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Particle Size Effect on the Physicochemical Parameters of Water Media in Treatment of Contaminants of AGO and PMS

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Abstract

Some of the physicochemical properties of contaminated water media with AGO and PMS was monitored upon the particle size effect and mix ratio. The physiochemical parameters monitored are potassium ammonia, iron and manganese concentration upon the performance of the formulated adsorbent immersed in the salt water and fresh water medium. The investigation demonstrates the occurrence of leaching in the process, which shows that some of the parameters adsorbed by the adsorbent returned back (reversible process occurred) into the contaminated system and this was attributed to saturation of that particular substance adsorbed as well as inability of the adsorbent to continuedly adsorbent more of the substance. The investigation revealed that the occurrence of the reversible process is within the adsorption time of 3 hours. The reversible process was experienced in most cases of the adsorbent after immense in the contaminated medium for the treatment of the AGO and PMS. The contaminants as labeled as AGO is diesel and the PMS is petrol motor spirit and it was observed that the rate of adsorption was dependent of its density and viscosity. This research is experimentally based research, in which the produced adsorbent performance was tested on the mitigation of some physicochemical parameters as presented in this study. The study also revealed that the water medium was contributing to the rate of substance removal or adsorbed by the adsorbent immersed in each contaminated batch unit.

Keywords: AGO, PMS, treatment, contaminants, physicochemical, parameters, effect

INTRODUCTION

The history of clean-up of oil spill started with natural and manual methods. As these methods could not completely remove traces of oil in water, researchers focused on developing chemical and synthetic products to improve the efficiency of clean-ups. This led to the development of synthetic organic sorbents such as polyurethane, polypropylene and polyethylene materials. To improve their oleophilic and hydrophobic properties, other products were added by copolymerization [1]. Though their sorbent characteristics improve greatly, the use of these synthetic products had a major disadvantage. They are not biodegradable and also very expensive. In a world now more sensitive to its environment, research pushed further to develop eco-friendly products. This led researchers to focus on the development of clean up materials from natural and agricultural products [2-4].

Clay had been discovered as a product good for adsorption and so research focused into the use of natural clay and later modified clay as a substitute

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for the synthetic products. I have reviewed in this chapter various combinations of clay with other agricultural products and their performances in remediation of oil spill [5]. They included natural Clay, Clay modified with surfactants, Clay minerals, Mixture of Clay and Sawdust. Agricultural products such as Rice husks, Cotton, Kapok, Sawdust. All these came out with very interesting results especially on costs and biodegradability [6-7].

However, none of these studies have looked at other locally available products such as using mixtures of Plantain and Banana stems with clay for remediation [8-9]. This is the main limitation of previous researches. It will therefore be novel to examine the performance of these mixtures as a way of deepening research and adapting it to its environment with locally available agricultural products. The result will be interesting as it will certainly reduce costs in addition to satisfying environmental concerns [10-13].

One of the major problems today in the Niger Delta of Nigeria is the issue of pollution of the environment with crude oil and its products [14-19]. While some of these pollution cases arises from operations of the oil companies in the region, many more others happen as a result of deliberate actions of sabotage and artisanal refining of crude petroleum in the creeks of the Niger Delta [20-23].

MATERIALS AND METHODS

Sample collection: The water samples were collected from Arashi River located in Ahoada main town in Ahoada East Local Government Area of Rivers State and lebelled as fresh water and the salt water was collected from Eagle Island River located at the back of the Rivers State University Port Harcourt. All the water samples were transported to the laboratory for analysis.

Clay Soil Sample

The clay soil was obtained with the Rivers State and then transported to the laboratory for analysis.

Agro – Based Raw Materials

The agro – base raw materials were obtained with the Rivers State and then transported to Laboratory for analysis.

Processing of the Raw Materials

Each of the raw materials was processed to obtain the required standard before mixing the clay soil with the agro – based raw material to produce the adsorbent with different mixed ratios.

Particle size description: 5.0 g of clay soil weighted and subjected into air dried and introduced to 500 mL dispersing cup and the dispersing solution of 20ml was added into the system. The process continuous by allowing the soil sample inside the cup to soak and the solution remain for 15 minutes and the battle instrument was dispersed into the cup as well as the blade use din stirring solution in the cup for period of 10 minutes. The process allows the sieve of the different particle sizes into different respectively sizes and the mathematical approach.

Calculation Approach

Let D_1 and D_2 represents hydrometer readings

T_1^1 and T_2^1 represents temperature in ^0F for period of 40 seconds as well as 2 hours.

Let T^0F represent calibration temperature of the hydrometer at 20^0C

Therefore,

$$\% \text{ (silt + day)} = D_1 + 0.2\ (T_1^1\text{-}T) - 2.0] \text{ x } \frac{100}{50} \quad (1)$$

$$\% \text{ clay} = D_2 + 0.2\ (T_2^1 - T) - 2.0] \text{ x } \frac{100}{50} \quad (2)$$

$$\% \text{ sand} = 100 - \% \text{ (silt + clay) for 51g sample} \quad (3)$$

Experimental Procedure

The adsorbents were produced by mixing the clay soil with the different agro – based materials and the particle sizes used are 1.18mm, $150\mu m$, $300\mu m$ and $600\mu m$ as well as the mixed ratios used are R1:9, R2:8, R3:7, R4:6, R5:5, R6:4 and R5:5. The formulated adsorbents were immersed in the contaminated plastic containers which contains AGO and PMS in water medium. The sampling period was one hour interval for five hours monitoring. Samples were collected and analysis was conducted to ascertain the variation in some of element and compound, such as potassium, ammonia iron and magenses. The obtain result from the sampling were recorded.

Iron (Ferric Oxide)

Procedure

1. Air dry soil samples and crush to pass a 10- mesh sieve. Scoop 5 g of soil without pressing the soil against the side of the container. Firmly tap the handle of the scoop three times with an 8 inch spatula and level off the soil by passing the spatula over the scoop, holding the spatula at a 90° angle.
2. Add the measured volume of soil to a 50 mL Erlenmeyer flask, tapping the scoop on the transfer funnel or flask to remove all of the soil from the scoop.
3. Add 20 mL of the extracting solution to each flask, place on the shaker and shake at 180 rpm or more for 30 minutes.
4. Filter through washed Whatman No. 2 filter paper (or equivalent) into 30ml polypropylene beakers.
5. Carry a blank through the entire procedure with each run.
6. Determine Zn in the extracts with the AA unit using appropriate instrument settings and Zn standards.

RESULTS AND DISCUSSION

The results obtained from the research are showcased in Figure 1 to 9 for the purpose of monitoring the effect of particle size on the formulated adsorbents for the treatment of contaminated water media with AGO and PMS.

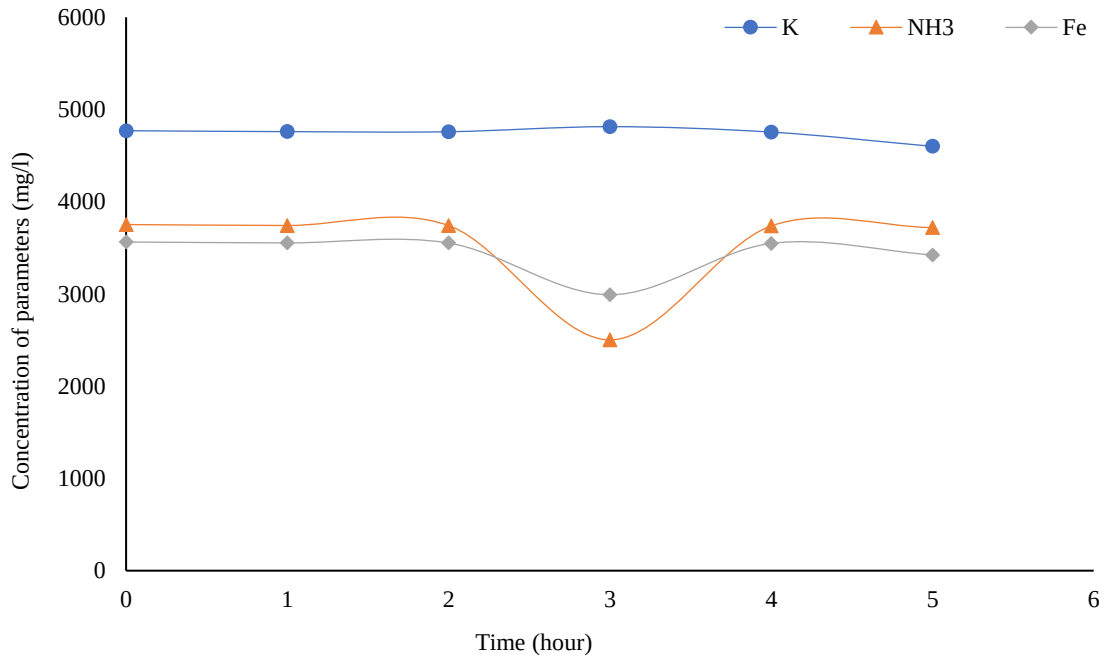

Figure 1. Variation of concentration of parameters versus time in Container 2 containing Plantain Ogoni Red in Fresh Water & AGO and clay adsorbent (R2:8, 300um).

Figure 1 shows the effectiveness of the adsorbent mixture of 2:8 ratio of particle size 300μm in the adsorption of Potassium (K), Ammonia (NH_3) and Iron (Fe) in fresh water medium contaminated with AGO. The adsorbent consists of 20% of plantain Ogoni red (POR) sample and 80% of clay soil sample. The formulated adsorbent was moulded in spherical shape and calcineed in an oven at temperature of 500℃ to 600℃ for the period of 5 hours and no ash content stage was obtained, rather the bonding strength of the adsorbent increased. This process enhanced the kinetic value of the adsorbent as well as its strength to withstand the fresh water environment contaminated with AGO without dissolving, but rather mitigate parameters adsorbent by the adsorbent. Decrease in ammonia (NH_3) and Iron (Fe) was observed from above zero hour to 3 hour before sudden increase was experienced. This shows that the adsorbent has attained the saturated point of ammonia (NH_3) and Iron (Fe) in take by the adsorbent rather leaching of the initial adsorbed parameters back to the contaminated fresh water medium was observed. For the case of Potassium (K) continuous adsorption of the component was experienced from above zero hour to 5 hours and no leaching was observed as demonstrated in experimental set-up of container 2.

Figure 2 shows that effect of adsorbent mixed in the ratio of 3:7 of plantain Ogoni red (POR) clay soil sample of 600μm of particle size with contact time. Decrease in concentration of the following parameters like Potassium (K), Ammonia (NH_3) and Iron (Fe) was experienced with increase in contact time for a period of above zero hour to 3 hours and sudden increase in the concentration of parameters investigated was seen, revealing the effect of leachate of the adsorbent to the fresh water container 3. The result further showcases that concentration of potassium (K) > concentration of Iron (Fe) > concentration of Ammonia (NH_3), both in the adsorption process of forward and backward. The research further revealed that the formulated adsorbent mixture possesses the characteristics of adsorbing potassium (K), ammonia (NH_3), and Iron (Fe) for the period of 3 hour effectively without reversible process taking place in the medium. The same process of calcination was carried out during the preparation of the adsorbent.

Figure 3 shows how the characteristics of potassium (K), ammonia (NH3), and iron (Fe) vary in container 4 containing plantain Ogoni red with fresh water medium contaminated with AGO as the adsorption time period increases using an adsorbent mixture of R4:6 10% to 90% ratio of plantain Ogoni red (POR) to clay soil sample of both with particle size of 600μm. Potassium (K), ammonia (NH_3), and Iron (Fe) levels decreased from zero hour to hour 2 samples, according to the parameters indicated in Figure 3, before abruptly increasing after hour 3. This showed that the adsorbent had reached a very saturated point after two hours, and that a reversible process had taken place in which the adsorbed parameters were leached back into the system. The magnitude of the parameters in container 4 as per the pollution level is further illustrated in Figure 3, where K > NH3 > Fe for the AGO. In the heating oven, the prepared adsorbent was carbonized for five hours at a temperature between 500 and 600 °C without reaching the ash content stage.

Figure 4 shows the variance characteristics of potassium (K), ammonia (NH3), Iron (Fe) and Manganese (Mn) in container 5 containing plantain Ogoni red with fresh water medium contaminated with AGO as the adsorption time period increases using an adsorbent mixture of 5:5 10% to 90% ratio of plantain Ogoni red (POR) to clay soil sample of both with particle size of 600μm. Potassium (K), Iron (Fe) and Manganese shows almost a similar trend of movement from hour 0 to hour 5, except for the fact that the concentration of Potassium (K) in container 5 was above 10000mg/l where Iron (Fe) and manganese were both below 2000mg/l. Whereas Ammonia shows the concentration of 7000ml at hour 0 and increased to concentration of over 8000mg/l from hour 1 to hour 3, before a decease took place in hour 4 and then a slight increase in hour 5 as seen in Figure 4. The magnitude of the parameters in container 5 as per the pollution level is further illustrated in Figure 4, where K > NH3 > Fe > Mn for the AGO. In the heating oven, the prepared adsorbent was carbonized for five hours at a temperature between 500 and 600 °C without reaching the ash content stage.

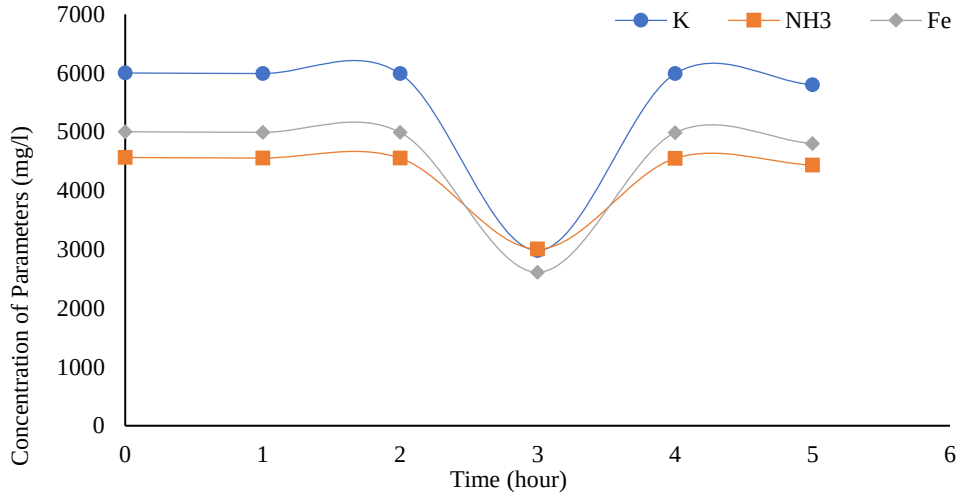

Figure 2. Variation of concentration of parameters versus time in Container 3 containing Plantain Ogoni Red in Fresh Water & AGO and clay adsorbent (R3:7, 600um).

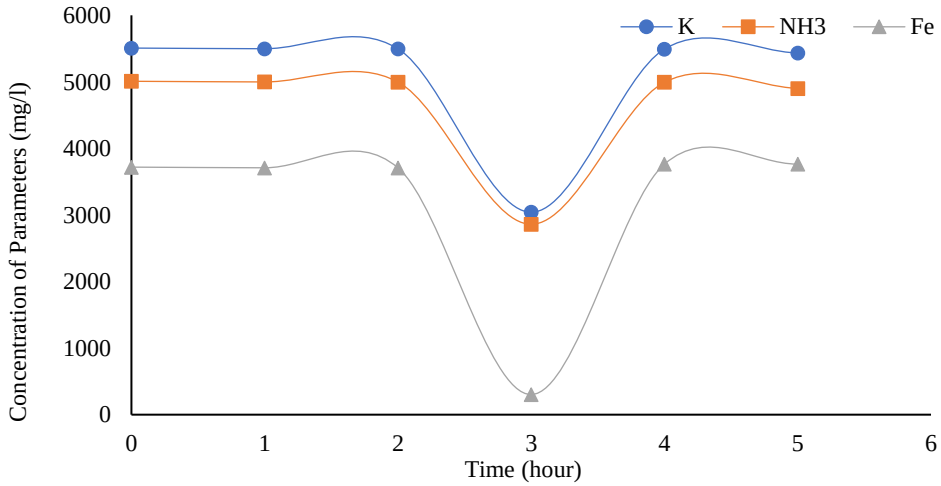

Figure 3. Variation of concentration of parameter versus time in Container 4 containing Plantain Ogoni Red in Fresh Water & AGO and clay adsorbent (R4:6, 600um).

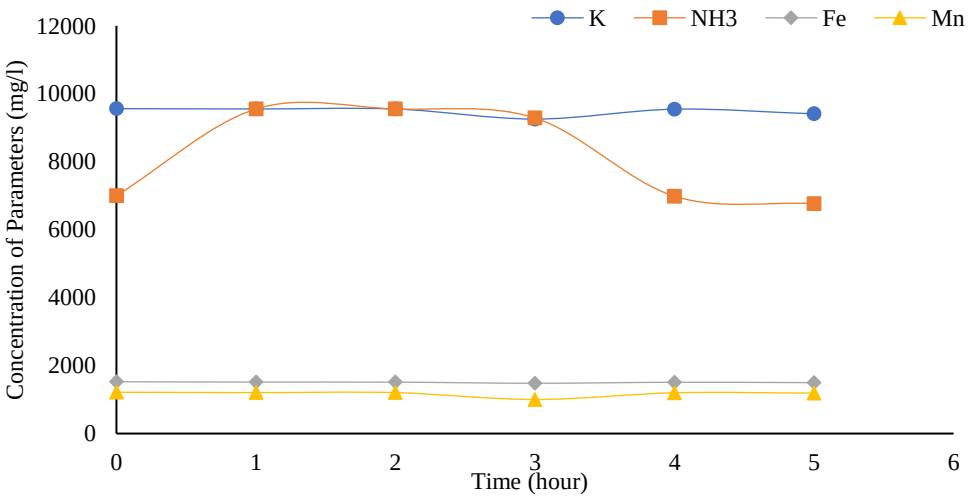

Figure 4. Variation of concentration of parameter versus time in Container 5 containing Plantain Ogoni Red in Fresh Water & AGO and clay adsorbent (R5:5, 600um)

Figure 5 depicts the results of an adsorbent mixture with a 600 μm particle size plantain Ogoni red (POR) clay soil sample in a R1:9 ratio. Potassium (K), ammonia (NH3), and iron (Fe) concentrations decreased with increased contact time for a period of more than one hour to three hours, and a sudden increase in the concentration of the parameters under investigation was observed, revealing the effect of the adsorbent's leachate into the fresh water container 1. The outcome further demonstrates that, both in the forward and backward adsorption processes, the concentrations of potassium (K) and iron (Fe) are greater than those of ammonia (NH3). The research further revealed that the formulated adsorbent mixture possesses the characteristics of adsorbing potassium (K), ammonia (NH_3), and Iron (Fe) for the period of 3 hour effectively without reversable process taking place in the medium. The same process of calcine was carried out during the preparation of the adsorbent.

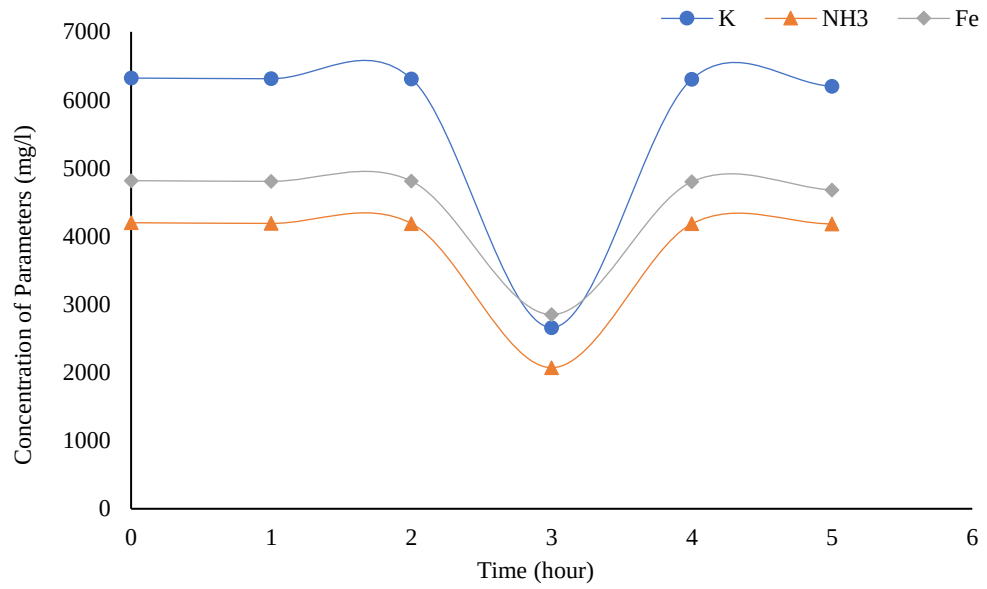

Figure 5. Variation of concentration of Potassium (K), Ammonia (NH3) and Iron (Fe) versus time (hour) in Container 1 containing Plantain Ogoni Red in Salt Water & PMS and clay adsorbent (R1:9, 150um).

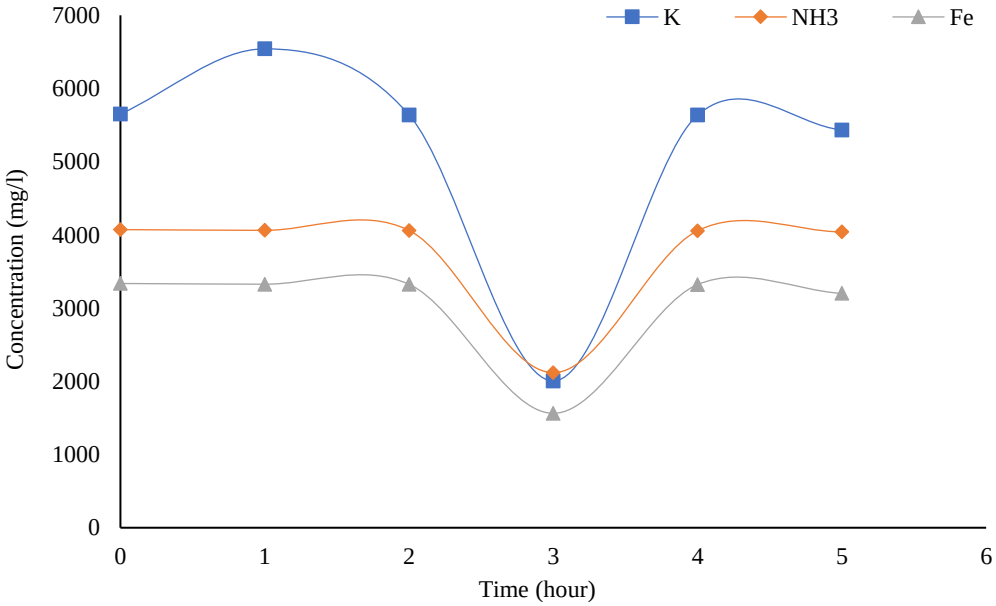

Figure 6. Variation of Concentration of Parameters with Time (hour) in Container 2 containing Plantain Ogoni Red in Salt Water & PMS and clay adsorbent (R2:8, 300um).

Figure 6 shows the impact of an adsorbent combined in a R2:8 ratio with a 300-m-particle-size plantain Ogoni red (POR) clay soil sample is depicted in Figure 6, Potassium (K), ammonia (NH3), and iron (Fe) concentrations decreased with increased contact time for a period of more than one hour to three hours, and a sudden increase in the concentration of the parameters under investigation was observed, revealing the effect of the adsorbent's leachate into the salt water container 2. The outcome further demonstrates that, both in the forward and backward adsorption processes, the concentrations of potassium (K) and ammonia (NH3) are greater than those of Iron (Fe). The study also showed that the developed adsorbent combination has the ability to successfully adsorb potassium (K), ammonia (NH3), and iron (Fe) over a duration of three hours without any reversible processes occurring in the medium. The adsorbent preparation technique utilized the same calcine procedure.

Figure 7 shows that effect of adsorbent mixed in the ratio of R3:7 of plantain Ogoni red (POR) clay soil sample of 600μm of particle size with contact time. Decrease in concentration of the following parameters like Potassium (K), Ammonia (NH_3) and Iron (Fe) was experienced with increase in contact time for a period of above zero hour to 3 hours and sudden increase in the concentration of parameters investigated was seen, revealing the effect of leachate of the adsorbent to the salt water container 3. The result further showcases that concentration of Ammonia (NH_3) > concentration of Iron (Fe) > concentration of potassium (K) both in the adsorption process of forward and backward. The research further revealed that the formulated adsorbent mixture possesses the characteristics of adsorbing potassium (K), ammonia (NH_3), and Iron (Fe) for the period of 3 hour effectively without reversable process taking place in the medium. The same process of calcine was carried out during the preparation of the adsorbent.

Figure 8 reveals the variation of concentration of parameters versus time (hour) in container 4 containing plantain Ogoni Red in Salt water of PMS, showing that effect of adsorbent mixed in the ratio of R4:6 of plantain Ogoni red (POR) clay soil sample of 1.18mm of particle size with contact time. Decrease in concentration of the following parameters like Potassium (K), Ammonia (NH_3) and Iron (Fe) was experienced with increase in contact time for a period of above zero hour to 3 hours and sudden increase in the concentration of parameters investigated was seen, revealing the effect of leachate of the adsorbent to the salt water container 3. The outcome further demonstrates that, in the forward and backward adsorption processes, the concentrations of ammonia (NH3), iron (Fe), and potassium (K) are in ascending order.

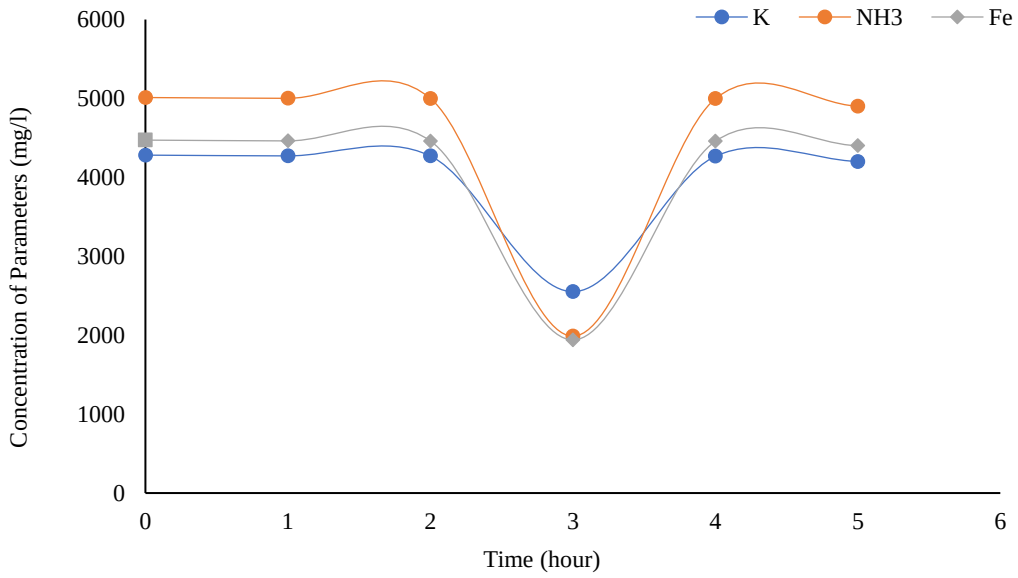

Figure 7. Variation of concentration of Potassium (K), Ammonia (NH3) and Iron (Fe) versus Time (hour) in Container 3 containing Plantain Ogoni Red in Salt Water & PMS and clay adsorbent (R3:7, 600um).

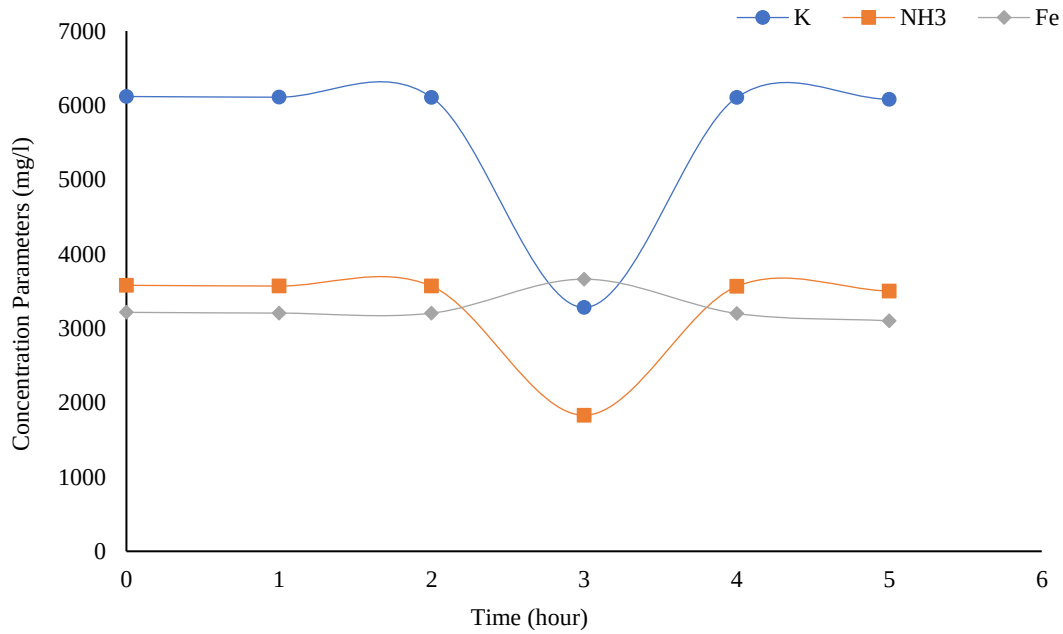

Figure 8. Variation of concentration of parameter versus time (hour) in container 4 containing Plantain Ogoni Red in Salt Water & PMS and clay adsorbent (R4:6, 1.18mm).

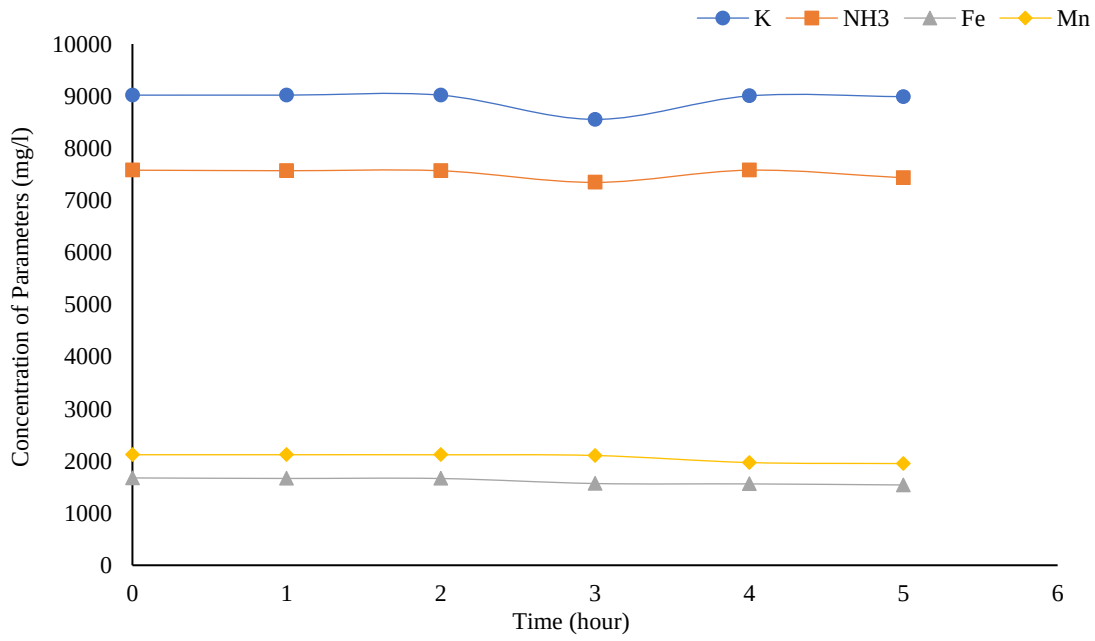

Figure 9. Variation of concentration of Parameter versus Time (hour) in Container 5 containing Plantain Ogoni Red in Salt Water & PMS and clay adsorbent (R5:5, 150μm).

The study also showed that the developed adsorbent combination has the ability to successfully adsorb potassium (K), ammonia (NH3), and iron (Fe) over a duration of three hours without any reversible processes occurring in the medium. The adsorbent preparation technique utilized the same calcine procedure.

Figure 9 demonstrates the concentration of parameter, potassium, ammonia, iron and manganese in terms of variation were compared with time in container 5 containing plantain Ogoni Red in Salt Water

polluted with PMS and clay adsorbent with the ratio R5:5 and soil sample of particle size 150μm. The result shows decrease of the concentration of parameters on the effect of contact time. The flow was demonstrated in this order, the concentration of potassium (K) > the concentration of ammonia (NH3) > the concentration of iron (Fe) > the concentration of manganese.

CONCLUSION

The trend of the substance adsorbed by the adsorbents demonstrates the significance of the formulated adsorbents in treatment of contaminated water medium. Increase in adsorbing the substance of interest was observed with increase in contact time. The thesis shows decrease in TPH, sulphur (S), nitrogen (N), ammonia (NH_3), phosphorus (P), potassium (K), copper (Cu), iron (Fe) and other formulated adsorbent possess the characteristics of adsorbing TPH and other substance or parameters as listed above. The performance of the adsorbents was related to the particle size and mix ratio effect and the research revealed that all the formulated adsorbents are effective and possess the potential to enhance adsorption processes without any menace or challenges in the process. The strength of the formulated adsorbent in water medium before dissolving was monitored and the research revealed that most of the adsorbent withstand up to 3 hours and some more than 5 hours and some more 6 months without dissolving and this was attributed to particle size and mix ratio.

The investigation revealed that each adsorbent formulated possess the required potential of adsorbing both the AGO and PMS in fresh and salt water environment or media within 3 hours without occurrence of reversible process. The formulated adsorbents mitigate nitrogen, copper, ammonia, iron, sulphur, manganese, potassium and phosphorus content and the reduction in the content or concentration of each component or parameter was attributed to the rapid rate of adsorbent, immersed in each system set-up for the investigation. The comparison of adsorbents in terms of the parameter adsorption shows that the controlling factors are particle size and mix ratio of the clay to the other agro-based materials such as Plantain Ogoni Red (POP), Banana Ogoni Red (BOR) and Plantain Agbagba 1. The adsorbent of particle size (PS) and mix ratio (mix R) of Mix R1:9 of PS 150µm, mix R2:8 of PS 300µm, mix R3:7 of PS 600µm, mix R4:6 of 1.18mm and mix R5:5 of PS 150µm was tested in both salt and fresh water polluted with PMS and AGO for the purpose of treatment to enhance the removal or adsorbing nitrogen (N), copper (Cu), Iron (Fe), manganese (Mg), ammonia (NH_3), sulphur (S) and others as demonstrated in this thesis. All the formulated adsorbents possess the potential of adsorbing any of the element investigation, both the adsorbent formulation of Mix R 1:9 of SP 150µm and Mix R 4:6 of PS 1.18mm was more effective compare to other as shown in this thesis.

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