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Performance of Diesel Engine Using Jatropha and Karanja Biodiesel

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Abstract*— Biodiesel is an alternative fuel of diesel, is described as fatty acid methyl ester from vegetable oils or animal fats. The main objectives of the present work is to reduce higher viscosity of Pongamia Pinnata (Karanja), Jatropha curcas(Jatropha) oil using Esterification followed by Transesterification and to assess the performance and emission characteristics of diesel engine. Engine parameters such as brake specific fuel consumption, brake thermal efficiency were calculated .Performance tests were conducted on a multi cylinder diesel engine. From the test results it has been established that blends of Jatropha and Karanja on preheating gives same or better results as that Diesel on same engine.
***Keywords*— Jatropha ,Karanja ,Transesterification ,Diesel Engine**.

I. INTRODUCTION

The constant increase in the rate of consumption of the fossil fuels, consequent upon the ever increasing population and the urbanization in the present day world, has made the depletion of these conventional fuel resources in the near future a quite inevitable fact. Also, the Greenhouse Gas emissions from these fossil fuels are constantly degrading the planet and causing global warming and other pollutant emission related problem. As such, the situation demands for an alternate source of energy that can be used to overcome the forecasted future energy crisis. Unlike rest of the world, India's demand for diesel fuels is roughly six times that of gasoline hence seeking alternative to mineral diesel is a natural choice. Biodiesel production is undergoing rapid technological reforms in industries and academia. This has become more obvious and relevant since the recent increase in the petroleum prices and the growing awareness relating to the environmental consequences of the fuel over dependency.

In recent years several researches have been made to use vegetable oil, animal fats as a source of Renewable energy known as bio diesel that can be used as fuel in CI engines. Vegetable oils are Alternative fuels for CI engines as they are renewable, biodegradable, non toxic, lower emission compared to diesel fuel. Even though "diesel" is part of its name there is no petroleum in bio-diesel. It is 100% vegetable oil based, that can be blended at any level with petroleum diesel to create a bio diesel blend.

II. PROBLEMS WITH BIODIESEL

Major problems encountered with vegetable oil as bio diesel used in CI engine are its low volatility and high viscosity due to long chain structure. The common problems faced are excessive pumping power, improper combustion and poor atomization of fuel particles. The conversion of the vegetable oil as a CI engine fuel can be done by Transesterification

A. Transesterification process

Transesterification is a chemical process where an ester is reacted with an alcohol to form another ester and another alcohol. For the creation of biodiesel, triglyceride oils (esters) are reacted with methanol (alcohol) to produce biodiesel (fatty acid alkyl esters) and glycerin (alcohol). The triglyceride contains three separate ester functional groups and can react with three molecules of methanol to form three methyl esters (fatty esters) and glycerol (glyceride). The catalyst for this reaction is sodium hydroxide or another strong base such as potassium hydroxide. These hydroxides cause the methanol to dissociate and produce the methoxide ion, which is the actual catalytic agent that drives the reaction forward to create biodiesel.

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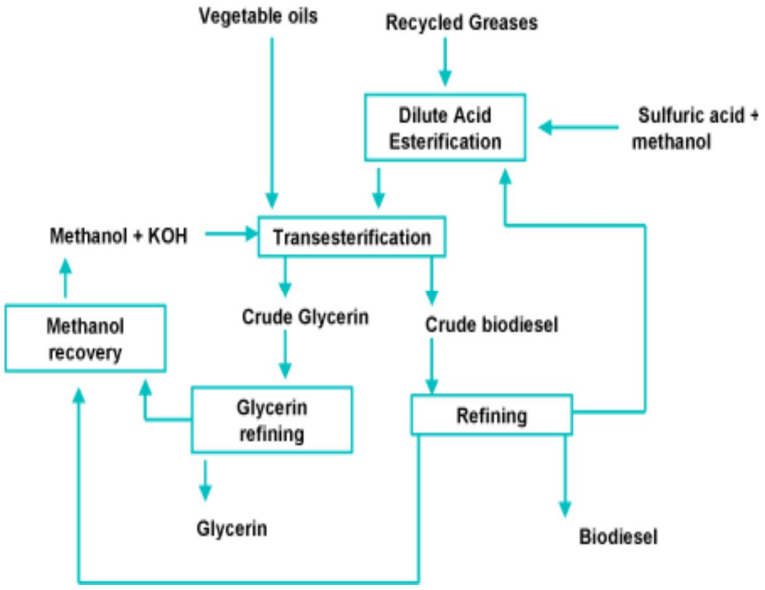

Fig. No.1. Process Flowchart for biodiesel Production

B. Preparation of Blends of Biodiesel

At present the amount of biodiesel available is less than that of diesel. The biodiesel blended with diesel by volume as B10 (10% karanja biodiesel & 90% diesel fuel), B20 (20% karanja biodiesel & 80% diesel fuel), B30 (30% karanja biodiesel & 70% diesel fuel), B40 (40% karanja biodiesel & 60% diesel fuel), B50 (50% karanja biodiesel & 50% diesel fuel), B100 (100% karanja biodiesel & 00% diesel fuel).

Fig. No.2. Blends of Biodiesel

III. EXPERIMENTAL SETUP

Study of Engine Performance has been an important process since the evolution of the engines. In the very early stages, only the external performance was studied with help of loading with a Dynamometer and measuring the parameters like Torque, Output power, Specific Fuel Consumption .For this, in the earlier research, Mechanical Spring and piston type recorders were used. Computerized IC engine Test Rigs with an intent not only to give the students how the testing is done and data is acquired, but to give them a more clear idea about the real time combustion by developing the combustion analysis system .Along with that, one can get all other data like Heat Balance Sheet, Thermal efficiencies, BSFC, Mechanical Efficiency, Air-fuel ratio etc.

A. Main components of system

1) Dynamometer :Eddy Current type with computerized torque measuring
2) Burette: For measuring the fuel consumption per unit time.
3) Manometer: For measuring the air consumption.
4) Temperature Indicator: For measuring the temperature at various locations.
5) Potentiometer: For loading the dynamometer.
6) Engine fitted with a Piezo sensor for Pressure measurement

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7) Computerized Fuel Flow measurement system
8) Computerized Water Flow measurement system

B. Engine Specifications

Make	BAJAJ(TEMPO TRAX)
Speed	1500 r.p.m
KW Rating	26 KW
Horsepower	35 H. P. AT 3000 r.p.m
Bore	0.11 m
Stroke	0.12m
Max. Output	20 H. P. AT 3000 r.p.m
Min. Output	5 H.P. AT 800 r.p.m

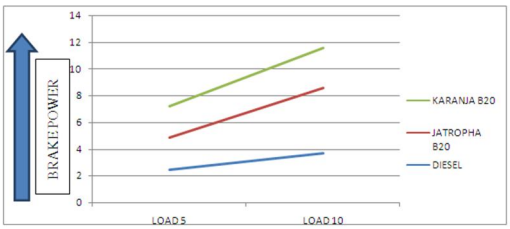
Fig. No.3.Experimental Setup

IV. PERFORMANCE ANALYSIS OF JATROPHA AND KARANJA BIODIESEL

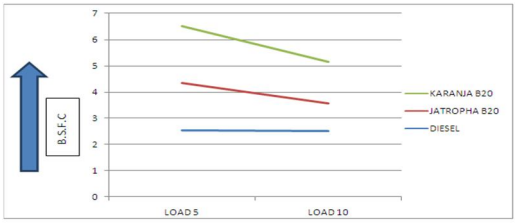
Performance tests were conducted on stationary cylinders, diesel engine, by using Jatropha and Karanja Biodiesel and its various blends with diesel from no load to full load condition i.e. at 5kg and 10 kg. The tests were also conducted with conventional diesel fuel for comparison; Biodiesel is blended with diesel in proportion like 20%, 40%, 60%, 100% These blends are termed as B20 (20% Biodiesel + 80% diesel), B40 (40% Biodiesel + 60% diesel), B60 (60%Karanja Biodiesel + 40% diesel), B100(100% Biodiesel). Petro diesel is used before and after the Jatropha and Karanja Biodiesel and their blends for verifying the engine performances because biodiesel and blends.

A. Engine Performance Analysis

The performance of an internal combustion engine is mainly studied with the help of combustion and operating characteristics. These characteristics obtained by using diesel, Jatropha and Karanja biodiesel in 4 cylinders, 4 strokes diesel engine with eddy current dynamometer. Performance tests were conducted from no load to full load conditions for diesel, B20, B40 and B60 and B100 for Jatropha and Karanja Biodiesel.



LOAD VS BRAKE POWER FOR B20



LOAD VS B.S.F.C. FOR B20

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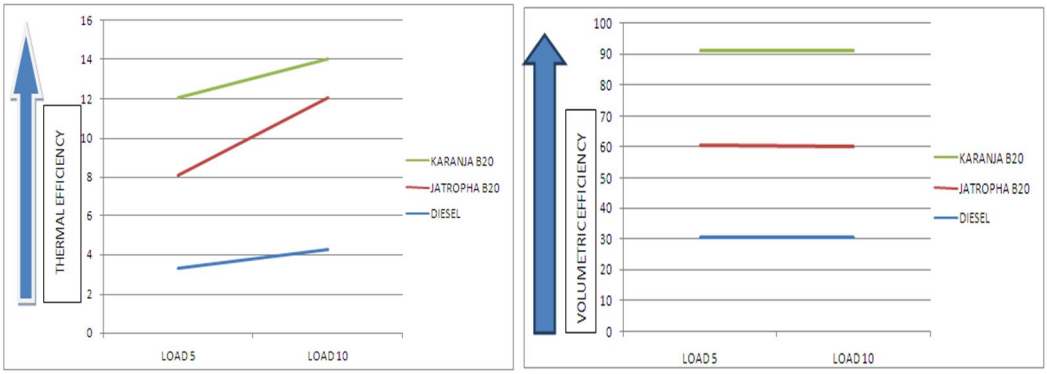
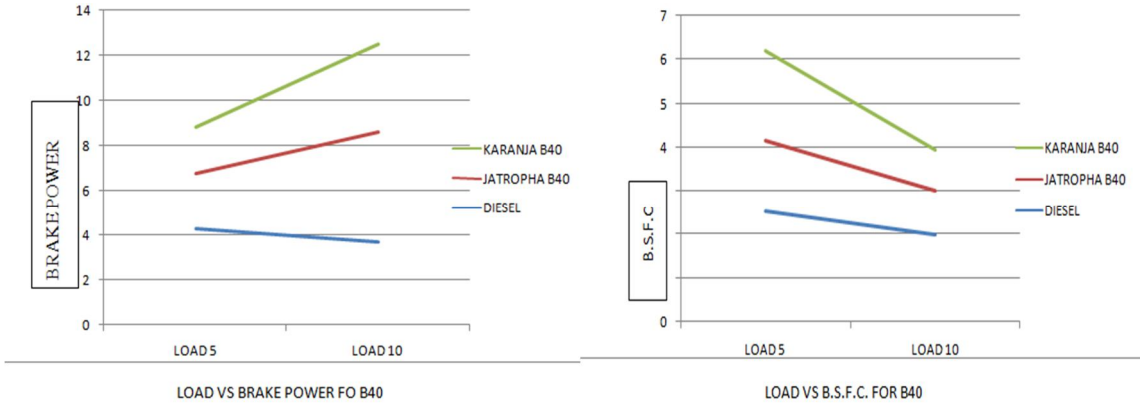


LOAD VS THERMAL EFFICIENCY FOR B20

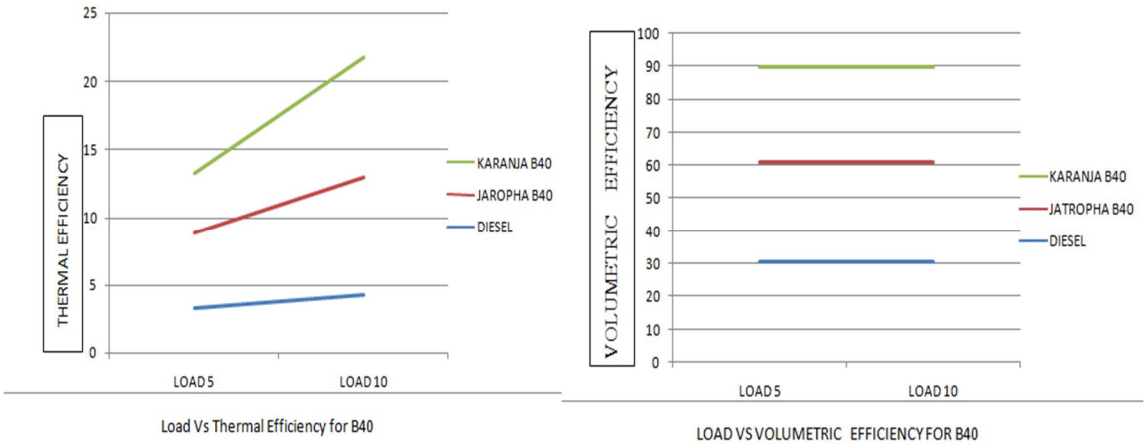
LOAD VS VOLUMETRIC EFFICIENCY FOR B20

For B20 blend, graphs show that Brake power of Karanja and Jatropha increases when load increases but brake power of diesel slightly increases with load. With increase in load .value of B.S.F.C. of Karanja and Jatropha Decreases gradually but B.S.F.C of diesel deceases slightly. When the load increases, thermal efficiency of Karanja and Jatropha increases rapidly but thermal efficiency of diesel slightly increases. Volumetric efficiency of Karanja, Jatropha and diesel remains constant when load increases.



LOAD VS BRAKE POWER FO B40

LOAD VS B.S.F.C. FOR B40



Load Vs Thermal Efficiency for B40

LOAD VS VOLUMETRIC EFFICIENCY FOR B40

For B40 blend, Graph shows that, brake power of Karanja and Jatropha increases when load increases. But when load increases brake power of diesel decreases. B.S.F.C. of karanja, Jatropha and diesel decreases when load increases. Thermal efficiency of Karanja, Jatropha increases rapidly but diesel's decreases slightly when load increases. Volumetric efficiency of Diesel, Jatropha and karanja remains constant when load increases.

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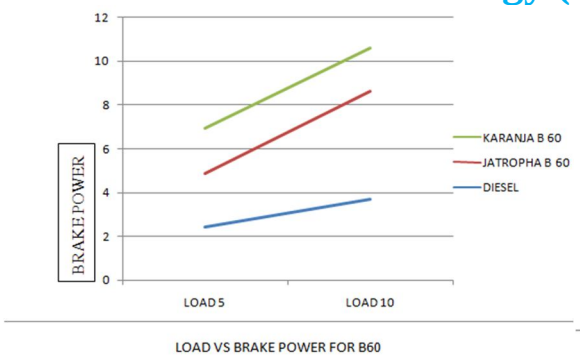
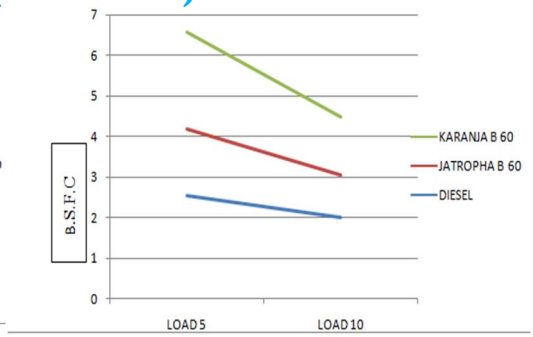
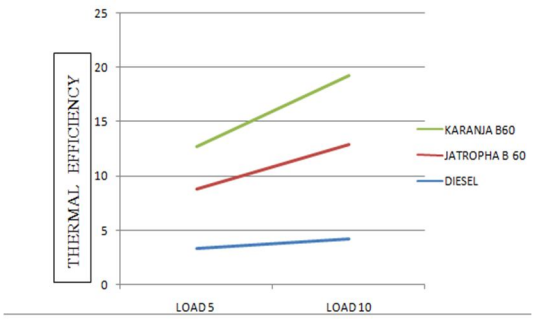


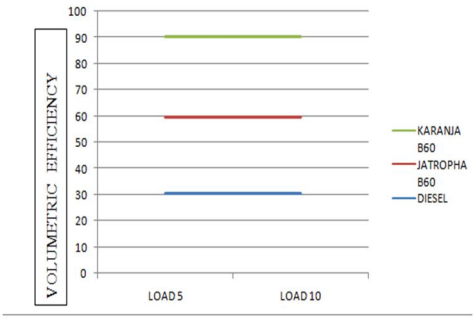
LOAD VS BRAKE POWER FOR B60



LOAD VS B.S.F.C. FOR B60

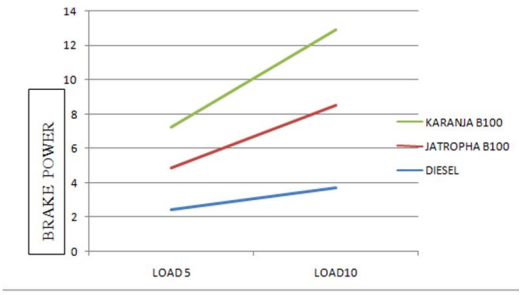


LOAD VS THERMAL EFFICIENCY FOR B60

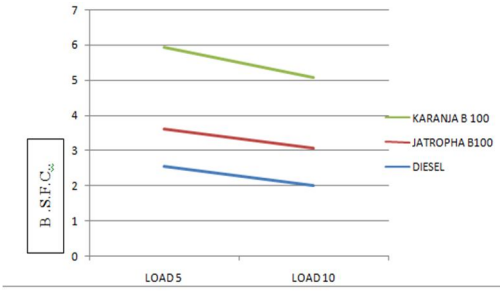


LOAD VS VOLUMETRIC EFFICIENCY FOR B60

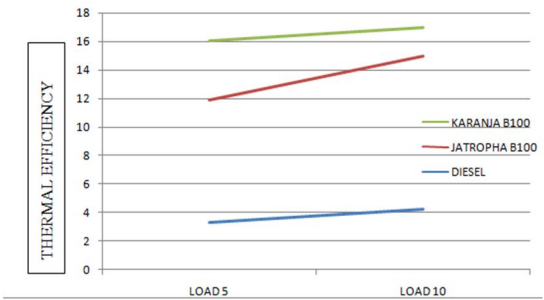
For B60 blend, Graph shows that, when the load increases brake power of Karanja and Jatropha increases rapidly but B.P of diesel increases slightly increases when load increases. B.S.F.C .of Karanja, Jatropha and diesel decreases when load increases. Thermal efficiency of Karanja, Jatropha and diesel increases when load increases. When load increases volumetric efficiency for Karanja, Jatropha and diesel remains constant.



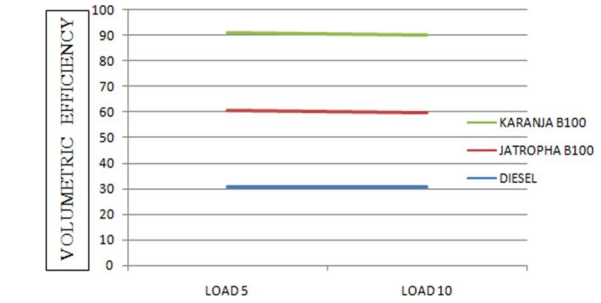
LOAD VS BRAKE POWER FOR B100



LOAD VS B.S.F.C. FOR B100



LOAD VS THERMAL EFFICIENCY FOR B100



LOAD VS VOLUMETRIC EFFICIENCY FOR B100

For B100 blend, Brake power of Jatropha, Karanja and diesel increases when load increases. B.S.F.C. of Jatropha, Karanja and

diesel decreases when load is increases. Thermal efficiency of Jatropha increases rapidly when load increases but Thermal efficiency of diesel and karanja increases slightly. When load increases, volumetric efficiency of karanja, jatropha and diesel remains constant.

V. CONCLUSION

A. Performance of C.I. Engine using Jatropha and karanja Biodiesel shows that Biodiesel is more efficient than diesel.

B. The thermal efficiency of Jatropha and karanja increases with increases in load rapidly but increases slightly for diesel. The volumetric efficiency of karanja, Jatropha and diesel remains constant when load increases.

C. The Brake power of Jatropha and karanja increases with increase in load but when load increase, Brake power of diesel decreases. B. S. F. C. of karanja and Jatropha drastically decrease but for diesel decreases gradually.

D. At the speed of 2000 rpm and load of 5 kg, value of B. S. F. C. for Jatropha is 1.6221kJ/k W hr and at the speed of 1970 rpm and load of 5 kg, value of B. S. F. C. for diesel is 2.54KJ/kW hr.

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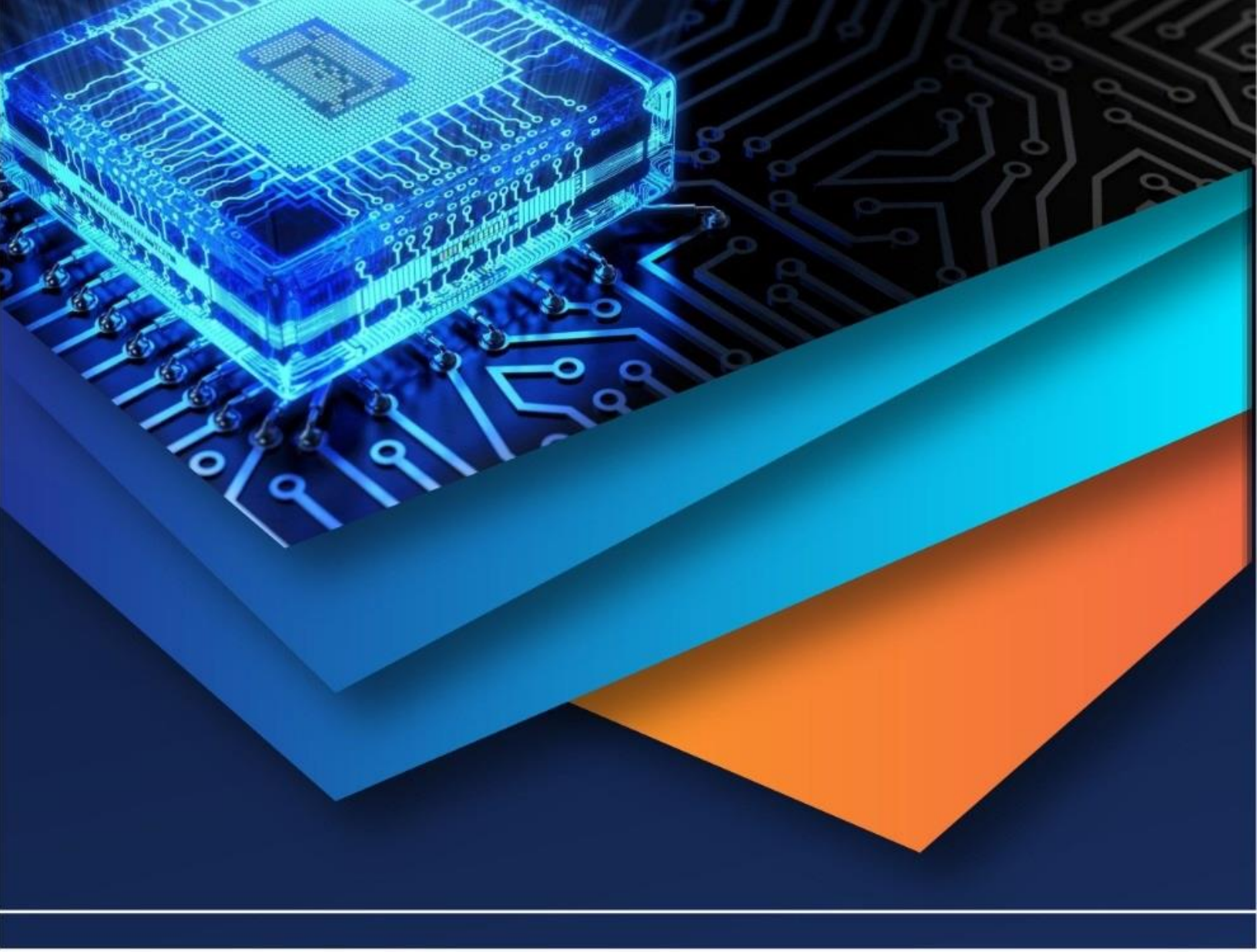

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