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Study of Parameters in Redesign of Existing Water Treatment Plant

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Abstract: ***Now a day's water scarcity is the burning issue. As it is quite obvious that there is day to day increase in population, the demand for water also increases to satisfy the needs of the community there comes a necessity to redesign the existing treatment plants, or design the new treatment plants. Redesign or design includes hydraulic design and process of treatment of water in the plant. Generally water can be treated in treatment plants for removing harmful substances present in it. The treatment process includes pretreatment, aeration, coagulation, flocculation, sedimentation, filtration, fluoridation, conditioning and disinfection. In this paper, redesign of water treatment plant for Maharashtra Industrial Development Corporation (MIDC), Avadhan, Dist. Dhule (MH) is presented. The source of raw water is Akkalpada Dam which is nearby located from Dhule city. This paper includes the detail of the treatment units present in the existing MIDC and foreseeing the increasing demand of water. All the design calculations for the new treatment plant and also the design criteria on which these have been designed are presented in the study. The study involves the new proposed site called as Raver which is located in surrounding area of Avadhan MIDC. And with the help of this area the expansion is possible and can be easily done. Overall the main purpose of this study is to help and propose a new design to the MIDC so that the future needs of the increasing industries can be met, and all the industries can effectively use this water.***

Keywords: Water treatment plant, intake well, cascade aerator, flash mixer, sedimentation tank, clariflocculator.

I. INTRODUCTION

MIDC (Maharashtra Industrial Development Corporation) is a major project of government of MIDC of Maharashtra state, India, and is a leading corporation of Maharashtra. It provides business with infrastructure such as lands, road, water supply drainage facility and street light. MIDC Dhule has an industrial area of 400.35heactor of land .about 278.0 hector has come into possession of MIDC. It provides the entire basic infrastructure such as roads, street lights, water supply, pipelines in this area. The existing water treatment plant of MIDC fulfills its need of water from Moti dam. The plant was constructed in the year 1984, when the member of industries was 150. The capacity of the plant in present today is 4.5 MLD. As the number of industries is increasing day by day it has become a must to increase its capacity for fulfilling the need in near future. In accordance to this, MIDC, Dhule has decided to take the surrounding area known as "Raver" into possession to fulfill the future needs. The proposed area for the expansion of water treatment plant is near about 642.29 hector.

Table I Calculation For Determination Of Capacity Of Water Traement Plant

Existing area of Dhule Industrial area = 312.67 Hector		Add 20% for enroute villages = 2864.88 Cum per day
Proposed area of Dhule Industrial area = 642.29 Hector		Total = 17189.28 Cum per day
Total = 954.96 Hector		Say 17000 Cum per day
Multiplying Factor = 15.0 m^3/ha/day		Discharge Q = 17 MLD
Water requirement (954.96hect X 15 cum per day) = 14324.40 Cum per day		Length = 40 kM

II. OBJECTIVES OF STUDY

A. To redesign existing water treatment plant from existing capacity of 4.5 MLD to 6.0 MLD for the upcoming future expansion.
B. To study Existing MIDC, Avadhan, Dhule water treatment plant &it's different units.
C. Redesign of each treatment unit considering future growth of various industries in the surrounding area.
D. To study design of existing treatment units & modify it considering increase in the capacity by numerical analysis.
E. To develop or redesign a proto model of overall treatment process considering future expansion & growth of MIDC.

III. DESIGN CONSIDERATIONS

A. *Design Criteria For Intake Well*

1) Areas of inlet openings are worked out by considering the velocity of flow between 0.1 to 0.25 m/s.
2) Inlet opening should be 1 to 1.5m below water level.
3) Diameter of Intake well is about 3 to 5 m.
4) Bottom of Intake well should be at least 3m below minimum water level.
5) Raw water gravity main is designed by using Hazen William formula, with velocity of water through the main ranging between 0.9 to 1.5 m/s.

Table II Coefficient Of Pipe Material (C_h)

Pipe material	Value of C_H Depending upon the smoothness of the pipe material
Concrete (regardless of age)	130
Cast Iron:	
New	130
5 years old	120
20 years old	100
Welded steel (New)	120
Riveted steel (New)	110
Vitrified clay	110
Brick sewers	100
Asbestos-Cement	140

B. *Design Criteria For Cascade Aerator*

1) A simplest cascade consists of a series of 3 to 4 steps.
2) Water is allowed to fall through a height of 1 to 3 meters.
3) Diameter of central shaft is considered to be 1.2 m.

C. *Design Criteria For Flash Mixer*

1) Detention Time = 1 to 3 minutes.
2) Square or circular basins are used for mixing depth = 1 to 11.5 m.
3) Velocity gradient = 700 to 1000 s^{-1}

D. *Design Criteria For Sedimentation Tank*

1) Overflow rate =15-30m^3/d/m.
2) Minimum side water depth =2.5m.
3) Detention period for coagulated water 2-4hrs.
4) Weir loading = 300m^3/d/m.
5) Side slopes for non mechanical cleaning =10% from sides towards longitudinal central line.
6) Longitudinal slope = 1% in case of rectangular tank.
7) Ratio of length and width = 3:1 to 5:1.
8) Settling velocity = To ensure removal of minimum size of particle of 0.02mm.
9) Detention time to flocculation chamber = 20-30min.
10) Skimming weir = To check the froth on the surface of outlet to reduce load on the filter.
11) Horizontal flow velocity = 0.15-0.9 m/s.

E. *Design Criteria For Clariflocculator*

1) Depth of basin = 3m to 4.5m.
2) Detention time = 20 to 60 min.
3) For rectangular type = length / width = 2 to 3.
4) Total paddle area = 15 to 20 % of vertical cross section basin.
5) Distance between paddle edge and bottom or side of basin = 15 to 30 cm.

6) The peripheral velocity of paddle = 0.2 to 0.6 m/s.
7) Horizontal velocity of flow = 1.5 to 2 cm/s.
8) Velocity difference between paddle of water = 75% of paddle velocity.
9) G = velocity gradient = 10 to 75 /sec.
10) Power consumption = 18 to 36 KW/ MLD.
11) Coefficient of drag = 1.8 for flat paddle with flat plate.
12) Product G×t should be between 10^4 to 10^5

F. Design Criteria For Rapid Gravity Filter

1) Rate of filtration = 3000 to 6000 lit/hr/m^2.
2) Number of filter units N=√(Q) 14.69 (Q in m^3/hr).
3) Filter bed size = L:B ratio = 1.25 to 1.33.
4) Depth of filter sand media = 60 to 90 cm.
5) Depth of base material (gravel) = 30 to 60 cm (well-graded).
6) Sand specification: maximum size = 1mm, Minimum size = 0.45mm & Effective size = 0.35 to 0.6 mm.
7) Depth of water area sand = 1 to 2 m.

G. Design Criteria For Under Drain System

1) Ratio of length of lateral to its diameter = 60.
2) Diameter of perforations in laterals = 5 to 12 mm.
3) Spacing of perforations along the lateral = 8 cm for 5mm holes. & 20 cm for 12mm holes.
4) Ratio of total area of perforation to the total cross sectional area of laterals = 0.25 for 5 mm.
5) Spacing of laterals = 30 cm.
6) The ratio of total area of perforation in the under drainage system to the entire filter area may be between 0.002 to 0.003
7) Cross sectional area of manifold = 1.5 to 2 times the total cross-sectional area of laterals.

H. Design Criteria For Wash Water Trough

1) Horizontal travel of dirty water over the surface of filter shall not be more than 0.5 to 1.0 m before reaching trough.
2) Bottom of trough should clear the top of expanded sand by 50 mm or more.
3) Upper edge of trough should be placed as far as above the surface of the undistributed sand surface as the wash water rises in 1min.

IV. DESIGN CALCULATIONS

Design calculations are performed for the following units and output if presented in the form of drawings.

A. Design of intake wall

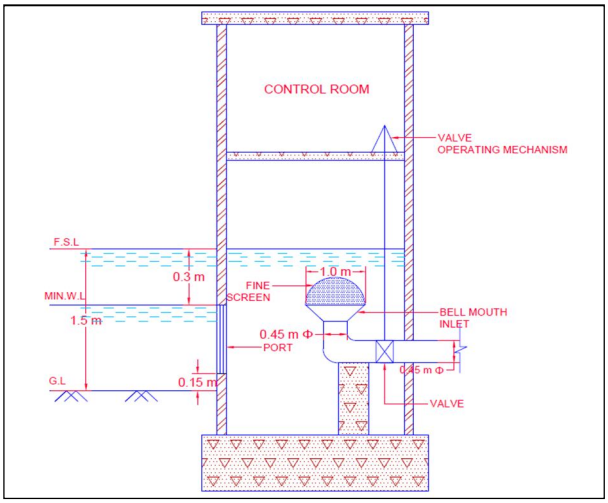

Fig. 1 Intake Well

b. Design of cascade aerator

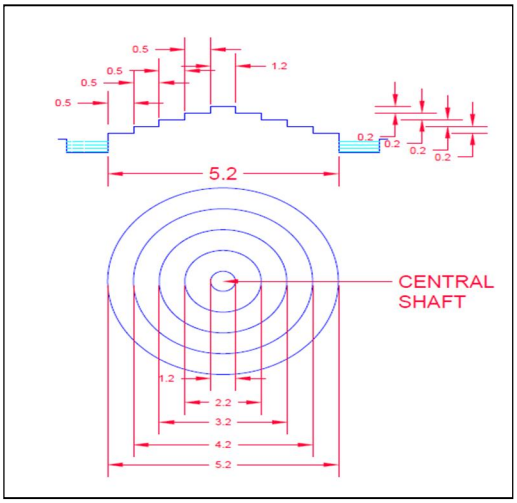

Fig. 2 Cascade Aerator

C. Design of flash mixer

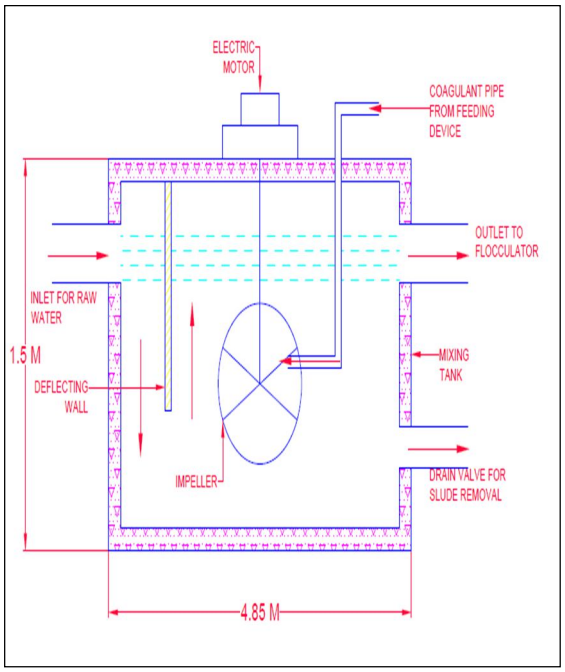

Fig. 3 Flash Mixer

d. Sedimentation cum flocculation tank

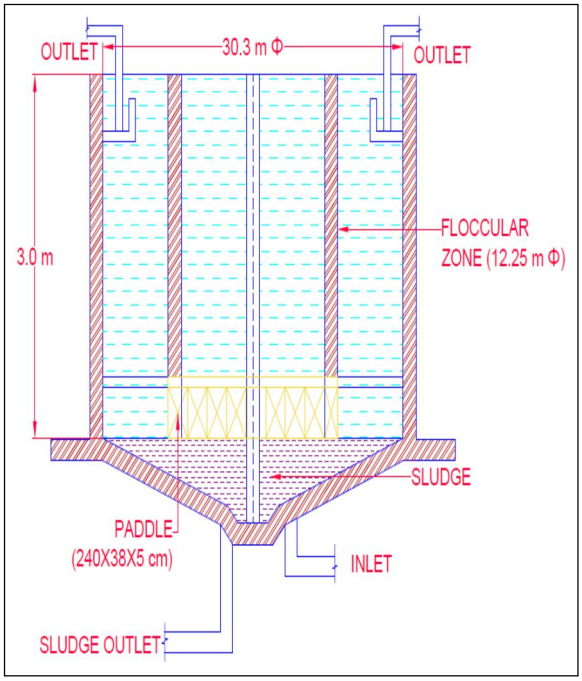

Fig. 4 Sedimentation cum Flocculation Tank

E. Rapid sand filter

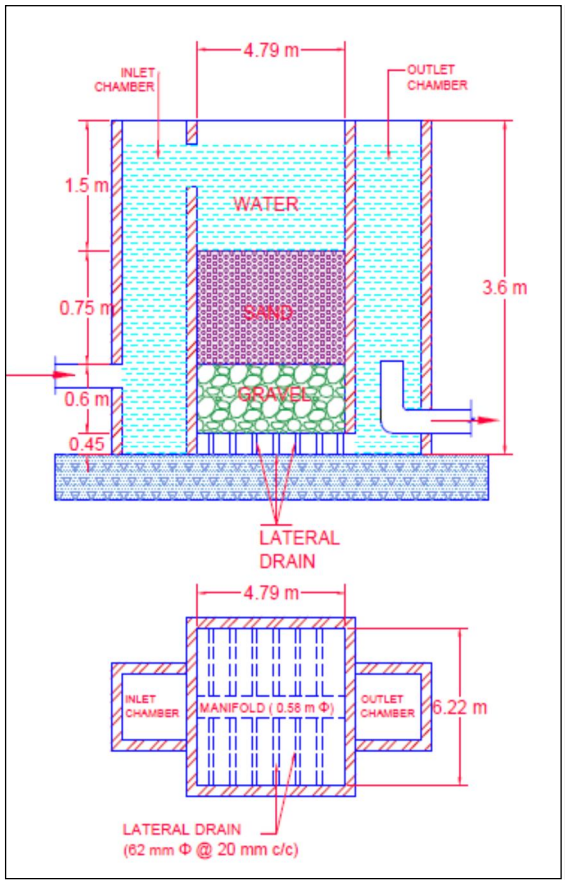

Fig. 5 Rapid Sand Filter

f. Design of elevated storage reservoir

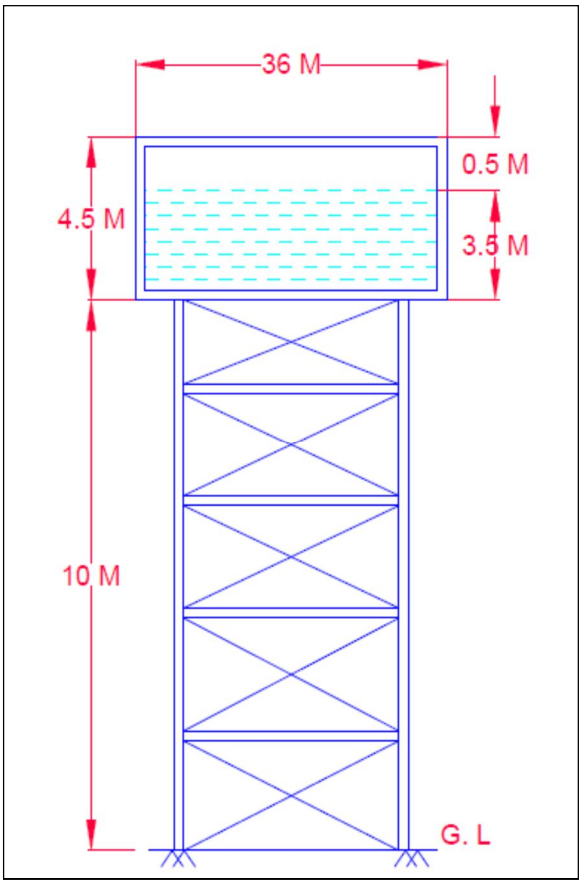

Fig. 6 Elevated Storage Reservoir

G. Design of pump house

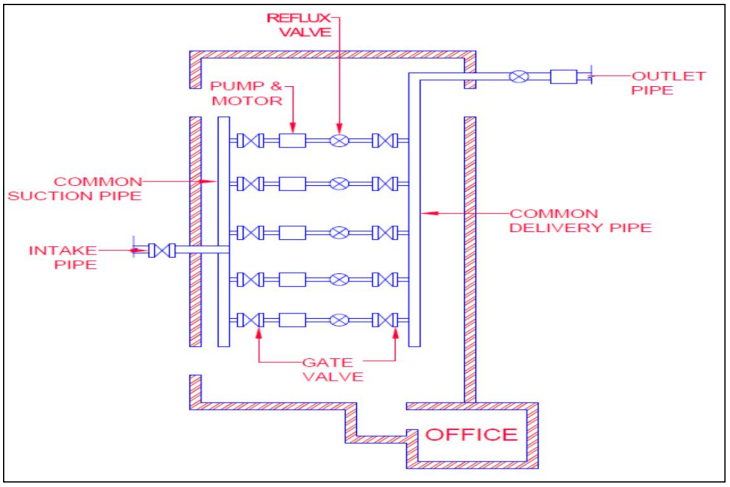

Fig. 7 Pump House

V. RESULTS

The final result shows the comparison between the existing and proposed water treatment plant and the dimensions of both the treatment units.

Table IIII Comparison Between Existing And Proposed Water Treatment Plant

SR NO.	TREATMENT UNITS	EXISTING WTP(4.5 MLD)	PROPOSED WTP(17 MLD)
1	Intake Well	-	3.5 m Φ
	Coarse Screen	-	Length - 2.4 m Height – 1.05 m
	Bell Mouth Entry	-	1.0 m Φ
	Intake Conduit	-	0.45 m Φ
2	Raw Water Rising Main		
	Diameter	350 mm	600 mm
	Distance	1.23 km	40 km
3	Cascade Aerator		
	Area	-	22.38 m^2
	Diameter	-	5.34 m
4	Flash Mixer		
	Size	1.0 m X 1.0 m X 2.75 m	4.85 m X 4.85 m X 1.5 m
5	Sedimentation Tank		
	Area	213.82 m^2	721.066 m^2
	Detention Period	180 min	180 min
6	Clariflocculator		
	Inner Diameter	6.30 m	12.25 m
	Outer Diameter	16.5 m	30.3 m
7	Filter House		
	Number of Units	4	6
	Area		
8	Pure Water Rising Main		
	Diameter	350 mm	600 mm
	Distance	0.117 km	0.150 km
9	Elevated Storage Reservoir	2 MLD (2 Tanks Each 1 MLD)	

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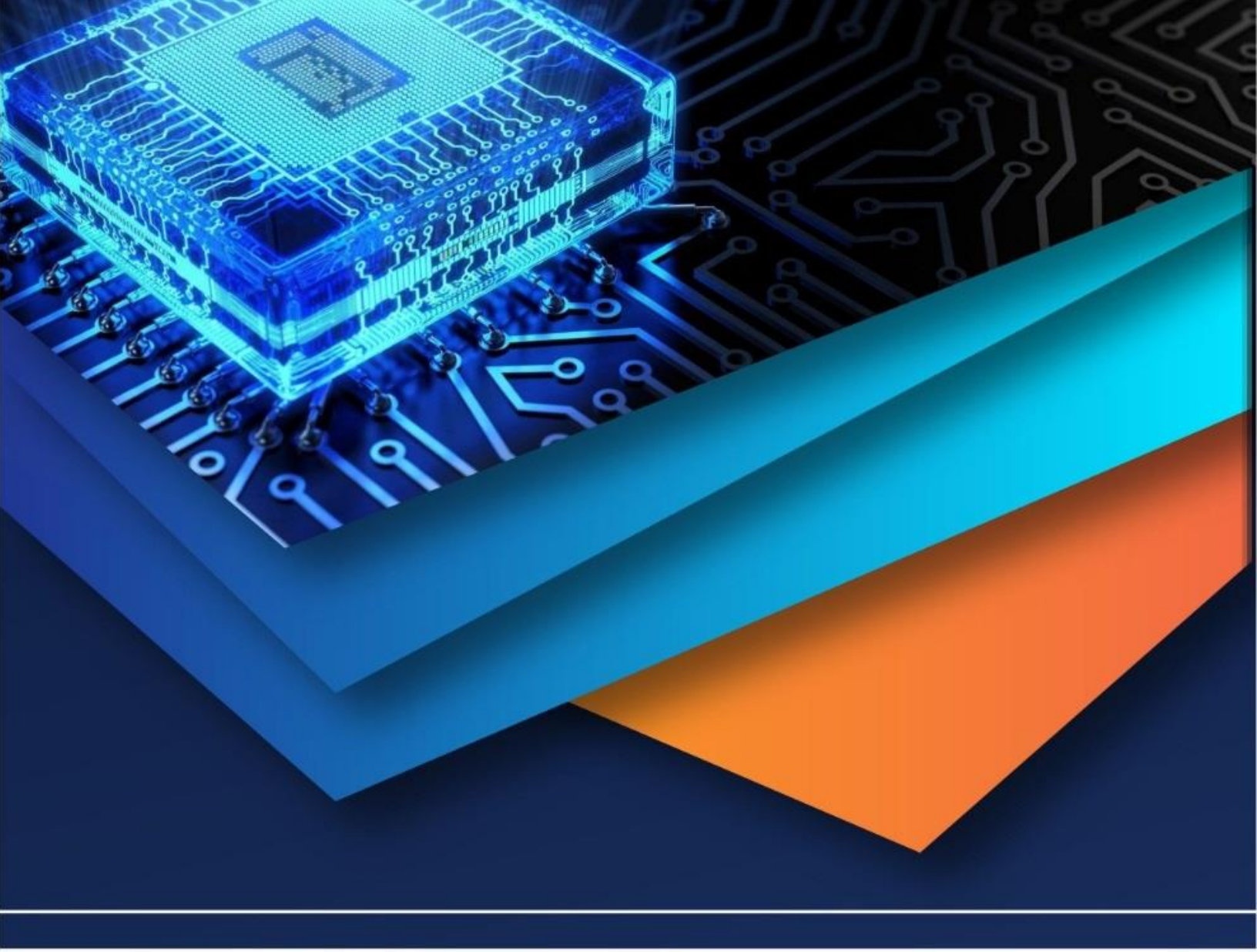

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