Synthesis and Characterization of Zinc Oxide Nanoparticle for the Adsorptive Remediation of Petrochemical Effluents

*JAMIU, W; 1ADEKOLA, FA; 2JIMOH, AA; 3AMEEN, OA; 4ADEBUSUYI, TA

1Department of Industrial Chemistry, University of Ilorin, Ilorin, Kwara State, Nigeria.
2Department of Chemistry, Kwara State University, Malete, Kwara State, Nigeria
3Department of Science Laboratory Technology, Kwara State Polytechnic, Ilorin, Kwara State, Nigeria
4Department of Chemical Sciences, Augustine University, Ilara-Epe, Lagos State, Nigeria.

*Corresponding Author Email: waschem06@gmail.com; Tel: +2348063029504

ABSTRACT: The zinc oxide nanoparticle was synthesized via precipitation method. It was characterized using SEM-EDX, FTIR and TEM for morphology, elemental, functional groups and internal structure respectively. The physicochemical behavior of a refinery effluent was assessed. The untreated raw refinery effluent from the point of discharge contained very high concentrations of pollutants for all the parameters, ranging between, pH (6.52-6.82), Turbidity (10-12 NTU), conductivity (266-289 μs/cm), COD (116-138 mg/l), BOD (14-18.5 mg/l), DO (7.5-15.6 mg/l), TDS (436-486 mg/l), TSS (127-133 mg/l), Oil and grease (14.8-16.3 mg/l), sulphate (113-125 mg/l) and chloride (240-280 mg/l). The effluent was treated with ZnO nanoparticle and reduced the pollutants to the normal permissible limit set by WHO, FEPA and NESREA standard for portable water. The treated effluent sample showed values ranging between, pH (6.55-6.6), Turbidity (4.2-4.5 NTU), conductivity (245-264 μs/cm), COD (39-40 mg/l), BOD (10 mg/l), DO (1.6-10.4 mg/l), TDS (151-183 mg/l), TSS (24-28 mg/l), Oil and grease (7.3-9.5 mg/l), sulphate (100 mg/l) and chloride (200 mg/l). The heavy metals profile that was investigated are Fe, Cu, Zn, Pb, Cd and Cr of which were found above the WHO and FEPA permissible limit, however, on the contact with the adsorbent therefore reduced the metals to the permissible limit. It can be ascertain that ZnO nanoparticle can be used as an effective adsorbent for the treatment of petrochemical effluent.

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Keywords: physicochemical parameters, petrochemical effluent, ZnO, remediation.

Wastewaters released by crude oil-processing and petrochemical industries are characterized by the presence of large quantities of crude oil products, polycyclic and aromatic hydrocarbons, phenols, metal derivatives, surface-active substances, sulfides, naphthylene acids and other chemicals (Otokunefor and Obiukwu, 2005). Due to the ineffectiveness of purification systems, wastewaters may become seriously dangerous; leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem (Beg et al., 2001 and 2003). Various studies have shown positive correlation between pollutions from refinery effluents and the health of aquatic organisms. Previous observations suggested a correlation between contamination of water and sediments with aromatic hydrocarbons from refinery effluents, and compromised fish health (Kuehn et al., 1995). An earlier study by (Onwumere and Oladimeji, 1990) demonstrated the accumulation of heavy metals with accompanying histopathology in Oreochromis niloticus exposed to treated petroleum refinery effluent from the Nigerian National Petroleum Corporation, Kaduna. The waste water released from the refineries are characterized by the presence of large quantity of crude oil products, polycyclic and aromatic hydrocarbon, phenols, metal derivatives, surface active substances, sulfides, naphthylene acids and other chemicals (Otokunefor and Obiukwu, 2005). As a result of ineffectiveness of purification systems, wastewater may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem (Beg et al, 2003; Aghalino and Eyiinla,

*Corresponding Author Email: waschem06@gmail.com; Tel: +2348063029504
2009). Drinking contaminated water can cause various
diseases such as typhoid fever, dysentery, cholera and
other intestinal diseases (Adeyemi, 2004). According
to Gore (1993), human beings are made up of water,
in roughly the same percentage as water in the surface
of the earth. Our tissues and membranes, brains, and
hearts, our sweat and tears, all reflect the same recipe
for life. Water is essential for the development and
maintenance of the dynamics of every ramification of
the society (United Nations Development Program,
2006). Water is indeed life and thus is the most
important natural resource, without which life would
be non-existent. Availability of safe and reliable
source of water is an essential prerequisite for
sustained development (Asonye et al., 2007). Oil
prospecting in Nigeria has brought with it untold
hardship to the environment. Dwellers of oil
producing areas generally suffer from scarcity of farm
lands as their lands have been made unproductive due
to constant oil spillages and waste dump. One of the
most visible consequences of numerous oil spills had
been the loss of mangrove trees. The mangrove was a
source of both fuels for the indigenous people and a
habitat for the area’s biodiversity, but it is now unable
to be sourced due to the oil toxicity of its habitat. Oil
spills pose serious health risks to people when they
consume contaminated seafoods (Bogardy, 2004;
Onuoha, 2007). From several literatures search, it was
revealed that no research work has reported the
physico-chemical characterization and adsorption of
physicochemical parameters using synthesized zinc
oxide nanoparticle. Hence, the aim of this paper is to
assess the physicochemical properties of
petrochemical effluent and adsorptive nanoremediation of the effluent using zinc oxide nanoparticle.

MATERIALS AND METHODS

Synthesis of zinc oxide nanoparticle: Zinc oxide
nanoparticle was synthesized in accordance with the
reported method by Awodugba and Abdul-joeed,
(2013). Solution of zinc acetate dihydrate was
prepared by dissolving 3 g of the salt in 100 ml
dionized water and kept under stirring till the salt
totally dissolved. Solution of sodium hydroxide was
prepared by dissolving 6 g of the pellet in 100 ml of
dionized water and kept under stirring till the salt
totally dissolved. The solution of sodium hydroxide
was added to the solution of zinc acetate dihydrate in
drop wise. The precipitate was obtained and the pH of
the resultant mixture was adjusted to 11 using 0.1M of
HCl acid and NaOH. The solution was filtered using
nano-filtered machine. The precipitate obtained was
washed for three times using ethanol and oven dried at
80 °C for 6 hours. The equation of the reaction is
shown below:

\[
\text{Zn(CH}_3\text{COO)}_2 + 2\text{H}_2\text{O} + 2\text{NaOH} \rightarrow \text{Zn(OH)}_2 + 2\text{CH}_3\text{COONa}. \text{H}_2\text{O}
\]

\[
\text{Zn(OH)}_2 \rightarrow \text{ZnO} + \text{H}_2\text{O}
\]

After the completion of the synthesized ZnO
nanoparticle, it was characterized using Fourier
Transform Infra-red Microscopy (FTIR) on Perkin
Elmer Spectrum 100 FTIR spectrometer at wave
numbers 4000-400 cm\(^{-1}\), scanning electron
microscopy (SEM) was done using LEO 1450
Scanning Electron Microscope (Tungsten filament,
EHT 20.00kV) and Transmission Electron
MicroscopeJEOL JEM 1400 model for (TEM).

Sampling of Petrochemical Effluent: The sampling of
the petrochemical effluent was done according to the
method reported by (Otukunefor and Obiukuw, 2005).
The sample was collected once a month between June
2018 and February 2019. The effluent was collected at
the point of discharge with a 2 litre plastic hydrosb
water sampler and transferred to 2 litre polyethylene containers. The samples were transported in ice chests and analyzed for pH,
temperature and conductivity within an hour of
collection. Other physicochemical parameters were
analyzed later using refrigerated samples.

Physicochemical Analysis Procedure: An HACH
conductivity/TDS meter (Loveland, CO 80539) was
used for conductivity, mercury thermometer (0-
110°C) for temperature, An HACH pH meter and
turbid meter was used for pH and turbidity
determination. Dissolved oxygen (DO), biochemical
oxygen demand (BOD), chemical oxygen demand
(COD), total solid (TS), total dissolved solid (TDS)
and total suspended solid (TSS) were determined
using the method reported by Amigun et al., (2018).

Heavy Metals Analysis: About 100 ml of the effluent
were digested using 10 ml triple acid mixture (5:1:1 -
HNO\(_3\):HClO\(_4\):H\(_2\)SO\(_4\)) in a 250 ml conical flask placed
in a fume cupboard and heated on a hot plate until
the solution was reduced to 10 ml. Thereafter, it was
allowed to cool and make up to a mark with distilled
water, it was then filtered into a 50 ml standard flask
labeled and made ready for further analysis (Amigun
et al., 2018). The concentrations of the heavy metals
in the wastewater were determined using Atomic
Absorption Spectrometer (Perkin, 210 VGP model).

Adsorption procedure for physicochemical and heavy
metals: This was carried out using the method reported
by Jimoh et al. (2013) with slight modifications. A 25
ml of petroleum effluent was measured in to 100 ml
conical flask, about 0.1 g of the zinc oxide
nanoparticle was added and shaken in a flask shaker
machine for about 3 hours, the sample was filtered and filtrate was analyzed for physicochemical parameters. In the case of heavy metals, about 25 ml was taken from the already digested sample, about 0.1 g of the adsorbent was added, agitated on a flask shaker for 3 hours and the filtrate was analyzed using Atomic Absorption Spectrophotometer.

RESULT AND DISCUSSION

Spectroscopic Characterization of Zinc oxide Nanoparticle: Scanning Electron Microscopy- Electron Dispersive Spectroscopy (SEM-EDX): The morphology of the synthesized ZnO nanoparticle was investigated by scanning electron microscopy (SEM), as shown in Fig. 1. The SEM photograph shows that the powder was porous with spherical shape and smooth surfaces, homogenous and agglomerated.

Fig. 1: SEM image of ZnO nanoparticle

The Fig. 2 shows the EDX spectrum of ZnO nanoparticle. EDX spectrum shows predominant peaks which are identified as zinc and oxygen (Table 1). Hence, it has been shown that pure ZnO nanoparticles in this study can be prepared by precipitation method. The present result is in line with reported ZnO nanoparticle prepared by Swatil and Raut, (2012).

Transmission Electron Microscopy: Physical characterization of nanoparticles is commonly characterized using transmission electron microscope (TEM). The shape, pattern and actual particle size was obtained which is normally explained by TEM. ZnO synthesized from the present study showed a homogenous shape that seem to be near hexagonal or nanosphere at 50 nm (Fig. 3).

Fourier Transform Infrared Spectroscopy (FTIR): FTIR spectrum studies shown in fig. 4 gives information regarding the chemical bonding between Zn and O. The spectrum showed a broad peak around 3454.87 cm$^{-1}$ corresponding to O-H stretching, the peak at 1636.82 cm$^{-1}$ corresponding to C=O while the peak at 452.61 cm$^{-1}$ corresponding to Zn-O bend. The FTIR results support the synthesized ZnO nanoparticle.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Elements</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zinc</td>
<td>71.91</td>
</tr>
<tr>
<td>2</td>
<td>Oxygen</td>
<td>20.85</td>
</tr>
<tr>
<td>3</td>
<td>Carbon</td>
<td>4.2</td>
</tr>
<tr>
<td>4</td>
<td>Potassium</td>
<td>3.04</td>
</tr>
</tbody>
</table>

Table 1: EDX weight % of elements present in ZnO nanoparticle

Fig. 2: EDX spectrum of ZnO nanoparticle

Fig. 3: TEM image of ZnO nanoparticle

Fig. 4: FTIR spectrum of ZnO nanoparticle
Synthesis and Characterization of Zinc Oxide Nanoparticle….

Physicochemical Analysis of Petrochemical Effluent Result: The experimental data on physicochemical properties of water samples collected from Kaduna petroleum refinery industry is presented in Tables 2 and 3.

Table 2: The mean±SD concentration of physicochemical characteristics of petrochemical effluent before and after adsorption process (dry season) and comparison with standard permissible limit

<table>
<thead>
<tr>
<th>Physicochemical parameters</th>
<th>Raw value before adsorption</th>
<th>Raw value after adsorption</th>
<th>Standard limits (WHO)</th>
<th>Standard limits (FEPA)</th>
<th>Standard limits (NESREA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.82±0.001</td>
<td>6.6±0.001</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
<td>6-9</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>35±0.1</td>
<td>30±0.1</td>
<td>30</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>12±1.3</td>
<td>4.2±0.6</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Conductivity (µs/cm)</td>
<td>289±0.19</td>
<td>245±0.19</td>
<td>250</td>
<td>240</td>
<td>NS</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>138±0.11</td>
<td>40±0.11</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>18.5±0.8</td>
<td>10.3±0.8</td>
<td>10</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>15.6±0.5</td>
<td>10.4±0.2</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>TDS (mg/l)</td>
<td>486±2.26</td>
<td>183±2.26</td>
<td>250</td>
<td>200</td>
<td>NS</td>
</tr>
<tr>
<td>TSS (mg/l)</td>
<td>133±5.34</td>
<td>28±5.16</td>
<td>30</td>
<td>30</td>
<td>NS</td>
</tr>
<tr>
<td>Oil and grease (mg/l)</td>
<td>16.3±1.42</td>
<td>7.3±1.93</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Nitrates (mg/l)</td>
<td>0.46±0.01</td>
<td>0.19±0.01</td>
<td>50</td>
<td>44</td>
<td>20</td>
</tr>
<tr>
<td>Sulphates (mg/l)</td>
<td>125±1.23</td>
<td>100±0.82</td>
<td>100</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Chlorides (mg/l)</td>
<td>280±4.10</td>
<td>197±4.10</td>
<td>200</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 3: The mean±SD concentration of physicochemical characteristics of petrochemical effluent before and after adsorption process (rainy season) and comparison with standard permissible limit

<table>
<thead>
<tr>
<th>Physicochemical parameters</th>
<th>Raw value before adsorption</th>
<th>Raw value after adsorption</th>
<th>Standard limits (WHO)</th>
<th>Standard limits (FEPA)</th>
<th>Standard limits (NESREA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.52±0.011</td>
<td>6.55±0.011</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
<td>6-9</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>32±0.1</td>
<td>30±0.1</td>
<td>30</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>10±1.12</td>
<td>4.5±0.1</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Conductivity (µs/cm)</td>
<td>266±0.13</td>
<td>246±0.19</td>
<td>250</td>
<td>240</td>
<td>NS</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>116±0.02</td>
<td>39±0.11</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>14±0.2</td>
<td>10±0.1</td>
<td>10</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>7.5±0.5</td>
<td>5.6±0.2</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>TDS (mg/l)</td>
<td>436±2.35</td>
<td>151±1.112</td>
<td>250</td>
<td>200</td>
<td>NS</td>
</tr>
<tr>
<td>TSS (mg/l)</td>
<td>127±4.31</td>
<td>24±4.05</td>
<td>30</td>
<td>30</td>
<td>NS</td>
</tr>
<tr>
<td>Oil and grease (mg/l)</td>
<td>14.8±1.32</td>
<td>9.5±1.92</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Nitrates (mg/l)</td>
<td>1.8±0.01</td>
<td>1.19±0.01</td>
<td>50</td>
<td>44</td>
<td>20</td>
</tr>
<tr>
<td>Sulphates (mg/l)</td>
<td>113±2.23</td>
<td>100±0.41</td>
<td>100</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Chlorides (mg/l)</td>
<td>240±2.21</td>
<td>194±4.11</td>
<td>200</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

NB: WHO= World Health Organization, NESREA= National Environmental Standards Regulatory and Enforcement Agency, FEPA=Federal Environmental Protection Agency, NS= Not specify. The analysis are conducted in triplicate and the results were expressed as mean± standard deviation.

The physicochemical parameters of the effluents investigated during dry and raining seasons before and after adsorption are presented in Table 2 and 3. The pH values of these industrial effluents range from 6.52 to 6.82 before adsorption and 6.55 to 6.6 after adsorption, which are within permissible limit of portable water (FEPA, 1991 and WHO, 1983). The pH value is an important index of acidity or alkalinity and the concentration of hydrogen ion in ground water. It has also been reported that the toxicity of heavy metals in water also acquired at particular pH, which is crucial significance in deciding the quality of waste water effluent (Amigun et al., 2018).

Igwemmar et al. (2013) reported that biochemical reactions of aquatic organisms are temperature dependent. Increase in temperature of water body will promote chemical reactions in the water. Effects, such as bad odour and taste will result due to non solubility of gases such as oxygen. The temperatures obtained were between 32 to 35°C which are above the permissible limit of WHO and FEPA, but within the permissible limit of NESREA. After adsorption, the temperature fell within the permissible limit of WHO (30°C). The higher temperature obtained from the raining season might be due to the climatic condition, because temperature values are known to be dependent on the climatic condition at a particular geographical area and period. Turbidity is due to the presence of colloidal particles arising from clay and silt during rainfall, or from discharges of sewage and industrial wastes. The turbidity of the petroleum effluent obtained was between 10 to 12 (NTU) which are above permissible limit of WHO and FEPA, but after adsorption, the turbidity of the samples were ranged from 4.2 to 4.5, which are within the permissible limit of portable water. Conductivity measures the ionic content of the water and it is linked directly to total dissolved solids. The conductivity of the samples ranged between (266 – 289 µs/cm) which is above the permissible limit of WHO and FEPA and it can be
attributed to due to high dissolved inorganic minerals. After adsorption process the conductivity obtained was between (245-246 μs/cm) which is within the permissible limit of portable water. The Chemical Oxygen Demand (COD) determination is a measure of the oxygen corresponding to the portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant (Amigun et al., 2018). COD is one of the common measures of organic pollutant material in water. Its function is similar to BOD; they both measure the amount of organic compounds in water. The COD values obtained were between 116 to 138 mg/l which is above the permissible limit of WHO, FEPA and NESREA. After the adsorption process, the value fell within the permissible limit of 39 to 40 mg/l. The biological oxygen demand (BOD) is the rate of removal of oxygen by microorganisms in aerobic degradation of the dissolved organic matter in water over a 5-days period.

Its function is similar to COD; they both measure the amount of organic compounds in water. BOD values obtained were between 14 to 18.5 mg/l which is above the permissible limit. After adsorption, BOD of 10 mg/l was obtained which is within the permissible limit of WHO and FEPA. The dissolved oxygen concentrations (DO) obtained were (7.5-15.6 mg/L) which is higher than the treated DO after adsorption (5.6-10.4 mg/L), these treated values are within the permissible limit of WHO and FEPA. The lower value of treated effluent could be attributed to the presence of degradable organic matter by aerobic microbes. Uzoekwue and Oghosanine (2011) also reported that, it may be partly due to the displacement of dissolved oxygen by dissolved solids within the effluent. Total dissolved solids (TDS) content in water is a measure of salinity in the water body. A large number of salts are found dissolved in natural waters, the common ones are chlorides, carbonates, sulphates, and nitrates of calcium, magnesium, sodium and manganese. Water can be classified based on the concentration of TDS (Wilcox 1995), desirable for drinking (up to 500 mg/l), permissible for drinking (up to 1000 mg/l), useful for irrigation (up to 2000 mg/l), not useful for drinking and irrigation (above 3000 mg/l). In the present study, the wastewater has TDS value of 436 to 486 mg/l. Based on the above classification, it was observed that industrial wastewater effluents is above the permissible limit of WHO, FEPA and NESREA.

The value obtained after treatment with nanoparticle adsorbent is 151 to 183 mg/l which is within the permissible limit. Total suspended solids (TSS) are the dry weight of suspended particles that are not dissolved in a sample of water. The values obtained for TSS before adsorption was 127 to 133 mg/l, which is higher than the permissible limit. After the treatment of the effluent with ZnO nanoparticle, the value fell within the permissible limit of 24-28 mg/l. In the present investigation, the average oil and grease content varies between (14.8 -16.3 mg/l), which is above the WHO permissible limit of (10 mg/l). The concentration fell between (7.3 – 9.5 mg/l) which is moderately between the permissible limit. It is essential to note that oil which forms a surface film on the river can coat plants and animals reducing oxygenation from the atmosphere.

The film of oil that floats over the water body affects the transmission of light through the water body there by disturbing the process of photosynthesis in the aquatic plants (Lokhande et al., 2011). Sulphates cause water hardening and therefore high levels are not recommended. The presence of Na₂SO₄ and MgSO₄ in drinking water beyond the prescribed limit may cause cathartic action. Sulphate may undergo transformations to hydrogen sulphide depending largely upon the redox potential of water. This is also an important anion imparting hardness to the water. The SO₄ ion concentration in the present studied water sample was found between 113 to 125 mg/l, which exceeds the WHO permissible limit. After treatment the value fell within the permissible limit of 100 mg/l.

Table 4: The mean±SD concentration of heavy metals of petrochemical effluent before and after adsorption process (dry season) and comparison with standard permissible limit

<table>
<thead>
<tr>
<th>Physicochemical parameters</th>
<th>Raw value before adsorption</th>
<th>Raw value after adsorption</th>
<th>Standard limits (WHO)</th>
<th>Standard limits (FEPA)</th>
<th>Standard limits (NESREA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>1.270±0.1</td>
<td>0.99±0.11</td>
<td>20</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.84±0.12</td>
<td>0.32±0.14</td>
<td>1.0</td>
<td>2.0</td>
<td>1</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.482±0.25</td>
<td>0.281±0.12</td>
<td>1.0</td>
<td>1.0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.38±0.2</td>
<td>0.013±0.01</td>
<td>0.01</td>
<td>0.001</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.233±0.1</td>
<td>0.0014±0.01</td>
<td>0.003</td>
<td>0.005</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.310±0.5</td>
<td>0.08±0.01</td>
<td>0.1</td>
<td>0.05</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Table 5: The mean±SD concentration of heavy metals of petrochemical effluent before and after adsorption process (rainy season) and comparison with standard permissible limit
The presence of chloride in natural water can be attributed to the salt deposits, discharge of effluents from chemical industries, sewage discharges etc. Each of these sources may cause the local contamination of both surface and ground water. Chloride content in the petrochemical effluent studied was found between 240 to 280 mg/l. This level of chloride content is above the permissible limit of WHO standards (200 mg/l). After adsorption process the values fell within the acceptable limit set by WHO.

Heavy metals analysis results: The experimental data on heavy metal analysis of water samples collected from Kaduna petroleum refinery is presented in Tables 4 and 5.

Heavy metal concentration in raw untreated petrochemical effluent samples was experimented to range from 0.213 to 1.270 mg/l, with most of these metals above the permissible limit such as Pb, Cd and Cr. However, Fe, Cu and Zn were found to be within the permissible limit by WHO and FEPA. After adsorption using ZnO nanoparticle, all the effluent samples fell within the permissible limit of WHO, FEPA and NESREA, ranging from 0.001 to 0.99 mg/l.

Conclusion: The results obtained in this research shows that most of the parameters are not within the standard specifications. Such effluent should not be discharged into the nearby water body or soil without treatment. They are unfit for irrigation and probably consumption. The high level pollution of the industrial effluents causes environmental problems which will affect plant, animal and human life.

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