iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: IV Month of publication: April 2024

DOI: https://doi.org/10.22214/ijraset.2024.60130

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue IV Apr 2024- Available at www.ijraset.com

Comparative Analysis of Natural and Artificial Coagulants

Abhijit Pawar[1], Hardik Sharma[2], Poonam Kharatmol[3], Yash Mahadik[4], Abhinesh Amrutsagar[5], Mayur Suryawanshi[6]
[1, 2, 3, 4, 5]Diploma student, [6]Guide, Department of Civil Engineering, V. E. S Polytechnic, Chembur, Mumbai-400071

Abstract: Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in the water when a lightis shined through the water sample. The higher the intensity of scattered light, the higher the turbidity Turbidity in the water creates both aesthetic and health issues. Surface water treatment plants remove particles because they can cause objectionable appearances, tastes, and odour and can interfere with disinfection. A wide range of natural coagulants, such as moringa seeds, banana peel, jatropha curcas, cassava peel starch, watermelon, pawpaw, beans, nirmali seeds, papaya seeds, organic dry hibiscus and okra have been studied previously. Natural coagulants in powder forms are usually added directly to wastewater. The most commonly used inorganic chemical coagulants in water treatment. Aluminium sulfate Al2(SO4)3 is the most commonly used chemical for coagulation in wastewater treatment. Additional commonly used coagulants include sodium aluminate $NaAIO_2$, ferric sulphate Fe2(SO4)3 and ferric chloride FeCl3.
Keywords: Turbidity, Natural, Artificial, flocculation, TDS

I. INTRODUCTION

The water becomes wastewater due to population growth, urbanization, industrialization, sewage from household, institutions, hospitals, industries and etc. For other uses by removing turbidity and total dissolved solids by using natural & artificial coagulants. In this process the waste water will be treated for other uses like in construction for mixing with cement or curing and other works. Turbidity and Total Dissolve Solid imparts enormous problem during waste water treatment. In this review study we observed that there are various types of natural coagulant which have been used in many forms for removal of turbidity by Natural & Artificial coagulants.

1) *TURBIDITY* – The cloudiness or haziness of a fluid caused by suspended solids that are usually invisible to the naked eye. The measurement of Turbidity is an important test when trying to determine the quality of water.
2) *TDS* – It stand for ‘Total Dissolved Solids’ present in water. The amount of minerals, metals, organic material and salts that are dissolved in a certain water volume. the particles can be organic or inorganic. For example - magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates.
3) *COAGULANTS* – It is a compound or agent which is added in water to purification or to remove dissolved particles in water.

TYPES OF COAGULANTS:

The three natural coagulants used are given below -

- Papaya Seeds
- Organic Dry Hibiscus
- Watermelon Seeds

The three artificial coagulants used are given below –

- Aluminium Sulphate Al2(SO4)3
- Sodium Aluminate NaAlO□
- Ferric Sulfate Fe2(SO4)3

II. METHODOLOGY

Experiments were conducted with Natural Coagulants such as Papaya Seeds, Organic Dry Hibiscus, Watermelon Seeds and Artificial Coagulants like Aluminium Sulphate Al2(SO4)3, Sodium Aluminate $NaAlO_2$, Ferric Sulphate Fe2(SO4)3.

The experimental methods that were used in the coagulation/ flocculation treatment for turbid water were carried out by using jar test, which is most commonly. Samples of water that was used in the experiments was Lake water. Jar test was used to coagulate the samples of water by adding some coagulants in the experiment. All the experiments of coagulation – flocculation treatment were performed at the ambient temperature. The sample should be mixed well before using of the jar test and after that, the samples must be measured for pH and turbidity to represent the initial concentration. 800ml of the water was put in beakers, then mixed at a highspeed reaching to 221rpm for 5 min by using a stirrer, and then mixed slowly at a speed of 40rpm for 15 min, and finally the sample was left to settle for 2 hours. After settling the sample, a volume of liquor supernatant was pulled at a distance of 5 cm from the surface of the sample for conducting the analysis required. Coagulants of varying concentrations (0.5-3) ppm were added in the beakers to determine the best dosage based on the minimum concentration of pollutants. To determine the best value of pH, the experiments were carried out at the range of pH (5-6).

III. BATCH ADSORPTION STUDY

Batch experiment were carried out in 1000ml glass jar with 800 ml test solution at room temperature (29 +/- 30°C). Doses of every coagulant powder of 0.5, 0.7, 0.9, 1.1 and 1.3 mg were mixed with solution. The jar, along with known volume of the test solution of fixed concentration at neutral pH, was shaken in jar test apparatus at 221rpm for 5min and 2 hours for settle to study the equilibration time for maximum adsorption does of solution at the end of desired contact time, the samples were filtered using whattman paper number 42 filter paper and the filterate was analysied. Modual no described in the standard methods of examination of water and waste water. The batch study performed to optimum condition and to study the effect of pH, adsorbent does, contact time and initial concentration on the test solution.

Fig. 1 Water Samples

Fig. 2 Checking the Clarity of water by light

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue IV Apr 2024- Available at www.ijraset.com

IV. JAR TEST OPERATION

The jar test is a common laboratory procedure used to determine the optimum operating conditions for water or wastewater treatment. This method allows adjustments in pH, variations in coagulant or polymer dose, alternating mixing speeds, or testing of different coagulant or polymer types, on a small scale in order to predict the functioning of a large scale treatment operation.
The jar testing apparatus consists of six paddles which stir the contents of six 1liter containers. One container acts as a control while the operating conditions can be varied among the remaining five containers. A rpm (revolutions per minute) gage at the top-center of the device allows for the uniform control of the mixing speed in all of the containers.

Fig. 3 Jar Test Apparatus

The jar test procedure includes the following steps:
Fill the jar testing apparatus containers with sample water. One container will be used as a control while the other 5 containers can be adjusted depending on what conditions are being tested. For example, the pH of the jars can be adjusted or variations of coagulant dosages can be added to determine optimum operating conditions.

1) Add the coagulant to each container and set at approximately 221rpm for 5 minutes.
2) The rapid mix stage helps to disperse the coagulant throughout each container.
3) Turn off the mixers and allow the containers to settle for 2 hours. Then measure the final turbidity in each container.
4) Reduce the stirring speed to 25 to 35 rpm and continue mixing for 15 to 20 minutes.
5) This slower mixing speed helps promote floc or large cluster formation by enhancing particle collisions which lead to larger flocs.
6) Residual turbidity vs. coagulant dose is then plotted and optimal conditions are determined. The values that are obtained through the experiment are correlated and adjusted in order to account for the actual treatment system.

V. CALCULATIONS

Sample Calculation of Natural & Artificial Coagulant

1) SAMPLE CALCULATION FOR ORGANIC DRY HIBISCUS

CASE (1):
For 0.5 mg/l: Initial TDS – 101.26 mg/l Final TDS – 145.81 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((145.81 – 101.26) / (145.81)) * 100
= 30.55 %

CASE (2):
For 0.7 mg/l: Initial TDS – 101.26 mg/l Final TDS – 182.27 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((182.27 – 101.26) / (182.27)) * 100
= 44.44 %
CASE (3):
For 0.9 mg/l: Initial TDS – 101.26 mg/l Final TDS – 212.65 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((212.65 – 101.26) / (212.65)) * 100
= 52.38 %
CASE (4):
For 1.1 mg/l: Initial TDS – 101.26 mg/l Final TDS – 245.05 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((245.05 – 101.26) / (245.05)) * 100
= 58.67 %
CASE (5):
For 1.3 mg/l: Initial TDS – 101.26 mg/l Final TDS – 275.43 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((275.43 – 101.26) / (275.43)) * 100
= 63.23 %

2) SAMPLE CALCULATION FOR ORGANIC ALUMINIUM SULFATE
CASE (1):
For 0.5 mg/l: Initial TDS – 101.26 mg/l
Final TDS – 152 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((152 – 101.26) / (152)) * 100
= 33.38%
CASE (2):
For 0.7 mg/l: Initial TDS – 101.26 mg/l
Final TDS – 185.2mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((185.2 – 101.26) / (185.2)) * 100
= 45.32%
CASE (3):
For 0.9 mg/l: Initial TDS – 101.26 mg/l Final TDS – 192.84 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((192.84 – 101.26) / (192.84)) * 100
= 47.49%
CASE (4):
For 1.1 mg/l: Initial TDS – 101.26 mg/l Final TDS – 268.05 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((268.05 – 101.26) / (268.05)) * 100
= 62.22%
CASE (5):
For 1.3 mg/l: Initial TDS – 101.26 mg/l Final TDS – 284.83 mg/l
% Removal Efficiency = ((FINAL TDS – INITIAL TDS) / (FINAL TDS)) * 100
= ((284.83 –101.26) / (284.83)) * 100
=64.44%

VI. RESULTS

1) Organic Dry Hibiscus Used As Natural Coagulant

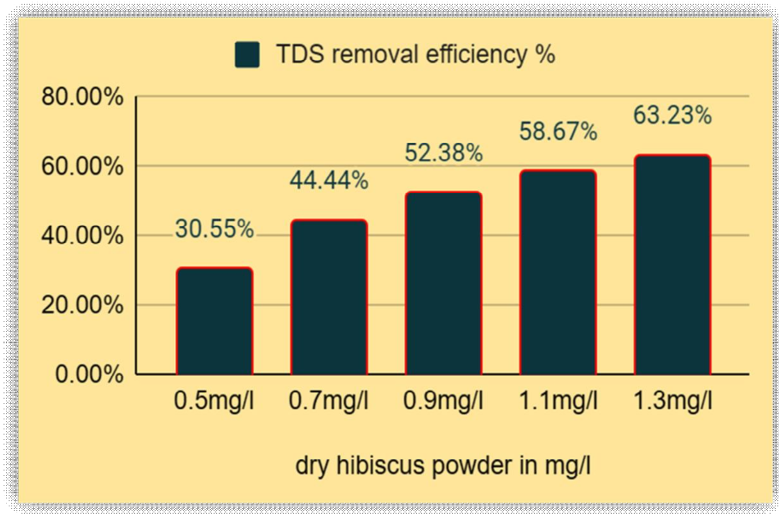


Fig. 4 Organic Dry Hibiscus Graph

Organic Dry Hibiscus were made into a fine powder and used as natural coagulant. Varying doses were used as shown in the Bar chart. Since the nature and effectiveness of this natural coagulant was unknown, dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/l respectively were used in each of the 5 jars. The Initial TDS of water sample was found to be 101.26 mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. Observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 63.23 mg/L.

2) Papaya Seeds used as Natural Coagulant

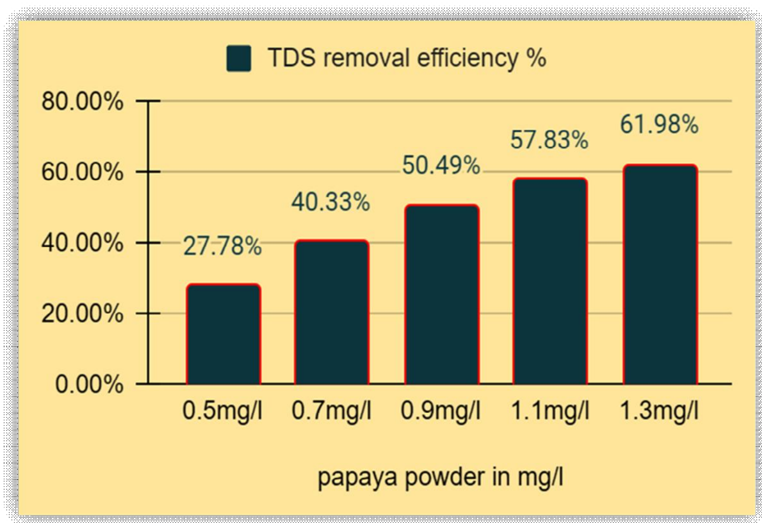


Fig. 5 Papaya Seeds Powder Graph

Papaya Seeds were made into a fine powder and used as natural coagulant. Varying doses were used as shown in the Bar chart. Since the nature and effectiveness of this natural coagulant was unknown, dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/L respectively were used in each of the 5 jars. The Initial TDS of water sample was found to be 101.26 mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 61.98 mg/L.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue IV Apr 2024- Available at www.ijraset.com

3) Watermelon Seeds used as Natural Coagulant

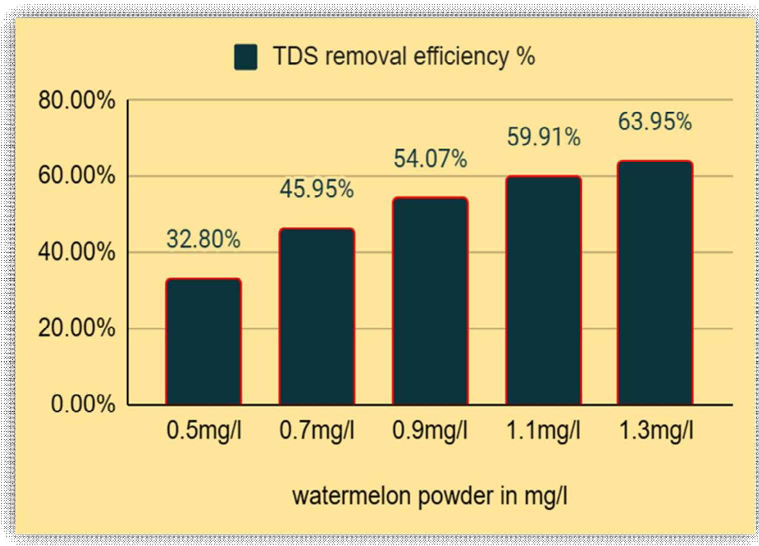


Fig. 6 Watermelon Seeds Powder Graph

Watermelon Seeds were made into a fine powder and used as natural coagulant. Varying doses were used as shown in the Bar chart. Since the nature and effectiveness of this natural coagulant was unknown, dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/L respectively were *USED* in each of the 5 jars. The Initial TDS of water sample was found to be 101.26mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 63.95 mg/L.

4) Aluminium Sulphate used as Artificial Coagulant

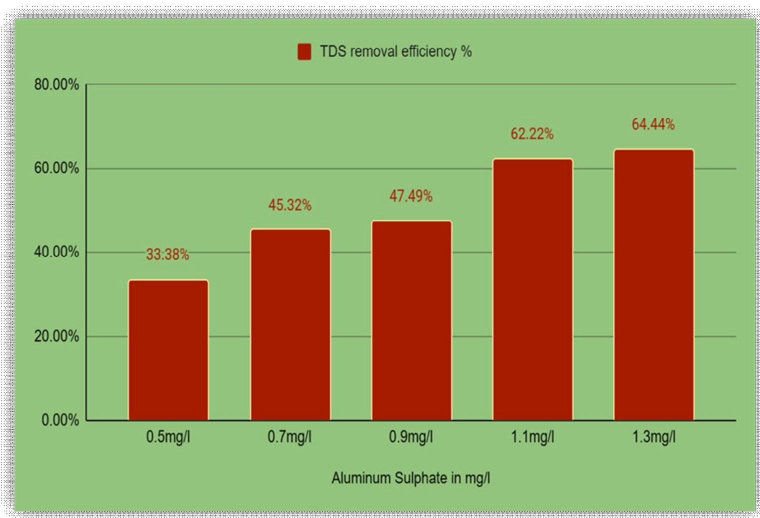


Fig. 7 Aluminium Sulphate Graph

Aluminium Sulphate were made into a fine powder and used as artificial coagulant. Varying doses were used as shown in the Bar chart. Since the nature and effectiveness of this chemical coagulant was known, dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/L respectively were used in each of the 5 jars. The Initial TDS of sample was found to be 101.26 mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 64.44 mg/L.

5) Sodium Aluminate used as Artificial Coagulant

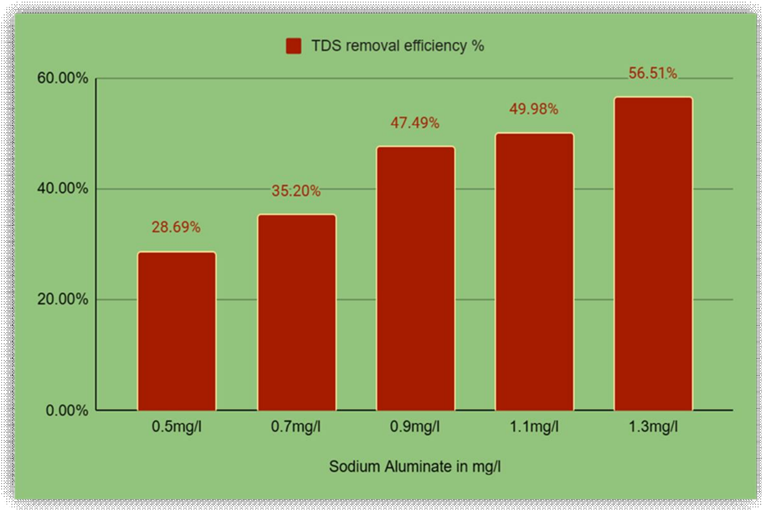


Fig. 8 Sodium Aluminate Graph

Sodium Aluminate were made into a fine powder and used as artificial coagulant. Varying doses were used as shown in the Bar chart dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/L respectively were used in each of the 5 jars. The Initial TDS of water sample was found to be 101.26 mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 56.51 mg/L.

6) Ferric Sulphate used as Artificial Coagulant

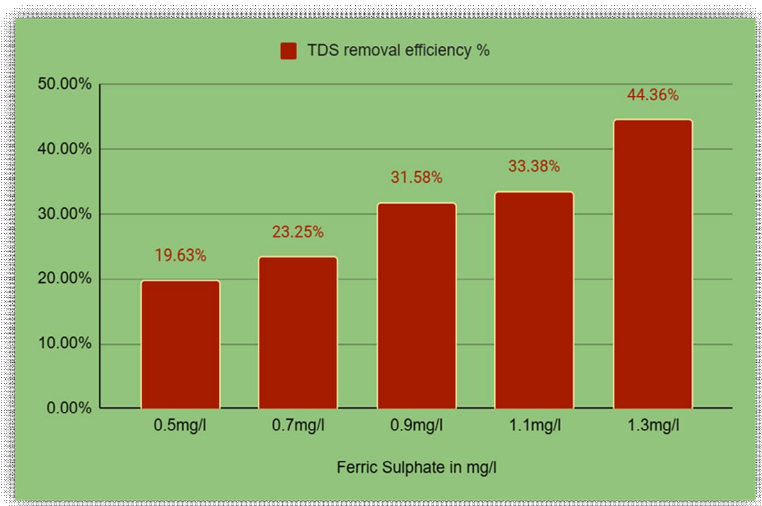


Fig. 9 Ferric Sulphate Graph

Ferric Sulphate were made into a fine powder and used as artificial coagulant. Varying doses were used as shown in the Bar chart. Dosages of 0.5, 0.7, 0.9, 1.1 and 1.3 mg/L respectively were used in each of the 5 jars. The Initial TDS of water sample was found to be 101.26 mg/lit. Once the Jar test experiment was completed, Final TDS of all samples was measured using a TDS Meter. observations and Bar chart plotted, maximum percentage TDS removal in this case was found at a dosage of 44.36 mg/L.

VII. CONCLUSIONS

The comparative removal percentage of TDS using various coagulants is shown in figure no.10. The graph is plotted for dosage corresponding to maximum removal efficiency of TDS to find effective coagulant and effective dosage of each coagulant.

NATURAL COAGULANTS VS ARTIFICIAL COAGULANTS

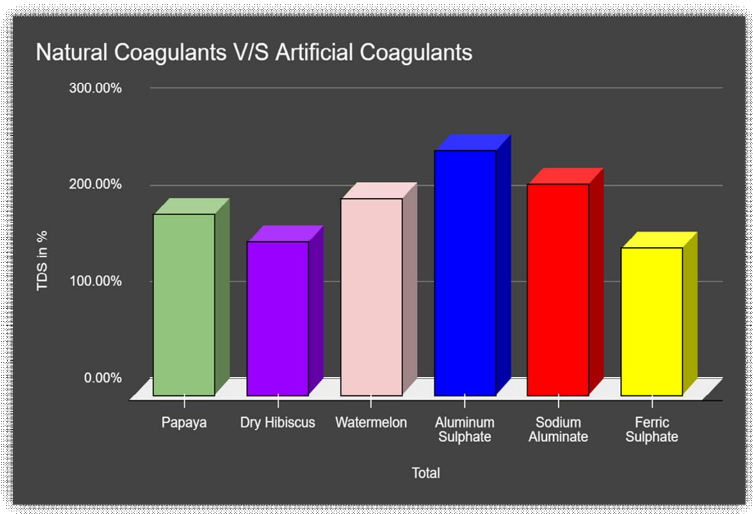


Fig. 10 Natural Coagulants VS Artificial Coagulants Graph

REFERENCES

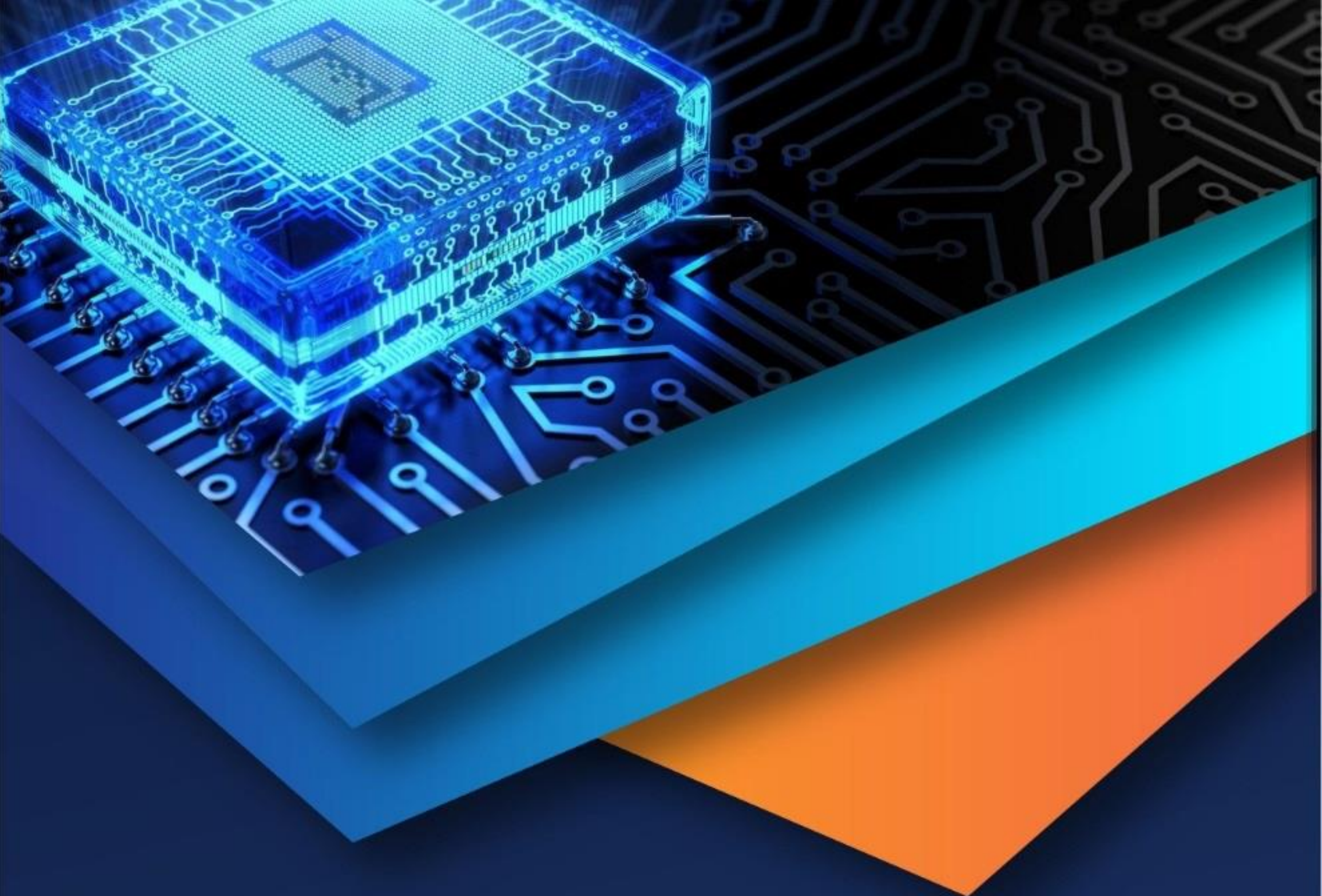
[1] Giridhar, V.S.S., A Study on The Uses of Alum for Turbidity Removal In Synthetic Water. National conference On Water, Environment Society 2016.

[2] Muthuraman. G. Turbidity Removal from Surface Water by Natural Coagulant and Its Potential Application.2011.

[3] Geetha And Sharpudhin, Comparative Study of Removal of Turbidity from Waste Water Using Chemical and Natural Coagulants. International Journal of Science Engineering and Technology Research,2015 (IJSETR) Volume 5, ISSN:2278-7798,

[4] Kumar P.S, Vaibhav K.N, Shiv R., Rhyagarajan A., Removal of turbidity from washing machine discharge using strychnospotatorum seeds: parameters optimization and mechanism prediction, resource –efficient, technologies,2016, SI7SI76

[5] Ramawandi, Treatment of Water Turbidity and Bacteria by Using a Coagulant Extracted from Plantago Ovate, Water Resources and Industry,2016, 36-50.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY