

Comparison of the Efficiency of Various Techniques Used in the Treatment of Waste and Sewage Water in Oko and its Environs

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ABSTRACT:

The efficient treatment of waste and sewage water is a critical aspect of environmental sustainability and public health. This study aims to compare the efficiency of various techniques used in the treatment of waste and sewage water in Oko and its environs, located in Anambra State, Nigeria. The research provides valuable insights into the performance and applicability of different treatment methods, helping to identify the most effective and suitable techniques for the region. The different test conducted on agricultural wastewater, industrial wastewater, domestic wastewater and Awgbu River, showed that impurities in the water are removed by coagulation, filtration and adsorption method of water treatment. Physical, chemical and microbial tests were done on all the four water samples. The experimental results showed that coagulation and adsorption treatment method is effective in the removal of bacteria, organic matter and reduction of turbidity, but adsorption method is most suitable method for removal of heavy metals content. The development and implementation of sustainable and efficient treatment methods are essential to mitigate the environmental and health risks associated with improper waste and sewage water management.

Keyword: wastewater, treatment, sewage, comparison, efficiency.

I. INTRODUCTION

The efficient treatment of waste and sewage water is a crucial aspect of environmental sustainability and public health. Inadequate waste and sewage water treatment facilities can lead to the contamination of water bodies, soil, and air, posing significant threats to ecosystems and human well-being. In many regions of Nigeria, including Oko and its environs in Anambra State, the management of waste and sewage water has been a persistent challenge due to various factors such as limited resources, inadequate infrastructure, and population growth.

The improper disposal of waste and untreated sewage water can have detrimental effects on the environment. It contributes to water pollution, leading to the degradation of water quality and the loss of aquatic biodiversity (UNEP, 2016). Additionally, the contamination of soil and groundwater can affect agricultural productivity and pose risks to human health through the consumption of contaminated food and water (WHO, 2018). The release of untreated sewage water into open drains and water bodies also contributes to the spread of waterborne diseases and infections, further compromising public health.

The need for effective waste and sewage water treatment techniques in Oko and its environs cannot be

overstated. The development and implementation of sustainable and efficient treatment methods are essential to mitigate the environmental and health risks associated with improper waste and sewage water management. Thus, there is a critical demand for research that compares the efficiency of various treatment techniques to identify the most suitable and effective approaches for the region.

Oko, a semi-urban area located in the Orumba North Local Government Area of Anambra State, Nigeria, faces significant challenges regarding waste and sewage water treatment. As is the case in many growing African towns, rapid urbanization and population growth in Oko have led to increased generation of waste and sewage water. However, the capacity to manage and treat this water has not kept pace with this growth, leading to significant environmental and public health issues. Waste and sewage water, if not appropriately treated, can result in the contamination of fresh water sources, leading to the spread of waterborne diseases such as cholera and typhoid (UNICEF & WHO, 2019). Furthermore, the improper treatment of waste and sewage water can lead to environmental degradation, affecting both terrestrial and aquatic habitats.

Conventional waste and sewage water treatment categories commonly used worldwide include preliminary

treatment, primary treatment, secondary treatment, and tertiary treatment (Metcalf & Eddy, 2014). Preliminary involves removal of light and floating objects e.g. leaves, rags, woods, charcoal, etc. It is the first stage of wastewater treatment. (Odumodu O.I., 2017). Primary treatment involves the physical removal of large solids through processes such as sedimentation. Secondary treatment, often referred to as biological treatment, utilizes microorganisms to break down organic matter and remove dissolved and colloidal substances. Tertiary treatment employs advanced processes such as filtration, disinfection, and nutrient removal to further enhance the quality of the treated water (Henze et al., 2008).

A. Statement of the Problem

The inefficiency of waste and sewage water treatment techniques in Oko and its environs has resulted in various environmental and health-related problems. The lack of proper treatment methods leads to the contamination of water sources, making them unsuitable for domestic use and agricultural activities. This poses a significant risk to the well-being of the local population, as access to clean and safe water is essential for maintaining good health and preventing the spread of waterborne diseases.

Furthermore, the release of untreated sewage water into the environment contributes to the pollution of soil, affecting agricultural productivity and food security in the region. The degradation of soil quality can also have long-term consequences, impacting the sustainability of the agricultural sector and the livelihoods of local communities that depend on it. Therefore, it is imperative to evaluate and compare the efficiency of various waste and sewage water treatment techniques to identify appropriate solutions for Oko and its surrounding areas.

B. Aim of study

The aim of this study is to compare the efficiency of various techniques used in the treatment of waste and sewage water in Oko and its environs, Anambra State, Nigeria.

II. MATERIAL AND METHODS

A. **Sewage Water:** Sewage water was collected from Dr. Nwosu Hostel Amaokpala, Orumba North Local Government Area Anambra state.

B. Agricultural waste water

The agricultural waste water used was collected from Local farm (yam produce) Oko, Orumba North Local Government Area Anambra state

C. Industrial Waste water

Industrial waste water was collected from Juhel pharmaceutical company Awka, Anambra state.

D. River Water

The river water used was collected from Awgbu river same local Orumba North Local Government Area.

treatment

E. Experimental Procedure

Laboratory experiment was carried out in Alpha Research Laboratory at Awka, Anambra state, and the followings were the experimental procedure conducted to determine the treatment efficiency of three different water treatment techniques.

F. Water treatment by filtration with granite powder

Batch experiments were conducted by adding 1g of each adsorbent to 100 ml (level 10g/l) wastewater in separate conical flasks and the flasks were capped. Flasks were then placed in a shaking water bath set at 100rpm at room temperature and left overnight. The water samples were then filtered and the adsorbents were removed. The samples were then subjected for physiochemical analysis.

G. Water Treatment by adsorption

100 grams of the precursor will be carbonized at a temperature of 700°C for 2h in a stainless steel vertical tubular reactor placed in a furnace. The charcoal produced will be added with an aqueous solution of potassium hydroxide (activation chemical) made by dissolving 50g of potassium hydroxide in 300ml of distilled water. The mixture will be mixed in a mechanical mixer for 1 hrs to ensure that the mixture will be properly mixed. After that, the mixture will be dehydrated in an oven at a temperature of 105°C for 2hrs. The activated product will be then cooled to room temperature and will be washed with hot distilled water to remove any undiluted residue of potassium hydroxide. Then, the precursor will be dry in an oven at temperature of 105°C for 1hrs. Finally, the dried precursor will be grounded and sieved to get the particle size of 125–250 µm and stored in plastic containers for further use. Batch experiments were conducted by adding 1g of each adsorbent to 100 ml (level 10g/l) wastewater in separate conical flasks and the flasks were capped. Flasks were then placed in a shaking water bath set at 100rpm at room temperature and left overnight. The water samples were then filtered and the adsorbents were removed. The samples were then subjected for physiochemical analysis.

H. Water treatment by coagulation

Moringa oleifera (good quality dried drumstick were selected and) wings and coat from seeds were removed manually. The seeds were oven-dried at a temperature of 105°C for 7h. The dried seeds were milled using attrition mill and sieve with a 600 µm stainless steel sieve mesh screen. Seeds were grounded in a blender and sieved through 600 µm stainless steel sieve. Oil was removed by mixing the seed powder (250g) in 700mls of ethanol. This was mixed with a magnetic stirrer for 30–45 min, and subsequently, separation of the residue from the supernatant was done by centrifuging for 10 min at 4000 rpm. The supernatant was decanted and the residual solid was dried (seed cake) at room temperature for 24 h (Alo et al., 2012). The moringa seed powder was stored in an airtight container. The stock solution was prepared by adding 100 ml of distilled water to Moringa oleifera seed cake to form a paste which possesses the coagulant properties (Alo et al., 2012). Wastewater Treatment: The

wastewater samples for the tests were taken at 7up Bottling Company, Aba, and the municipal wastewater will be collected from Waterside River, Aba which is the main artificial drain of domestic wastewater in Aba. The pretreatment qualities of the wastewaters was analyzed and tabulated. All samples were stored in the refrigerator to

prevent alteration of their characterization. Wastewater treatment was performed using a PB700 6 Paddle Jar Test apparatus. Two beakers were labeled and about 500 mL of water sample was added.

III. RESULTS AND DISCUSSION

Table 1: Effect of three different water treatments on industrial waste water

PARAMETERS	Industrial waste water	Filtration treatment	Coagulation treatment	Adsorption treatment	Control (Aquafina)	WHO standard
Ph	4.34	5.30	7.15	6.80	7.00	6.5-8.5
Colour (pt/co unit)	76.00	14.00	16.00	18.00	16.00	15.00
Temperature (°c)	25.50	24.00	25.00	24.00	25.0	24.00-30.00
Total dissolved solid (Mg/L)	680.00	413.00	470.00	319.00	180.00	Below 200
Electrical conductivity (ms/cm)	743.70	415.80	439.00	520.90	622.50	1000
Total soluble Solid (mg/L)	19.50	9.65	6.55	9.42	10.88	500.00
Turbidity (NTU)	45.87	15.18	13.51	11.00	18.08	5.0
Alkalinity (Mg/L)	155.80	65.80	45.50	39.70	55.10	Below 250.00
Acidity (Mg/L)	47.30	19.30	1.30	6.37	4.37	Below 5.00
Dissolved oxygen (Mg/L)	17.00	7.30	2.00	3.88	21.00	Below 800
Biochemical oxygen demand (Mg/L)	137.00	72.30	82.00	73.05	111.00	Below 800
Chemical oxygen demand (Mg/L)	375.33	128.30	155.70	179.00	145.62	Below 1700
Total hardness (mg/L)	64.40	51.80	37.10	21.60	35.40	100-500
Chloride Cl ⁻ (mg/L)	42.40	21.27	12.00	36.80	22.80	250.00
Nitrate NO ₃ ⁻ (mg/L)	1.00	0.27	0.05	0.21	0.35	45.00
Phosphate PO ₄ ⁻ (mg/L)	1.40	0.94	0.45	1.10	3.90	250.00
Zinc (ppm)	1.87	1.05	0.63	0.62	1.14	2.00
Iron (ppm)	1.79	1.64	0.06	0.39	0.84	0.01-0.1
Cadmium (ppm)	0.84	0.71	0.09	0.05	0.63	0.1-5.70
Lead (ppm)	2.17	1.85	0.19	0.17	0.00	0.01-1.0
Total Bacteria count(CFU/ml)	3.80x10 ²	3.51 x10 ²	2.10x10 ²	1.20x10 ²	1.73 x10 ²	> 100cfu/ml
Total coliform(MPN/100ml)	39.00	27.00	13.00	7.00	21.00	Nil
Total fungi count(MPN/100ml)	5.30x10 ²	3.11x10 ²	0.30x10 ²	1.70x10 ²	0.50x10 ²	> 100cfu/ml

Table 2: Effect of three different water treatments on Agricultural waste water

PARAMETERS	Agricultural waste water	Filtration treatment	Coagulation treatment	Adsorption treatment	Control (Aquafina)	WHO standard
pH	5.70	7.10	6.00	5.90	7.00	6.5-8.5
Colour (pt/co unit)	93.00	25.00	15.00	28.00	16.00	15.00
Temperature (°c)	25.00	25.00	25.00	25.00	25.00	24.00-30.00
Total dissolved solid (Mg/L)	537.00	428.00	184.00	219.00	180.00	Below 200
Electrical conductivity (ms/cm)	628.00	409.00	288.00	460.90	622.50	1000

Total soluble Solid (mg/L)	11.00	5.10	9.50	7.25	10.88	500.00
Turbidity (NTU)	62.80	33.65	24.50	19.70	18.08	5.0
Alkalinity (Mg/L)	205.80	115.30	67.90	57.00	55.10	Below 250.00
Acidity (Mg/L)	10.10	9.80	10.16	8.30	4.37	Below 5.00
Dissolved oxygen (Mg/L)	87.00	53.10	75.10	43.00	21.00	Below 800
Biochemical oxygen demand (Mg/L)	127.08	54.00	75.00	28.00	111.00	Below 800
Chemical oxygen demand (Mg/L)	285.00	108.40	117.50	94.80	145.62	Below 1700
Total hardness (mg/L)	104.00	66.00	53.00	69.00	35.40	100-500
Chloride Cl ⁻ (mg/L)	28.80	12.20	10.90	16.00	22.80	250.00
Nitrate NO ₃ ⁻ (mg/L)	0.86	0.55	0.16	0.27	0.35	45.00
Phosphate PO ₄ (mg/L)	1.07	0.63	0.51	0.66	3.90	250.00
Zinc (ppm)	1.15	1.00	0.36	0.73	1.14	2.00
Iron (ppm)	1.05	0.85	0.00	0.11	0.84	0.01-0.1
Cadmium (ppm)	0.94	0.06	0.01	0.06	0.63	0.1-5.70

Table 3: Effect of three different water treatments on Domestic waste water.

PARAMETERS	Domestic waste water	Filtration treatment	Coagulation treatment	Adsorption treatment	Control (Aquafina)	WHO standard
pH	5.44	6.60	7.00	6.80	7.00	6.5-8.5
Colour (pt/co unit)	54.00	11.50	21.00	18.00	16.00	15.00
Temperature (°c)	25.00	25.00	25.00	25.00	25.00	24.00-30.00
Total dissolved solid (Mg/L)	520.00	398.00	216.00	196.00	180.00	Below 200
Electrical conductivity (ms/cm)	323.00	301.00	243.00	200.90	622.50	1000
Total soluble Solid (mg/L)	26.00	11.10	9.50	10.20	10.88	500.00
Turbidity (NTU)	75.10	36.60	20.00	11.50	18.08	5.0
Alkalinity (Mg/L)	275.10	113.00	53.10	50.00	55.10	Below 250.00
Acidity (Mg/L)	8.80	2.34	3.16	2.11	4.37	Below 5.00
Dissolved oxygen (Mg/L)	96.00	50.00	38.10	49.00	21.00	Below 800
Biochemical oxygen demand (Mg/L)	148.00	43.10	50.00	37.00	111.00	Below 800
Chemical oxygen demand (Mg/L)	280.00	128.50	110.50	114.80	145.62	Below 1700
Total hardness (mg/L)	129.00	65.00	51.00	90.00	35.40	100-500
Chloride Cl ⁻ (mg/L)	25.70	10.20	13.00	15.00	22.80	250.00
Nitrate NO ₃ ⁻ (mg/L)	0.80	0.31	0.10	0.25	0.35	45.00
Phosphate PO ₄ (mg/L)	1.59	0.60	0.43	0.67	3.90	250.00
Zinc (ppm)	1.79	1.08	1.17	0.96	1.14	2.00
Iron (ppm)	1.00	0.76	0.05	0.08	0.84	0.01-0.1
Cadmium (ppm)	0.66	0.04	0.00	0.00	0.63	0.1-5.70
Lead (ppm)	0.11	0.18	0.10	0.07	0.00	0.01-1.0
Total Bacteria count(CFU/ml)	1.11x10 ²	0.96x10 ²	0.37x10 ²	0.21x10 ²	1.73 x10 ²	> 100cfu/ml

B. PHYSICOCHEMICAL AND MICROBIAL ANALYSIS OF THE THREE DIFFERENT WATER TREATMENTS

pH: The analysis in tables 4.1-4.4 above shows that pH of all the three different water treatments are efficient treatment method in domestic wastewater and Awgbu River. Coagulation and adsorption are efficient pH treatment method in industrial wastewater but only filtration method is efficient in pH agricultural waste water treatment.

Turbidity: The analysis in tables 4.1-4.4 above shows that the turbidities of all the three different water treatment are not efficient that is, the values are not within the permissible range of WHO standard.

Acidity: The acidity value of treated water showed that the water remains within the recommended standard by WHO except with filtration and adsorption method which is not good in industrial wastewater but all three different methods are not efficient in agricultural wastewater treatment. Turbidity helps to check faulty filters, finding the amount of chemicals needed for treatment and effectiveness of these chemicals.

Temperature: The temperature values of the three different wastewater treatment of the four samples show that water remain within the permissible range of WHO standard and the three methods are efficient. The temperature indicates the level of dissolved oxygen and bacterial activity in water. The higher the temperature, the lower the dissolved oxygen and the lower the survival rate of micro-organisms.

Total Dissolved Solids: The TDS values of the treated wastewater show that the waters are within the WHO standard with coagulation treatment method and adsorption treatment method. The presence of TDS shows salinity and may affect ecosystems, domestic and agricultural usefulness. TDS comprises mainly inorganic salts such as calcium, magnesium, potassium, sodium, chlorides and sulphates that are dissolved in water.

Dissolved Oxygen: The dissolved oxygen values of the treated wastewater showed that the waters remain within the permissible range of WHO standard and also the three methods of wastewater treatment are efficient. The value of DO decreases with increasing temperature. The stronger the amount of waste discharged into a stream the greater the amount of DO required by micro organism to completely degrade the waste.

Alkalinity: The alkalinity value of the wastewater tested showed that the water conforms to the stipulated standard of alkalinity of drinking water and the three methods of wastewater treatment are efficient. The alkalinity is due to salts of weak acids of strong bases such as hydroxides, carbonates and bicarbonates.

Total Hardness: The analysis in table 4.1-4.4 above showed that the total hardness of wastewater treated met to WHO standard. There was no violation of the drinking water guidelines since no health-based guideline value was proposed for hardness in drinking water.

Phosphate: The phosphate value of the treated wastewater falls below recommended limit of phosphate. The three methods are good in wastewater treatment of phosphate.

Chlorides: The analysis in table 4.1-4.4 above showed that the chlorides of treated water falls below

recommended limit of chlorides. There was no violation of the drinking water guidelines. Excessive chloride content has been linked to corrosion of metals in the distribution systems depending on the alkalinity of the water. Excessive chloride content can also be detected by a change in the taste of the water.

Iron: The Iron value of the wastewater tested showed that the water conforms to the stipulated standard of Iron concentration of drinking water with coagulation treatment method and adsorption treatment method. The presence of excessive concentrations of iron and manganese in water creates serious problems and affect laundering operations, stains plumbing fixture, supports bacterial growth in distribution system and imparts taste to water.

Biochemical oxygen demand: The biochemical oxygen demand values of the treated wastewater showed that the waters remain within the permissible range of WHO standard and also the three methods of wastewater treatment are efficient.

Chemical oxygen demand: The chemical oxygen demand values of the treated wastewater showed that the waters remain within the permissible range of WHO standard and also the three methods of wastewater treatment are efficient.

Total coliform and E. coli: The water analysis results of treated wastewater showed that total coliform and E. coli have 0 cfu/100ml and 0 cfu/ml respectively. There was no violation of the NIS and WHO drinking water guidelines respectively for total coliform and E. coli:

IV. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, research work shows that the three different methods of wastewater treatment techniques; filtration, coagulation and adsorption methods are 90 to 99% efficient in reduction of pathogens in wastewater parameters like total dissolved solids, chloride, nitrate, phosphate, zinc, alkalinity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand and temperature. Coagulation and adsorption method of wastewater treatment techniques have shown that heavy metals like lead, cadmium, zinc and iron can be removed adequately. Filtration method is adequate in reduction of total fungi count but all of the three different methods are adequate in removal of total coliform because no violation of the NIS and WHO drinking water guidelines respectively for total coliform and E. coli.

Recommendation:

It has been recommended that;

1. A forum be created for awareness program to be conducted in all villages in Orumba North Local Government Area and beyond, where people can be educated on importance of the different wastewater treatment techniques.
2. In case of further investigation the five or more different wastewater treatment techniques should be used to have more comparative analysis of result of each treatment technique.
3. Government should provide the appropriate solutions (master plan) for various waste and sewage water in every community, cities and its surrounding areas.

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