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Adsorption Efficiency of Phosphoric Acid Activated Gulmohar (Delonix regia) Fruit Shell Charcoal using Methylene Blue

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Abstract: Adsorption studies on activated charcoal prepared from Gulmohar fruit shell for the removal of methylene blue from its aqueous solution was performed. The effects of various parameters such as Contact time, Volume of dye solution, adsorbent dosage and pH on adsorption were studied to find out the efficiency of activation of the charcoal.
Key words: Gulmohar fruit shell, Activated charcoal, Methylene blue, Adsorption efficiency,

I. INTRODUCTION

Methylene blue is an important dye which is used in many industries for colouring and dying purposes and its concentration in effluents is usually more than the tolerance limit (1mg/L). This poses serious environmental problems causing water pollution. This leads to damage the surrounding flora and fauna.

Therefore, it has to be removed from effluents but its removal has remained a challenge for availability of cost effective techniques. Activated Charcoal (AC) is one of the potential substances that can be employed for this purpose based on its adsorption capacity. Use of AC requires highly activated surface of the substrate to bring about maximum adsorption.

Many studies are reported in the literature [1-19] using ACs prepared from expensive agro-waste materials as precursors. In the present study AC prepared from Gulmohar fruit shell using non- toxic activating agent (H_3PO4) as earlier reported by the authors [20] was used to study its efficiency. This AC was employed for the removal of MB from its aqueous solutions. The various parameters such as volume of dye solution, contact time, pH and adsorbent dosage were studied to investigate the adsorption efficiency of AC.

II. MATERIALS AND METHODS

A. Preparation of methylene blue solution

Methylene blue (MB) AR grade was used to prepare the stock solution. The stock solution was prepared by dissolving 0.2g MB in distilled water. The experimental solutions were prepared by diluting the stock solution.

B. Selection of Activated charcoal activated by phosphoric acid

For adsorption studies of MB on activated charcoal, AC was prepared using phosphoric acid as activating agent in the concentration range of 5-20%. The precursors were soaked at these concentrations for six hours. The activated samples were then dried and carbonized at temperatures ranging from 300-450^{o}C.

C. Adsorption studies of MB on activated charcoal

Adsorption of methylene blue (MB) on activated charcoal was studied in detail taking consideration of several important parameters such as effect of contact time, pH, adsorbent dosage, effect of volume of dye solution. The percentage removal of MB from the solution was measured using absorbance measurements performed at 680nm.

D. Effect of contact time

To study the effect of contact time 100 ml of MB solution was taken in a conical flask. To this 0.1 g activated charcoal was added and the solution was stirred constantly using magnetic stirrer. An aliquot of MB solution was withdrawn at a time interval of 10 minutes. The intensity of decrease in colour of dye solution showed the amount of dye adsorbed by the AC.

E. Effect of pH

pH plays an important role in the adsorption hence it was studied in the range of 2.0 - 11.3. The volume of the MB solution was kept 50 ml, an amount of 0.1g of AC was added to it, keeping the contact time of ten minutes, the pH of MB solution was adjusted in the range of 2.0 - 11.3 by adding dilute hydrochloric acid and sodium hydroxide respectively.

F. Effect of adsorbent dosage

To study the effect of adsorbent dosage on MB adsorption, different amounts of adsorbent (AC) in the range of 0.1 g to 0.25 g was added to 100 ml of MB solution keeping the contact time of 10 minutes.

G. Effect of volume of dye (MB) solution

Effect or dye volume was studied by adding 0.1g of AC to different dye volumes 25- 100 ml range for a contact time of ten minutes. The reduction in colour of different solutions at different volumes was estimated by measuring absorbance at 680nm and computing from the calibration curves.

III. RESULTS AND DISCUSSIONS

A. Selection of AC for adsorption studies of MB

The AC prepared using phosphoric acid in the concentration range 5-20% at carbonization temperature 300-450^{o}C was subjected to adsorption for MB. The results obtained after adsorption studies suggested that 20% concentration of activating agent carbonized at 450^{O}C gave best adsorption results (Fig 1). Thus it was selected for the study of other parameters.

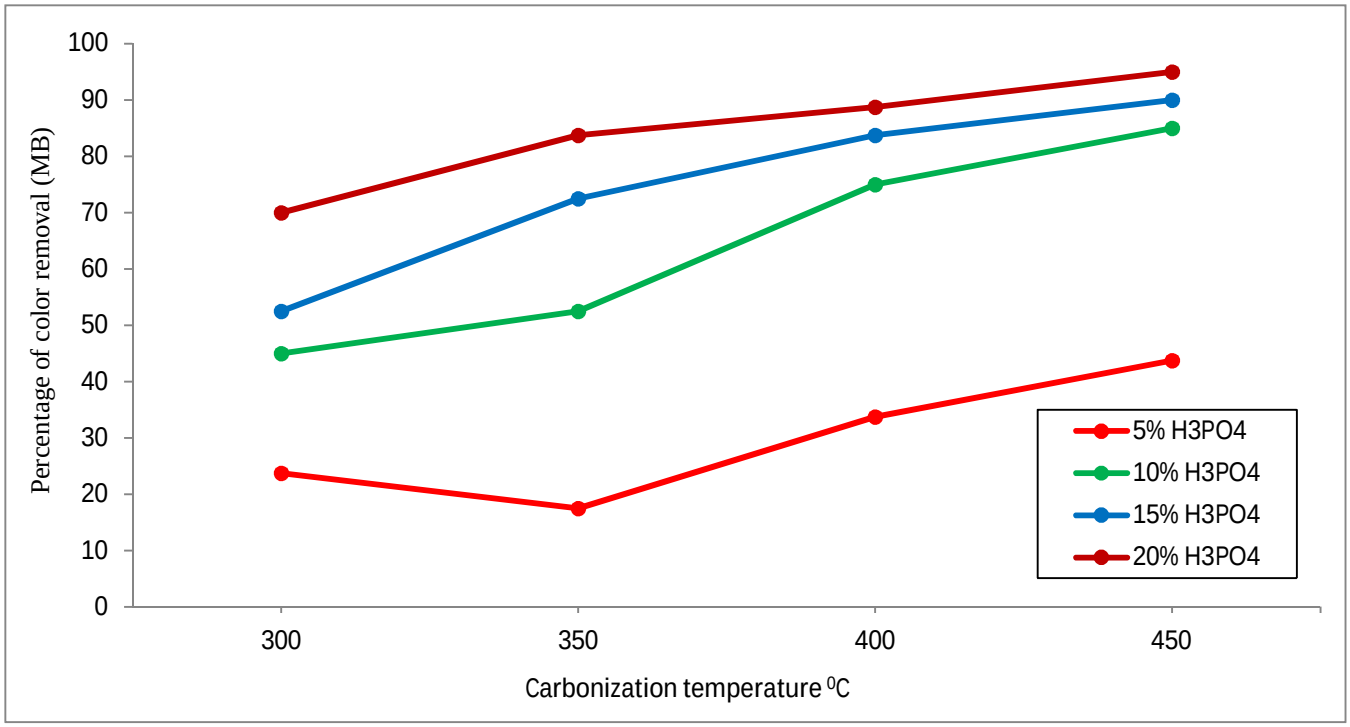

Fig 1: Concentration of activating agent and Carbonization temperature on the adsorption of MB

B. Effect of contact time

The effect of contact time on the adsorption of methylene blue dye is shown in (Fig 2).The percentage colour removal of dye increases with the lapse of time. The slope in the graph suggests rapid initial adsorption which slowed down and became a gradual increase with the rise in contact time. The adsorption continued to around 90 minutes beyond which it became almost constant. This phenomenon of slowing down can be explained that during adsorption of dyes on AC, initially the dye molecules reach the boundary of the AC, where they diffuse into the adsorbent and finally reaches into the interior of the pores of the adsorbent. Since, this is a long process hence it requires relatively longer contact time [21]

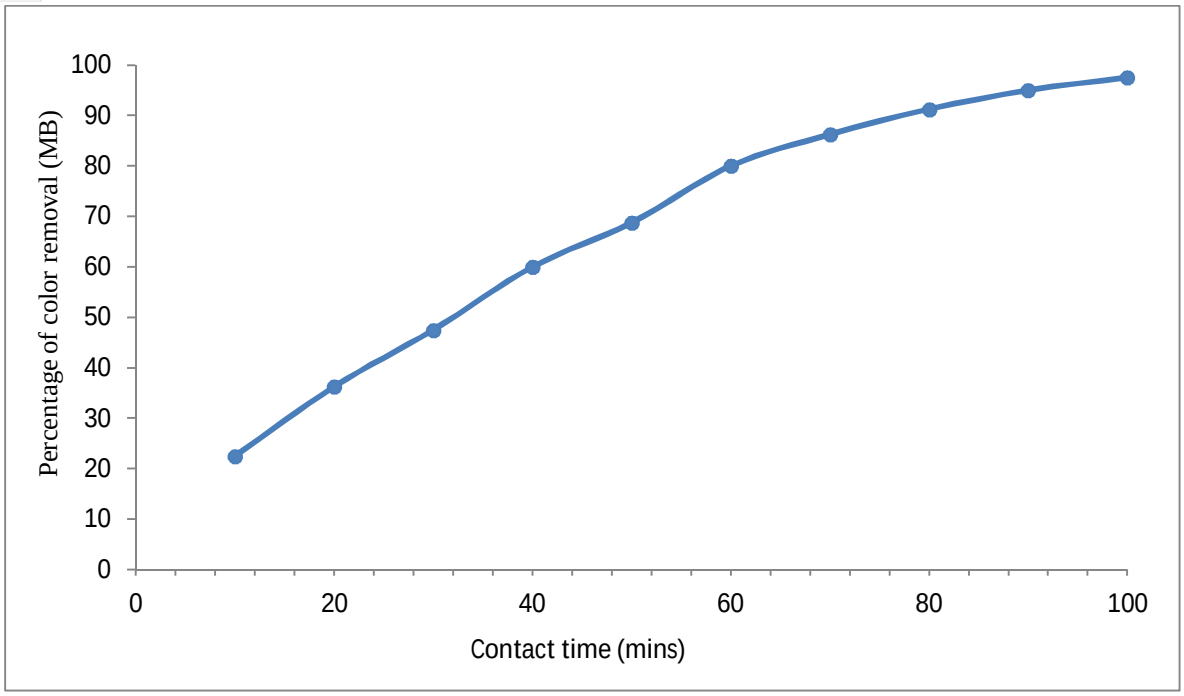

Fig 2: Effect of contact time on adsorption.

C. Effect of volume of dye (MB) solution

The effect of volume of MB solution on adsorption on 0.1g AC is shown in (Fig 3). The study shows that the percentage removal of dye decreased with increasing dye volume.

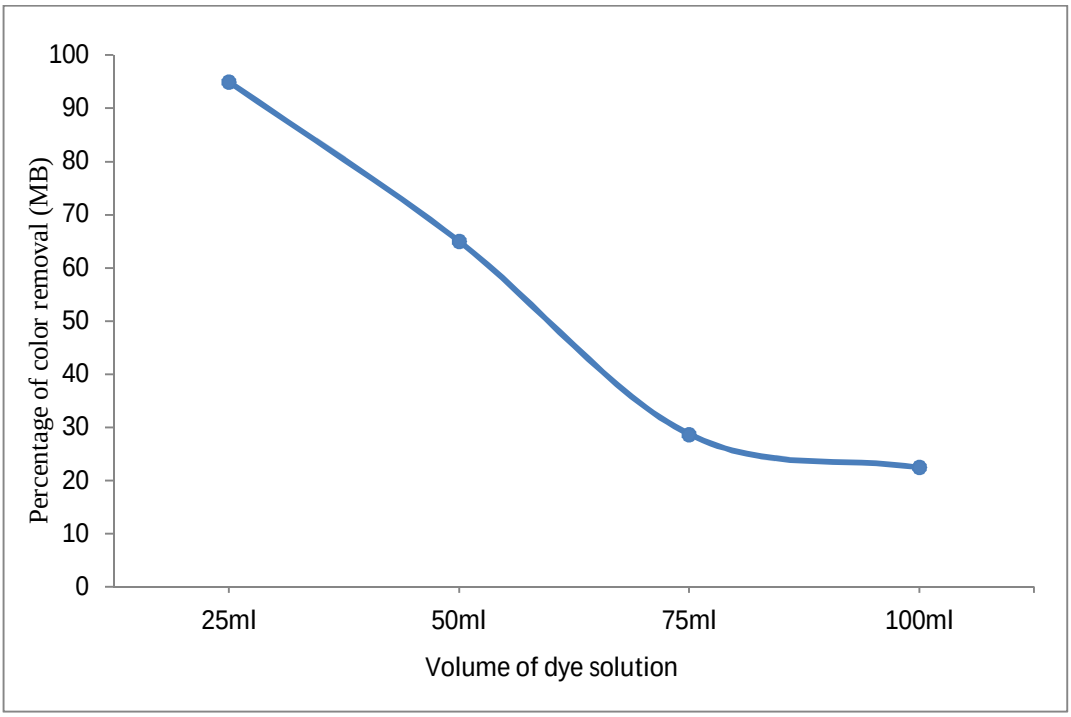

Fig 3: Effect of MB volume on adsorption

D. Effect of pH

The effect of pH on adsorption of MB is shown in the (Fig 4). The adsorption increases with increase in pH of the solution. Maximum adsorption is in the pH range of 6.5to 8.5. Further increase in the pH leads to decrease in adsorption.

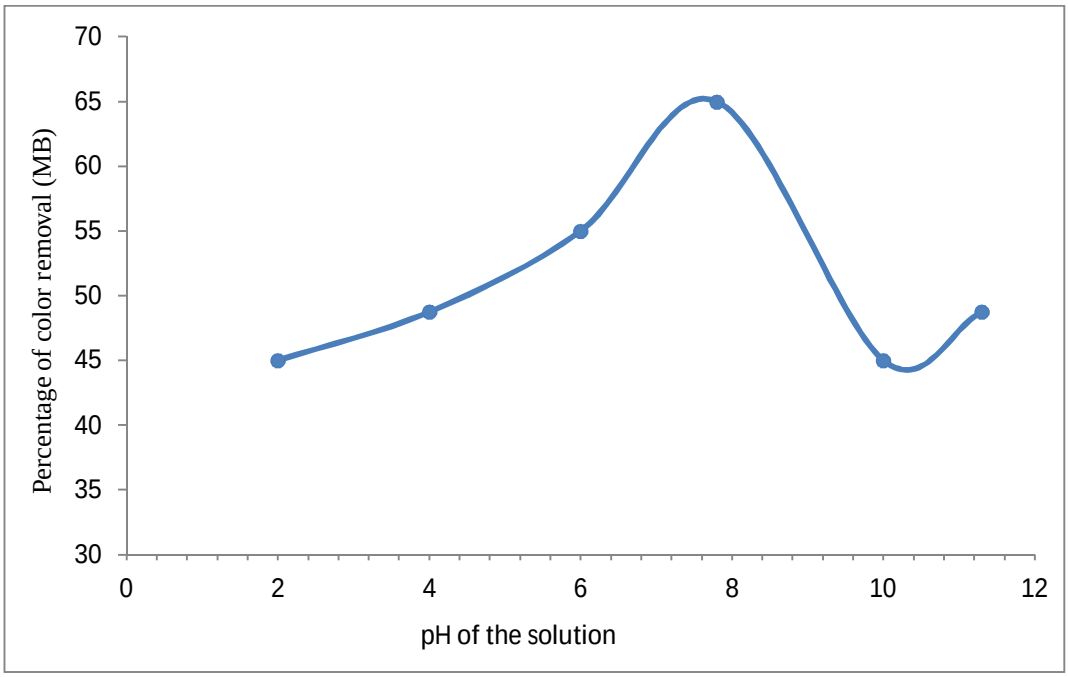

Fig 4: Effect of pH on adsorption

E. Effect of adsorbent dosage

For a 100 ml MB solution, the adsorption increased with increase in the AC dosage as shown in the Fig 5. With the increase in the dosage 0.1g to 0.25g adsorption of the dye also increased.

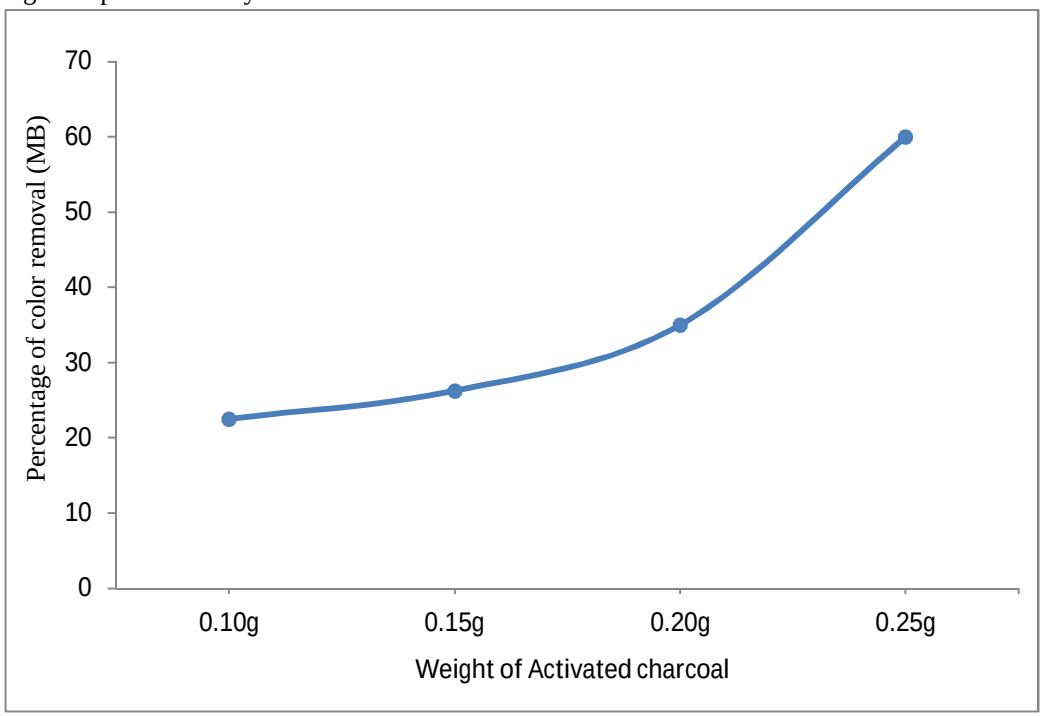

Fig 5: Effect of adsorbent dosage on adsorption

IV. CONCLUSION

The phosphoric acid activated Gulmohar fruit shell charcoal prepared by authors was tested and found to be remarkably superior in this adsorption studies. The most effective pH range for the removal of MB is the same as the pH of potable water (6.5-7.5) and the pH of AC. Therefore, it does not require adjusting the pH by chemical addition for removal of MB. The AC was found to be

remarkably time effective also as it removes most of (95%) MB in only ten minutes thus it has the potential to remove any dye in a short duration. Contact time of only ten minutes was found suitable for the removal of almost 95% dye using just 0.1 g of the AC from a 25 ml dye solution. However, same quantity of AC removed more than 65% of colour when volume is doubled. With an increase in contact time the decolourization increases with the same dosage of AC (0.1g). Most importantly the AC produced with phosphoric acid is nontoxic and this can be employed for adsorption of colours and pigments from potable water.

V. ACKNOWLEDGEMENT

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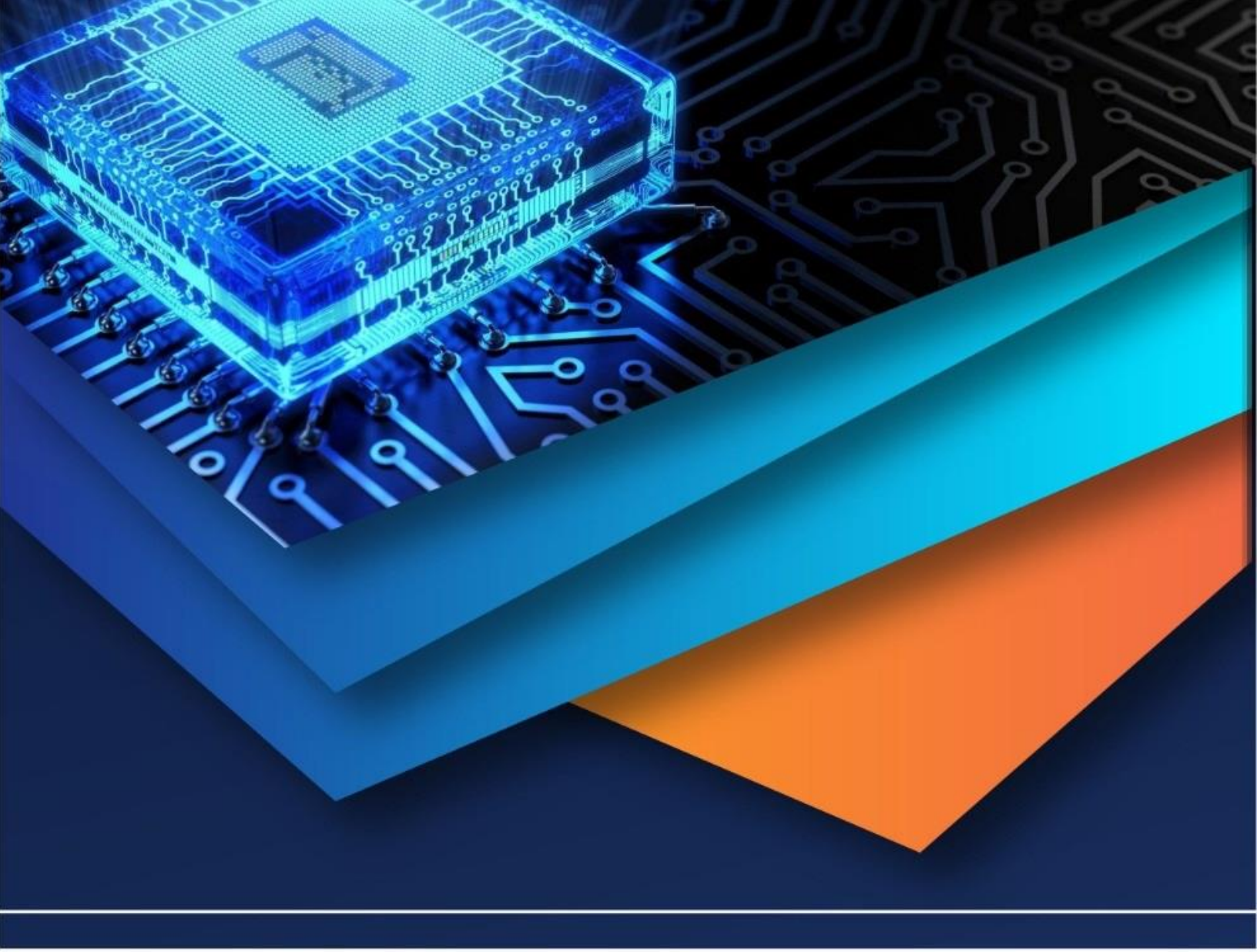

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