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Study of Chloride Content in Gwalior City and its Removal using Bio Adsorption

Shiv Pratap Singh Dhakar[1], Prof. Deepak Rastogi[2]
[1]*M.Tech Student,* [2]*Associate Professor, Department Of Civil Engineering, M.I.T.S. Gwalior (M.P)*

Abstract: ***Chlorides are the natural substances which are found in the water bodies in varying amounts. Chlorides in concentration above 600mg/L produces salty taste in water. The concentration of chloride content above 250mg/L is considered objectionable. Presence of high quantity of chloride content in water resources indicate pollution due to human and industrial wastes and also from the earthen rocks in the sub-surface. High Chloride concentrations in freshwater can harm aquatic organisms survival, growth and reproduction by interfering with Osmo-regulation, the biological processes which maintains the proper concentration of salts and other solutes in the bodily fluids. In large concentrations it can create problems to water supply line and human health as well. Many physico – chemical techniques like Demineralisation, reverse Osmosis, Coagulation, Precipitation, Electrodialysis etc have been practised to reduce chloride content. While these are cost consuming both capital maintenance cost wise. Therefore, this paper deals with study of chloride concentration for Gwalior city and its removal using parthenium sp. as Bio adsorbent in batch study. The paper concluded that parthenium sp. dried biomass is capable to achieve reduction in the chloride content upto 40% at Lab scale.***

Index Terms: Bio adsorption, Chloride content, Parthenium sp. biomass Groundwater quality.

I. INTRODUCTION

Chloride is a salt compound results due to combination of chlorine gas and a metal. The common chloride salts include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). Industrial processes such as battery manufacturing, pulp mills, bullion refining, electroplating, pesticide manufacturing, a large number of small scale processing units etc are the sources of chlorides in water.
In majority of these industries, the main source of chlorides in the effluent is the use of Lime ($Ca(OH)_2$) or sodium hydroxide (NaOH) for the neutralisation of acidic effluents.

1) *Origin:* Exposure to chloride in air has been reported to be negligible. Chlorides in Surface and Groundwater are from both natural and anthropogenic sources such as runoff containing deicing salts, use of inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, irrigation drainage and sea water intrusion in coastal areas. The addition of salt during processing, cooking and eating can markedly increase the chloride level in food.
2) *Effects:* Chlorides increases the electrical conductivity of water and can lead to corrosion of iron and decrease in disinfection efficiency leading to microbial regrowth. The major impact of chloride on waters is the permanent hardness. They are also known to increase the ratio of sedimentation. Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism in congestive heart failure. Also, excessive intake of drinking water containing sodium chloride at concentrations above 2.5 g/litre has been reported to produce hypertension.
3) *Recommendations of WHO:* The concentration of chloride content above 250mg/l is undesirable. For this reason, chlorides are generally limited to 250mg/l in supplies intended for public use.

II. MATERIALS AND METHODS

36 Ground water Samples were collected in pre-sterilized plastic bottles from deep bore wells of twelve locations, in the month of February March (2020). Before collecting samples, water pumped out for 6-10 minutes until water temperature is stabilized then sampling is carried out.
Each of the sample is analyzed for Chloride content using Argentometric method and also for various water quality parameters such as pH, electrical conductivity, alkalinity and T.D.S. as per standard procedures recommended by ALPHA(water and wastewater handbook), Table02. The experimental values were taken as average of the 3 observations of each samples and compared with standard values recommended by WHO for Drinking water quality and Bureau of Indian Standards (BIS) for drinking water (Table01).

Table-01

S.No.	Parameters	Indian Standards for drinking water (IS 10500: 1991)
01	pH	8.5 mg/l
02	E.C.	300 micromhos
03	Chloride Content	250 mg/l
04	T.D.S.	500 mg/l
05	Total Hardness	300 mg/l
06	Alkalinity	120 mg/l

Table-02

S. No.	PARAMETERS	INTRUMENTS USED	METHOD ADOPTED
01	pH	Digital pH Meter	pH Meter
02	CHLORIDE CONTENT	-	Argentometic Method
03	ELECTRICAL CONDUCTIVITY	Digital Conductivity Meter	Conductivity Meter
04	TOTAL HARDNESS	-	Volumetric Method
05	T.D.S.	-	Gravimetric Method
06	ALKALINITY	-	Volumetric Method

A. BIO Adsorbent

For the removal of Chloride, a Plant called Parthenium sp. popularly known as Gajar Ghas (fig.01) is used as Bio adsorbent. It is a herbaceous annual/ephemeral member of the family Asteraceae. Literature study shows that this plant can be successfully and economically used as biological alternative for chloride removal.

Fig01

III. METHODOLOGY

A. Objective

The objective of this work is to determine the presence of chloride content in Gwalior city and its governing parameters. Then to compare the values obtained with Standard values. The location where Chloride content is above permissible values, attempt is made to reduce the amount using parthenium sp. as Bio adsorbent.

B. Work Plan – An Overview

A total of 36 samples are collected from 12 sampling stations (3 samples from each region). The samples then characterise for various parameters along with Chloride content.

At the same time, parthenium sp. plant is collected and biomass substrate is made via standard procedures at standard temperatures. Then samples are subjected to adsorption and removal efficiency is analysed. Results obtained are compared and discussed.

C. Study Area – An Overview

Gwalior is the oldest and major city of central India. It is northern part of Madhya Pradesh state located at the average elevation of 197 meters (646 feet) above the sea level and geographically situated at 26.22^{o} N latitude and 78.18^{o} E longitude coordinates. Gwalior has a sub-tropical climate with hot summers from late March to early July, the humid monsoon season from late June to early 2011 October, and a cool dry winter from early November to late February. The maximum temperature during this season soars to about 43-47^{o}C. Therains in Gwalior begin in late June or starting of July in monsoon and received average rainfall of 910 mm annually. The present study is based on the determination of Chloride content in Gwalior city. In this study almost equally distant sites are selected within the city and water samples were collected from these locations. For the study purpose we have divided it in four Regions as Morar Region, Fort Region, Gwl central Region and Lashkar Region. The Twelve sampling stations (i.e. three samples from each region) are pointed out in the city and samples were taken through the deep borewell. The selected locations are marked below in the fig.1 and fig.2.

Fig-02

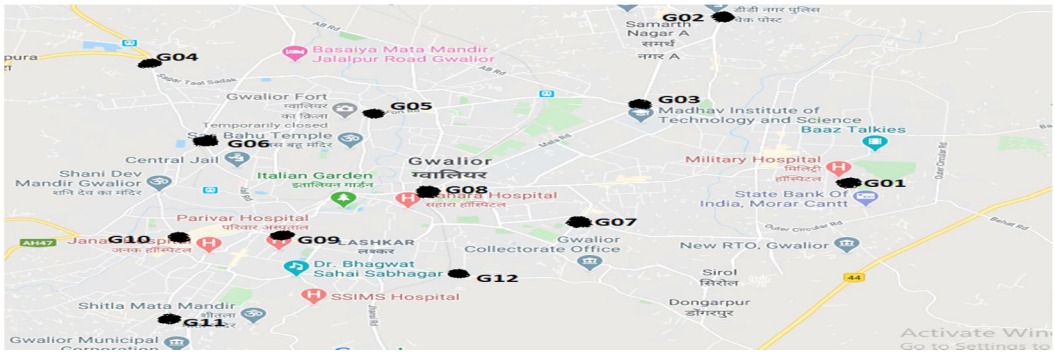


Fig-03

IV. OBSERVATIONS

Table 3 Various water parameters in Morar Region

TITLE	SITE	pH	E.C.	CHLORIDE CONTENT	T.D.S.	HARDNESS	ALKALINITY
G01	MORAR CANTT	7.6	0.23	390	150	380	190
G02	D.D. NAGAR	7.7	0.5	402	320	487	156
G03	MITS CAMPUS	7.6	0.16	252	100	288	262

Table-04 Various water parameters in Fort Region

TITLE	SITE	pH	E.C.	CHLORIDE CONTENT	T.D.S.	HARDNESS	ALKALINITY
G04	PURANI CHHAWANI	7.6	0.25	268	160	450	255
G05	HAZIRA CHOK	7.2	0.19	218	120	410	272
G06	URVAHI GATE	7.8	0.33	310	210	477	178

Table-05 Various water parameters in Gwl central Region

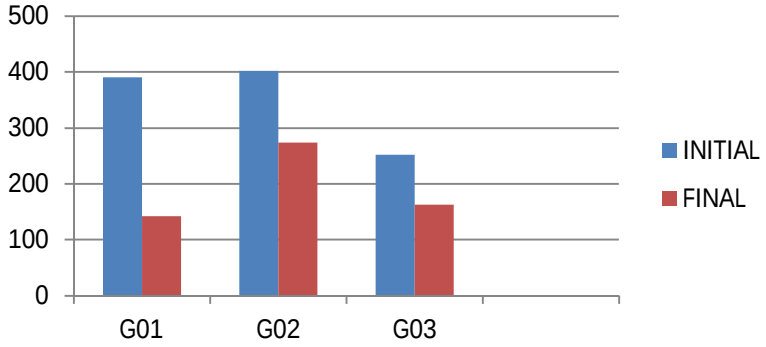
TITLE	SITE	pH	E.C.	CHLORIDE CONTENT	T.D.S.	HARDNESS	ALKALINITY
G07	JIWAJI UNIVERSITY	7.4	0.25	170	160	250	205
G08	PADAV	7.3	0.19	290	120	490	204
G09	JAYENDRAGANJ	7.2	0.16	142	100	244	225

Table-06 Various water parameters in Lashkar Region

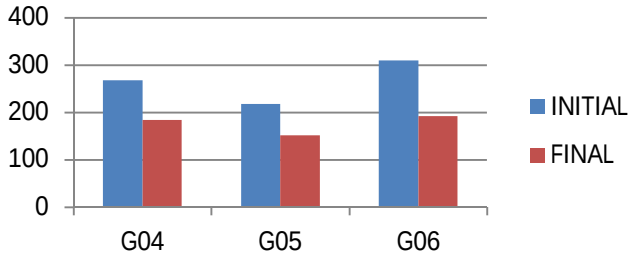
TITLE	SITE	pH	E.C.	CHLORIDE CONTENT	T.D.S.	HARDNESS	ALKALINITY
G10	MAHARAJ BADA	7.4	0.22	250	140	324	185
G11	KAMPOO	7.5	0.22	242	140	305	244
G12	LASHKAR	8.0	0.34	160	220	280	135

Table 07 Percentage Removal of Chloride

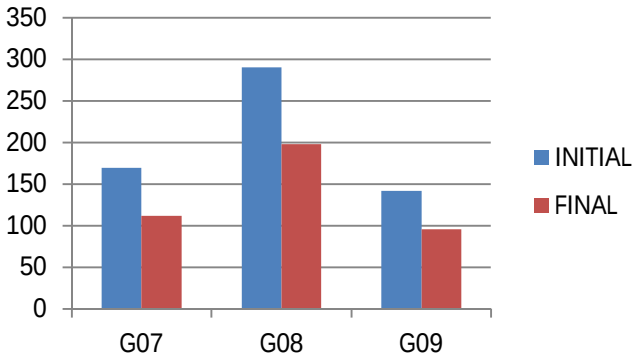
TITLE	LOCATION	INITIAL CHLORIDE CONTENT	FINAL CHLORIDE CONTENT	% CHLORIDE REMOVAL
G01	MORAR CANTT	390	142	36.41
G02	D.D. NAGAR	402	274	31.84
G03	MITS CAMPUS	252	163	35.31
G04	PURANI CHHAWANI	268	184	31.34
G05	HAZIRA CHOK	218	152	30.27
G06	URVAHI GATE	310	192	38.06
G07	JIWAJI UNIVERSITY	170	112	34.12
G08	PADAV	290	198	31.72
G09	JAYENDRAGANJ	142	96	32.40
G10	MAHARAJ BADA	250	165	34.0
G11	KAMPOO	242	167	31.0
G12	LASHKAR	160	98	38.75



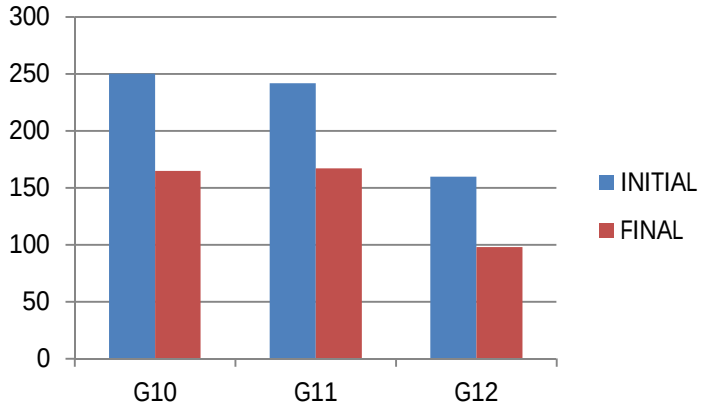
Graph 1- Graph Showing Initial and Final Chloride content in Morar Region



Graph 2- Graph Showing Initial and Final Chloride content in Fort Region



Graph 3- Graph Showing Initial and Final Chloride content in Gwl central Region



Graph 4- Graph Showing Initial and Final Chloride content in Lashkar Region

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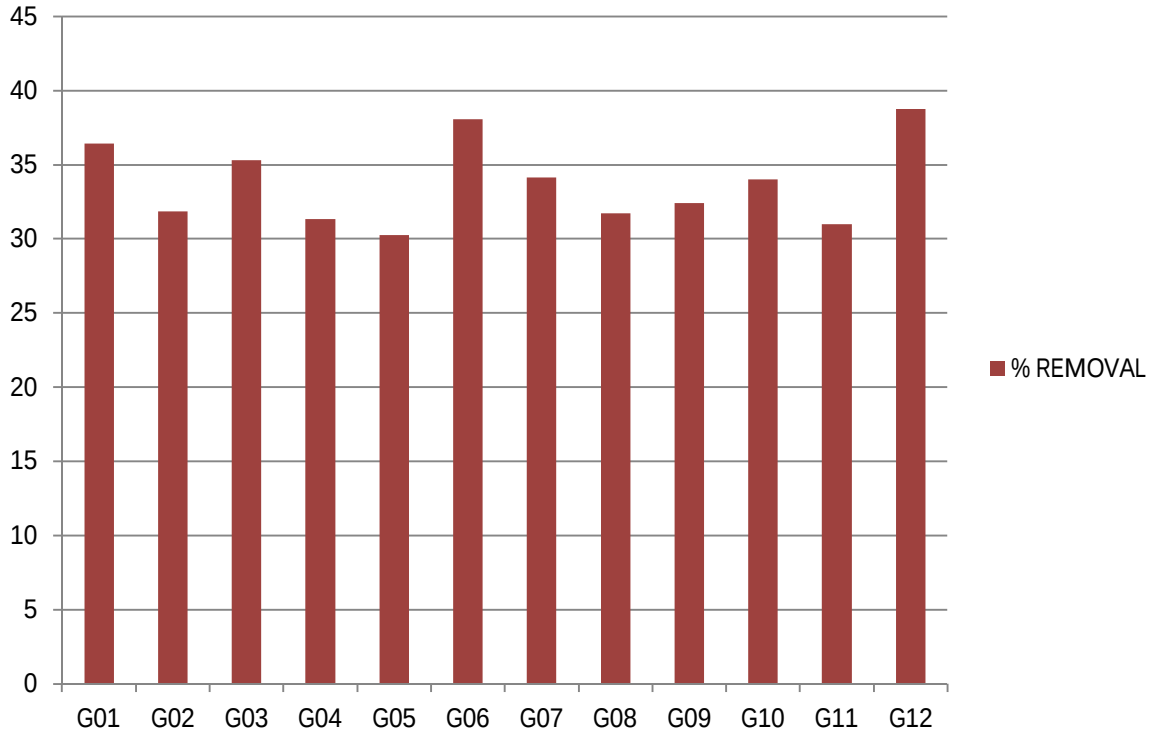
V. RESULTS AND DISCUSSIONS

Water samples are collected from 12 sampling stations of Gwalior city. The 6 parameters including Chloride content determination are analysed for each location in the duration of study.
The results are

A. Chloride Content

G01, G02, G03 in morar region, G04, G06 in fort region, G08 in gwl central region are the sampling stations where chloride content is above permissible value recommended by WHO and BIS (10400:1991).
All the collected samples are acted upon under adsorption using Parthenium sp. substrate and results shows that Dried biomass of parthenium sp. leaves with some mechanical agitation are found to remove about 40% of chlorides from solution at pH 7-7.5 in about 1 hour.
And amount of chloride at above mentioned location samples comes less than 250mg/L which is under recommended permissible value. So, this is suitable to use Parthenium sp. plant which is cheap and easily available as an effective adsorbent to vanish the problem of chloride salts in Gwalior city. Theresult shows percentage chloride removal of various points is shown by given Tables and Bar charts below.



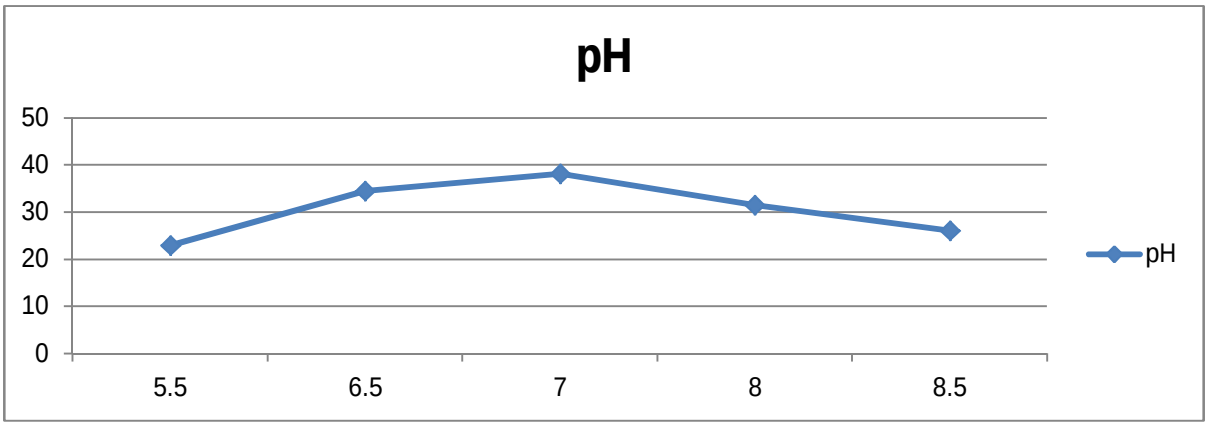
Graph 5- Graph Showing Percentage Chloride Removal Efficiency at sampling satations of city.

B. Other Parameters

1) *pH:* Value of pH ranges 7.2-8.0 for groundwater samples from study area. The permissible limit of pH ranges 6.5-8.5. So, found within limits.
2) *E.C.:* Electrical Conductivity (E.C.) is a measure of current carrying capability in water samples and positively related to dissolved solids in water. It is found within limits for all samples.
3) *T.D.S.:* The total dissolved solids in the groundwater samples obtain in 100-320 which is below permissible limit of 500 mg/l as per BIS. It is positively associated with Cl.
4) *Total Hardness:* The value varies 240-490mg/l for samples which are under permissible limit of 600 mg/l as CaCO3, as per BIS. Hardness is positively associated with Cl.
5) *Alkalinity:* It varies 160-280mg/l which is under the permissible value of 500mg/l. It is negatively related to Cl presence.

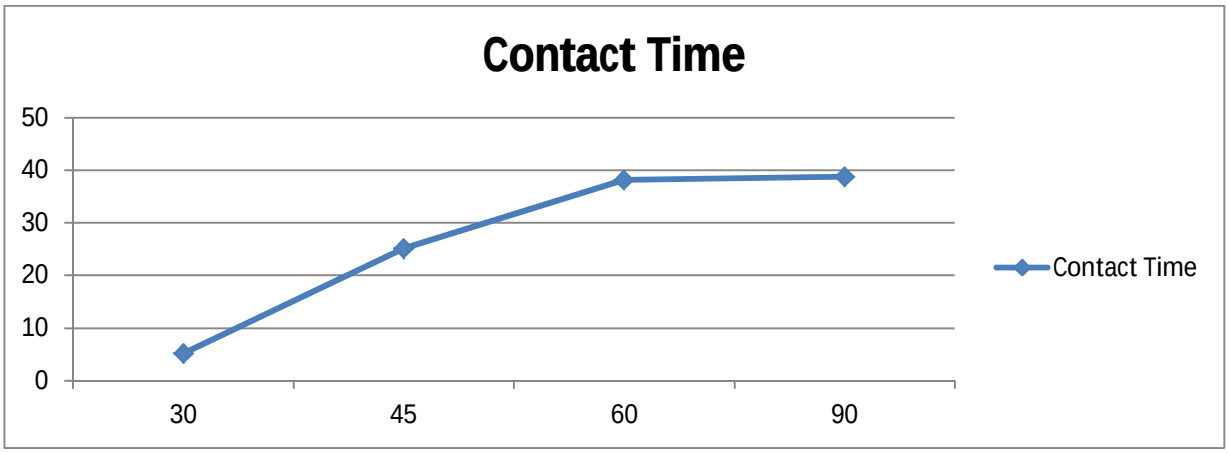
C. Chloride Removal Study

1) Effect of Reaction pH: The optimum chloride removal is found at pH 7.



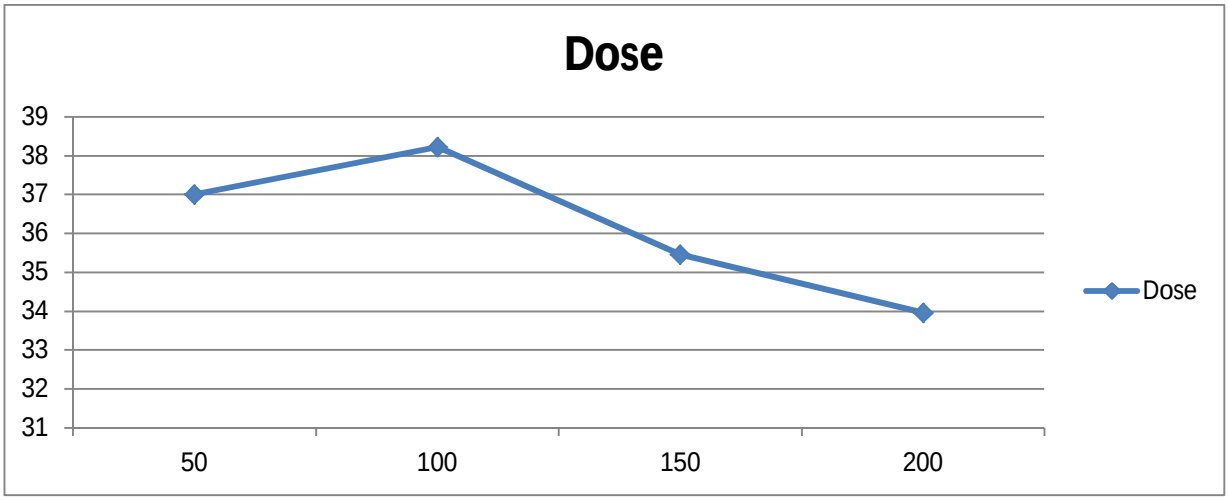
Graph6 - Effect of pH on removal efficiency

2) Effect of Contact Time: The optimum chloride removal is found at contact time of 60 minutes.



Graph7 - Effect of contact time on removal efficiency

3) Effect of Adsorbent Dose: The optimum Chloride removal is fount at Bio adsorbent dose of 100mg/100ml test water sample.



Graph8 - Effect of dose on removal efficiency

VI. CONCLUSIONS

Points demarcating the conclusions from study and analysis are

A. The Parthenium sp. may be used for removal of chloride from ground water. And it shows maximum absorbance at pH 7.
B. During the variation in the adsorbent dose, the optimum chloride removal is at a dose of 100mg/100ml test sample.
C. On varying contact times, no further significant increase in chloride removal percentage is observed after 60 minutes.

The results obtained concludes that parthenium spp. leaf biomass is as a best alternative technique to remove chloride from water. Also, it proves economically fine and easy in monitoring. In lab conditions on varying pH, contact time and adsorbent dose, the chloride removal percentage varies. While on optimum dose of 0.1gm/100ml, pH 7 and 60minutes contact time, chloride removal percentage ranges 32-40% at different sampling stations.
The problem generally faced in Gwalior city due to high amount of salty ground water can be easily and effectively sort out by using Parthenium sp. biomass.

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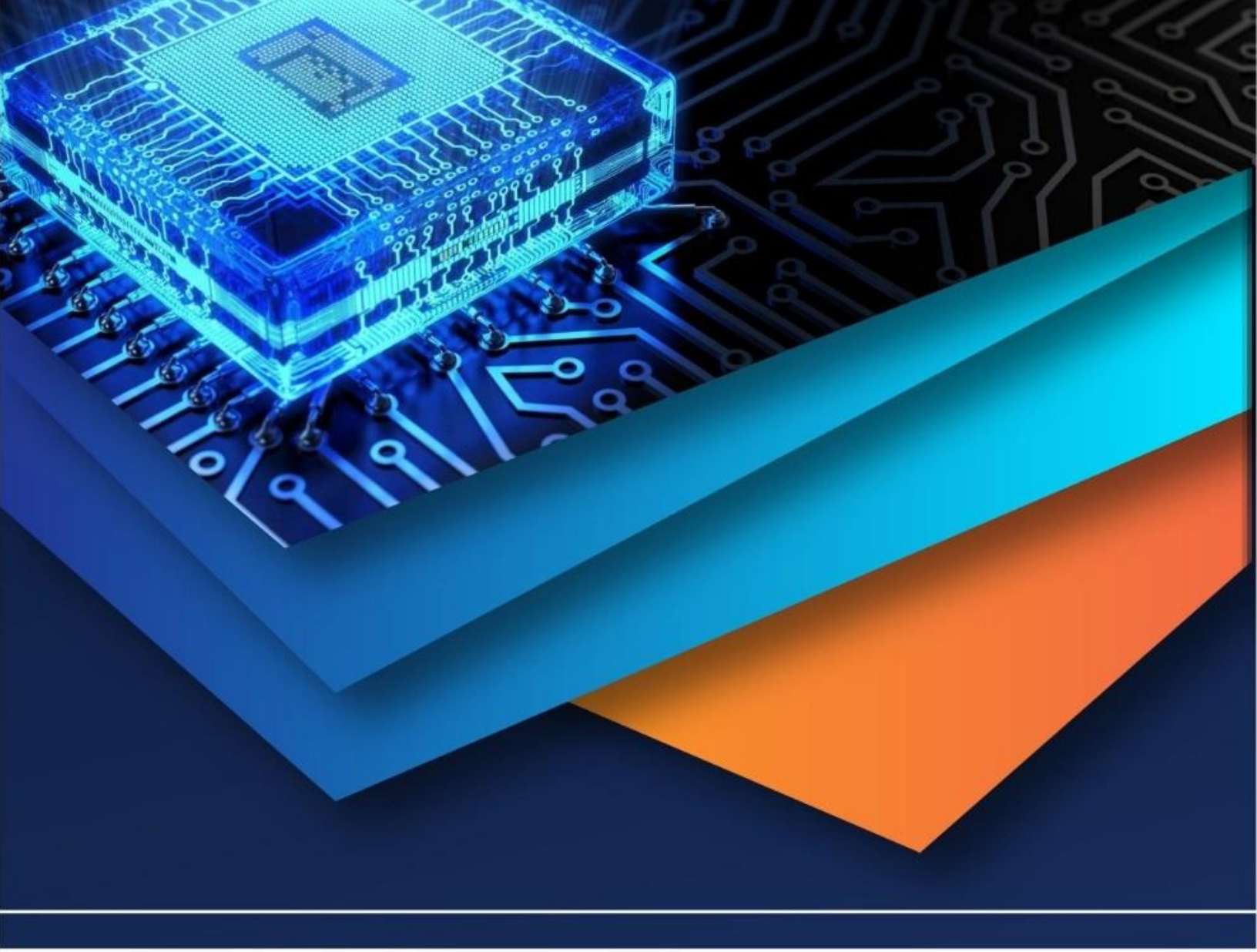

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