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A Research Study of Development of Oil Skimmer for Sugar Industry

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Abstract: ***In this paper includes the study of the Development of Oil Skimmer for the Sugar Industry. The utilization of skimmers in industrial applications is often needed to remove oils, grease, and fats before more treatment for environmental discharge compliance. Placed before an oily water treatment system, an oil skimmer could give greater overall oil separation efficiency for improved discharge sewer water quality.***

Index Terms: Oil recovery, Waste water treatment, Belt type oil skimmer, Sugar industry.

I. INTRODUCTION

Pollution is that the most vital danger that threatens the attribute. The most dangerous of those pollutants is oil pollution; as a result of oil, pollution threatens the surroundings further as the economy. It's been studied that recently with increasing use of oil. In line with Environmental Protection Agency, nearly 14000 oil spill area units reported every year within the oceans alone. Several countries have created tight safety norms for wastewater disposal content with oils primarily method from petrochemical industries and process industries so such industries are equipped with such quiet oil skimmers to separate the oils from sewerage. Recently world required speed in every field. So rapidness and quickness in operation are most important. Currently, days for achieving rapidness, numerous machines and therefore the equipment's are being factory-made. In such a contemporary era of the easement, small-scale industries are tributary during a massive thanks to the expansion of our country. The engineer is continually confronted with the challenges of conveying ideas and style into reality. New machines and techniques are being developed endlessly to manufacture the varied product at cheaper rates and top quality. Taking under consideration the higher than contribution we've tried to manufacture such instrumentality, that is that the accent of the machine to possess the treatment to the cutting fluid once having used as an agent. As a result of the agent once having continuous use, gets concerned with the oil, and its property gets modified. Therefore it becomes necessary to separate the oil from the mixture of the oil and therefore the fluid.

An oil skimmer is a tool that's designed to get rid of oil floating on a liquid surface. looking on the particular style they're used for a variety of applications such as oil spill response, as a region of oily water treatment systems, removing oil from machine fluid and liquid components washers, and assembling fats oils and greases in sewer water treatment in food manufacturing industries, chemical industries other industries.

1) *Types of Oil Skimmer:* Oleophilic skimmers contain disc, belt, tube, brush, mop, brush, grooved disc, smooth drum, and grooved drum. Non-oleophilic skimmers contain weir (manual or self-adjusting).
2) *Oleophilic:* Oleophilic skimmers perform by using a component such as a drum, disc, belt, rope, or mop to which the oil adheres. Ex. Belt, Drum, Disc, etc.
3) *Non-oleophilic:* Non-oleophilic skimmers are distinguished by the part used to collect the oil. A metal disc, belt, or drum is used in implementation wherever an oleophilic material is inappropriate, such as during a hot alkaline aqueous parts washer. The skimmer is mostly turned off whenever there is no oil to skim thus minimizing the quantity of water collected. Metal skimming elements are nearly as economical as oleophilic skimmers when oil is present. Ex. Weir

II. LITERATURE SURVEY

A. Thombare Babasaheb B. (2018) has studied in their paper as named "A Review on Analysis of Belt type Skimmer" that according to polar and non-polar properties of oil and water, water contains H+ and OH- having power nature whereas oil acts as non-polar substance. thus they are doing not get mixed and also the oil floats on water rather than sinking in. they studied that oil has a lesser density than water thus oil floats on water. The belt material they chose was non-polar because of that the oil gets attracted to the belt. They used belt material like (cotton, rubber, steel, oleophilic, etc.). They took the fabric that had higher adhesive properties than water. Because of that belt absorbs oil a lot of simply than water. This can be what they complete in their paper.

B. Mamta Patel (2015) has studied in her paper as named "Design and efficiency Comparison of various Belt type Oil Skimmers" that the slight distinction in style and material will provide a giant impact on the oil recovery capability of oil skimmer. She conducted that the improvement of the oil skimmer toward to incorporate further belt shaft and use steel belt with steel material rather than rope significantly improves the oil recovery potency of oil skimmer. Even by creating the changes within the use of fabric additionally as slight changes within the style (in short if the oil skimmer is changed a small amount it will improve the potency oil sick capability of the oil skimmer and even create the skimmer simple to use).

C. Sathiyamoorthi, V (2018), has studied in their paper named "A review on mobile oil skimmer" regarding the oil recovery capacity and the oil recovery potency. They noticed that the belt speed, belt incline angle, the thickness of the slick, and therefore the speed of the belt are necessary parameters among the others. They studied that the water drops are units collected at the side of oil. Thus for the skimmer to work efficiently, it's to be reduced. Stirrer Mechanism is often wont to improve oil removal rate. Thus numerous processes are developed to get rid of oil from the contaminated space by use of booms, dispersants, and skimmers. It may be separated by an oil-water separator or any stuffed materials. They resulted that the planning improvement of the everyday oil skimmer towards the belt shaft and use of skimmer belt considerably improve the oil recovery potency and conjointly assimilates less complicated. Briefly, they studied that the right design of the skimmer and correct use of fabric will increase the oil recovery rate of the skimmer and might work efficiently. The angles of the belt and therefore the speed of the belt play a very important role within the smart potency of the skimmer.

D. Vishal G. Naphade (2018), has studied within their paper named that the fabric of the disc in the disc type oil skimmer will amendment "Design of Disc type Oil Separator" the oil recovery capability of the skimmer thanks to the burden of the fabric. They studied that the mild steel disc will increase the burden of the skimmer creating it more durable to hold around. Thanks to significant disc the oil recovery capability changes drastically.

Rather than the low carbon steel disc, they used an acrylic disc that is lightweight in weight and doesn't soak oil. They resulted that the acrylic disc skimmer has a higher oil recovery capability than the low carbon steel disc skimmer. They even finished that the acrylic disc provides higher performance than the low carbon steel disc and is simple to handle and clean when utilized.

E. Rafi Jamal Algawi (2014) in their paper named "Study of operating conditions for oil skimmer apparatus from water" has studied that the oil recovery rate will increase with the rise in belt move speed. The oil recovery potency decreases with the rise in belt move speed. They even resulted that the oil recovery rate will increase with the decrease within the oil temperature; however, a decrease in oil temperature decreases the oil potency rate. They studied that oil consistency plays a very important role in oil recovery employing an oil skimmer. A lower temperature will increase the oil recovery rate and therefore the oil recovery potency by increasing the consistency. They even concluded that the hydrogen ion concentration of the water features an important impact on the oil as it changes its physical properties of the oil creating it tough to be recovered. They even finished that the fabric of the belt used on the skimmer features an important role as its changes the oil recovery rate of the skimmer. briefly, they finished that the factors like the consistency of the oil, belt material, encompassing atmosphere of the oil spill will amendment the oil recovery rate furthermore because the oil recovery potency of the skimmer touching the recovery of the oil.

F. Arturo A. Keller (2008) Studied in their paper named "Oil recovery with novel skimmer surfaces under cold climate conditions" that the temperature of the surrounding and oil plays an essential role within the recovery of the oil. They terminated that because the temperature of the oil rises it becomes difficult for the skimmer to skim it out of the water surface. Because of temperature rise, the skimmer belt is a modification to soak up it as a result of it becomes hard. The decreasing temperature of the oil reduces the oil consistency as a result decreasing the oil recovery rate of the skimmer. They terminated that because the temperature of the oil decreases it becomes less cohesive to the belt used for the skimming reason. They Studied and concluded to add the cohesive materials to the oil before putting it through the skimming method. This cohesive material makes oil adhere to the belt surface and recover the oil from the surface of the water. Briefly, they studied that the lower temperature atmospheres can make oil recovery difficult from the surface of the water. For the motive to recover the oil it is required to add some cohesive admixtures to the oil spill for it to be improved as it becomes noncohesive with the reducing temperature of the atmosphere. In short, the viscosity of the oil plays a major role in the oil recovery rate as well the oil recovery efficiency.

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III. DESIGN OF OIL SKIMMER

A. *Design of Shaft*

Mainly shaft is used to mount and rotate the drum. There is a very small driving load on the shaft. But the weight of the drum and licit tension will exert the force at the center of the shaft thus there is bending movement of the shaft. Therefore, we have designed the shaft for both bending and torsion.

1) Tension on tight side of belt (T_1) = Max. Stress × c/s area = $F_1 \times B \times T = 1.5 \times 106 \times 0.34 \times 5 \times 10^{-3} = 2550$ N
2) Tension on slack side = $2550/T_2 = e^{0.3} \times 3.14$, $T_2 = 994.11$ N
3) Maximum tension (T_m) = (T_1-T_2) × R = (2550-994.11) × 0.17 = 264.50 N
4) Torque on shaft (T_1) = (P×60000)/2 × 3.14 × 20 = 1068.37 N-m, $T_e = \sqrt{(T_m)^2 + (T_t)^2} = 1100.70$ N-m

Fs = Allowable shear stress = Ultimate share stress/3, from design data ultimate shear stress = 500 mpa, Fs = 500/3 = 166.66 Mpa

5) Diameter Shaft (d) = $T_e = \pi/16 \times F_s \times d^3 = \pi/16 \times 166.66 \times d^3$, d = 32.31 = 40 mm.

B. *Design of Belt*

Flat Belt, V Belt, Circular Belt, Timing Belt. We used the flat belt on the open belt drive. (Canvas Belt), Area of belt = Width of belt × Thickness of belt = b × t = 340 × 5 = 1700 mm^2

1) Maximum tension in tight side of belt (T) = f × a = 1.5 × 1700 = 1.5 × 1700 = 2550 N
2) Mass of belt (M) = Area × Length × Density = 0.17 × 3.7 × 1220 = 2.07 kg/m
3) Total mass of belt = 2.07 × 3.7 = 7.79 kg
4) Centrifugal tension in belt = $M \times V^2 = 7.33 \times 0.39^2 = 1.17$ N (Velocity of belt = $\pi \times d \times n/60 = 0.392$ m/s)
5) Total tension in belt (T_1) = T - T_c = 2550 - 1.17 = 2548.73 N Now, Ratio of tension in belt, $T_1/T_2 = e^{\Theta\mu}$, $2548.73/T_2 = e^{0.3\times3.1}$, T_2 = 993361 N
6) Power capacity of belt = (T_1-T_2) × V = 606.49 Watt
7) Finding width of belt, (b), w = b × t × f, T = b × t × f, 2550 = 1.5 × 106 × 0.005 × b, b = 0.34 m

Length of belt (L) = (D + d) + α (D – d) + 2c.cosa = 500 + 0 + 2c = 500 + 0 + 3200 = 3700 mm
The thickness of the belt = 5 mm, Width of the belt = 340 mm.

C. *Motor Selection*

The selection of motor is the most important aspect during selecting particular applications. We have selected 3 HP, 3 phase A.C. induction motor because of the advantages like constant speed, low starting torque, better power factor during load, easy to control speed, low noise, low cost, cooling is efficient, low maintenance cost, efficiency is higher, etc.
Motor Specifications:- Power – 3HP, RPM- 1440, Voltage- 415V, Current 480A, Frequency- 50HZ

D. *Gear Box*

We need the speed of the skimmer belt to be too low. For that speed reduction is required for this purpose, we have a worm reducer from the factory.
Specifications- Made- Planetary or Epicyclic Gear Box, Type- U500, Ratio- 50:1

E. *Speed of Roller*

(Speed of motor × Number of teeth on the motor wheel) / Number of teeth on roller gear = 40×1836 = 20 rpm

F. *Chain Design*

Z_1-speed of sprocket driver = 18 Teeth, Z_2-speed of sprocket driven = 24 Teeth, No. of links in the chain (L_h)
$L_h = 2(a/p) + (z_1+z_2)/2 + [(z_1-z_2)/2\ \pi]^2 \times (p/a) = 2(550/15) + (24+18)/2 + ((24-18)/2\ \pi)^2 \times (15/550) = 94.35$ links = 98 links
Total Length of chain (L) = $L_h \times p = 98 \times 15 = 1470$ mm

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IV. DEVELOPMENT OF SYSTEM

A. Working Principle

Oil and grease always float on the water surface. They do not mix with water separation it is based on surface tension, relative density, and viscosity. The "oil skimmer" unit has a rubber belt that is rotated by mechanical means such that it is just touching the surface of the water. The particles of oil and grease are stick with the belt material and travel with the belt up to the scrapping arrangement where scrapping of oil and grease are collected.

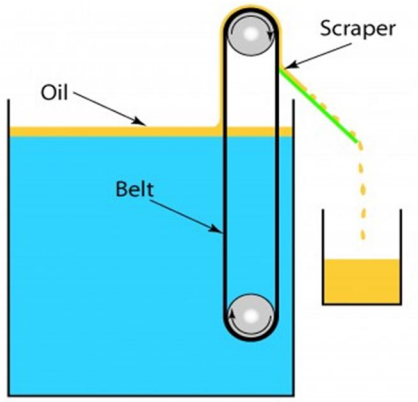

Fig. No.1 – Belt Oil Skimmer

B. Construction and Working

This unit consists of a rectangular frame that is formed of 2" angle. At the top of the surface of the frame, the motor and gearbox are fitted. The 3 phase induction motor is used having 1440 rpm. And the gearbox is a worm reducer having a reduction ratio of 50:1. A drive shaft is fitted on the upper part of the frame with the help of the pedestal which is given rotary motion by the motor with reducer speed through gearbox and coupling. At the lower end or bottom of the frame to plates are welded vertically. At the bottom of the plat-driven shaft is fitted in a tightening arrangement. The arrangement is provided for the shaft per requirement for the tightening of the belt.

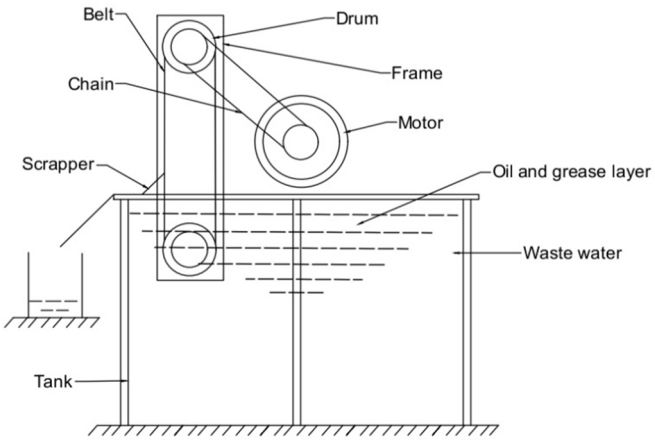

Fig. No. 2 – Modeling of Oil Skimmer on CAD

One drum each is fitted on two shafts with the help of a pedestal. On these drums main oil extracting belt is placed. With the help of a tightening arrangement, the belt is adequately tightened so that it will not slip. Four screw jacks are fitted at the lower end of the frame. This screw jack is providing upward and downward movement of the entire unit. This offers benefits for the tightening of the unit as per the level of the water flow. On one side of the frame, a scrapping arrangement is connected that removes the oil and grease from the surface of the belt. The removed oil and grease are carried through the collector pipe to the barrel. When the unit is switched ON, this is coupled to the gearbox. The motion of the shaft is given to the gearbox which reduced the speed. This reduces speed is given to the driver through coupling. Here scrapping oil and grease occurs and is collected within the tank through a collector pipe. The belt after crapping again goes downward in the gutter. This cycle repeated continuously.

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Photograph No. 1 – Actual Model of Oil Skimmer

C. Advantages

1) Oil and grease particles can be easily extracted from the wastewater.
2) It is more efficient in working and easy in construction.
3) It is a special arrangement for belt-tightening.
4) It requires less manpower. As workers require for.
5) It has less vibration in working conditions.
6) The machine can be adjusted as per the flow level of the water.
7) It is more economical than any other process of oil removal.
8) It requires less space and has less maintenance.

D. Applications

It can be used in the,

1) Sugar factories
2) Steel Mills
3) Chemical Industries
4) Food Industries
5) Waste transfer facilities
6) Industrial water waste treatment systems
7) Petrochemical industry
8) Oil refineries

V. OBSERVATIONS AND CALCULATIONS

A. Data Recording During Trial:-

Table no 1 Data Recording During Trial

Sr. No.	NAME OF TEST	REMARK	Sr. No.	NAME OF TEST	NAME OF TEST
1.	MOTOR RPM	1440	6.	SLIPPING OF BELT	NO
2.	GEAR BOX RPM	40	7.	MACHINE NOISE	LOW
3.	LIVE SHAFT RPM	28	8.	VIBRATION	LOW VIBRATION
4.	OIL AND GREASE EXTRACTION	21-23 Lit/Day	9.	BELT	CANVAS
5.	BELT-TIGHTENING	TIGHT	10.	MOTOR	3 HP

B. PH Measurement

Table no 1 B. PH Measurements

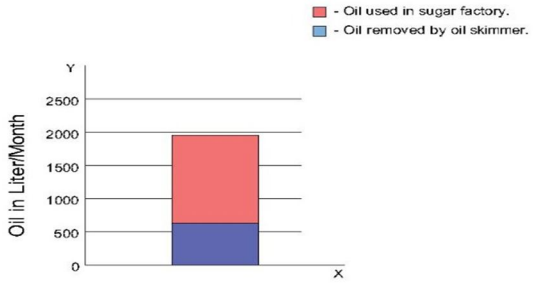
PH MEASUREMENT AFTER OIL EXTRACTION	
PH MEASURED	5.4

C. Motor RPM Measurement

A tachometer (revolution-counter, RPM gauge) is a device used to measure the rotation speed of a shaft or disk, as in a motor or other machine. The device usually shows the revolutions per minute (RPM) on a calibrated analog dial, but digital displays are increasingly common.

Measurement Result: - RPM Measured by Tachometer is 1440 RPM.

VI. RESULT AND DISCUSSION



Graph No. 1 – Oil use and Recovery

Oil removing rate – 0.8 lit/hr. = 0.8 × 24 = 21 lit/day and Oil removing rate per month = 21 × 30 = 630 lit.

On the X-axis, Oil Skimmer Machine indicated, and on Y-axis indicated oil removing rate in liter/month. The total oil used in the sugar industry is 1950 liter/month. Oil Skimmer machine oil removal per month is 630 liter.

VII. CONCLUSION

From the above literature Survey, we've studied various forms of oil skimmer utilized in various fields of application. We have to develop the oil skimmer for the sugar industry, where oil removed load will be handled by oil skimmer isn't that heavy as compared to a special field of applications. From the study of this review, we'd favor reviewing the belt-type oil skimmer, its configuration, and area of application. As a result, we decided to use a belt-type oil skimmer within the proposed sugar industry. The sugar industry requires a straightforward mechanism as compared to the categories discussed above to induce eliminate oil from effluent. It has optimum efficiency as per the need of the sugar industry. If placed before an E.T.P system an oil skimmer may give greater overall oil separation efficiency with improved sewer water quality. It helps to increase efficiency and industrial growth of industries where pollution is additionally a giant issue.

VIII. FUTURE SCOPE

A. Waste oil is used in the boiler as a fuel.
B. Waste oil is used for lubrication purposes in industries.
C. Speed of the belt cannot vary so it is to be improved by providing multispeed arrangement and also Scrapper plate arrangement may be improved.
D. The oil prevents belt may be fitted to improve the life and strength of the belt.
E. The solar panel can be attached to run the motor so improving the energy efficiency.
F. The belt slips slightly on the drum because of the collection of oil. Water drops are collected together with oil and this is to be reduced for better performance.
G. To improve the oil removal rate stirrer mechanism can be used.
H. Concept of use in multiple systems.
I. Concept of remote control machine.

IX. ACKNOWLEDGMENT

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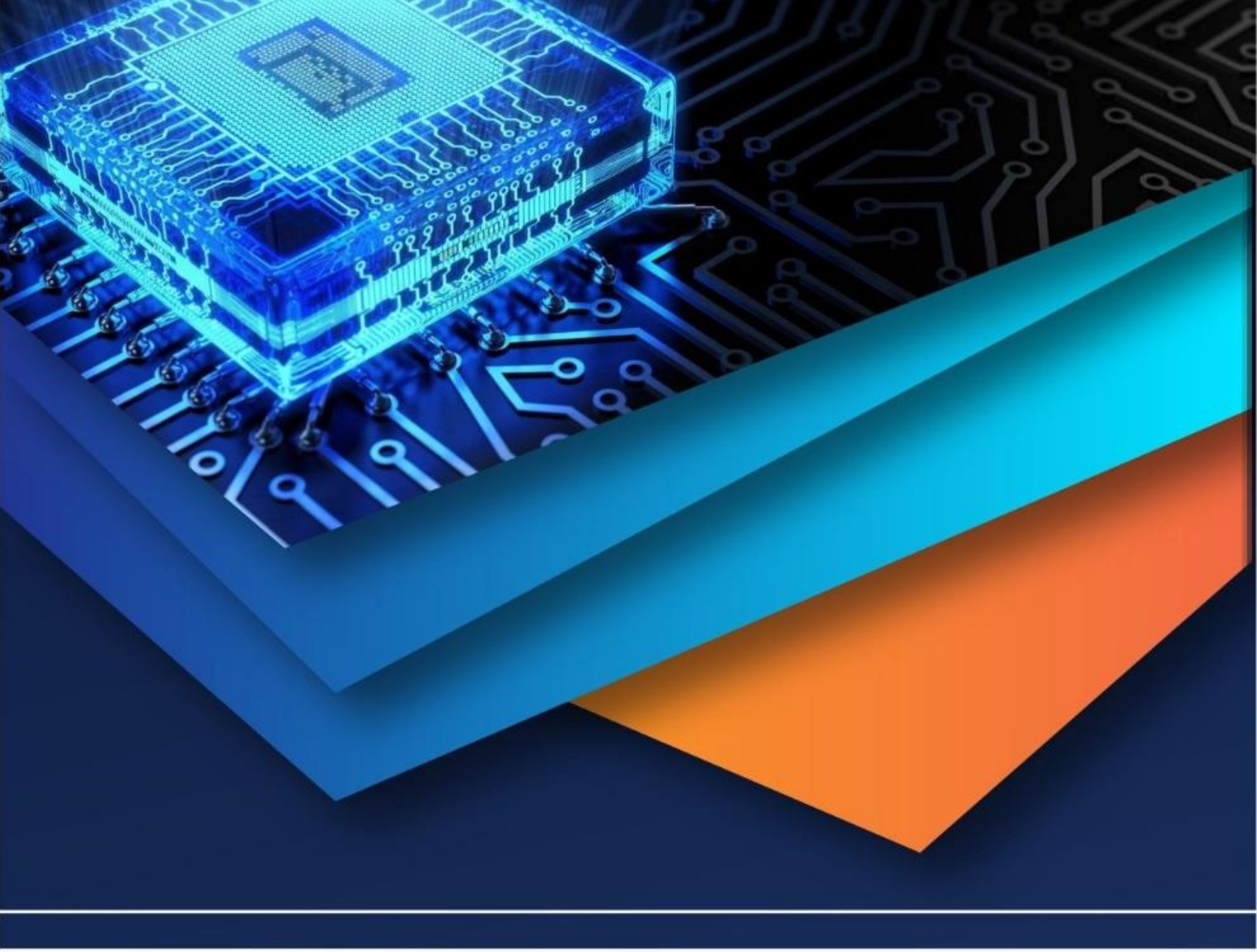

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