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Assessment of Groundwater quality for Drinking and Irrigation purposes in Tindivanam ,Villupuram district, Tamilnadu.

P. Ramamoorthy
Department of Civil Engineering, Mailam Engineering College, Mailam,Tamilnadu.

Abstract:- The study area Tindivanam town has choosen to determine the groundwater quality for drinking and irrigation suitability. In order to assess the quality of groundwater in study area, 20 groundwater samples were collected and analyzed for various physical and chemical parameters of groundwater such as TDS, pH, EC, Ca, Mg, Na, K, Cl, NO3, F were determined. The collected samples are compared with the WHO standards of drinking water quality. Therefore the study reveals that how the groundwater is contaminated by effluents from small scale industries and dumping of wastages from markets and domestic wastages from in and around Tindivanam town.

Key words: pH, Tindivanam , Groundwater quality, EC,TDS, Cl, SSP .

I. INTRODUCTION

Groundwater is the prime source of drinking water supply for many of the Indian rural and urban habitats, like in other parts of the world (Abdul Saleem et al.,2012). Due to inadequate supply of surface water, demand for groundwater resource has increased in many folds in recent times for drinking, irrigation, and industrial purposes in the world. It is estimated that approximately one third of the world's population use groundwater for drinking(Nickson et al., 2005).Due to overexploitation of groundwater for domestic, irrigation and industrial purposes for the past few years the groundwater level has depleted forcefully it will adverse affect of groundwater quality and quantity. Once the groundwater is polluted, it is not easy to restored by stopping the pollutants from the supply. Contamination of groundwater also depends on the geology of the area and it is rapid in hard rock areas especially in lime stone regions where extensive cavern systems are below the water table (Singh, 1982). This is a feature common, not only in developed countries but also in developing countries like India. The changes in quality of groundwater response to variation in physical, chemical and biological environments through which it passes (Singh et al., 2003).

The chemical composition of groundwater is very important criteria that determine the quality of water. Water quality is very important and often degraded due to agricultural, industrial and human activities. Even though the natural environmental processes provide by means of removing pollutants from water, there are definite limits. It is up to the people to provide security to protect and maintain quality of water (Ikhane Philips et al.,2010). The present study was focused to evaluated the groundwater quality and its suitability for drinking purpose in Tindivanam town. Groundwater is the only source of study area due to lack of surface water.

II. STUDY AREA

Tindivanam is a Municipality city in district of Villupuram, Tamil Nadu. Tindivanam is located at a distance of 120 km from Chennai in South West Direction and at distance of 35 km from Pondicherry in North West Direction. Tindivanam is one among the three sub-divisions of Villupuram District, Tamil Nadu. This small town lies about 65 km northwest of Cuddalore. The Total area of the Tindivanam town (Fig:1)is of the 22.3 Sq.km.

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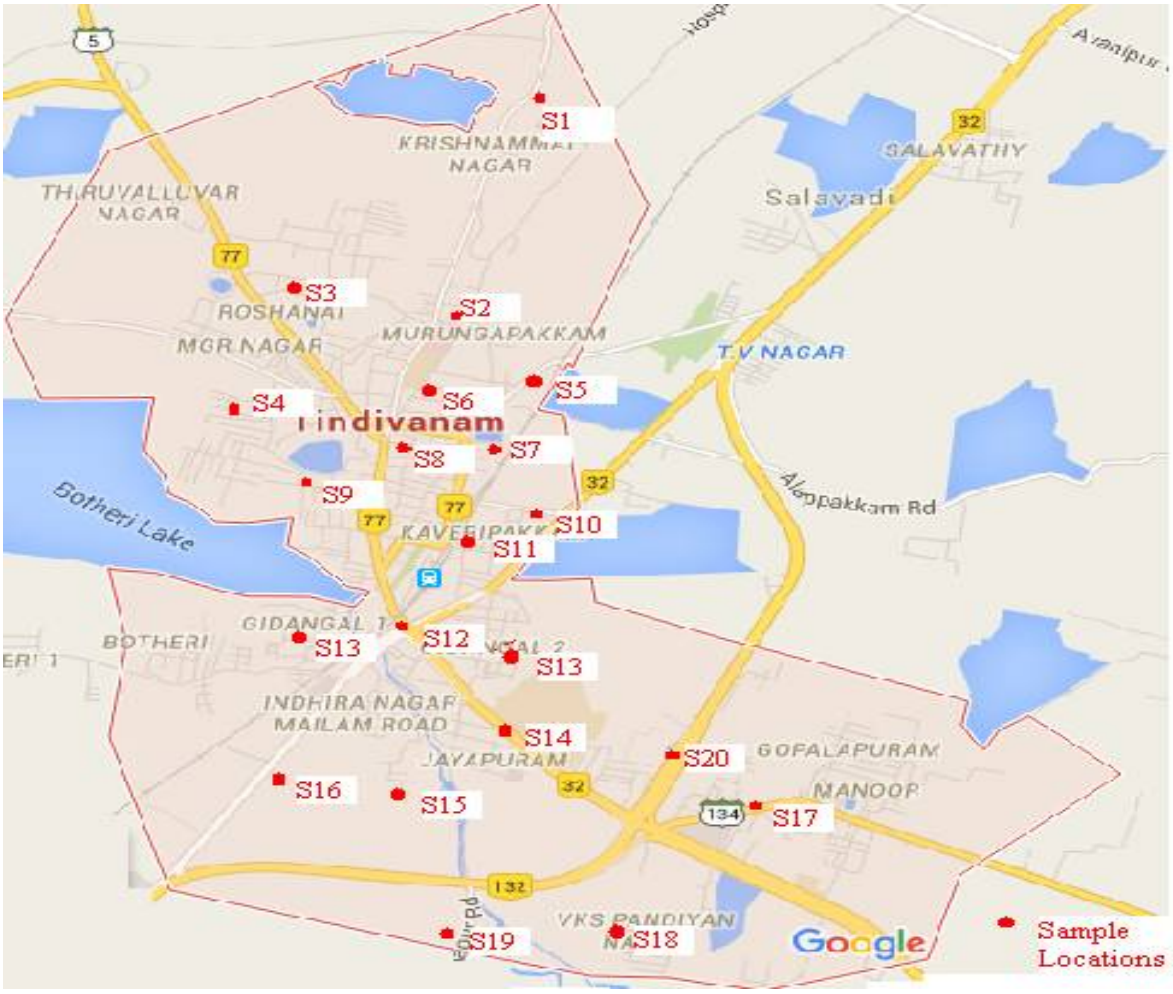

Fig:1 Location Map of Study area

III. MATERIALS AND METHODS

Samples were collected from bore well and open wells and analysed for different parameters. All samples should be properly labelled with details of the locations, date and time of sampling. Samples are collected at the following locations Jagampet,Gidangal-1,GH road, College road, Salavathi road, TMG Nagar, Housing board, VKS Pandian Nagar, Jayapuram, Karunavur road, Nagalapuram, Theertha Kulam, Avarappakkam, Roshanai, Gandhi statue, Murungapakkam, Sedankuttai street, Kaveripakkam, Tindivanam Bus stand, Gidangal -2. Water sample collected in the field were analyzed in the laboratory for the major cations and anions using the standard methods as suggested by the American Public Health Association(APHA, 1995)

IV. RESULTS AND DISCUSSION

A. pH

The purpose of finding the pH value is to determine whether the drinking water is acidic or alkaline in nature. The pH values of groundwater samples range between 7.06 to 8.36, which indicates that the groundwaters are slightly alkaline in nature. In general, groundwater pH is

slightly alkaline due to the influx of HCO_3 ions in the groundwater aquifer which is due to percolation of rain water through soil (Mor, et al,2006 , Alam, et al, 2012).

Table: 1, Ground water suitability for drinking and domestic purposes

Parameters	Permissible limit as per WHO,1997	Concentration Observed		No. of Samples Exceeding Permissible Limit
		Minimum	Maximum	
pH	9.2	7.06	8.36	NIL
TDS	1500	571	2120	6
Calcium	200	79.4	212	1
Sodium	200	78	182	NIL
Magnesium	150	18.8	56.3	5
Potassium	12	2.8	5.2	NIL
Chloride	600	108	212.4	2
Nitrate	50	10.6	36.7	NIL
Sulphate	600	12.2	64.7	NIL
Fluoride	1.5	0.697	1.69	1

B. TDS

Total dissolved solids (TDS) mainly consist of inorganic salts such as carbonates, bicarbonates, chlorides, sulfates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc and small amount of organic matter and dissolved gases (Shubhra Singh et al 2015). The TDS concentrations ranges were between 571 to 2120 mg/l. To ascertain the suitability of groundwater for any purposes, it is essential to classify the ground water depending up on their hydro chemical properties based on their TDS values (Catroll, 1962). which are presented in (Table. 2).

Table-2 Classification of ground water based on TDS Classes.

TDS mg/L	No.of. samples	Percentage %	Description
<500	Nil	Nil	Excellent
500-1000	6	30	Good
1000-2000	12	60	Fair
>2000	2	10	Poor

Most of the groundwater samples are within the maximum permissible limit for drinking as per the WHO international standard, except 6 (S7, S14, S15, S16, S17, S18) samples in study area. The maximum TDS value of (2120mg/L) was found in the sample (S16) and the minimum value of (670 mg/L) was found in the sample (S3). TDS value below 1000 mg/l indicating low content of soluble salts in groundwater which can be used for drinking without any risk (Ramamoorthy and Rammohan,2014) .

C. Electrical Conductivity (EC)

The electrical conductance value of all the samples varies in the range of 825 to 2990 µS/cm. The maximum electrical conductivity value of (2990 µS/cm) was found in the Sample (S16) and the minimum value of (825 µS/cm) was found in the Sample (S3).The electrical conductance is a good indication of total dissolved solids which is a measure of salinity that affects the taste of portable water(Mohamed Hanipha and ZahirHussian,2013). The electrical conductivity is also influenced by ionic mobility, ionic valence and temperature (Ramamoorthy and Rammohan,2014) .

D. Calcium (Ca)

Calcium is an essential nutrition element for human being and aids in maintaining the structure of plant cells and Soils(Chari and Lavanya ,1994). The value of calcium of all the samples varies in the range of 79.4 to 212 mg/l. The maximum value of the calcium was obtained at the sample (S3), and the minimum value of the calcium was obtained at the sample (S2).

E. Magnesium(Mg)

The magnesium value of all the samples varies in the range of 18.8 to 39.01 mg/l. The maximum value of magnesium was obtained at the sample (S12), and the minimum value of the magnesium was obtained at the sample (S10). The Magnesium concentration on the study area are derived from the dissolution of magnesium calcite, gypsum/or dolomite from source rock (Garrels and Mackenzie, 1967).

F. Chloride(Cl)

Chloride originates from sodium chloride which gets dissolved in water from rocks and soil. It is good indicator of groundwater quality and its concentration in groundwater will increase if it mixed with sewage or sea water(Deshpande and Aher,2012). The chloride value of all the samples varies in the range of 108 mg/l to 212.4 mg/l. The maximum value of the (212.4 mg/l). The maximum value of chloride is obtained at the sample (S14). The minimum value (108 mg/l) of the chloride is obtained in the sample (S12). Soil porosity and permeability also play an important role in building up the chloride value in the groundwater (Jain, et al., 2005)

G. Potassium (K)

Potassium is an essential element for humans, plants and animals, and derived in food chain mainly from vegetation and soil. The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation (Deshpande and Aher,2012). The European Economic Community (EEC,1980) has prescribed the guideline level of potassium at 10 mg/l in drinking water. The Potassium value of all the samples varies in the range of 2.8 to 5.2 mg/l. The maximum value of magnesium was obtained at the sample (S8), and the minimum value of the magnesium was obtained at the sample (S4, S14). The collected groundwater samples fall within the permissible limit as per WHO standards(Table:1).

H. Nitrate (NO3)

The nitrate value of all the samples varies in the range of 10.6 mg/l to 36.7 mg/l. The maximum value (36.7mg/l) of the nitrate is obtained at the sample (S15). The minimum value (10.6mg/l) of the nitrate is obtained in the sample (S3). The contamination of groundwater may be due to sewage and other wastes rich in nitrates(VenkateswaraRao ,2011) The presence of nitrate in groundwater may be due to leaching of nitrate with percolating powder(Mohamed Hanipha and ZahirHussian,2013). Toxicity of nitrates in infant's cause's methaemoglobiaemia(US-EPA,2012).

I. Sulphate (SO4)

The sulphate value of all the samples varies in the range of 12.2 to 64.7 mg/l. The maximum value of the sulphate is obtained at the sample (S13). The minimum value of the sulphate is obtained in the sample (S5). High concentration of sulphate may cause gastro-intestinal irritation particularly when magnesium and sodium ions are also present in drinking water resources(Indrani Gupta , et al.,2011)

J. Fluoride (F)

The value of fluoride for the groundwater samples is recorded between 0.69 to 1.69 mg/l. The permissible limit of the fluoride value in the groundwater is 1.5 mg/l as per WHO standards. The fluoride values of groundwater samples are within the permissible limit except two samples (S16 and S19). High concentration of fluoride in groundwater may be due to breakdown of rocks and soils or infiltration of chemical fertilizers from agricultural land(Mohamed Hanipha and ZahirHussian,2013. Skeletal fluorosis is an important disease due to presence of high fluoride content in groundwater(Mangale Sapana, et al.,2012).

K. Ground water suitability for Irrigation purposes

The concentration and composition of dissolved constituents in groundwater determine its quality for irrigation use. The suitability of groundwater for irrigation is liable on the effects of the mineral constituents in the water on both the plants and soil (Richards,1954). Higher salt content in irrigation water causes an increase in soil solution osmotic pressure (Thorne and Peterson, 1954). Effect of salts on soil causing changes in soil structure, permeability and aeration in directly affect plant growth. Since plant roots extract water osmosis, the water uptake of plants decreases.

The osmotic pressure is proportional to the salt content or salinity hazard. The salts, besides affecting the growth of plants directly, also affect the soil structure, permeability and aeration, which indirectly affect the plant growth. An important factor allied to the relation of crop growth to water quality is drainage. If a soil is open and well drained, crops may be grown on it with the application of generous amounts of saline water; on the other hand, a poorly drained area combined with application of good quality water may fail to produce as satisfactory a crop (Todd,1980)

L. Sodium Percentage (% Na)

Percent sodium (% Na) is also widely utilized for evaluating the suitability of water quality for irrigation(Wilcox,1948). Excess sodium concentration in groundwater produces the undesirable effects because Na reacts with soil to reduce its permeability and support little or no plant growth (Raju et al,2009) (Vasanthavigar et al,2010). The % Na is computed with respect to relative proportions of cations present in water, where the concentrations of ions are expressed in meq/l, using the following formula:

Na% = (Na + K)×100 {(Ca +Mg + Na + K)} (meq l)

Table: 3.Classification based on % Na in groundwater

%Na	Water class	Sample Number
<20	Excellent	Nil
20-40	Good	3,13,16,17
40-60	Permissible limit	1,2,4,5,6,7,8,9,10,11,12,14,15,18,19,20
60-80	Doubtful	Nil
>80	Unsuitable	Nil

The calculated value of Na% ranges 30.65 to 59. Sodium percentage value should not go beyond 60% in irrigation waters. The collected samples are fall within the permissible limit(Table.3).Minimum value was observed in the sample S17 and Maximum value is observed in the sample S9.The Na% was higher may be dissolution of minerals from lithological composition, and the addition of chemical fertilizers by the irrigation waters(Subba Rao, et al 2002)

M. Sodium Absorption Ratio (SAR)

The sodium adsorption ration (SAR) indicates the effect of relative cation concentration on sodium accumulation in the soil; thus, sodium adsorption ration (SAR) is a more reliable method for determining this effect than sodium percentage(Richards,1954). SAR is calculated

from the ratio of sodium to calcium and magnesium. Calcium and magnesium ions are important since they are tending to counter the effect of sodium. Higher concentration of SAR leads to breakdown in the physical structure of the soil (Shubhra Singh et al 2015).Sodium adsorption ration (SAR) is calculated using the following formula:

$$\mathbf{SAR = [Na+] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2}}$$

Ions are expressed as milliequivalents per liter (meq/L). The sodium adsorption ration (SAR) content in study area has shown (Table:4)range from 8.14 to 21.78. Maximum value (21.78) of SAR value is observed in the sample S11. 60% of samples fall in good category for irrigation purposes.

Table:4, SAR classes of groundwater

Parameter	Range	Water class	No.of Samples
SAR	< 10	Excellent	2
	10 - 18	Good	12
	18 - 26	Doubtful	6
	> 26	Unsuitable	Nil

N. Permeability Index (PI)

Soil permeability is affected by long-term use of irrigation water with high salt content as influenced by Na^+, Ca^{2+}, Mg^{2+}, and HCO_3 contents of the soil. PI is defined by the following equation (Raghunath, H.M. 1987).

$$\text{Permeability Index} = \frac{Na^{+}+\sqrt{HCo_3}}{(Ca^{2+}+Mg^{2+}+Na^{+})} * 100$$

The PI values >75% comes under class I and indicates that the excellent quality of water for irrigation. The PI value between 25% - 75% comes under class II indicates that the good quality of water for irrigation and the PI value less than 25% comes under class III indicates that the unsuitable nature of water for irrigation. The calculated PI value ranges from 34.90 to 70.34 meq/l. Maximum value of Permeability index was observed in the sample S6. All 20 samples fall in good quality of water for Irrigation purposes.

O. Soluble Sodium Percent (SSP)

The Soluble Sodium Percent (SSP) for groundwater was calculated by the formula,

$$SSP = \frac{Na \times 100}{Ca^{2+} + Mg^{2+} + Na^{+}}$$

Where the concentrations of Ca^{2+}, Mg^{2+} and Na^{+} are expressed in milliequivalents per liter (epm). The Soluble Sodium Percent (SSP) values less than 50 or equal to 50 indicates good quality water and if it is more than 50 indicates the unsuitable water quality for irrigation (Deshpande S.M. and Aher K.R.,2012). Maximum value of (58.45) SSP was observed in S8 and minimum was observed in S17. 70% of samples from study area shows suitable for irrigation purposes.

V. CONCLUSION

The results revealed that groundwater in the study area were mostly slightly alkaline. Based on the concentration of TDS, groundwater samples are good to fair category. The electrical conductivity value of study area range from 825 to 2990 µS/cm. The cation and anion values of groundwater samples of study area fall within the permissible limit as per WHO .The concentration of fluoride is within the permissible limit as per WHO except two samples, it may be due to rocks and soils or infiltration of chemical fertilizers from agricultural land. Irrigation waters classified based on SAR value has indicated that 60% of samples from the study area shows suitable for irrigation purposes. Irrigation water quality based on % Na indicates that 80% of the water samples fall within the permissible limit. However, PI values shows that almost all the groundwater samples are suitable for irrigation puroses. According to Soluble Sodium Percent (SSP) 70% of samples from study area suitable for irrigation.

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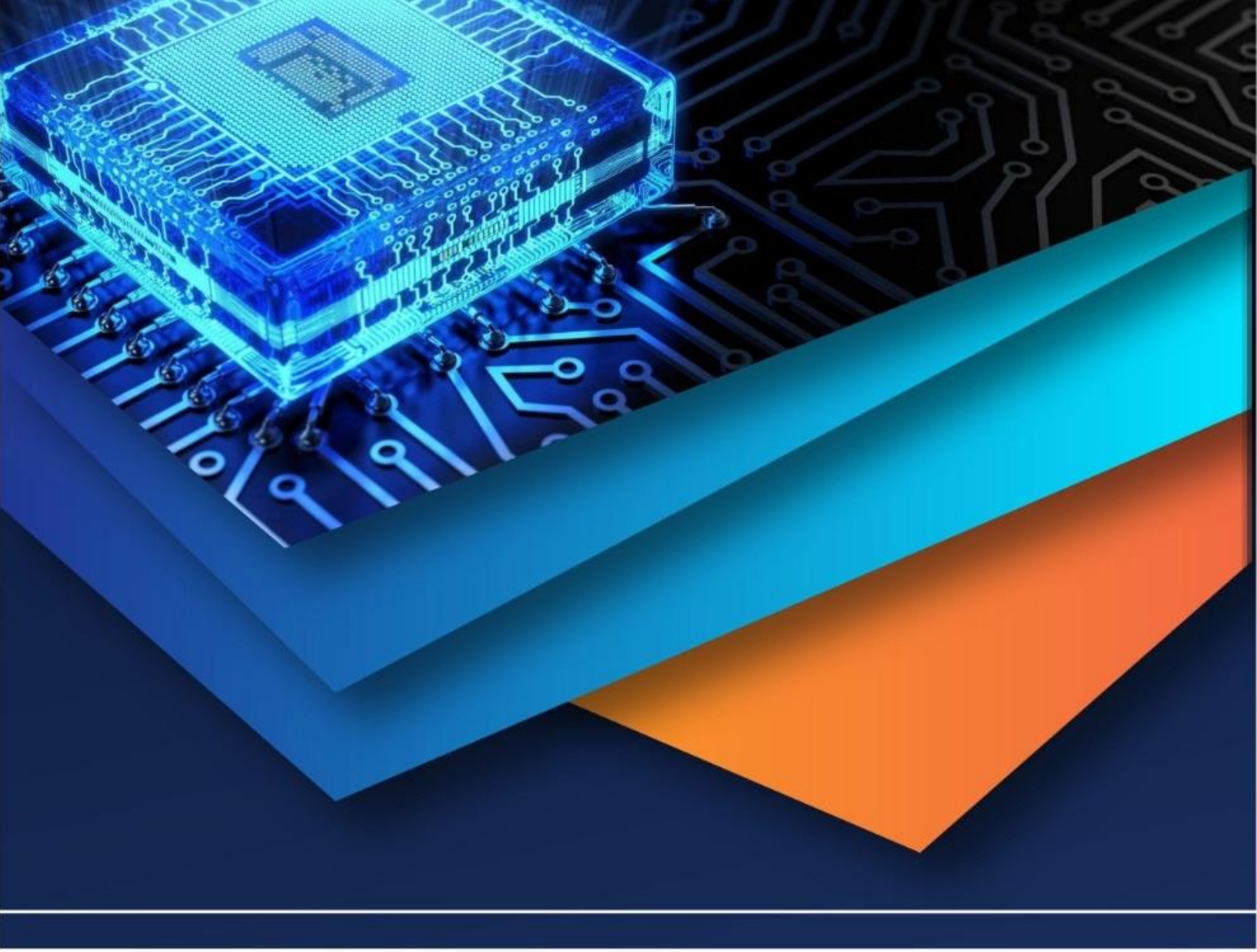

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