iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** X **Month of publication:** October 2020

DOI: https://doi.org/10.22214/ijraset.2020.31791

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue X Oct 2020- Available at www.ijraset.com

Analysis of Adsorption Capacity of Synthesized Activated Carbon

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Abstract: ***The amount of waste sawdust from the sawmill industry is 15-20% of the total production. This number is huge and its use is not maximized. Thus, in this study teak sawdust utilized as activated carbon using an activator H_3PO_4 . The largest contents of teak wood is cellulose 47.5% and 29.9% lignin. The presence of cellulose showed that teak can be used as an adsorbent.***

Various methods were developed to reduce the levels of heavy metals in waters, one of the methods is the adsorption. The adsorption has proven a useful tool to control the degree of contamination in the water, low cost materials which have an adsorption capacity.

The adsorbent that often used is porous solids, such as charcoal, zeolite, allophane, sand, and silica gel. Most research on adsorption was performed using a single adsorbent, whereas in this study conducted adsorption with single adsorbent, which is activated carbon from teak wood sawdust.

Teak sawdust can be used as a precursor of an effective activated carbon. The carbon produced from teak sawdust under physical activation has a microporous and mesoporous structure with pore sizes ranging from 0.6 to 100 nm. This adsorbent was employed for dye removal from a Industrial effluent. Many textile, printing, plastic, dye synthesis, pulp and paper mill, leather, electroplating, food, cosmetic, pigments, petroleum, rubber, pesticide etc. Industries that use dyes release a huge amount of highly coloured effluent in their wastewater. The presence of very small amounts of dyes in water affects photosynthetic activity by preventing light penetration and upset the biological metabolism processes in aquatic life.

I. INTRODUCTION

Adsorption is a surface phenomenon. It exploit the ability of certain solids preferentially to concentrate specific substances from solution onto their surfaces. It is used as a separation process where a species present in a fluid phase is transferred to the solid phase and gets attached to the solid surface, if the concentration of the species in the fluid-solid boundary region is higher than that in the bulk of the fluid. In an adsorption process, molecules or atoms or ions in the fluid phase get concentrated or accumulated on the surface of a solid, where they bond with the solid surface or are held there by weak inter-molecular forces. The accumulated or concentrated species on the surface of solid is called the adsorbate, and the porous solid material is known as an adsorbent.

A. Objective of the Project

The purpose of the present paper is to study the performance of activated carbon obtained from teak wood saw dust for the removal of crystal violet dye contaminated waste water. Activated carbon is commonly used in water treatment to remove water contaminants from industrial water and waste water from other sources. Activated carbon is used in home water filtering system due to its excellent adsorption capacity.

1) We study and evaluate the adsorption capacity of absorbent for the removal of Crystal Violet dye from the aqueous solution through:
2) We study and understood the characterization of adsorbent for determination of proximate analysis.
3) Studying and understanding effect of various parameters on adsorption capacity of Activated carbon by studying the following parameters on adsorption capacity:
a) Effect of adsorbent dose.
b) Effect of Time.
c) Effect of absorbent pH
d) Effect of initial concentration.
e) Effect of temperature.

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II. SYNTHESIS OF ACTIVATED CARBON FROM TEAK WOOD

A. Saw Dust

Procedure

1) The Teak Wood Saw Dust were collected from Saw mill and was washed with distilled water which were then sun dried to remove maximum moisture content.

2) Initially the crushed teak wood saw were impregnated with H_3PO_4 for 24 h.(For 1gm of Sawdust 1ml of H_3PO_4 is used. The ratio of saw dust to H_3PO_4 was 1:1.

3) Then this impregnated saw dust was washed with distilled water and then kept in a muffle furnace at 105°C for drying.

4) Then it is carbonized at 400 °C and activated at 450°C for a period of 30 min.

5) The activated carbon thus obtained was grounded well, sieved and characterized.

6) The activated carbon (adsorbent) retained on the 2.36mm sieve size has been used for the present study.

Fig.1 (a) Measuring of H_3PO_4

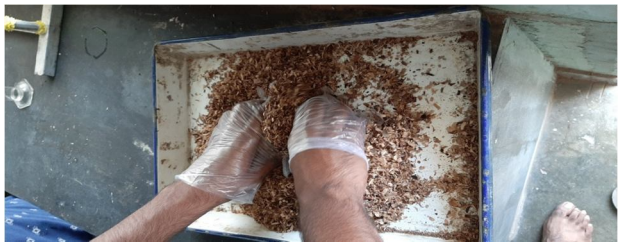

Fig.1 (b) Mixing of sun dried teak wood saw dust with H_3PO_4

Fig.1 (c) Activated carbon obtained after burning in muffle furnace

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B. Proximate Analysis

1) Moisture Content: To determine moisture content AC, weight of empty crucible, W1 was taken. One gram of sample was added in the crucible and weight W2, was taken. The crucible was tapped gently to spread the sample was kept in oven at a temperature of 378 K (105°C) For One hour. After one hour the crucible was kept in a desicator and the weight of crucible was kept in a desiccator and the weight of crucible (W3) was taken. The percentage moisture was calculated as:

$$\%\text{Moisture} = \frac{\text{Mass of water Removed}}{\text{Mass of original sample}} = \frac{W1 - W3 \times 100}{W2 - W1}$$

Where,
W1 = Mass of empty crucible
W2 = Mass of crucible + Sample, before heating
W3 = Mass of crucible + dried sample

2) Ash Content: To determine ash content of AC, weight of empty crucible, W1 was taken. One gram of sample was added and the weight of the crucible with AC W2, was taken. The crucible was gently tapped to spread the sample evenly over the bottom of the crucible. Crucible was then placed in a high temperature furnace. The sample was heated at 1023 K (750°C for one hour so that all the combustible material completely burnt. The crucible was then removed from the furnance and cooled for about one minute in the labouratory, then placed in the desicator until it was cooled to room temperature. The weight of sample W3 was taken. The percentage ash was calculated as:

$$\%\text{Ash} = \frac{\text{Mass of Residue after Combustion}}{\text{Mass of original sample}} = \frac{W3 - W1 \times 100}{W2 - W1}$$

Where,
W1 = Mass of empty crucible
W2 = Mass of crucible + Sample, before heating
W3 = Mass of crucible + Residue after heating sample

3) Volatile Matter Content: To determine volatile matter of AC, the weight of cylindrical empty crucible with lid was taken as W1. One gram of sample was added in the crucible and the weight of the crucible and the weight of the crucible (Plus lid) and sample was taken as W2. The crucible was gently tapped to spread the sample evenly over the bottom of the crucible. The covered crucible was then placed into a high temperature muffle furnace at 1173 plus or minus k (950°C) in the furnace for seven minutes in the laboratory, then placed in the desiccators until it was cooled to room temperature. The weight of sample was taken as W3. The percentage volatiles quoted in a proximate analysis excludes moisture. However, both moisture and volatiles are driven off during heating. Thus, Volatiles content is given by:

$$\%\text{Volatiles} = \frac{W2 - W3 \times 100}{W2 - W1} \text{ -- M}$$

Where,

W1 = Mass of empty crucible

W2 = Mass of crucible + lid + Sample, before heating

W3 = Mass of crucible + lid, after heating sample

M = % moisture content

4) Fixed Carbon Content: The Fixed Carbon was calculated using following formula:

% Fixed carbon = 100 – (% moisture + % volatiles + % Ash)

Table: - 2 Proximate analysis results

PROXIMATE ANALYSIS

1) Proximate Analysis of Activated Sawdust

1) Percentage Moisture Content — IS 1350.1 1984

Where,

W_1 = Mass in gram of the empty vessel

W_2 = Mass in gram of the vessel and sample before heating and

W_3 = Mass in gram of vessel and sample after heating

S.N.	Particulars	W_1	W_2	W_3	% Moisture
1	AS	40.40	41.40	41.15	25%

2) Percentage Volatile Matter

Where,

W_0 = Percentage of moisture in the sample on air dried basis

W_1 = Mass in gram of empty crucible and lid

W_2 = Mass in gram of crucible plus lid and sample before heating and

W_3 = Mass in gram of crucible plus lid and sample after heating

S.N.	Particulars	W_1	W_2	W_3	% Volatile Matter
1	AS	65.7	66.70	66.18	27%

3) Percentage Ash Content

Where,

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W_1 = Mass in gram of empty dish

W_2 = Mass in gram of dish and sample before heating

W_3 = Mass in gram of dish and ash after heating

S.N.	Particulars	W_1	W_2	W_3	% Ash Content
1	AS	40.40	41.4	40.5	10%

4) Fixed Carbon

OR

Fixed Carbon = Residue after volatile matter test minus ash

S.N.	Particulars	% Moisture	% Volatile	% Ash	Fixed Carbon
1	AS	25.00	27.00	10.00	38.00

Fig.2 Muffle Furnace and Crucible with lid.

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C. Preparation of Standard Solution

Procedure

1) Weigh 1gm of crystal violet dye with high precision weighing balance.
2) Take 1000 ml of the water in the 1 litre volumetric flask.
3) Mix the weighed crystal violet dye in the flask with regular stirring and make a homogenous solution of it, with Continuous stirring.
4) The standard solution of 1000 PPM is used further for preparation of 200 PPM, 100 PPM, 50 PPM……and so on.
5) The various standard solution prepared from 1000 PPM standard solution are obtained by using normality Equation.

Normality Equation :

$N1 \times V1 = N2 \times V2$

Where,

N1 = Normality of standard solution
V1 = Volume of standard solution
N2 = Normality of sample to be prepared
V2 = Volume of sample to be prepared

Fig.3 (a) Samples of various Concentrations.

Fig.3 (b) Samples collected in beaker after measuring Absorbance value.

D. Procedure For Construction of Standard Graph

The various solution prepared from standard solution of 1000 PPM are then tested for Absorbance. The results obtained are then plotted with the help of graph. The test is carried out on SHIMADZU **UV**-VIS 1800 spectrophotometer.

Table: - 3 Absorbance value of standard solutions of various concentration

Concentration of sample	Absorbance value
0.1	0.023
0.2	0.024
0.25	0.031
0.5	0.081
1.0	0.107
5.0	0.355
10	0.680
50	3.391

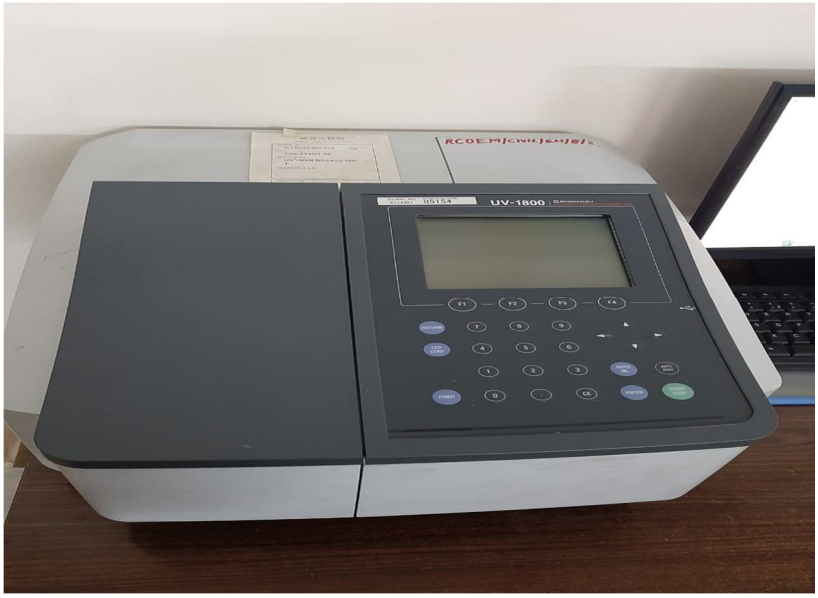

Fig. 4 (a) UV-1800 SPECTROPHOTOMETER

Fig.4 (b) UV-1800 SPECTROPHOTOMETER ALONG WITH PC CONTROL

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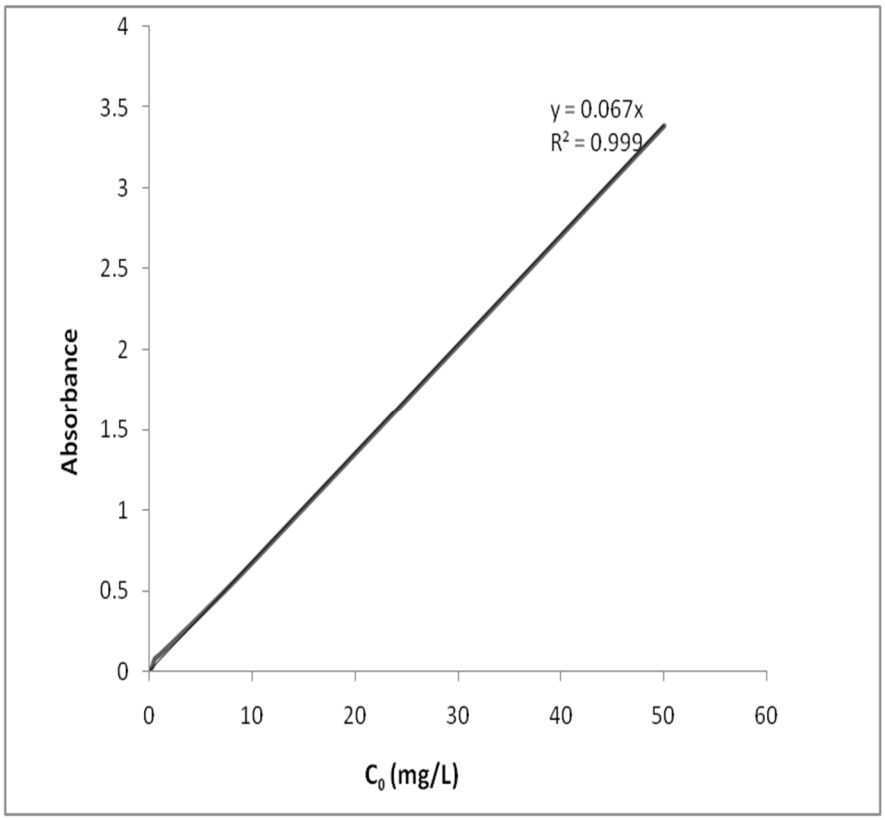
E. Standard Graph



F. Factors Controlling Adsorption

The amount of adsorbate adsorbed by an adsorbent from aqueous solution is depend upon a number of factors which are discussed below.

1) Nature of Adsorbent
2) Adsorbent dose
3) pH of Solution
4) Contact Time
5) Initial Concentration of Adsorbate
6) Temperature
7) Degree of Agitation.

III. DETERMINATION OF OPTIMUM DOSAGE OF ACTIVATED CARBON

A. Procedure

1) A 50 ml sample was taken from 50 PPM Standard solution and was subjected to different dosages such as 0.1gm, 0.2gm, 0.3gm, 0.4gm, 0.5gm……and so on upto 2gm of activated carbon sample.
2) The sample was placed in the shaking Incubator operated at 150 rpm at a standard temperature of 30°C for about 1 hour.
3) After 1 hr all the samples from shaking Incubator are taken out and then each sample is filtered by filter paper so that clear sample is obtained for the absorbance test without any residue left out in the sample.
4) Absorbance study is carried out by placing the sample in the UV- SPECTROPHOTOMETER operated at wavelength of 590 nm.
5) The sample for which the absorbance value is minimum and amount of activated carbon used is optimum is termed as optimum dosage.

The results obtained are then converted in tabular format as shown below :

Table: - 4 Absorbance value for the varying dosage samples prepared

SN	Dosage (mg/50 mL)	Dosage (mg/L) (m)	Absorbance	Final Concentration, C_e (mg/L)	% Removal	Amount adsorbed, x	q_e=x/m	q_e (mg/g)
1	0	0	0	0.000	0	50	0.000	50.000
2	0.1	2	0.197	2.940	94.12	47.06	23.530	23.530
3	0.2	4	0.028	0.418	99.16	49.58	12.396	12.396
4	0.3	6	0.027	0.403	99.19	49.60	8.266	8.266
5	0.4	8	0.02	0.299	99.40	49.70	6.213	6.213
6	0.5	10	0.018	0.269	99.46	49.73	4.973	4.973
7	0.6	12	0.013	0.194	99.61	49.81	4.150	4.150
8	0.7	14	0.017	0.254	99.49	49.75	3.553	3.553
9	0.75	15	0.024	0.358	99.28	49.64	3.309	3.309
10	1	20	0.042	0.627	98.75	49.37	2.469	2.469
11	1.5	30	0.017	0.254	99.49	49.75	1.658	1.658
12	2	40	0.014	0.209	99.58	49.79	1.245	1.245

B. Graph Obtained From The Above Observations

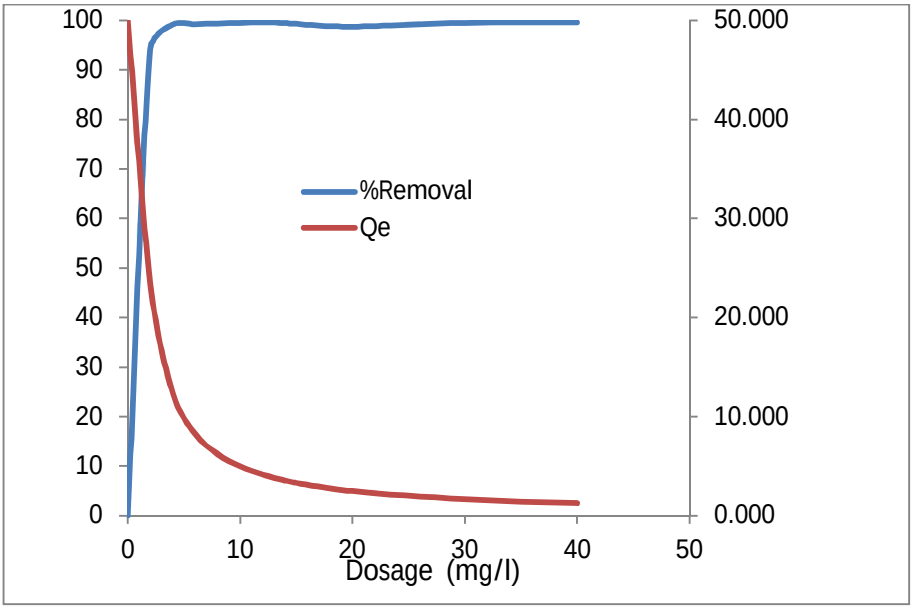


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Fig.5 (a) Filteration of sample


Fig.5 (b) Collection of filtered sample


Fig.5 (c) Placing of sample in shaking Incubator

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IV. CONCLUSIONS

Teak Sawdust has an adsorption property which can be used as an adsorbent for the removal of toxic materials and contaminants from the industrial and municipal water and wastewaters.

The major conclusions drawn from the present work are given below:

1) The results obtained from Proximate Analyis of Activated teak saw dust carbon are found to be: -

a) Ash Content: - 10 %

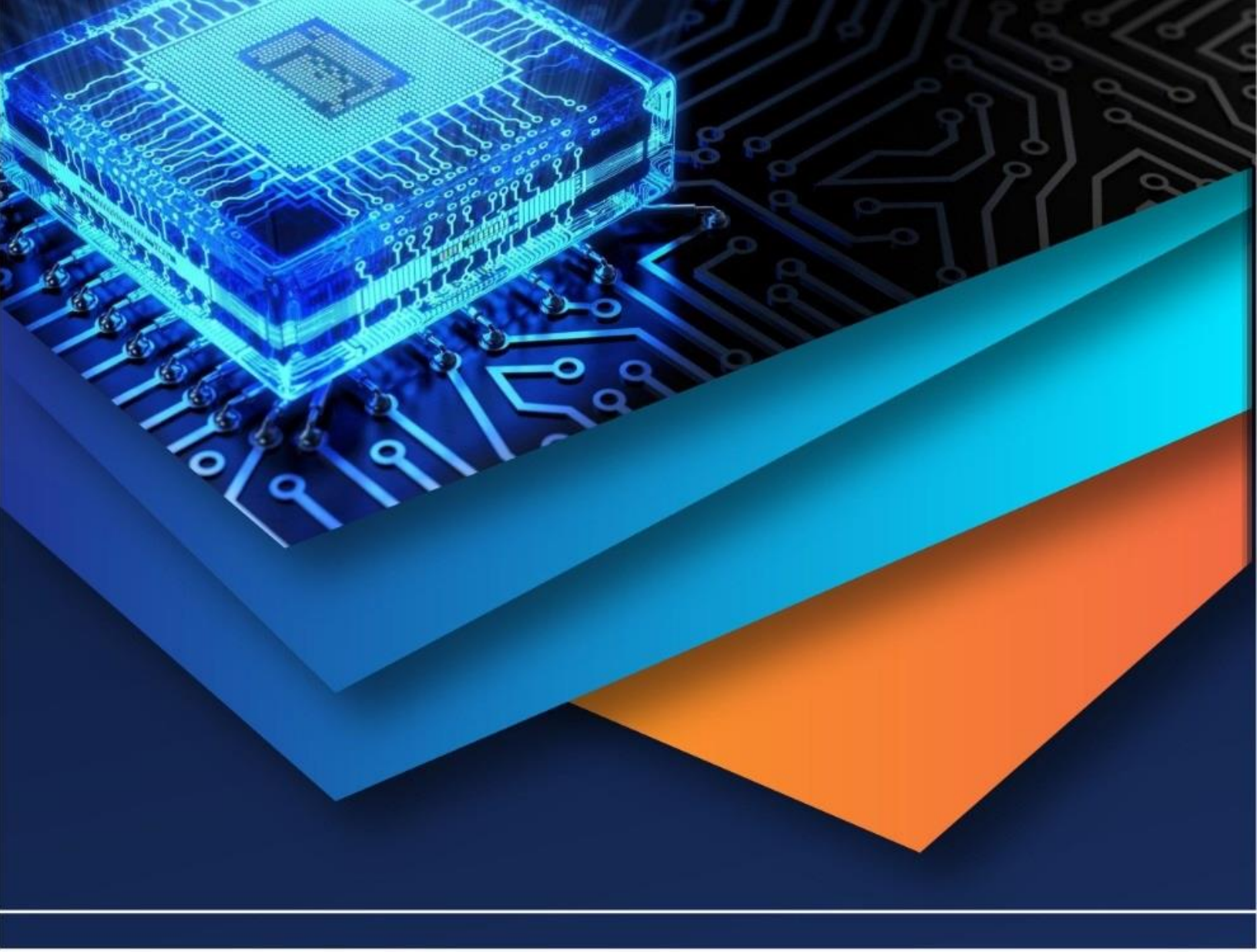
b) Volatile Content: - 27 %

c) Moisture Content: - 25 %

d) Fixed Carbon Content: - 38 %

2) The optimum dose for teakwood sawdust activated carbon for present study was found to be 12 mg/l .

3) Percent removal of crystal violet dye increases with the increase in adsorbent dose up to a certain limit and then remains almost constant.



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