# ADSORPTION OF PHOSPHATE USING NATURALLY AVAILABLE ADSORBENTS

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***Abstract:*** *The adsorption of phosphate on laterite soil, black cotton soil and Fuller's earth was investigated at room temperature in this study. The major goals of this research are to investigate the physio-chemical features of Laterite soil, Black cotton soil and Fuller's earth, Phosphate removal by adsorbents is measured as a function of contact time, adsorbents dosage, and pH. Although the adsorption approach is most commonly employed for the treatment of water and waste water, the goal of this study is to find a Naturally Available adsorbents. The optimum contact time for Phosphate removal by Laterite soil, Black cotton soil, and Fuller's earth was found to be 55 minutes, 60 minutes, and 50 minutes, with removal efficiency of 65 percent, 70 percent and 60% respectively. The optimum Phosphate removal dosages for Laterite soil, Black cotton soil, and Fuller's earth are 1000mg, 1200mg and 800mg, with removal efficiency of 67 percent, 70 percent, and 63 percent respectively. Laterite soil, Black cotton soil, and Fuller's earth have ideal pH for removing phosphate, which are 7.5, 7 and 6.5 with removal efficiency of 64 percent, 62.5 percent, and 66 percent respectively.*

**Key Words**– Phosphate, Adsorption, Contact time, Dosage, PH.

## I. INTRODUCTION

Excess phosphate in water bodies promotes the growth of photosynthetic algae and toxic cyanobacteria. Phosphate removal from wastewater has been accomplished using a variety of techniques, the most common of which are chemical precipitation, biological treatments, and adsorption. Among these, adsorption is regarded as a dependable and effective method of phosphate removal. High adsorption capacity and low cost are important factors to consider when choosing an adsorption method. In recent years, Naturally Available adsorbents have received a lot of attention, particularly natural mineral and industrial wastes such limestone, iron-based compounds, aluminum-based compounds, natural zeolite, iron oxide tailing, ferric sludge, blast furnace slag, and other materials.

One of the most effective methods for removing Phosphate from wastewater is 'ADSORPTION.' However, standard adsorbents such as silica gel and others are expensive. Naturally Available adsorbents, such as Laterite soil, Black cotton soil, and Fuller's earth, are readily available and can serve as a cost-effective alternative.

Phosphate-containing wastewater is a major polluter of the environment. If it exceeds the allowable limit, it causes a serious problem known as eutrophication in water bodies, as well as bone and muscle problems and increases the risk of heart attacks and strokes in humans.

### 1.1Scope of the study

The waste from the industries and untreated waste from many sources is discharged into the environment, it affects the living beings hence, and adsorption is one of the treatment methods for the removal of heavy metals. For this study the naturally available Naturally Available adsorbents like red soil, black cotton soil and fullers earth soil are used for the removal of heavy metal namely phosphate.

### 1.2Objectives of the study

To evaluate a feasible and economical low-cost treatment of Phosphate, as present in synthetic sample by Black cotton soil, Laterite soil and Fuller's earth which are naturally available as an adsorbents.

- To study the physical properties of adsorbents like Laterite soil, Black cotton soil and Fuller's earth.
- Adsorbing capacity of Laterite soil, Black cotton soil and Fuller's earth. on adsorption of Phosphate as a function of contact time, adsorbents dosage and ph.

## II. Literature review

**Nia Gray-Wannell, Peter J. Holliman, H. Christopher Greenwell, Evelyne Delbos1 and Stephen Hillier (August 2020):** Have studied the "Adsorption of phosphate by halloysite (7 Å) nanotubes (HNTs)". The adsorption and retention of phosphates in soil systems is of wide environmental importance, and understanding the surface chemistry of halloysite (a common soil clay mineral) is also of prime importance in many emerging technological applications of halloysite nanotubes (HNTs). The adsorption of phosphate anions on tubular halloysite (7 Å) has been studied to gain a greater understanding of the mechanism and kinetics of adsorption on the surface of HNTs. Two well-characterized tubular halloysites with differing morphologies have been studied: one polygonal prismatic and one cylindrical, where the cylindrical form has a greater surface area and shorter tube length. Greater phosphate adsorption of up to 42 μmol g–1 is observed on the cylindrical halloysite when compared to the polygonal prismatic sample, where adsorption reached a maximum of just 15 μmol g–1 compared to a value for platy kaolinite (KGa-2) of 8 μmol g–1. Phosphate adsorption shows strong pH dependence, and the differences in phosphate sorption between the prismatic and cylindrical morphologies suggest that phosphate absorption does not occur at the same pH-dependent alumina edge sites and that the lumen may have a greater influence on uptake for the cylindrical form.

**Xiaoyan Yang, Xiangwei Chen, Xitian Yang (2019):** Have Studied the" Effect of Organic Matter on Phosphorus Adsorption and Desorption in A Black Soil from Northeast China". Phosphorus (P) adsorption–desorption in soil is an important internal cycle related to soil fertility problems, as well as for determining the environmental fate of P. Soil organic matter (SOM) has been identified as an important factor affecting the adsorption–desorption of soil P through different mechanisms. In this study, humic acids were added to change the SOM content in black soil. Following an incubation period of 30 days, the changes in soil P adsorption–desorption capacity were studied. The results indicated that increased SOM led to increases in the soil available P and the P activation coefficient. All soil treatments fitted well with both Langmuir and Freundlich equations. The P adsorption and desorption characteristics were analysed using the Langmuir equation as a local isotherm. The maximum adsorption capacity of P increased with the increase in SOM, but the P bonding energy and maximum buffering capacity first decreased, and then increased, with the lowest values obtained with a SOM content of 75.3 mg $kg^{-1}$. Both the maximum desorption capacity of P and the ratio of soil P desorption showed a fluctuating trend, which were the greatest when the SOM content reached 75.3 g $kg^{-1}$ in black soil, showing an improved ability to release P. Thus, the addition of organic matter could efficiently enhance P availability by reducing the strength of P adsorption and the maximum phosphate buffering capacity and increasing the desorption of P to some extent, with the greatest P availability obtained at a SOM content of 75.3 g $kg^{-1}$.

## III.MATERIALS AND METHODOLOGY

### 3.1 Selection of Suitable Adsorbents

**Laterite soil:** It's a sort of soil and rock that's high in iron and aluminum, and it's thought to have originated in hot, humid tropical climates. Because of the high iron oxide content, nearly all laterites are rusty-red in colour. Because of the high iron oxide content, nearly all laterites are rusty-red in colour. They form as a result of extensive and long-term weathering of the parent rock. Tropical weathering (laterization) is a long-term chemical weathering process that results in a wide range of soil thickness, grade, chemistry, and ore mineralogy. Between the tropics of Cancer and Capricorn, the majority of the geographical area containing laterites is found. As shown in Figure 1. Availability of Laterite soil in India as shown in Figure 2.

Figure 1: Laterite Soil

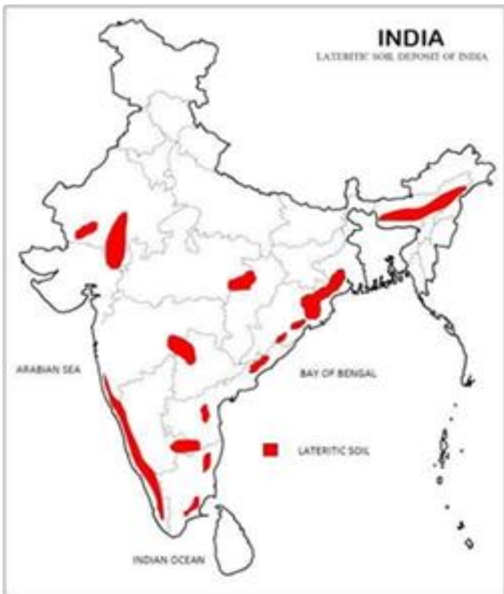


Figure 2: Availability of laterite soil in India

**Black cotton soil:** Black soil is also called as Black cotton soil as its colour is black. The central, western, and southern states of India, including Karnataka, have black cotton soil. One of India's biggest soil deposits is black cotton soil. When wet, they are extremely tenacious of moisture and extremely sticky. Large and deep fractures arise as a result of the significant contraction that occurs during the drying process. These soils have a lot of iron and a lot of lime, magnesia, and alumina. Nitrogen, phosphorus, and organic matter are all deficient in black soils. Montmorillonite and the bielliptic group of clay minerals are abundant in the soils. As shown in Figure 3. Availability of Black cotton soil in India as shown in Figure 4.

**Figure :3 Black cotton soil**

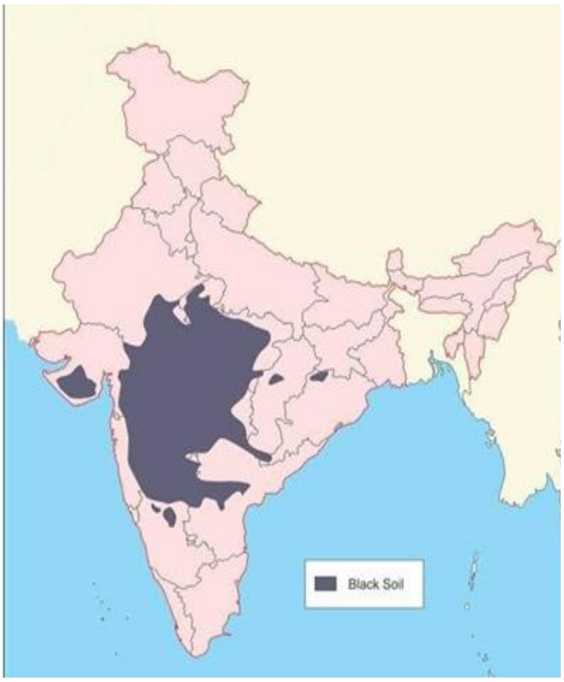


**Figure 4: Availability of Black cotton soil in India**

**Fuller's earth:** It's a clay material that can decolorize oil and other liquids without the need of chemicals. Palygorskite (attapulgite) or bentonite are the most common components of Fuller's earth. Fuller's earth is now used as an absorbent for oil, grease, and animal waste (cat litter), as well as a pesticide and fertilizer carrier. Filtering, clarifying, and decolorizing; active and inactive ingredients in beauty goods; and filler in paint, plaster, adhesives, and medications are just a few of the minor applications. As shown in Figure5.

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**Figure 5: Fuller's earth**

The physio-chemical characteristics of Naturally Available adsorbents are shown in table-1

**Table -1: Physio-Chemical characteristics of adsorbents**

| SI.NO | Characteristics | units | Laterite soil | Black cotton soil | Fuller's earth |
|---|---|---|---|---|---|
| 1 | Moisture Content | % | 3.6 | 6 | 5.6 |
| 2 | Ph | --- | 7.0 | 7.2 | 6.7 |
| 3 | Specific Gravity | --- | 2.46 | 2.54 | 1.88 |
| 4 | Bulk Density | g/cc | 1.38 | 1.21 | 0.96 |
| 5 | Colour | | Red | Black | Light Grey |
| 6 | Surface Area | $m^2/g$ | 453 | 520 | 750 |

## IV. RESULTS AND DISCUSSION

This research deals with the efficiency of low-cost adsorbents in removing phosphate as a function of

- Effect of Contact Time
- Effect of Dosage
- Effect of pH

### 4.1 Effect of optimum contact time

The contact time has a strong influence on adsorption. To investigate the effect of contact time, 100mL of 10mg/L Phosphate solution is mixed with 1gm of adsorbents and stirred on a Gyro shaker for various time intervals of 5, 10, 15, and up to 60 minutes while maintaining constant dosage and sample pH. The samples are filtered and the Phosphate concentrations are determined using a UV spectrophotometer. The removal efficiency of phosphate by Laterite soil, Black cotton soil, and Fullers earth is found to be 65%, 70%, and 60%, respectively, with optimum contact times of 55 minutes, 60 minutes, and 50 minutes. As shown in Figure 6.

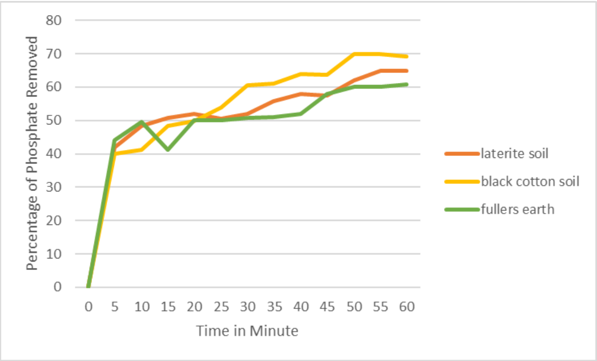


**Figure 6: Effect of Contact Time on phosphate removal by Naturally Available adsorbents**

### 4.2 Effect of optimum dosage

To investigate the optimum adsorbents dosage, different adsorbents dosages are added to 100mL of 10mg/L Phosphate solutions in conical flasks. The solution in the conical flask was stirred for various dosages of 200, 400 upto 2000 mg with optimum contact time and sample PH. The samples are then filtered and tested for Phosphate residual concentration. The dosage that results in the lowest residual concentration is chosen as the optimum dosage. The optimum dosages for phosphate removal by Laterite soil, Black cotton soil, and Fullers earth are 1000mg, 1200mg, and 800mg, with removal efficiencies of 67 percent, 70 percent, and 63 percent, respectively. As shown in Figure 7.

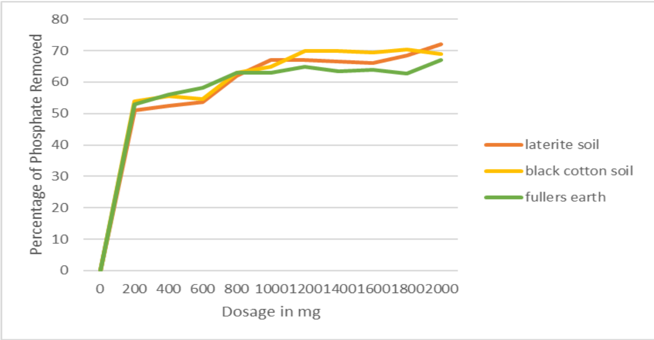


**Figure 7: Effect of Adsorbents Dosage on Phosphate removal by Naturally Available adsorbents**

### 4.3 Effect of optimum pH

To investigate the optimum pH, 100 mL of 10mg/L Phosphate solution is taken in the conical flask and the optimum dosages of adsorbents are added. The pH of the flask is adjusted to 4.5, 5, up to 7, and 7.5. The flask is shaken to the optimum contact time. Following stirring, the samples are filtered and the residual Phosphate concentration is determined. The pH that results in the lowest residual concentration is chosen as the optimum ph. Figure 6 shows the optimum pH for phosphate removal by Laterite soil, Black cotton soil, and Fullers earth, with removal efficiencies of 62.5 percent, 64 percent, and 66 percent, respectively. As shown in figure 8.

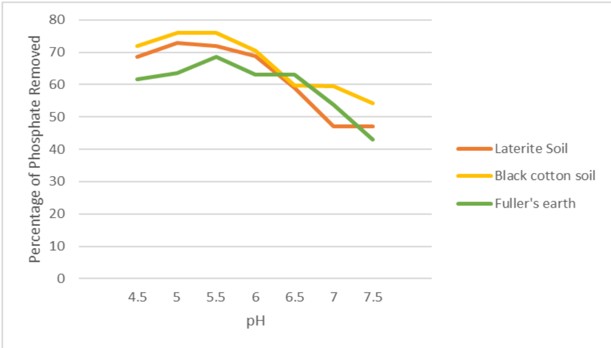


**Figure 8: Effect of pH on phosphate Removal by Naturally Available adsorbents**

## V. CONCLUSION

- According to the physio-chemical properties of Naturally Available adsorbents, moisture content of laterite soil, Black cotton soil and fuller's earth are 3.6, 6 and 5.6 respectively. pH of laterite soil, Black cotton soil and fuller's earth are 7.0, 7.2 and 6.7 respectively. specific gravity of laterite soil, Black cotton soil and fuller's earth are 2.46, 2.54 and 1.88 respectively. Bulk density of laterite soil, Black cotton soil and fuller's earth are 1.38, 1.21 and 0.96 respectively. Surface area of laterite soil, Black cotton soil and fuller's earth are 453, 520 and 750 respectively.
- The optimum contact time for the removal phosphate by Laterite soil, Black cotton soil and fuller 's earth is found to be 55 minutes, 60 minutes and 50 minutes with removal efficiency of 65%, 70%, and 60% respectively.
- The result of experiment on optimization of dosage of adsorbents reveals that, increase the amount of dosage added increases the removal of phosphate from the solutions. The optimum dosage for phosphate removal by Laterite soil, Black cotton soil and fullers earth are 1000mg, 1200mg and 800mg with the removal efficiency of 67%, 70% and 63% respectively.
- The adsorption of phosphate is mainly pH dependent. The optimum pH for phosphate removal by Laterite soil, Black cotton soil and fullers earth are 7.5, 7 and 6.5 with removal efficiency of 62.5%, 64% and 66% respectively.
- The adsorbing capacity of laterite soil, black cotton soil and fullers earth is found to be 3.5/1g, 3.0/1g and 4.0/1g respectively
- From the batch study it can be concluded that phosphate removal efficiency of black cotton soil > laterite soil > fuller's earth.

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**BIOGRAPHIES**

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