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Experimental Investigation on the Influence of Injection Timing with Comparative Analysis on Performance and Emissions of a DI, CI Engine fuelled with Ricinus Communis Bio Diesel and Diesel Blends

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Abstract: ***The use of bio diesel in the conventional diesel engine is gaining a lot of importance due to its environmental benefits obtained in terms of pollution. The emissions obtained in the diesel fueled engines basically are Carbon monoxide, hydrocarbons, particulate matter and NOx. The control systems for these emissions include diesel oxidation catalyst, diesel particulate filter and selective catalytic reduction. However, these control strategies again increases the burden to the conventional diesel engine in terms of cost and maintenance. So in-order to utilize all the available resources from the oil plantation crops, the production of bio diesel came into existence where a variety of oil seeds were processed for the preparation of bio diesel to be used in the conventional diesel engines.***

An experimental work is performed to compare the performance and emission characteristics of castor seed oil blended with diesel at different crank angle positions. The blend proportion used in this experiment is 25% bio diesel (B25) and 75% pure diesel (D75) at crank angles of 24^0 BTDC, 23^0 BTDC, 22^0 BTDC and 21^0 BTDC and is compared with the performance characteristics of D100 at a crank angle of 23^0 BTDC.

Keywords: Bio diesel, Diesel engine, Crank angle, blends, emissions

I. INTRODUCTION

The day by day increase in the population resulting in the drastic increase in the use of automobiles for faster reach to destinations in the day to day life. This leads to the growth of automobile sector and also in the increase of pollution in parallel. It is impossible to stop using of automobiles as just they are one of the reasons for the increase in pollution. Instead, the pollution decreasing technologies should be implemented with the advanced research in science and technology. One such advanced technology is the e-mobility which uses only electricity as fuel and having zero emissions. However, it is impossible to convert all the conventional vehicles into electric vehicles. This can be achieved only in a step by step procedure. On the other hand the use of fossil fuels not only increasing the environmental issues but causing their own exploitation. Therefore, although people in live in comfortable environments, they must suffer the inconvenience caused by the air pollution, global warming, green house effect, acid rains, desertification, fog, hage and volatile organic compounds [1-3].

The use of bio diesel as an alternate fuel is one of the best ways for the partial control of environment pollution up to certain extent. A report given in [4] said that the bio diesel can be used in the conventional diesel engines without any (or with minor) engine modifications. The diesel engines are more efficient than gasoline engines and are widely used. Though hydrocarbons and carbon monoxide emitted from the diesel engines are low, the impact of NOx and particulate matter have adverse effect on environment. The particulate matter can be reduced with the use of bio diesel as it is produced from plants and animals due to its inherent characteristics. The use of bio diesel increases the CO_2 and this CO_2 is absorbed by the plants as they grow. Thus, the significant use of bio diesel can reduce global warming and the green house effect. Even though bio fuels are having these many positive attributes, they can not be used to the fullest in a diesel engine as they comprises of higher viscosity and density. This leads to injector nozzle clogging and pad corrosion. So, to overcome this situation the mixed blends are used.

Upendra Rajak et al. [6] performed numerical study on performance of nine different alternative fuels and diesel. The results showed that bio diesel can be used as an optional fuel in CI engines.Studies [8-11] says that the brake specific fuel consumption of blended fuels is high. Huang et al. [12] conducted tests to study the performance and emissions of engine fueled with ethanol diesel blends. They found that it was feasible and applicable for the blends with n-butanol to replace pure diesel as the fuel for diesel engine.

All the studies state that the use of bio diesel will be definitely an alternative for the conventional diesel engines which in addition are more advantageous to the environment by decreasing the pollutant emissions that cause several effects in the life style of human beings and bio life. There are different range of categories that serve bio fuel as an alternative fuel and one such category is the trans-esterification.

II. METHODOLOGY AND TESTING

A. Methodology

The bio diesel was produced from castor oil by trans-esterification process. The properties were determined according to ASTM standards. Required fuel properties such as flash point, fire point, viscosity, density, calorific value and pH value are measured and shown in Table-1. In this method, the main focus is held on the properties of these esterified oil by standard method and developed an experimental setup with all the necessary equipments or devices to study the objective at above specified crank angle degrees. The main motto of this work is to obtain a superior or equivalent brake thermal efficiency with less specific fuel consumption and lower emissions over pure diesel.

B. Fuel Properties

TABLE I
COMPARISON OF FUEL PROPERTIES

Property	**B25**	**D100**
Flash point ^{0}C	77	52
Fire point ^{0}C	82	65
Kinematic viscosity Cst at 40^{0}C	4.78	2.87
Density gm/cm^3	0.863	0.848
Calorific value MJ/kg	39.72	42.34
pH value	6.11	6.87

C. Experimental setup

The experiment was conducted on a three cylinder, four stroke, naturally aspirated, water cooled, direct injection, compression ignition engine loaded with eddy current dynamo-meter having a compression ratio of 17.5 with a hemispherical combustion chamber of three hole injection and orifice size of 0.3mm under speed of 2000rpm. The injection timing was changed by changing the number of shims under the fuel injection pump. Injection timing was checked by manual spill method. The flywheel of the engine was attached with a circular protractor to read the crank angle position at the time of spill. It was observed that the injection timing alters by 1^0 by adding or removing a shim of 0.2mm thickness. It was observed that if the injection timing advanced or retarded beyond 1^0, the engine was unable to start. Therefore, fuel injection timings of 24^0 BTDC, 23^0 BTDC, 22^0 BTDC and 21^0 BTDC were selected in order to investigate the effect of variation of fuel injection timing. The engine is loaded by supplying current to the dynamo-meter. The engine is started by manual cranking.

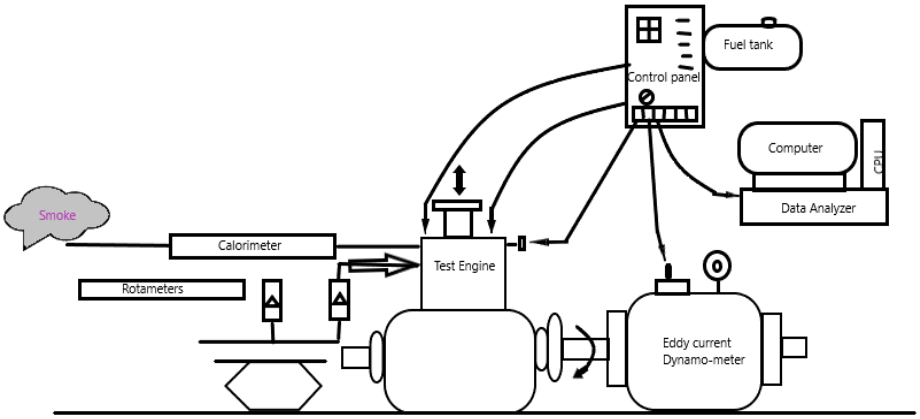

Fig.1 Model Engine Test Rig

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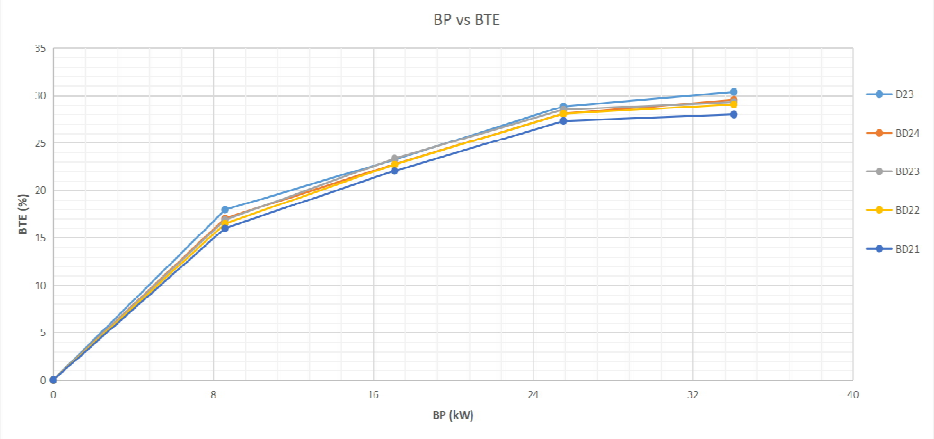
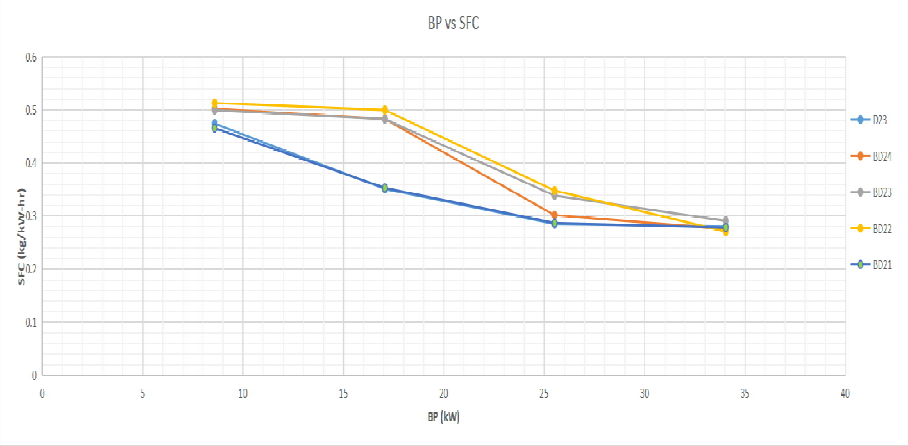
III. RESULTS & DISCUSSION

The performance of an engine describes how efficient it is. The performance always depends on the maximum utilization of input to get the desired output. i.e, the optimum utilization of fuel gives the maximum efficiency which is the best performance of the engine. Following are the performance and emission parameters that are obtained during this work.

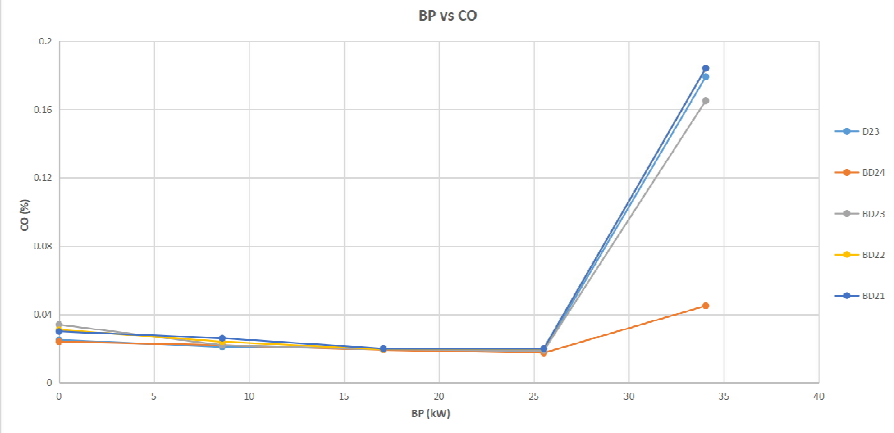
A. Graph between Brake power and Brake thermal efficiency



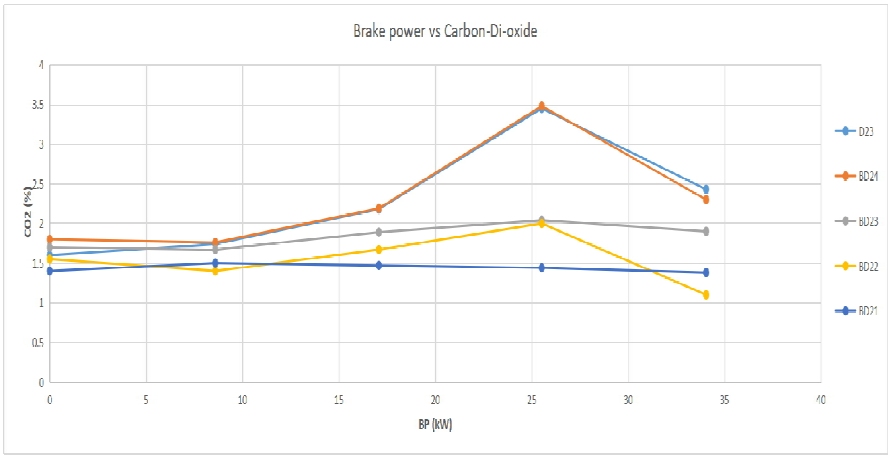
B. Graph between Brake power and Specific fuel consumption



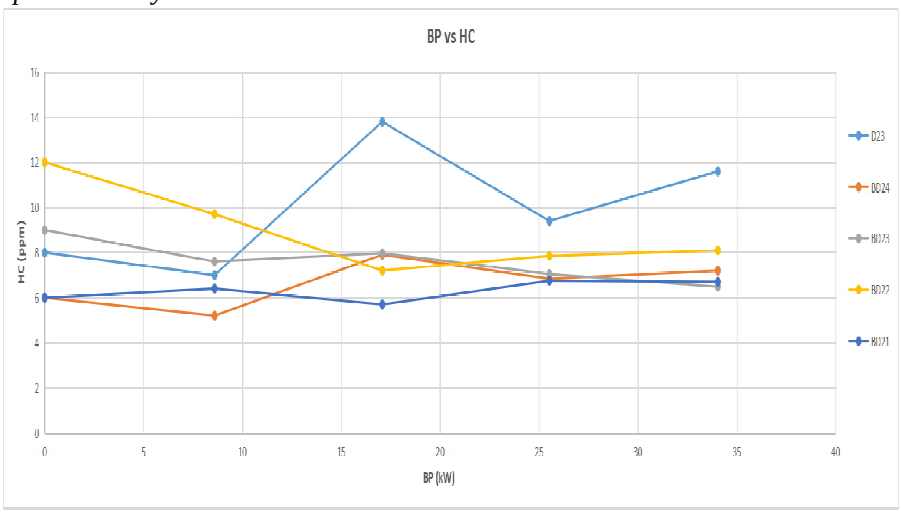
C. Graph between Brake power and Carbon monoxide



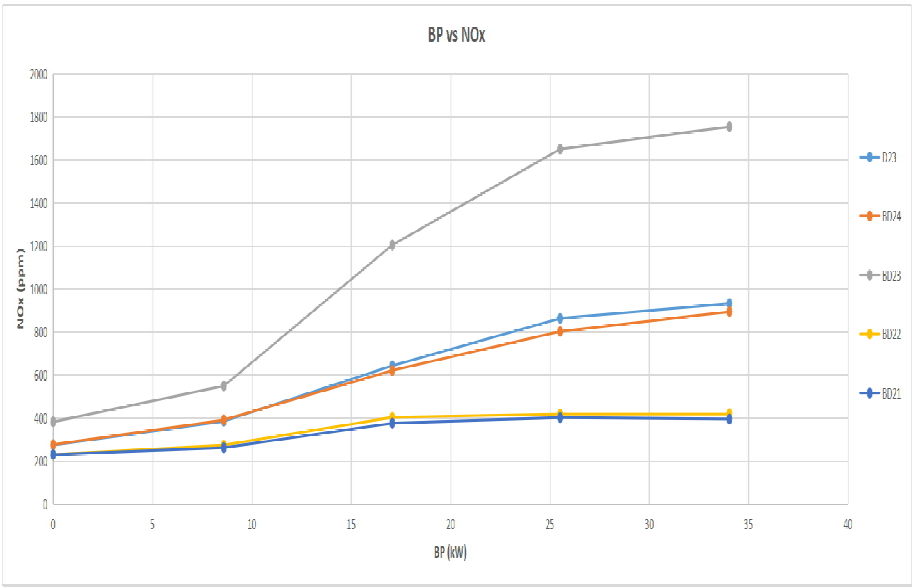
D. Graph between Brake power and Carbon-Di-oxide



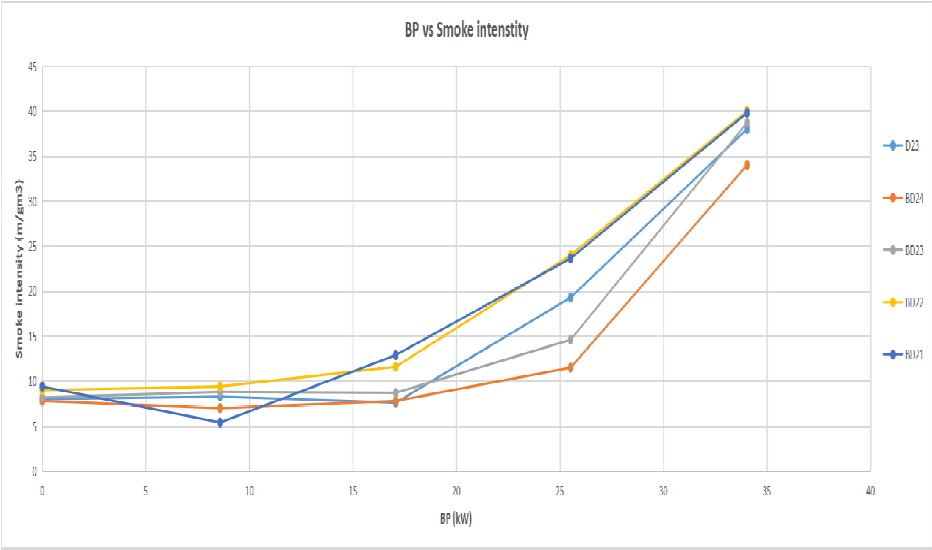
E. Graph between Brake power and Hydro carbons



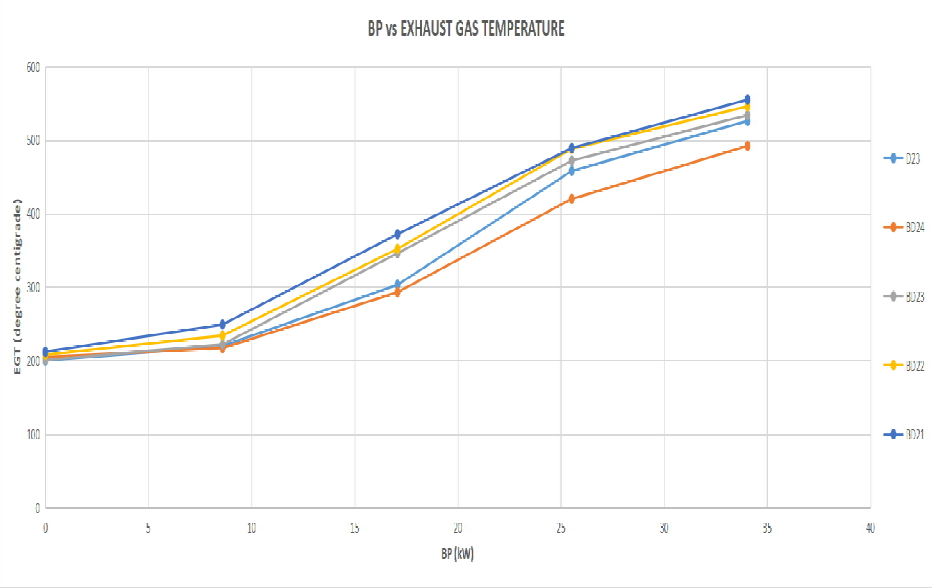
F. Graph between Brake power and Nitrogen oxides



G. Graph between Brake power and Smoke intensity



H. Graph between Brake power and Exhaust gas temperature



IV. CONCLUSIONS

In this experimental analysis, It was found that the use of bio diesel as a fuel at low temperatures may lead to some problems. But, in safety point of view using bio diesel is very much safe as it has high viscosity and high fire point. It is also bio-degradable and non toxic in nature. In the experiment it was found that the brake thermal efficiency of bio diesel at 24^0 BTDC has nearer equal characteristics to that of diesel at 23^0 BTDC. For standard diesel at 23^0 BTDC an efficiency of 30.37% was obtained where as for bio diesel at 24^0 BTDC it was 29.54%. At low loads, the CO emissions obtained are acceptable for all types of crank angle degrees. However,at full load there is a decrease in CO emission for advanced injection timing. At low loads and after attaining half load, the fuel consumption of the engine is almost similar for both the fuel samples. Comparing the CO_2 emissions, it was observed that both pure diesel at 23^0 BTDC and bio diesel at 24^0 BTDC are having almost same level. Though the retarded injection timings of other crank angle degrees shows a little CO_2 emissions, it has no much impact as the emitted CO_2 can be taken by plants. At three quarter load the HC emissions have no particular impact. The emissions of nitrogen oxide were slightly lowered by the use of bio diesel, but it can further be lowered by varying the injection timing. But, this creates the other emissions to increase and therefore, not preferred. The smoke intensity reduced by 10.52%. The exhaust gas temperature was reduced by 6.463% at 24^0 BTDC.

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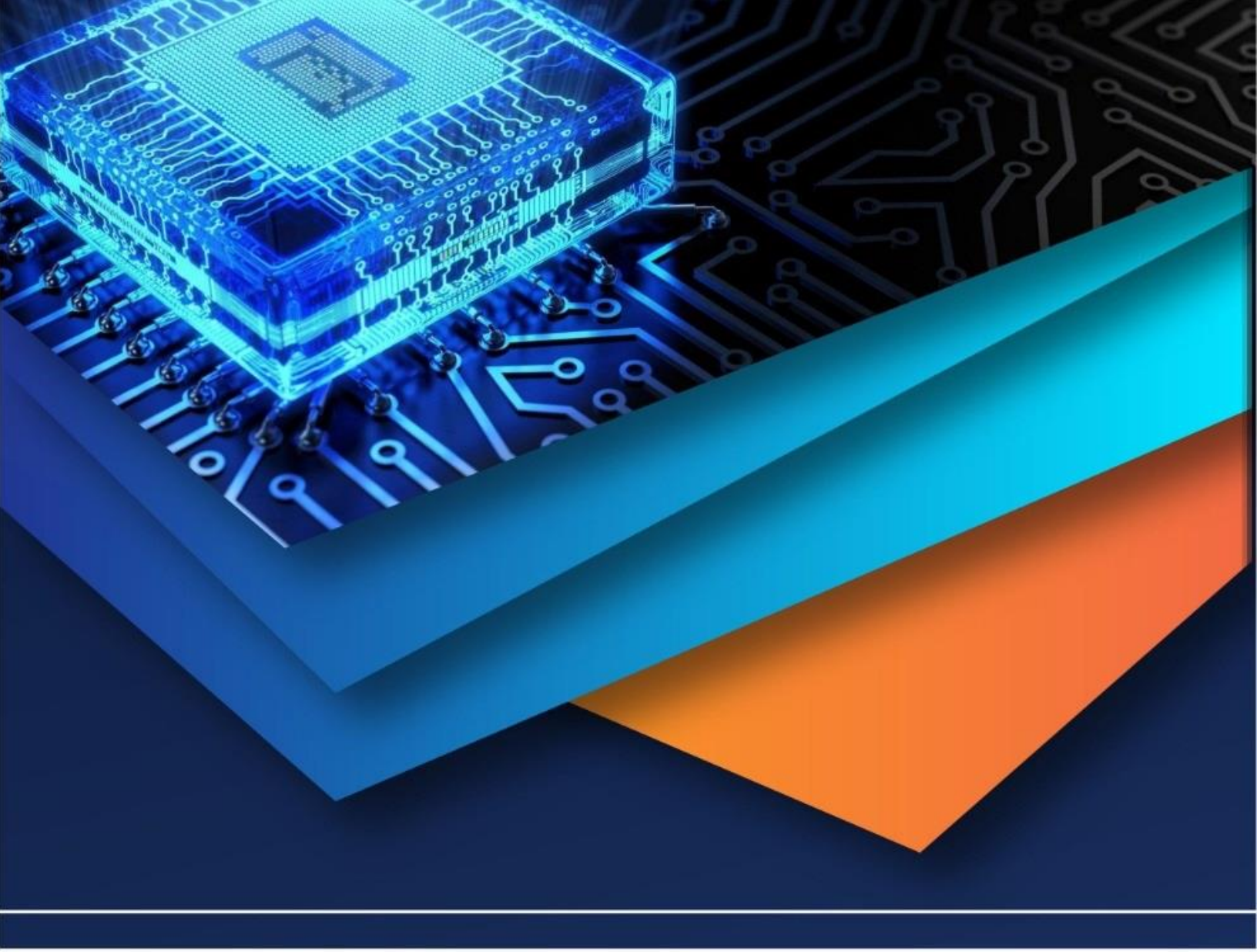

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