commercial activities. It can be categorized based on material, such ads plastic, paper, glass, metal, and organic waste.Wastewater is used water such from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Used water from Industries and businesses are also regarded as wastewater.Solid waste and Wastewater are wastes that can be treated in other to minimise environmental and public health hazards.

Impact of Waste on Environment: Environmental degradation being the diminution of the environment in quantity and its deterioration in quality. Poor waste management aggravates environmental degradation by indiscriminate discharge of solid and liquid wastes and eutrophication of rivers Agunwamba (1998). Pollutants are the residuals of production and consumption. These residuals eventually return to the environment in one form or the other. A major environmental concern is gas release by decomposing garbage. The problem with these gases is their contribution to the enhanced greenhouse gas effect and climate change. The cost

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of environmental damage include cost of remediation, and treatment cost Agunwanba (2001).

Impact of Waste on Human Health. The potential risks to health is from improper handling of wastes. Waste can cause immediate injury when people breathe, swallow, or touch it. For the general public, the risks arise from the breeding of disease vectors, primarily flies and rats (CDC, 2009), the organic wastes generated from household which are not manage very well, decompose easily, attract insects and causes disease Pervez and Kafeel (2013). According to Pervez and Kafeel (2013), the steps in the prevention of impact are as follows:

- Generation of waste should be decreased
- Promoting the production of goods which minimize waste generation after use
- Material recycling and recovery should be increased
- Promoting the use of plastic recycling identification codes and labels in order to make sorting and recycling of plastic packaging
- Legislation in the waste sector should be improved.

The poor management of waste affects their human health, especially in developing and low-income countries, where people are vulnerable to the risk associated with poor waste management (Rathi, 2006; Sharholy et al, 2005; Kansal et al.,1998; Singh et al., 1998)

Impact on Socio-economy. Poor waste management has a significant negative effect on the national economy. Thousands of education days and work-days are lost each day because of diseases which improve management can prevent Agunwanba (2001).

Waste Treatment:

It is not possible to completely eliminate the production of waste. Different methods are used for treatment. The choice of method depends on the nature of waste, the facilities available, the money available, environmental norms in the region and the feasibility of the treatment method Indu (2006). Some of the commonly used methods can basically be divided into physical, chemical and biological methods. And in the other hand, wastes can be categorized as hazardous and non-hazardous.

Types of Waste Considered

- Solid Waste

Solid waste are mostly generated from industrial, residential, and commercial activities. It can be categorized based on material, such ads plastic, paper, glass, metal, and organic waste.

- Wastewater/Sewage

Wastewater is used water such from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Used water from Industries and businesses are also regarded as wastewater

II. METHODS:

SOLID WASTE: The purpose of waste management is to reduce the amount of waste through recycling and its disposal in a way that does not obstruct environmental conservation. Waste management involves refuse; reuse; recycle and reduce. Solid waste management is concerned with the generation, storage, collection, transportation, processing and finally disposal of solid waste Aquino (1994).

Solid Waste Treatment: the recent strategies in the treatment of solid waste are geared towards reducing the amount of solid waste that could be discarded, as well as recovering and utilizing the materials present in the disposed waste as a resource to the largest possible extent. Different methods are used for treatment and the choice of proper method depends on refuse characteristics, land are available and disposal cost Moeller, (2005).

- **Primary Treatment**

Primary treatment methods selectively remove materials which could interfere with the physical operation and subsequent treatment processes. The processes are based on exploitation of the physical properties of the contaminants and are generally used at the initial stage of effluent treatment. It helps in improving the treatment efficiencies by reducing the surface area. Screening, flow equalization, comminuting, mixing, floatation, flocculation and sedimentation are some of the methods which are used during the initial stages of effluent treatment. Pre – and Primary Treatment: this processes include racks and bar screens, comminutor, grit chamber, skimmer and grease traps, and flow equalization tanks. These units are used for screening out coarse solids, reduction of particle sizes, separation of floating oils and grease and smoothening of flow to enhance treatment efficiencies of the subsequent units.

- **Secondary Treatment**

Soluble and colloidal form of organic matter can be removed by secondary treatment also referred to as biological treatment. Both aerobic and anaerobic microorganisms are employed here. Anaerobic digestion is the most suitable option for

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the treatment of high strength organic effluents. Anaerobic and aerobic treatment systems can remove most of the biologically removable organics, CODs and colour. Biologically treated distillery wastewater is non-biodegradable. Anaerobic treatment of effluents from different alcohol-producing industries has been performed. Aerobic processes are more reliable, stable and better understood, anaerobic treatment process generates less sludge and biogas. Anaerobic processes have a slower rate of reaction.

- **Tertiary Treatmnt**

A variety of treatment methods and strategies like thermal pre-treatment, wet air oxidation, concentration-incineration, anaerobic treatment, etc., have been tested for the treatment of wastewater. All these schemes on their own are either incomplete, or are impractical or unviable. Thus, there is an urgent need of assessment of the possibility of combination of the available partial treatment schemes for the complete treatment.

- **Treatment of Non-Hazardous Solid Waste**

Non-hazardous solid waste include municipal waste, industrial waste, agricultural waste, and sewage sludge. The municipal solid waste has four components; recycling, composting, landfilling, and waste–to-energy through incineration. Municipal solid waste are a significant.

- **Treatment of Hazardous Solid Waste**

Almost all the manufacturing and industrial processes generate waste in the form of solid, liquid or gas. Some wastes are considered hazardous depending upon characteristics like ignitability, corrosively, reactivity and toxicity which due to their quantity, concentration, and physical, chemical or infectious characteristics may result in increased mortality and also cause serious irreversible or incapacitating reversible illness. Hazardous waste can be managed by waste minimization and thereafter its treatment and disposal.

III. TREATMENT PROCESS

- **Physical Separation:** This is essential for the conversion of hazardous components of waste into less hazardous form, making it more suitable for further treatment and disposal.

Gravity Separation: this can be used to remove solid or liquid waste from aqueous waste stream when those materials have a density significantly different from that of water.

Gravity Floatation: Floatation refers to quiescent gravity flow being similar to sedimentation. In gravity floatation, primary sludge removal occurs at the surface of the tank rather than the bottom.

Dissolved Air Floatation: It is a physical separation process for removing suspended liquids or solids that do not sink or float at sufficiently high rate. It is based on specific gravity difference between the aqueous liquid and the suspended materials. Removal is done by producing fine gas bubble in the liquid waste.

Air Stripping: Air stripping is done by using unit configuration, including aeration tank, spray tower and cross current tower. The most common configuration for hazardous waste application is the countercurrent packed tower. It is used for dilute concentration of volatile contaminants such as organic solvents or toxic gases. It converts the contaminants from aqueous form to gaseous form, which can then be treated by activated carbon sorption.

Sorption on Activated Carbon. It is used for physical separation of watercontaminated hydrocarbons and chlorinated solvents. Activated carbon is commonly used to treat the effluent gas from air stripping processes.

- **CHEMICAL TREATMENT:** Chemical treatment can reduce toxicity, ignitability, reactivity and corrosively of the waste.

Neutralization. Base neutralization is a common hazardous waste treatment. Neutralization processes can be carried out in batch or continuous flow system.

Chemical Precipitation. Precipitation is a chemical process that involves removal of soluble contaminants from the solution by causing a reaction, which form an insoluble product. It is used in removal of inorganic contaminants from aqueous waste. Hydroxide precipitation, sulphide precipitation and carbonate precipitation methods are used.

Oxidation. This is a chemical reaction in which electrons are removed from an ion, atoms or molecules. The goal of oxidation is to remove the hazardous nature of waste by transforming contaminants to less harmful products.

Ozonation. Ozone can directly react with contaminants and indirectly by generating hydroxyl radicles.

Thermal Treatment. In thermal treatment high temperature is applied to convert hazardous waste into less toxic, low volume and easily disposable waste. Incineration and pyrolysis methods are used. Incineration is combustion of waste in the presence of oxygen. Pyrolysis is cracking or thermal decomposition of materials in the absence of

oxygen. Liquid injection, rotary kiln, fluidized bed, and multiple hearth are important incinerators process.

- **BIOLOGICAL TREATMENT:** Biological treatment processes are used to decrease the hazardous nature of waste by transforming contaminants into less harmful forms. Biological treatment relies on useful microbial reactions including degradation and detoxification of hazardous waste containing organic, inorganic nutrients and electron acceptor consumption, metal transformation, and pH adjustments,. Microorganisms involved in biological hazardous waste treatment processes include bacteria, fungi, protozoa and some algae.

WASTEWATER/SEWAGE TREATMENT:

Industrial municipal and commercial activities release toxics and recalcitrant compounds in wastewater effluents. Toxic hazardous chemicals are also released from medical and military activities. The aim of wastewater treatment is to convert waste materials present in wastewater into stable oxidized end products that can be easily disposed. The method is helpful in protecting public health, recycle and recovery of valuable components, and compliances of legal standards and consent conditions placed on discharge Agunwamba (1994).Wastewater treatment is based on the sequencing of various units operations which are affected by the characteristics of the wastewater, require effluent quality, and cost and availability of land. It is necessary to treat the waste water as it will help in the reduction of biochemical oxygen demand; reduction of suspended solids; destruction of pathogens; removal of nutrients; removal of toxic compounds; removal of non-biodegradable compounds; and removal of dissolved solids.

Sewage treatment: Sewage comes from human excreta, urine and sullage(wastewater from bathrooms, laundry and kitchen). Sewage may contain pathogenic organisms, organics and nutrients and needs to be treated before discharge so as to prevent pollution of surface and underground water sources. Sewage exerts biological oxygen demand in rivers which depletes oxygen, thereby starving aquatic organisms of oxygen Thome-Kozmiensky (1986). Wastewater is treated by supplying it with oxygen so that bacteria may utilize the waste as food.

- **PHYSICAL METHODS**

Stream Stripping: used for treatment of waste air with high concentration of organic or less volatile contaminants. In the process influent wastewater is partially heated by energy from the effluents, and influent then enters the tower, from where the waste flows downward through a series of trays. An upward flow of steam heats the waste, causing contaminants to volatilize into gaseous form. The contaminants rise through the tower with the steam and are carried out of the column with steam vapour.

Solvent Extraction. It is the physical separation that involves removing contaminants from liquid solution by contacting another immiscible liquid in which contaminants are more soluble. It can be carried out in countercurrent packed columns, concurrent columns, centrifuges or batch process mixer-settlers.

Incineration. According to Hasselriis 1994, thismethod is used in the pharmaceutical manufacturing industries to treat organic and inorganic constituents in wastewater. In this, the water is burnt at a very high temperature in the absence of air. A bed or multiple hearth incinerators, equipped with an acid gas scrubber, for the control of generated hydrochloric acid. Contaminants in the wastewater is destroyed by combustion and the remaining water vapour is discharged to the atmosphere.

Sedimentation: This is the gravitational separation of suspended solids heavier than water. Primary sedimentation tanks are used for production of high degree of clarification and thickening of sludge. The process of sedimentation achieves 70% removal of suspended solids and 42% BOD removal. The design of sedimentation tank is such that wastewater flows at a sufficiently slow velocity to allow significant amount of solids to settle out.

Flocculation: flocculation of sewage is the coalescence of singly divided suspended solids by gently stirring, primarily under the influence of physical forces with the use of chemicals and in the absence of biologically active slime. As flocculated particles develops, their settling velocity ordinarily increases and they are more rapidly removed. Stirring facilitates floc formation by increasing the number of collision or contact by releasing entrapped gases. The stirring is achieved by mechanical paddles or mixers, air agitation or other means. Flocculation is often utilized in increasing suspended matter removal or increasing the effectiveness of settling tank capacity or both.

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Floatation: Floatation is to convert finely divided suspended solids and grease into floating matter. Air bubbles are introduced in sewage and tend to adhere to the solid particles. Under quiescent conditions, the solids rise upwards and are floated by the lifting action of the gas bubbles. Floatation helps in the removal of grease, light and heavy solids, and grit in one unit; reduction in tank size because of shorter detention time, and possible savings in construction costs; reduction in odour nuisance; and formation of thicker scum through floatation than by gravity settling and skimming.

- **CHEMICAL METHODS:**

Cyanide destruction. This includes alkaline chlorination, hydrogen peroxide oxidation, and basic hydrolysis. The reaction is a two-step process and is normally performed separately in two reactor vessels. Treatment is normally performed in batches- it is necessary to use an additional equalization tank to store accumulated wastewater during treatment.

Hydrogen Perioxide treatment. This involvesadding hydrogen peroxide to cyanide bearing wastewater to convert free cyanide to ammonia and carbonate ions. The pH is adjusted as the wastewater is heated in the reaction vessel.

Oxidizing agents like ozone, UV rays and hydrogen peroxide. Ozone gas is highly reactive as it oxidizes 5 antibiotics, 5 betablockers, antiphlogistic, lipid regulator metabolites, the antiepileptic drug, carbamazepine, and the natural estogen, estrone. The combined treatment of hydrogen peroxide and UV radiation also reduce the amount of Diclofenac present in wastewater.

Semiconductor Photocatalysis. In Semiconductor Photocatalysis, the samples are exposed to radiations in the presence of Semiconductor, generally TiO_2. It transforms, deactivates and finally minimizes environmental persistent compounds, or xenobiotics. In a study by Doll and Frimmel, 2005 carbamazepine, clofibric acid and iomeprol showed higher degradation tendency when subjected to Semiconductor Photocatalysis. This Photocatalysis is remarkably active, cheap, non-toxic and chemically stable over a wide pH range and it is not subject to photo corrosion.

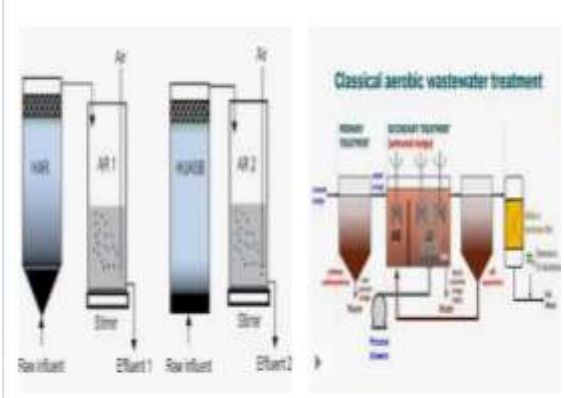
- **BIOLOGICAL METHODS:**

Biological methods involve the use of microbes and plants for the treatment of wastewater. Microbes degrade or convert the waste into some other form. Plants absorb the waste through roots. In both cases the end products are not more toxic and problematic than the initial compound.

Use of Microbes. Microbial processes are basically Anaerobic and aerobic. Microbes either degrade or convert the toxic compound.

Biological Oxidation of Organic Matter: the presence of organic matter a major problem associated with wastewater. It involves the conversion to inert and stable compounds with the help of microorganisms, either in the presence of oxygen (aerobic oxidation) or absence of it (anaerobic oxidation). The organic matter is composed essentially of carbohydrates, nitrogenous compounds, hydrogen and a little quantity of oxygen. For optimum oxidization of waste, it is essential that certain compounds be available to support bacterial growth. When bacterial growth is retarded there will be inadequate concentration of microorganisms for biological waste degradation or treatment.

Aeration:for aerobic treatment systems, the amount of dissolved oxygen is necessary. The amount of dissolved oxygen required for complete oxidation may not be adequate. In the aerobic treatment systems artificial air is introduced to a greater quantity. Aeration helps to oxidise iron and manganese in water,; to maintain a certain level of oxygen suitable for treatment and disposal; remove H_2S to eliminate taste and odour; and to remove volatile oils and similar odour and taste producing substances released by algae and other microorganisms. Aeration can be achieved by diffusion of air into the wastewater or by spreading drops of wastewater into the air directly. The contact between the air and wastewater is achieved by the use of compressed air system or mechanical system.



Compressed Air System Aeration. This is the introduction of air under pressure through porous or perforated distributors, turbines, injectors, impingement bowls or venture- diffusers which is classified as dispersed air system. This gives an unlimited total oxygenation capacity.

Mechanical aeration: the top surface of the liquid is skimmed and splashed through the air in such a way that t6he particles fall within the confines of the tank. The sewage particles are aerated as they pass through the air. As the aerated particles fall back on the surface, further mixing takes place and the bubbles of air are forced downward into the tank. The rate of mechanical mixing depends on temperature, depth of tank, chemical composition of sewage, depth of submergence and the nature of aeration device.

Amount of oxygen required for aerobic waste treatment: oxygen must be supplied in aerobic systems for oxidation reactions and basic cell maintenance. The amount of oxygen required is based on empirical relationships since the process of oxygen utilization is a complex one. The oxygen requirement is a fraction of the COD removed and the endogenous requirement.

Trickling Filter: It consists of a bed of crushed rock, slag or gravel whose particles are in the range of about 50 – 100 mm in size. The bed is commonly 2 to 3 m deep, although shallowed beds are sometimes used. Wastewater is applied to the surface of the filter intermittently by one or more rotary distributors and percolates downward through the bed to underdrains, where it is collected and discharged through an outlet channel. Recirculation of trickling filter effluent is a common feature of trickling filters. The rate of recirculation are generally adjusted as the wastewater flow changes to maintain approximately constant flow through the filters. The performance of a trickling filter is influenced by the size, nature and depth of media, temperature, waste strength, flow rate, cleanliness of media, and the method of distribution of influent.

Anaerobic Reactors: Anaerobic digestion by microbes consists of enzymically catalysed reaction in which such substances like protein, starch etc, called biopolymers are converted to amino acids, sugar, and other substances (monomers). The monomers are later fermented to a variety of reduced product which in turn are completely converted to carbon dioxide and methane by the organisms. This makes use of anaerobic filter which is a fixed film biological wastewater treatment process as a fixed media matrix is used to retain anaerobic biological solids within a reaction vessel. Treatment occurs as wastes flow through the unit and comes into contact with the microorganisms contained inside it. Young 1983 states the problems associated with this system that they cannot predict the effect of failure countermeasures.

Use of Plants

A useful tool for bioremediation as well as biomonitoring is the use of plants, especially aquatic plants. Azolla has been shown to have the capacity to bioaccumulate sulphadimenthoxine upto 1000ppm and Lythrum salicaria can bioaccumulate flumequine Indu (2006).

IV. CONCLUSION

The fundamental objective of processing waste is to reduce the amount of waste through treatment and its disposal in a way that does not obstruct environmental conservation. The treatment systems mentioned in this study are effective ways to reduce the volume of waste, stabilize it and make it detoxic. It is found that with the increase in global population and industrialization there has been a rise in the quantity of waste being generated daily. wastes that are not adequately treated or managed pose serious health hazard and lead to the spread of infectious diseases.

REFERENCES

[1]. Adegoke, O.S. (1989). Waste management within the context of sustainable development. Pro. of workshop held at the NICON NOGA Hilton Hotel, Abuja on The Environment and sustainable Developmentin Nigeria, 103-110

[2]. Agunwamba, J.C. (1994). Industrial waste management in Nigeria – A Review, Integerated Approach and Future Development. An invited keynote paper presented at the 8th Conference of Chemical Society of Nigeria, 28th July

[3]. Agunwamba, J.C. (1998). Solid waste management in Nigeria: Problems and issues. Environmental Management 22 (6), 849-856.

[4]. Agunwamba, J.C. (2001). Waste engineering and management tools. Immaculate publications Ltd. Enugu. Nigeria.

[5]. Aquino, J.T. (1994). Solid waste management around the world. Waste age magazine, Washington D.C. pp. 5-17

[6]. FEPA (1991). Guildlines and Standards for environmental pollution control in Nigeria. Lagos

[7]. Hasselriis, F. (1994). Environmental acceptability of medical waste incineration in the US. ISWA, 1, 12 - 14

[8]. Indu S.T. (2006). Evironmental Biotechnology Basic concepts and

applications. I.K. International Pvt. Ltd. New Delhi, India

[9]. Kempan, R. and Notenboom, G. (1999). Concept technologies in wastewater treatment. WQI

[10]. Thome-Kozmiensky, K.J. (1986). Waste management in developing countries. Energic and unweltechnik, Berlin. Pp. 226-352