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Technical and Economic Feasibility of Rice Husk Based Power Generation in Jalpaiguri District, West Bengal

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Abstract: ***Rice is the staple food of our country. In India about 120 million tons of Rice paddy is produced per year. Rice Husk is a by-product of Rice milling process. Rice Husk is carbon-neutral and considered as an alternative fuel and it is environment friendly as it can mitigate CO2, SO2 and NOX emission compared to the conventional fuel. Rice is cultivated in most of the parts of the Jalpaiguri district. A large amount of rice husk is dumped as a waste that causes waste disposal and methane emission problems. Rice Husk can be used in the electricity generation in an effective manner by which it can be converted from agricultural by product to valuable fuel for boosting the farm economy and development of rural areas. In the present study the rice milling process, potential of rice husk based power generation in the district are investigated. The cost benefit analysis and carbon credits that can be earned from the rice husk based power generation project are also evaluated.***
Keywords: Rice mill industry, Husk, Jalpaiguri, power plant, carbon credit, cost benefit analysis.

I. INTRODUCTION

Jalpaiguri district is one of the largest districts of West Bengal covering an area of 3044 km² [1]. It is situated between 26°16' and 27°0' North latitudes and 88° 4' and 89° 53' East longitudes, which is a northern part of West Bengal. Jalpaiguri falls in the monsoon climate zone of South-eastern Asia with temperature ranging from 34°C in May to 11°C in January and average rainfall of about 3160mm. A number of river flows through the district. The soil is mainly fine loamy to coarse loamy that generally needs more irrigation and frequent watering.

Jalpaiguri district is made of two sub-divisions, namely Jalpaiguri Sadar Subdivision and Mal subdivision consisting of seven blocks. According to the 2011 census the district had a population of 3,869,675. A large section of the population lives in the rural areas that have little or even no access to electricity which has affected the development of the state. Rice Husk based power generation is an effective way of electrifying the areas. The concept came into existence in the year 2007 with main goal to provide affordable, reliable, environmentally sustainable energy to the rural areas [2] .Production of rice paddy is normally associated with production byproducts like Rice Husk, Rice Bran, and Broken Rice.

Rice Husk is about 20% of the weight of paddy. India alone produces 120 million tons of rice paddy per year giving about 24 million tons of Rice Husk per year [2] .The income of the rice milling industry can be increased both directly and indirectly using rice husk generated in the industry. Rice husk can be used in making building material like bricks, polishing agent in the metal and machine industry etc. Although there is so many use of rice husk but still little portion is utilized in effective way because of lack of awareness among the farmers and industry persons.

II. PADDY PRODUCTION IN JALPAIGURI DISTRICT

Jalpaiguri district produces about 2.5% paddy of total production of West Bengal. The Table-1 depicts the paddy production in different blocks of Jalpaiguri district. The raw paddy normally rice weighs 63%, Rice husk weighs 20%, Bran weighs 5%, Broken Rice about 5% and 7% wastage comprising of the straw stones mud and sand particles [3] .

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Table I : Paddy Cultivation In Jalpaiguri District (2015-2016)[3]

	AREA (HA)	PRODUCTION (MT)	PRODUCTIVITY (KG/HA)	RICE (MT)	RICE HUSK (MT)
JALPAIGURI SADAR	25500	98819	3875.26	62256	19763.8
RAJGANJ	36816	183518	4984.73	115616	36703.6
MAYNAGURI	25980	110073	4236.84	69346.1	22014.6
DHUPGURI	28015	96014.2	3427.24	60489	19202.8
MALBAZAR	15855	69112.9	4359.06	43541.1	13822.6
MATIALI	5003	16526.8	3303.38	10411.9	3305.36
NAGRAKATA	5297	18150	3426.62	11434.5	3630
TOTAL	142466	592213.9	4156.878	373094.6	118442.76

III. RICE MILLING PROCESS

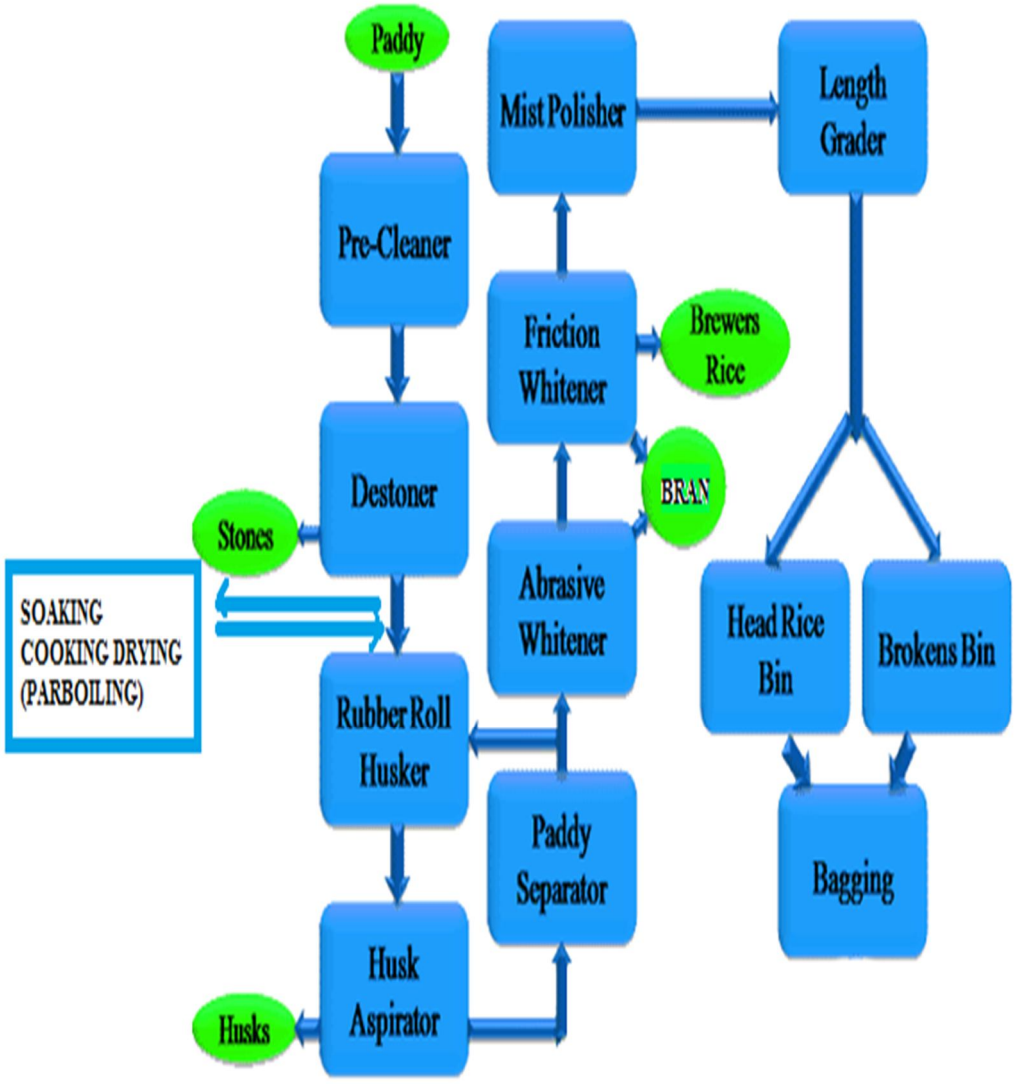

Fig 1. Flowchart of Rice Milling Process

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Rice milling process involves removal of outside husk layer and bran layer to produce whole white rice kernels. On average 63 % white rice, 20 % husk, 5% bran, 5% broken rice and 7% wastage is produced[4].

IV. PROPERTIES OF RICE HUSK

S. No	Property	Range
1	Bulk density (kg/m^3)	96 - 160
2	Length of husk (mm)	2.0 – 5.0
3	Hardness (Mohr's scale)	5.0 - 6.0
4	Ash (%)	22.0 - 29.0
5	Carbon (%)	≈ 35.0
6	Hydrogen (%)	4.0 - 5.0
7	Oxygen (%)	31.0 – 37.0
8	Nitrogen (%)	0.23 - 0.32
9	Sulphur (%)	0.04 - 0.08
10	Moisture (%)	8.0 - 9.0

Fig 2. Composition of Rice Husk

The calorific value of Rice Husk is about 3000-3500 kcal/kg[4] .

V. USES OF RICE HUSK AND RICE HUSK ASH

A. Rice husk ash is potential source of silica it is used in the manufacture of Portland cement.
B. Rice husk ash is used as a sealant in the construction industry.
C. Rice husk ash is used as a tire additive.
D. Rice husk can be used in brewing beer to increase the lautering ability of a mash.
E. Rice husk coated with fine grained gun powder used in the fireworks.
F. Rice husk can be used in the steam engines.
G. Rice husk is used as fiber in pet foods.
H. Rice husk is used as an insulating material.
I. Rice husk uses also include aggregates and fillers for concrete and board production, economical substitute for micro silica,

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absorbents for oils and chemicals [5].

VI. WAYS OF GENERATING ELECTRICITY FROM RICE HUSK

A. Gasification

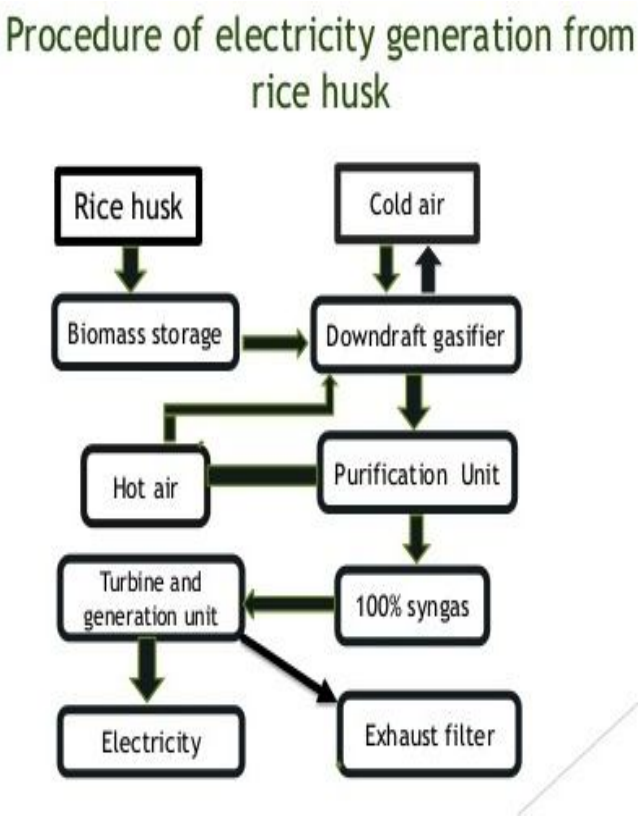

Fig 3. Flowchart of Electricity generation from Rice Husk.

The process involves production of syngas from gasifier using rice husk as fuel. The purified syngas is used in steam turbine or gas turbine to generate electricity.

B. Direct Combustion

Another process is where rice Husk is burned to generate hot flue gases, which is directly fed into a boiler to generate steam. The steam can be used for industrial purposes or space heating or even to drive turbines to generate electricity [6].

VII. POTENTIAL OF RICE HUSK BASED POWER GENERATION IN JALPAIGURI DISTRICT:

Amount of Rice Husk generated in the district: 118442.76 Tons per year =118443 Tons per year approx.

A. Calculation for amount of electricity (units) that can be produced per year from the Rice Husk generated in the Jalpaiguri District

Considering the total rice husk to be used for centralized power generation:
Amount of heat generated from the rice husk considering 95% [7] combustion efficiency with Calorific value of 13.33 GJ/ Tonne and 30% [8] power plant efficiency.
=118443*0.95*13.33*0.30
= 449970.8 GJ/Year
= 449970800 MJ/Year
=124991.8 MWh/Year≅125 million kWh/Year approx.

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B. Calculation of the capacity of power plant that can be established in the Jalpaiguri District from the Rice husk generated.

Considering the power plant operating 350 days a year and 24 hours

=124991.8 MWh / (350*24) = 14.87 MW ≅ 14 MW

Therefore a 14 MW Rice husk based power plant can be easily set up in Jalpaiguri District which will be running for 24 hours and 350 days a year.

C. Calculation for Decentralized Rice Husk based power plant catering power to Jalpaiguri District:

Total amount of electricity that can be generated in the district from the available rice husk:124991.8 MWh/Year

Total amount of electricity consumed by all the rice mills of the district: 4609.32 MWh/Year

Amount of electricity available for supply: 124991.8-4609.32=120382.8 MWh/Year

Jalpaiguri city electricity demand=63000 MWh/Year[13]

Therefore, only 50 % of total power generation from rice husk can easily serve the power requirement of Jalpaiguri City.

Jalpaiguri District electricity demand: 240000 MWh/Year[13]

Therefore only 50.15% of the power meet up is possible for the district from the power generation from rice husk available.

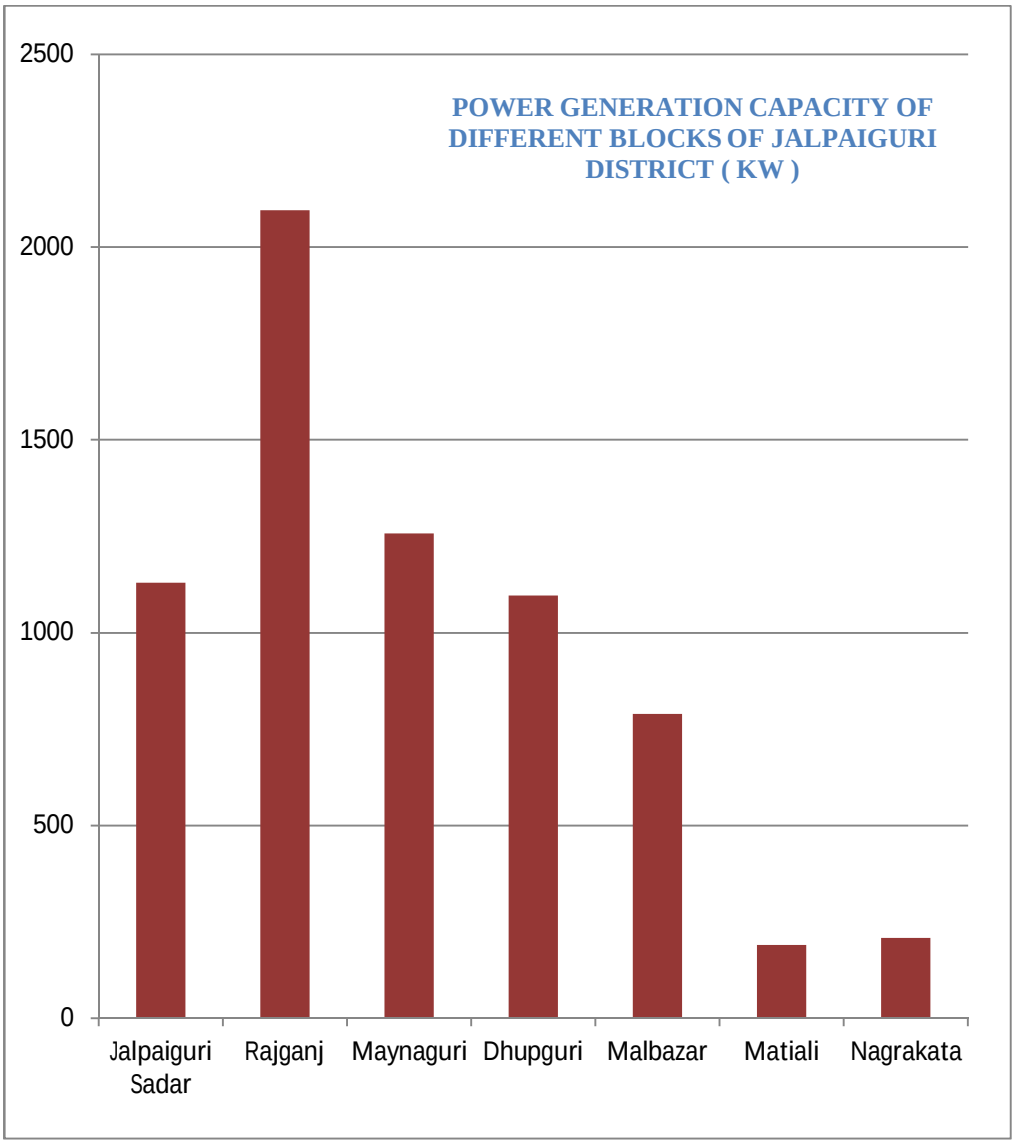

Fig 4. Power Generation Capacity of the different blocks of the Jalpaiguri District

D. Calculation of the commercial value of the rice husk ash that would be produced from rice husk during power generation

Considering Rice Husk ash content is 22%,

Therefore 22% of 118443 MT= 26057 MT of rice husk ash will be produced yearly.

Commercial value=26057000*Rs.10=Rs.260570000≅Rs.26 Crores [9]

VIII. COST BENEFIT ANALYSIS OF USING RICE HUSK AS A FUEL FOR A 14MW POWER PLANT.

Number of units produced in one hour=14000 kWh= 14 Mwh

Let the production cost is Rs. 2/ kWh =14000*2=Rs.28000

Cost of fuel 50% of the production cost=50% of Rs.28000=Rs.14000

Therefore fuel cost=Rs.14000/14 Mwh = Rs.1000/ Mwh

Therefore production cost-Rs.28000/14 Mwh=Rs.2000/ Mwh

Cost of purchasing one truck load of Rice Husk of payload capacity of 22 tones = 22000*Rs.2=Rs.44000 [3] .

Cost of transporting the rice husk from rice mill to power plant =Rs.4000 [8] .

The rice mill owner can earn a profit of Rs.44000/22=Rs.2000/ tons

If half of the profit is transferred to the farmers, they will get Rs.1000/tones.

There are several fiscal incentives given by the government of India like the Accelerated depreciation on high efficiency equipment, tax holiday for five years and 30% exemption for nest five years, exemption on central excise duty for renewable energy devices including raw material component and assembly.

IX. CARBON CREDITS

It is long known that global warming is a global concern and pollution even if occurs locally, it affects globally. Based on this global principle, United Nations framework Convention on Climate Change (UNFCCC) has arranged several Earth Summits with the aim to mitigate this global menace. Among these Earth Summits, Kyoto Protocol is a major step which has been ratified in 2005 by 181 countries. Under the Clean Development Mechanism (CDM) of Kyoto protocol the rice husk based power plant is eligible for registration to earn carbon credits and, thereby, foreign finance support. Some examples of projects in India are Suzlon Energy and Shriram EPC havingbusiness in wind energy are eligible for earning carbon credit. Gujarat Flourochemicals was among the early companies to register for Clean Development Mechanism (CDM) project.The 800 million farming community in India has also a unique opportunity where they can sell Carbon Credits to developed nations. The India's Delhi Metro Rail Corporation (DMRC) has become the first rail project in the world to earn carbon credits because of using regenerative braking system in its rolling stock. DMRC has earned the carbon credits by using regenerative braking system in its trains that reduces 30% electricity consumption [10].

A. Carbon Credits Earned By Setting 14 Mw Rice Husk Based Power Plant In Jalpaiguri District:

Calculation

1) Considering a 14MW Coal fired power plant operating 350 days a year for 24 hours =14*350*24=117600 MWh units produced per year=117600000 kWh produced per year.
2) Considering on an average, 1 kg CO2 is generated for producing 1 kWh of electricity from coal based thermal power plant [11]
   Amount of CO2 emissions: 117600000 kWh/year=117600000 kg of CO2/Year=117600 tones of CO2 per year .
   Present price of One tones of CO2 in International Market is ≅ 6€ [12]=Rs.72*6=Rs.432.
   Total= 117600*Rs.432=Rs.50803200=Rs.5.08 Crores.

Therefore 117600 CER (Certified Emission Reduction) amounting to Rs.5.08 Crores can be earned by establishing 14 MW Rice Husk based Power Plant.

X. CONCLUSION

Despite having so many uses of Rice husk it is treated basicallyas waste ,apart from some heat generation utilization, in Jalpaiguri district and also in many other places where large quantity is generated. Although small power plants, particularly Captive in nature, are coming up using rice husk as a fuel but utilization in bigger scale is still not found. There are reasons like insufficient information of use of Rice husk, lack of interest, lack of environmental concerns. This paper investigates the various potential uses of Rice Husk including power generation and its techno-commercial feasibilities in the Jalpaiguri District. Investigation regarding utilization potential of rice husk for Jalpaiguri district which ultimately contributes towards sustainable development has not been heard before.

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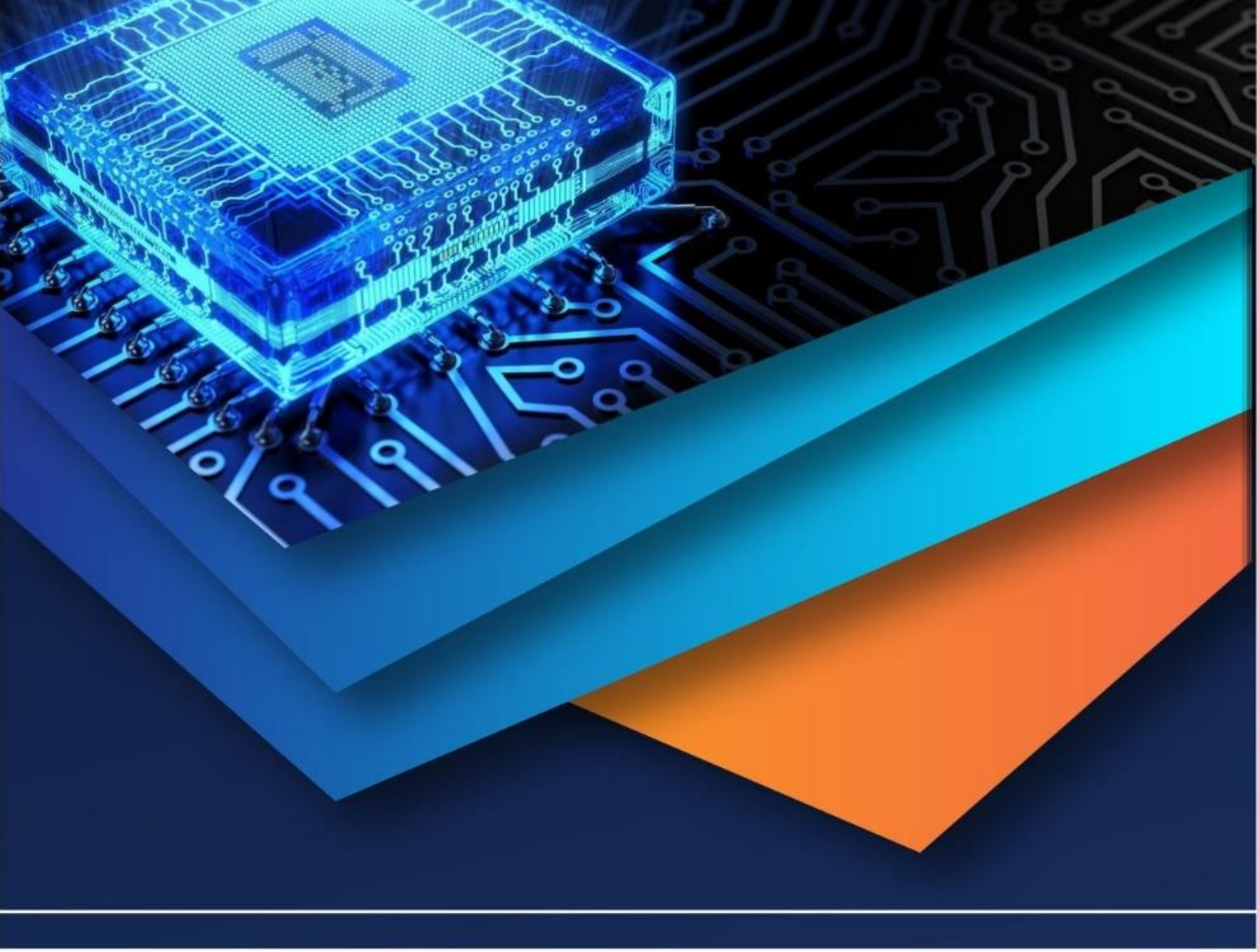

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