iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** I **Month of publication:** January 2020

DOI: http://doi.org/10.22214/ijraset.2020.1023

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 8 Issue I, Jan 2020- Available at www.ijraset.com

Effect of Untreated Dairy Effluent, Waste Water and its Treatment Solutions

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Abstract: ***Waste water generated in a dairy contains highly putrescible organic constituents. This necessities prompt and adequate treatment of the waste water before its disposal to the environment. Almost all the organic constituents of dairy waste are easily bio degradable. Hence the waste water is amenable to biological treatment-either aerobic or anaerobic or a combination of the two. General Treatment Systems applied for dairy wastewater are primary and secondary treatments. Primary Treatment Consists of following units Bar Screen, Grit Chamber, Oil & Grease trap/separator, Equalization Tank- with aeration as w/w is readily biodegradable, Coagulation, Flocculation& Sedimentation or plain settling- optional as anaerobic treatment is preferred for secondary ttm. For Secondary treatment All aerobic and anaerobic ttm suitable. TF- single or two stage, upto 95% efficiency & ASP- 85-95% efficiency. The process has certain advantages over trickling filter- Less area required, Lower construction cost ,Efficiency about 95% ,The process will be expensive for small scale industry. Power costs are higher and sensitive for shock load, Not good option for small dairies. Oxidation Ditch-Highly suitable for Indian condition, Less expensive than ASP, Efficiency about 95-98%. Aerated lagoons: Aerated lagoon can give BOD reduction from 50-90% depending on aeration time, With 4 day detention time system give 90% BOD reduction .,Capital & running cost of the system is same as oxidation ditch. Anaerobic lagoon followed by stabilization pond is the simplest type of anaerobic digester. It consists of a pond, which is normally covered to exclude air and to prevent methane loss to the atmosphere. Far easier to construct than vertical digester types, but the biggest drawback is the large surface area required. Anaerobic lagoon followed by stabilization pond would be most economical and would not required any mechanical equipment. By using these technique a reduction of BOD about 85-90%. It is the most economical and cheapest technique. Anaerobic digestion followed by ASP-more economical for the biological stabilization of dairy wastes, as they do not have the high-energy requirements associated with aeration in aerobic systems.organic load in a waste stream can be converted to biogas (methane and carbon dioxide) which can be utilized as a heat or power source. This process gives efficiency about 95%. And then UASB followed by ASP.***
Keywords: Untreated Dairy Effluent; Effects of Dairy Waste Water on Environment; Treatment Options

I. INTRODUCTION

Effects of untreated effluent on, Inland surface water, On land and Public sewers are studied

A. Effects Of The Wastes On The Receiving Streams/Sewers

As observed from the above table the waste is basically organic in nature. This is also slightly alkaline when fresh. When these wastes are allowed to go into the stream without any treatment , a rapid depletion of the dissolved oxygen content of the stream occurs ,along with growth of sewage fungi covering the entire bottom of the submerged parts of the hydraulic structures within it. The waste is said to carry , occasionally ,the bacteria responsible for tuberculosis. Though alkaline in fresh condition ,the milk waste becomes acidic due to the decomposition of lactose into lactic acid under anaerobic condition, particularly after complete oxygen depletion of the stream. The resulting condition precipitates casein from the waste , which decompose further into a highly Odourous black sludge. At certain dilutions the dairy waste is found to be Toxic to fishes also.

As the dairies are usually situated in rural areas or in small towns, the question of discharging the dairy waste into the sewers does not arise . In large cities, combined treatment of domestic sewage and dairy waste may be considered if the later constitutes only 10% in the volume of the former. In that case the dairy waste should be discharged in a fresh condition, as a putrefied waste may cause corrosion of the sewers.

B. Treatment Of The Dairy Wastes

As evident from the low COD:BOD Ratio ,the dairy wastes can be treated efficiently by biological processes. Moreover , these wastes contain sufficient nutrients for bacterial growth. But for economical reasons , attempt should be made to reduce volume and strength of the waste.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
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This may accomplished by

1) The prevention of spills, leakages and dropping of milks from cans,
2) By reducing the amount of water for washes,
3) By segregating the uncontaminated cooling water and recycling the same ,and
4) By utilizing the butter milk and whey for the production of dairy by products of good market value.

Due to the intermittent nature of the waste discharge ,it is desirable to provide Equalization Tank , with or without aeration , before the same is sent for biological treatment. A provision of grease trap is also necessary as a pretreatment to remove fat and other greasy substances from the waste. An aeration for a day not only prevents the formation of lactic acid ,but also reduces the BOD by about 50%.

Both high rate trickling filters ,and activated sludge plants can be employed very effectively for a complete treatment of the dairy waste. But these conventional methods involve much maintenance ,skilled personnel ,and special type of equipments. On the other hand the low cost treatment methods like oxidation ditch, Aerated lagoon, Waste Stabilization pond etc. can be employed with simpler type of equipments and less maintenance.

Oxidation ditches in India may be designed with a low organic loading (about 0.2 kg/kg of MLSS),high biological mass concentration (in the order of 4000 mg/l), and extended period of aeration (in the order of 1.5 days), for BOD reduction of about 95 to 98%. In a waste stabilization pond, a BOD reduction of 52 to 74% could be achieved after 12 days of retention and an organic loading of 550 to 585 kg/hectare/day.

BOD reduction of about 90% may be obtained with a retention time of 7 days and a depth in order of 3 m, in an anaerobic lagoon. An organic loading in the order of 0.48 $kg/m^3_{/day.}$
Is Suggested for the above.

Use of dairy waste for irrigation after primary treatment in an Aerated lagoon may also be good answer for the disposal of Dairy waste.

II. WASTE WATER TREATMENT

A. Effluent Treatment Plant

Presently the effluent treatment Plant (ETP) is having Combined Aerobic and Anaerobic Treatment of capacity 10 Lakh Litres. The Wastewater from Process Plant comes to ETP. The Separate collection of Wastewater from receiving Platform, cans and Tanker Washings is done and Taken for Irrigation Purpose after Treatment. Periodic maintenance and cleaning of plant machinery carried out outside the plant to maintain hygienic conditions inside the plant. The flow diagram of ETP is as shown in fig.1. Preliminary treatment of Screening is done then the wastewater is Taken to fat removal tank, here Scum is removed. Further effluent is brought to Waste-Water holding basins. Equalization of Wastewater parameters takes place in two stages to Overcome fluctuations in Wastewater parameters. The effluent from Waste water holding basins then pumped to UASB for Primary Treatment. Here effluent detained for 6-8 hours for Anaerobic Treatment. From UASB effluent comes to Storage Tanks, and then pumped to Aeration Tank 1 and 2,3 for Aerobic Treatment. In Aeration Tank , Mechanical Aeration is done with air blowers. Further Treatment Consists of Tube Settler and Final Outlet.

B. Inlet

The Raw influent generated from the all the Sources from industrial activity is Directly collected to the Water Holding Tank after passing to the Screen Chamber And Fat Removal Tank.

C. Screen Chamber / Scum Removal Tank

Screen /Scum Chamber is basically provided to remove heavy particles such as Plastic, Paper, and or other floating material. To achieve the target ,mild steel Screens are Provided. The cleaning of this material is done by manual cleaning. The cleaning is done every day. After passing through Screen/ Scum Chamber, influent enters into the Fat Removal Tank. Here oil, grease along with fats is Trapped on the surface of Water. (Conventional Phenomena of density principle are applied for the separation of oil/ fat and water layers.) Then Water free from fat and oil enters to the Waste Water holding Tank. A Skimming tank is a Chamber so Arranged that the floating matter like oil, fat, grease etc., rise and remain on the surface of Waste Water (Sewage) until removed, While the liquid flows out Continuously under Partitions or Baffles. It is necessary to remove the floating matter from sewage otherwise it may appear in the form of unsightly scum on the Surface of the Settling Tanks or interfere with the activated sludge process of sewage Treatment.

D. Fat Storage Tank

Fat & Scum removed from Fat & Scum Removal Tank is Stored in Fat Storage Tank. This Stored Fat is Used for UASB. The capacity of this tank is about 4 thousand litters and is in the shape of Rectangular.

E. Waste-Water Holding Tank

Provided with Rectangular Shape with Capacity of 160 m^3 each. Here all the effluent gets Proper detention time and gets equalized for further Treatment. Then Pumped to UASB. In this tank PH is also adjusted by adding Chemicals like lime or alum if required.

F. UASB

UASB is provided with the 80000 and 40000 litres capacities. Anaerobic Digestion of effluent takes place here. For collection of the gas, dome is provided. Anaerobic digestion is the breakdown of organic material by a microbial population that lives in an oxygen free environment. Anaerobic means literally "without air ". When organic matter is decomposed in an anaerobic environment the bacteria produce a mixture of methane and carbon dioxide gas. Anaerobic digestion Treats waste by converting putrid organic materials to carbon dioxide and methane gas. This gas is referred to as biogas. The biogas can be used to produce both electrical power and heat. The conversion of solids to biogas results in a much smaller quantity of Solids that must be disposed. During the Anaerobic Treatment Process, Organic Nitrogen Compounds are Converted to Ammonia, Sulphur Compounds are Converted to hydrogen sulphide, Phosphorus to orthophosphates, and Calcium, Magnesium, and Sodium are converted to a variety of Salts. Through Proper Operation, the inorganic constituents can be converted to a variety of beneficial products. the end products of anaerobic digestion are natural gas (Methane) for energy Production, heat produced from energy production, a nutrient rich organic slurry, and other marketable inorganic products. The effluents Containing particulate and soluble constituents. The particulate solids can be sold or exported from the dairy while the nutrient rich liquids are applied to the land.

G. Aeration Tanks

Two Stage aeration is provided for the biological system. In this, first aeration tank is provided with the capacity of 30000 litres and second 40000 litres and third 40000 litres. In first aeration tank, air is be supplied to the system by means of fixed type of Surface Aerator along with micro nutrients through Urea, Cow dung and DAP. In second stage, it is provided with twin lobe blower and diffused Aeration. In this tank, bacteria are provided and are developed by addition of bacterial culture. Biological process has found vide use in the treatment of wastewaters because of high levels of biodegradable organics in the raw water. Biological processes are used extensively in wastewater treatment to convert biodegradable organics and other nutrients into a more manageable form. Biological process form the basis for secondary treatment in which dissolved and colloidal organics are converted into biomass that is subsequently separated from the liquid stream. Sludge recycling facility is provided here to maintain the microbial activity. Then the water enters to the Secondary Settling Tank.

H. Tube Settler

A common Tube Settler is designed to settle down the micro-organism (suspended) and to remove it and recirculate to the Aeration tank from the Waste Water. 30 min detention time is proposed for the settling of solid waste in Tube Settler. Excess Solids settled at the bottom of Tube settler will be drained out. Concentrated impurities, discharged from the bottom of the settler are known as sludge, while the particles that float to the surface of the liquid are called scum. Clarified Water From Settler get Transferred to the Final Outlet.

I. Treated Water Collection

After complete Treatment all the treated water will be utilize for the Garden / Irrigation Purpose. The Water From this Final Outlet is used for the Agriculture of Their own & Created small Wetland, Greenery cover is get maintained their as well. The plants grown in this area is used in Cattle breeding.

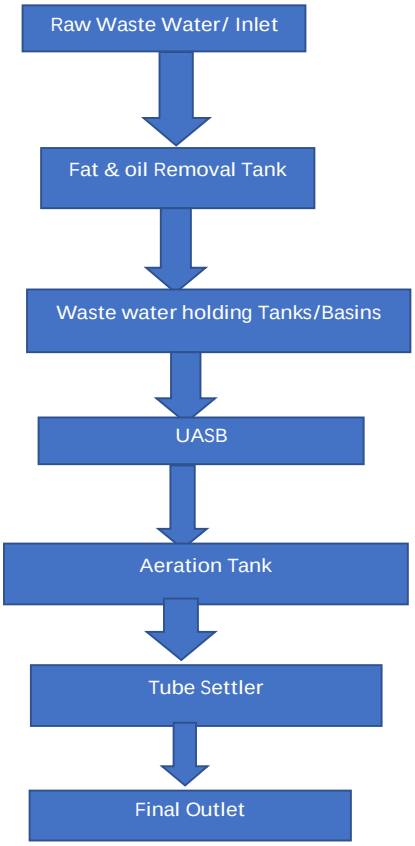
J. Solid Waste Treatment, Handling And Disposal

The Fat, oil, grease content Accumulated in the wastewater treatment process must be treated and disposal off in a safe and effective manner. The purpose of Digestion is to reduce the amount of organic matter and number of disease causing micro-organisms present in the solids.

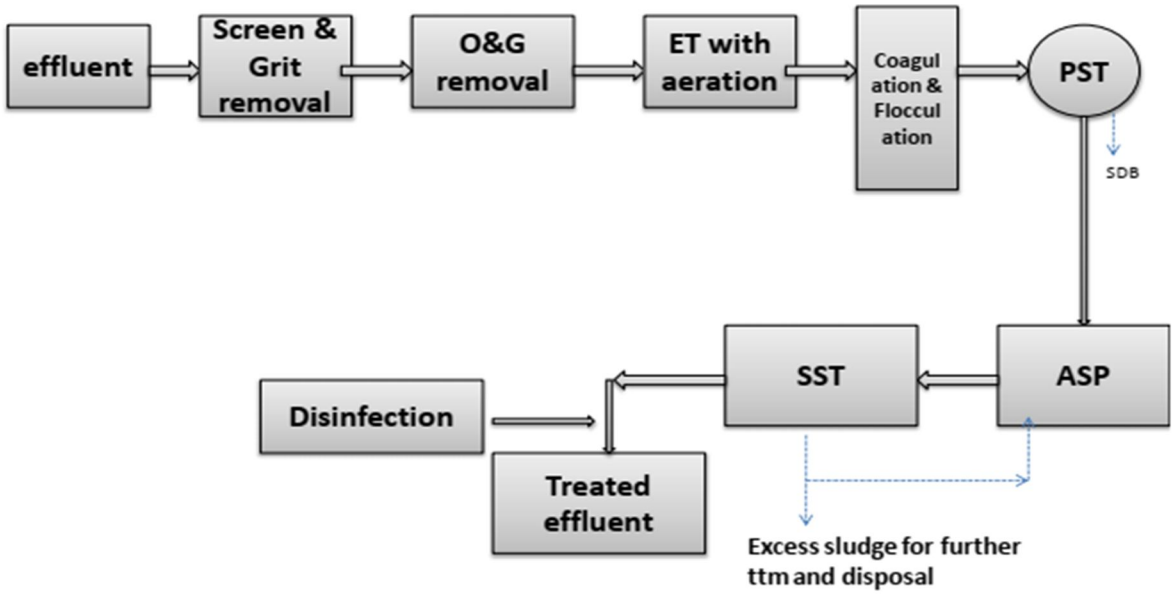
K. Cleaning Of Pumps

The solid Particles which get clogged into the pumps is identified when discharge gets low of Waste Water. They are Cleaned by manually as Shown below

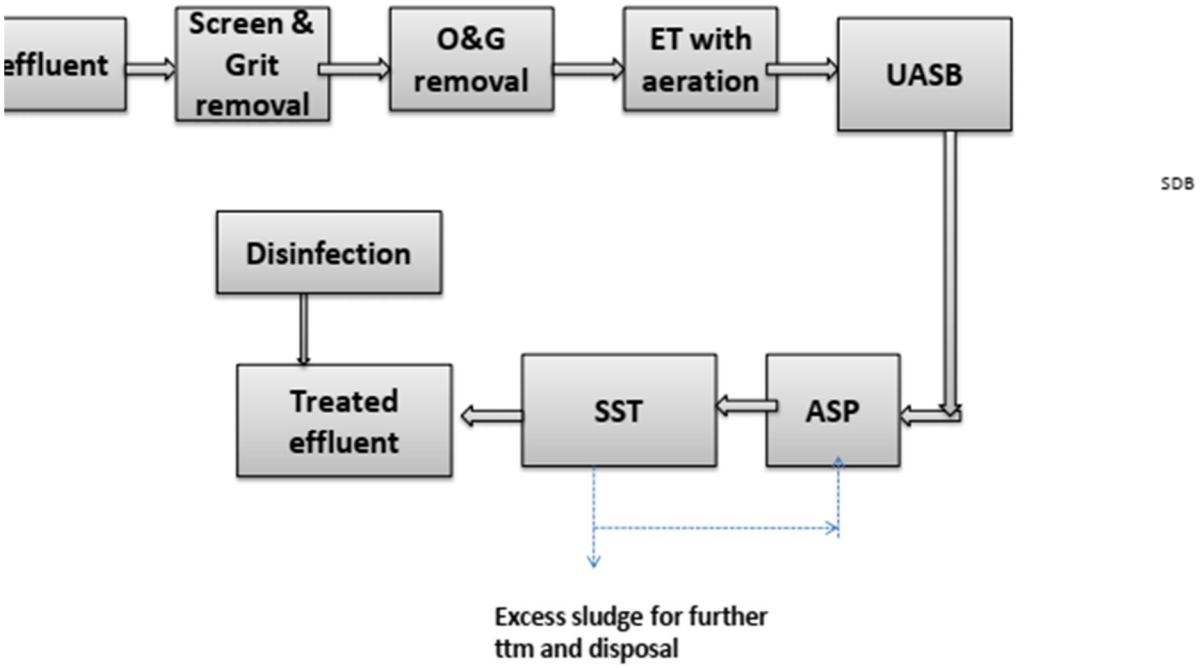
Fig. 1. Flow Diagram of Effluent Treatment Plant



Treatment flow diagram 1



Treatment flow diagram 2



Treatment flow diagram 3

1) Casein Recovery From Rejected Milk

a) Main protein of milk

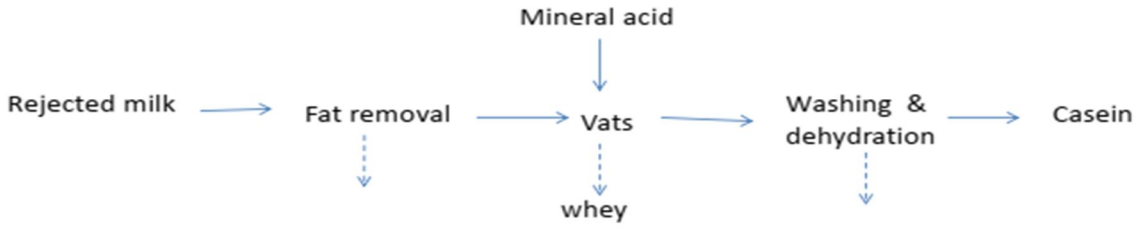
b) Responsible for the white, opaque appearance of milk in which it is combined with calcium and phosphorus as clusters of casein molecules

c) Earlier used mainly for non-food applications such as adhesives for wood, in paper coating, leather finishing and in synthetic fibers, as well as plastics for buttons, buckles

d) During the past 30 years, however, the principal use of casein products has been as an ingredient in foods and imp. Source of protein supplements

e) In many countries casein is produced from skim milk

2) Casein Recovery



3) Summary

Biological methods of treatment include

a) Non mechanised methods such as anaerobic ponds, aerobic oxidation ponds and combination of these two.

b) Mechanical methods such as trickling filters, aerated lagoons and activated sludge process based on extended aeration. In large dairies it is possible to use the anaerobic processes such as anaerobic filter or up-flow anaerobic sludge blanket (UASB process) followed by one of the non mechanized or mechanized aerobic processes. Recently sequencing batch reactors, aerobic as well as anaerobic, have been found to be effective in treating dairy waste waters.

Milk solids consist essentially of carbohydrates, fats, proteins, roughly the BOD of 1kg of milk fat is 0.89kg. 1kg of milk proteins is 1.03kg and 1kg of milk sugar is 0.69kg. Dairy waste are made up of dilutions of whole milk and byproducts. The BOD values of the products of milk are -

whole milk-90,000-1,05,000mg/l
Skim milk-65,000-75,000mg/l
Butter milk-55,000-65,000mg/l
whey-25,000-35,000mg/l

The manufacturing activities in a dairy are of the "batch" type i.e. one batch of milk is processed, the equipment is drained thoroughly, cleaned and the next batch is taken for processing. As a result the flow of waste water from a dairy comes in slugs. This fact should be taken into account in designing a waste water treatment plant to handle dairy waste water.

The amount of water used in a dairy and hence the volume of waste water produced depends on its availability. However an average value of waste water generated ranges between 4-8 litres per litre of milk processed. The bulk of water consumption goes towards cleaning of the equipment and floor washing. The average characteristics of dairy waste are-5 day 20°C BOD 1200mg/l, COD 1800mg/l, suspended solids 600-800mg/l, oil and grease 200-900mg/l. The ratio of COD:BOD is favourable for applying biological methods of treatment preceded by some form of pretreatment such as flow equalization and oil and grease removal.

III. CONCLUSIONS

A. Operations in a Dairy

Receiving, Pasteurizing, Bottling, Condensing, Dry milk manufacture, Cheese making, Butter making and Casein making

B. Essential Steps In Reducing The Pollution Load In The Dairy Include

1) Allowing the cans and tankers to be emptied completely by keeping them in inverted position till almost all the milk is drained out.
2) Minimizing spillage and leakages in the bottling section.
3) Attending to leaks in pipes, valves and equipment promptly.
4) Observing good housekeeping practices.
5) Using minimum amount of water for cleaning operations.

C. Waste Minimization

1) Provide more draining time for milk cans with installations of drip pans.
2) High pr. Low volume rinse
3) Preventing overflow from vats , tanks and coolers.
4) Prevention of leakages.
5) Segregation of clean wastewater from strong w/w.
6) Reuse of cooling water and condensates
7) Preventing entrainment of milk solids in condenser water in vacuum pans

D. By Product Recovery

1) Milk drippings and primary rinsing for feeding animals
2) Combined effluents for breeding carps
3) Whey after concentration and evaporation as animal feed.
4) Protein supplements from whey for human consumption
5) Use of Yeast produced on whey as animal feed
6) Recovery of Casein from rejected milk
7) Oil and Grease removed can be used in soap manufacturing industries.

E. Conflict Of Interest

The authors confirm that this article content has no conflict of interest.

F. Acknowledgements

Declared none.

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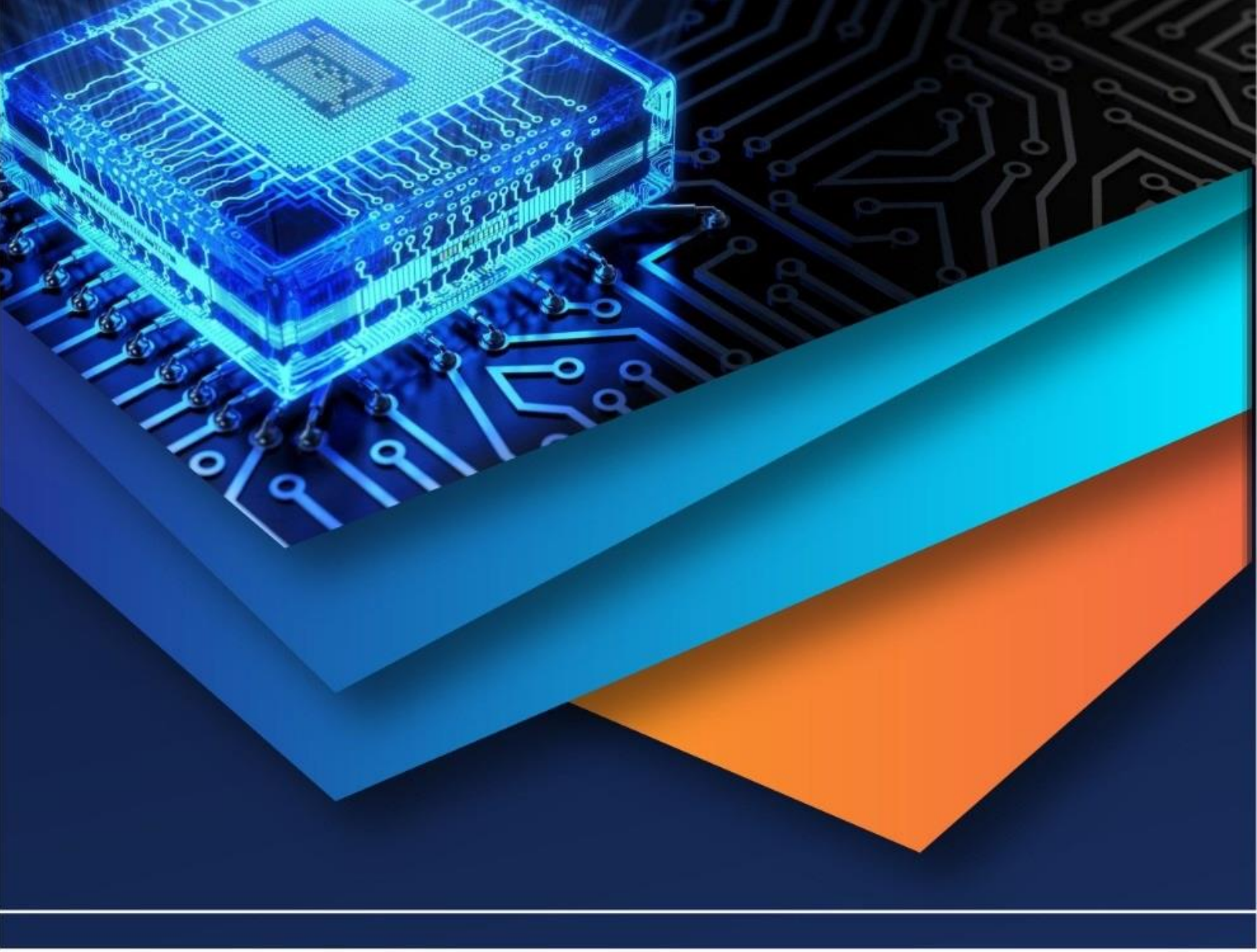

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