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An Experimental Study on Recycle and Reuse of Waste Water by Poly Aluminium Coagulants of Veerapandi Area, Salem, India

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Abstract: ***Recycled waste water is a reliable source of water that must be taken into account in formulating a sustainable water policy. Water reuse is increasingly been integrated in the planning and development of water resources in thirumanimuttar river basin region, particularly for irrigation. Increasing water demand, increase in population and variation of variation of rainfall scale, tends to pollute ground water and improper sewage design that leads to pollute groundwater and improper sewage design that leads to overflow causes contamination of groundwater level. Waste water samples are collected from the Veerapandi zone and analyzed for their chemical constituents. The locations of samples water were collected from five areas and the entire area is 49 sq.km and the reuse water has been cultivated around 50 acres of agricultural land. Here we have analyzed the Physical, chemical and biological parameters of waste water for irrigation purpose. The result values are compared with the permissible value as per IS codes. By adding Poly aluminium chloride (PAC) as a coagulants the alum entraps and neutralize with waste water (dirt particles) the metal hydroxide gets precipitates during coagulation process. Therefore the removal efficiency of total dissolved solids (TDS) and sulphate level is highly recommended in the treatment process. Some location sample shows that are in mere contamination and unfit for agricultural and irrigation purposes.***

Keywords: Water reuse, Irrigation, Total dissolved solids (TDS), Sulphate level. Poly aluminium Coagulants

I. INTRODUCTION

In today's world Water is essential natural resource for sustaining life and environment. Growth of urban population has increased the demand for fresh water sources and its rapid depletion has been a concern to ecologists. By reuse the waste water collected in the urban areas reclamation of water is one of the method to recycle it and moreover nearly 23% is used for irrigation purpose, but the reclaimed water is a miscellaneous process to recycle, since the amount of wet waste collected in the water required high standards to recycle it. The enhanced raw waste water is initially treated with preliminary treatment process and converted secondary and tertiary treatment process. The quality of irrigation water is mainly depends on amount of salinity level present in the treated water. If there is high water level salinity the more salts will be formed and tends to reduce permeability level to the root growth level and becomes more toxicity which cause more distortions to the small leaves. By adding 10 % Poly Aluminium Chloride as a Coagulant the pH of treated water gets reduced nearly 40% and the pH is maintained to acidity level which is used for an treatment process, since the optimum pH for micro nutrients is less than 7.0. The main factors of the irrigation water characteristics is determined by the pH, Influence of pH on Turbidity, Correlation between Electrical conductivity (EC) and Total Dissolved Solids, Sodium Adsorption Ratio (SAR) and boron content. There are also some main other factors need to determine such as sodium (Na), Hardness, Magnesium, phosphorus levels and residual sodium carbonate (RSC).

II. OBJECTIVE OF THE STUDY

A. To study the amount of sewerage collected in the veerapandi zone
B. To collect the water samples from veerapnadi zone
C. To determine important water quality parameters by conducting laboratory tests
D. To compare the results with irrigation water quality standards
E. To assess impacts of treated waste water on soil, crop produce and groundwater quality
F. To be enhancing water efficiency through improved irrigation systems agronomic practices and using validated stimulated models.

III. STUDY AREA DETAILS

The present study was conducted in the Veerapandi is a large village located in Salem taluka of Salem district, Tamil Nadu with total area of 49 sq.km lies between north latitudes 11°31'52 "to 11° 36'54" and east longitudes 78° 02'54" to 78°08'30".The area consists number of surface water bodies/lakes, which are well connected by drainage with quantity of sewage generated as 0.72 MLD. In veerapandi nearly 83% area is characterised by the agricultural activities, there must be a ground water depletion in upcoming years. The surrounding areas in the nearby areas has the bad quality of TDS levels which is more toxicity for irrigation purposes and they are considered to be bad quality areas. The entire area receives a Monsoon rainfall (June to December) of 0.795 metre. Due to that the groundwater levels gets reduced and the number bore wells gets increased to nearly 18% in 2018. According to the recent data available with the public works department the average groundwater level in veerapandi area, Salem district currently available is at 10.20 metre. The same area was marked at 14.25 metre depth in the same month in 2017.

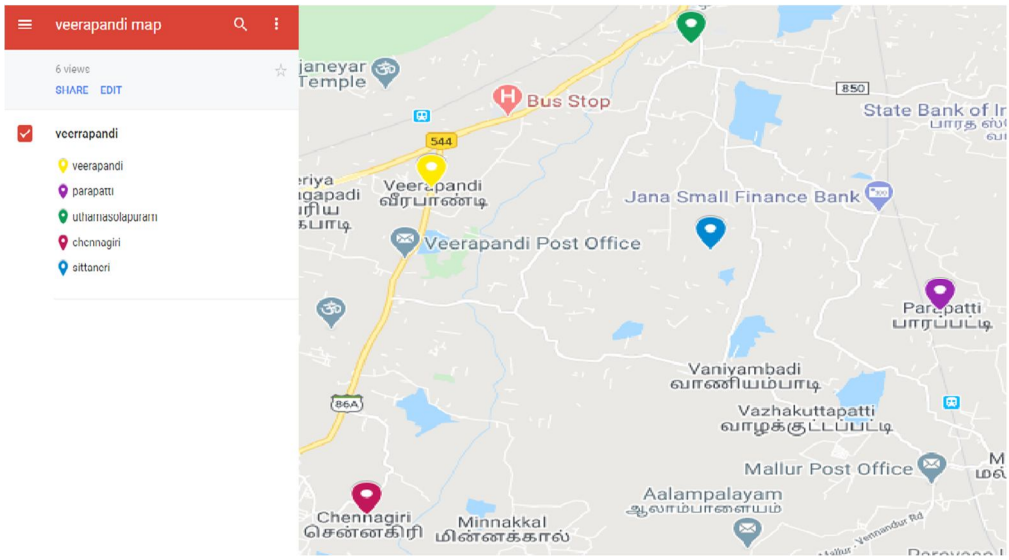

Fig. 1 Location of sample water from veerapandi area

For this study, the sample were collected in five different regions which are marked in fig. 1 such as Veerapandi, Parapatti, Uthamasolapuram, chennagiri, Sitteneri. Characterization tests were performed on the effluent and different parameters determined are pH, turbidity, hardness, Electrical conductivity, Total solids and Total dissolved solids and boron content as per IS codes.

IV. POLY ALUMINIUM COAGULANTS CHARACTERISTICS AND APPLICTIONS

Poly aluminium chloride is increasingly used for water treatment. It shows distinct advantages the conventional use of aluminium sulfate (alum). Since Poly aluminium chlorides (PAC) are easily dissolved in water. The polymer in the PAC gets neutralize to form insoluble aluminium as a poly – hydroxides which forms a precipitate in big volumetric flocs. During the process of coagulation the flocs particles gets rapidly mixed with the suspended impurities or dirt particles in water which are neutralized with the PAC and form together be easily removed the impurities. PAC can be used as a flocculent for all types of water treatment, industrial waste water, urban waste water and in the paper industry.

Fig. 2 Poly Aluminium Chloride (PAC)

Reasons for using Poly aluminium chloride as a coagulants in the treatment:

A. Limited coagulation maintains pH range as 6.5 to 7.5
B. By using lower dosage of PAC to give 100% percentage of alum
C. Shorter flocculation and coagulation time
D. Small amount of sludge
E. Highly treated impure quality of water

Characteristics	Adding of PAC with 10 %	Adding of PAC with 30%
Appearance	Liquid with yellow color	Liquid with yellow color
Al_2O_3 content	8.8 – 9.2%	27 – 29 %
Cl	9.8 – 11%	31 – 32 %
Basicity	62 – 68 %	46 – 52 %
Specific weight at 20 degree Celsius	1.18 – 1.22 g/ml	1.36 – 1.39 g/ml

TABLE. 1 Characterization of Poly aluminum chloride (PAC)

The table.1 shows that the PAC of 10 % replacement of Al_2O_3 high basicity is mostly used for drinking water treatment is summarized and with replacement of 30 % Al_2O_3 is widely used for the most of the applications.

V. EXPERIMENTAL METHODOLOGY

The research was carried out in two stages, namely a preliminary test and the test continue .Test prelude an in initial test of the waste water laboratory which aims to study the properties and characteristics of the waste water Laboratory while further tests to find the optimum concentrations of substances used as coagulant. The sample water collected in a jar of one liter using a magnetic stirring apparatus. By adding Poly aluminum chloride (PAC) 10, 15, 20, 25 and 30% as solutions in to each as a concentration in each of the beakers. The initial test of the sample is allowed to 100 rpm for 1 minute and then decreased the speed to 30 rpm for 10 minutes. Then the stirrer is turned and the flocs particles gets settled down at least for 20 minutes. The supernatant from each beaker is used to determine the pH, Turbidity, Electrical conductivity, TDS, SAR, hardness and RSC in each samples.

VI. TESTING OF SAMPLE RESULTS

A. pH

The pH is an important parameter of a water supply describes how acidic or alkaline it is. The generally accepted pH for irrigation water is between 5.8 and 7.5 and the averages is 7.0 but some problems can occur within this range. Alkaline water may contain high concentrations of bicarbonate (generally in water pH and above) and carbonates (generally pH 9 and above).

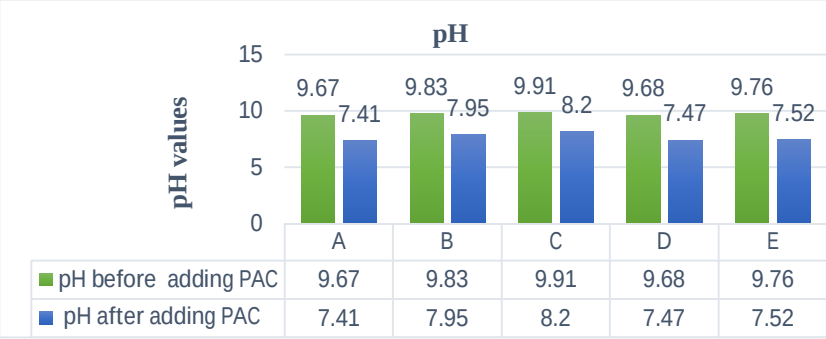

Fig. 3 Comparison of pH

From the fig. 3 the sample B and C is less than 7.5 which affects the acid and alkaline content of soil and the plant's ability to absorb certain nutrients is disrupted. Some trace elements, like copper and potassium, will also be less available to the plant in this situation. A pH greater than 7.5 is likely to reduce the effectiveness of chlorine disinfection.

B. Influence of pH on turbidity

A high level of turbidity can affect the performance of the irrigation facility, and decrease in the amount of sunlight for photosynthesis which forms the growth of algae. For example if there is presence of suspended particles in waste water by the passage of an sunlight to it forms algae due to the formation of hydroxyl ions in pH. By the process of coagulation the pH of treated water is necessary for turbidity removal and corrosion control in pipes.

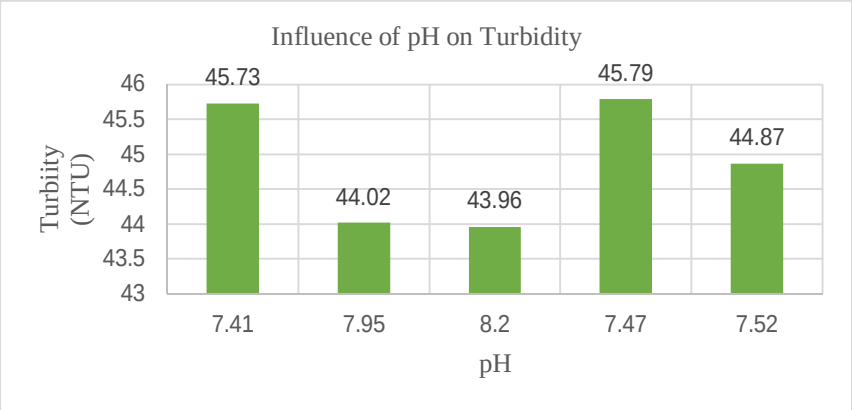

Fig. 4 Influence of pH on turbidity

From the fig. 4 the results shows that the average pH is 9.70 -9.80 which indicates the growth of aquatic living organisms in the waste water. The water quality and the average turbidity is 44.87 which indicates more variations in turbidity and the value of turbidity lies between in the range of 42 – 44 NTU which indicate the bad quality in terms of turbidity. From this correlation that there is no direct influence of waste water pH on turbidity significantly but there exist certain insignificant positive correlation with other factors.

C. Correlation between EC and TDS

The importance of electrical conductivity is to determine the amount of salt concentration and Total dissolved solids in the water to the plants. If the electrical conductivity is more than 12 ds/m, which indicates it has greater salt content in the water. Due to the higher concentration of salts to the lower concentrations of total dissolved solids the salinity level of a water gets reduced and the water must be easily transferred to the roots to the surrounding yields.

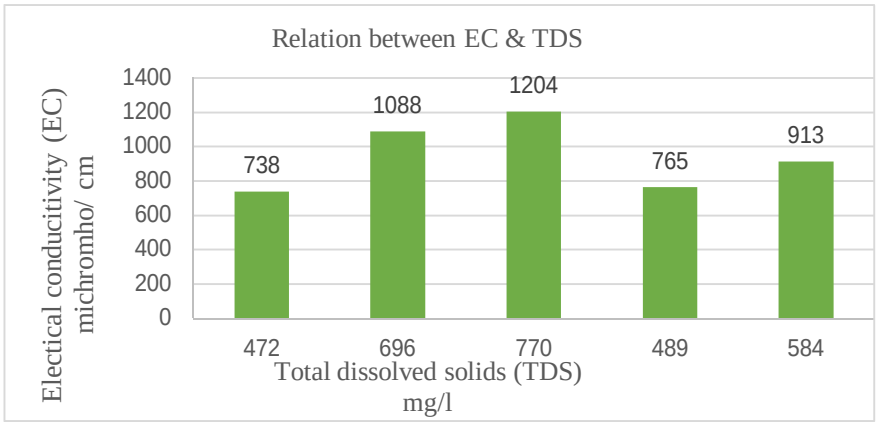

Fig. 5 Relation between EC and TDS

The relationship between TDS and EC is a function type and nature of the dissolved cations and anion. From the fig.5 EC can be converted to TDS using the following calculation:

TDS (ppm) = 0.64 X EC (µS/cm) = 640 X EC (dS/m)

The average ratio of calculated TDS to conductivity falls to 0.73 and causes no changes in the lower ion sum an un measured constituent such as ammonia or nitrate may be present at significant concentration and the acceptance criteria for this ratio is 0.55 - 0.7. If poorly dissociated calcium and sulfate ions are present, the TDS may be high as 0.8 times the EC.

D. Sodium adsorption ratio (SAR)

By the process of hardness Ca^{2+} and Mg^{2+} and Na^{+} ions the sodium adsorption ratio is calculated to determine the adsorbed of the soil clays and causes dispersion of soil particles.

$SAR = Na^{+} / [(Ca^{2+} + Mg^{2+})/2]^{0.5}$

Sample	Na^{2+}	Ca^{2+}	Mg^{2+}	SAR Value	Class
A	74	112	47	8.2	Low
B	143	244	79	11.25	Medium
C	167	297	88	12.03	Medium
D	81	129	53	8.5	Low
E	94	143	67	9.2	Low

TABLE. 2 Water quality rating based in SAR values

From table. 2 the water quality rating based on SAR values it is found that the most of the samples falls under low water quality and two samples are undesirable for irrigation. This causes of unsuitability are due to storage due to bedrock formation, agricultural activities. The sample B and C are generally undesirable for irrigation and should not be used on clay soils if low permeability. However, it is used to irrigate plants of high salt tolerance, when grown on salty soils to protect against under decline fertile lands. The moderate water can be used to irrigate salt –tolerant and semi tolerant crops under favorable drainage conditions.

E. Boron content

Though boron is essential micronutrient for plant growth, its presence in excess in irrigation water affects metabolic activities of the plant. For normal growth the safe limits of boron content is to be around 3 ppm and more than 3 ppm boron is harmful to crops.

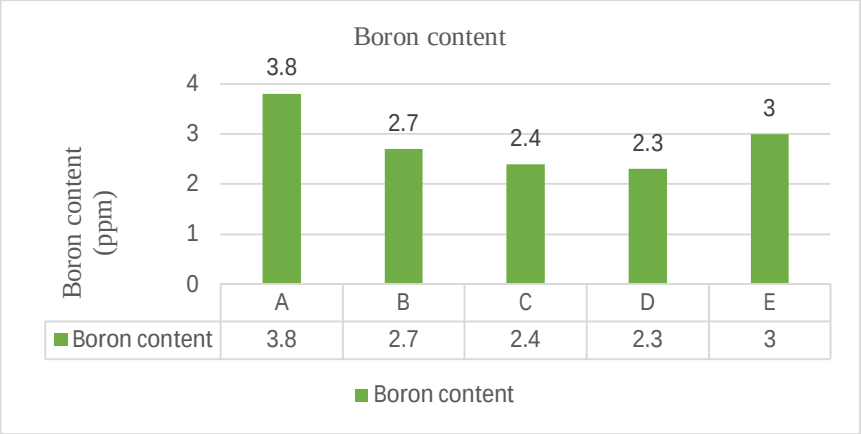

Fig .6 Boron content in treated water

From the fig.6 the boron content relatively tends to change the tolerance levels as if the Sample B, C and D moderately low compared to other samples indicates that those plants are prefer to be good growth of plants. The test Samples A and E indicates that the boron content not in the levels of normal range. Indicates that it in the range of the low water quality level and becomes toxic, which affects the plants growth and the nutrient content is less.

F. Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) also are used to assess the sodium permeability hazard, and this value includes the influence of HCO_3^{-} and CO_3^{2-} as compared to Ca^{2+} and Mg^{2+}.The range of an RSC values is greater than the 1.0 me/L to + 0.5 me/L which is considering for the irrigation purposes. If there is a negative value RSC which indicates lack of concentration calcium and magnesium ions.

RSC values in the sample 1 ranged from 4.47 to 0.57me/L (Avg : -1.97 me/L), In the sample 2 ranged from 5.54 to 0.77 me/L (Avg : -2.83 me/L), In the sample 3 ranged from 9.73 to 2.08 me/L (Avg : 2.7 me/L), In the sample 4 ranged from 4.85 to 061 me/L (Avg : -2.0me/L), In the sample 5 ranged from 5.13 to 0.69 me/L (Avg : -2.6 me/L)

VII. CONCLUSION

The analysis of five samples from different areas in Veerapandi Zone has been treated by using Poly aluminium chloride as a coagulant. Though all the chemical characteristics have been classified separately, they are present in each irrigation water, and the chemical characteristics of a particular class of water is independent of the chemical characteristics of different class in independent of the chemical characteristics of a particular class of water.

For example, a water of high Electrical conductivity may or may not have high Sodium Adsorption ratio (SAR) or Residual sodium carbonate (RSC) or boron. These physical and chemical characteristics interact with each other to the treated water and cause hazardous effects on soil properties and crop growth.

The following conclusions are drawn from the above study by adding 10% of PAC

A. When adopting physical and chemical process for treatment of waste water by adding PAC, it is essential to carry out a lab – scale model for a representative sample of the waste under control. The average pH is determined for this study is 7.5 – 7.7

B. By adding poly – aluminum chloride 10 % the optimum pH range for turbidity removal was found 7.2 – 7.5 for PAC and alum resulting in the maximum turbidity removal. The highest removal efficiency was more than 74% for alum and more 83% for PAC over applied range of turbidity.

C. A correlation can only exist if the dissolved solids include only in ionic compounds and there are no soluble mineral acids. Since the concentration level of ions in waste water is high. So use of conductivity for TDS only if the solids composition of the Samples around to be 0.55 -0.6 for samples A and E which is fairly well fixed. for sample B and C we can't use the sewage water for irrigation purpose.

D. The dose of the coagulant is directly proportional to the concentration of the organic load in the waste water. Therefore, after determining the optimum dose of the coagulant for a particular waste should be adopted.

E. Based on SAR of the study area occupied are occupied by the suitable ground water for irrigational purpose.

F. Based on RSC classification the sample A, B, D and E were below in the range of less than 1.25 me/L and these samples water are safe for irrigations. Since the pH for sample C is 8.2 which has high concentrations sodium bicarbonate is alkaline by adding the medium level of RSC is reduced to low level which is safe for irrigation.

G. The pH of an treated water is maintained due to high efficiency for the process rapid and slow mixing. The flocculation size distribution for Poly aluminium also exhibited excellent settling characteristics, with majority of the size of the particles settled out in the initial 5 min of settling. It is important that rapid and slow mixing speeds and time be determined by jar test for each waste water, but good results were obtained for semi - aerobic with a maximum rapid mixing speed 150 rpm for 1 min, 20 rpm slow mixing speed for 20 mm and a settling time of 30 min.

H. In the study area the sample A, D and E (60%) samples fall in good to permissible field, the remaining samples B and C (40%) are fall in doubtful to unsuitable field.

VIII. FUTURE SCOPE

According to the recent studies, by the end of 2030, the contamination of ground water level in India is reduced to 40% due to poor rainfall. India produces nearly 40000 million liter per day of sewerage water, out of that nearly 22 % only recycled process and remaining untreated to the earth. The application of PAC as a reclaimed water has set a unique challenges in it, but the negative effect to the plant system is only 15%. Micro and macro nutrients remains constant after the treatment process which the growth of the plants would not the affect. The low salinity level of a water by adding PAC with 10% can't harmful not only to the plants but also to the soil. Since the Cost of PAC is deliberately high, but by adding 30 % in it as a coagulant the water gets more softened and the effect of the reclaimed water is safe for irrigation purposes can support for further research.

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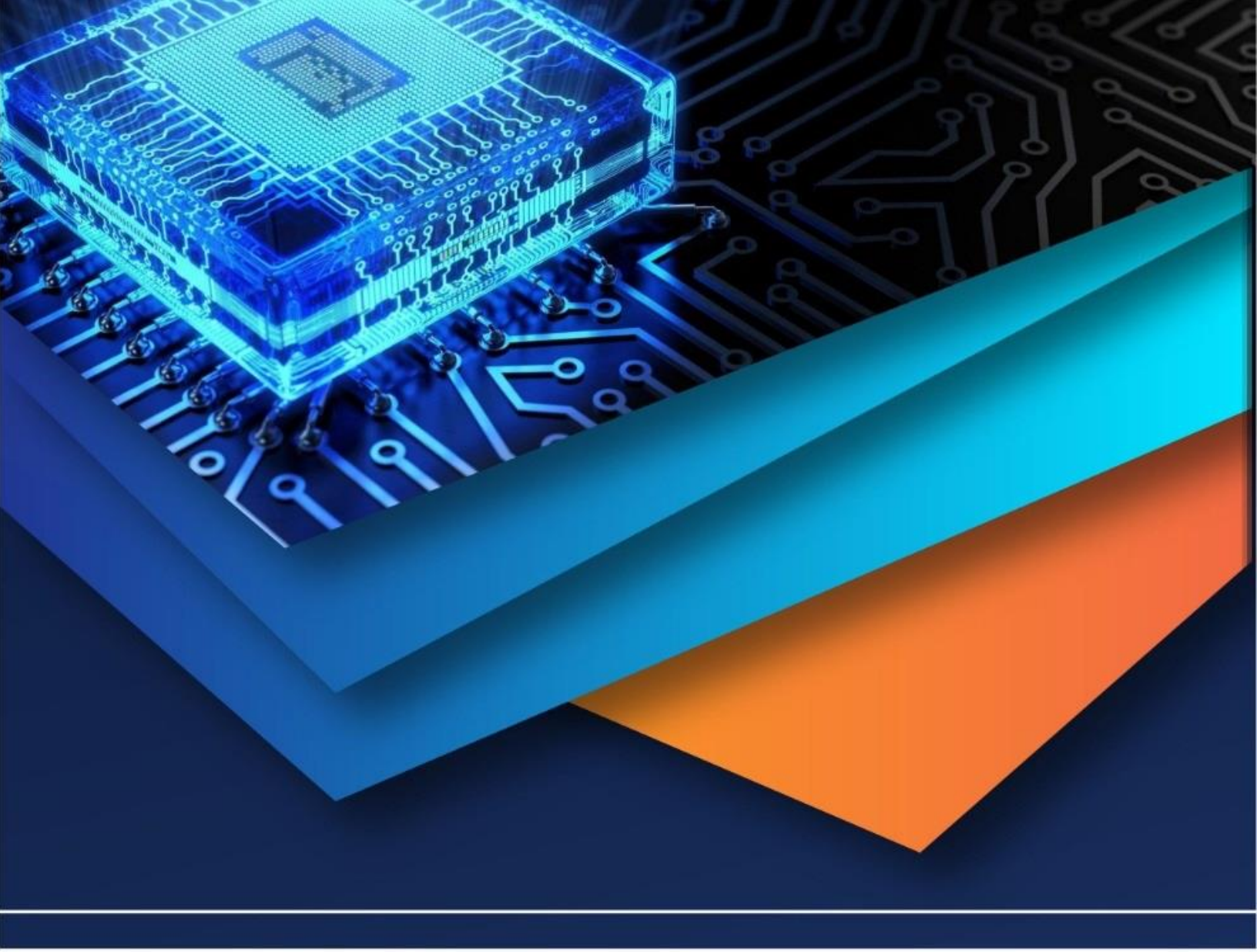

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