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Experimental Analysis of Fish-Oil Bio Diesel with Methanol as Additive

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Abstract: ***Availability of pure air is everyone's right, not only of the human beings but all animals living on the globe. The main source which pollutes the air is exhaust emissions from diesel engines. Also the extensive use of fossil fuels results in its depletion and increase of greenhouse gases and global warming. Bio-diesel is an alternative diesel fuel that is produced from vegetable oils and animal fats. The present work deals with the oil extraction from the waste fish oil which are abundantly available in coastal areas. The extraction of oil is done using steam distillation process and the oil was separated from water and other impurities using separating funnel. The performance and emission tests on a single cylinder four stroke diesel engine were conducted with bio diesel blends of B5, B10, B5 M3 and B5 M6 at different loads. The most suitable condition was found to be B5 M6 which gave higher efficiency and brake power than other blends. The BSFC of the blend B5 and B10 are closer to diesel.***
Keywords: ***Bio-diesel, methyl, methyl ester, Tranesterification, Diesel engine, Fish oil, CRDI, NOx.***

I. INTRODUCTION

Considering India as developing country, there are many improvement has been done on many field, such as transportation, technology, medical, commerce field etc. The major issue with the transportation is consumption of energy which is increasing day by day. Now a day's many engines are run by petroleum product. Petroleum is a finite source and causes general environmental problems such as rising carbon dioxide levels in the atmosphere. About 90% of petroleum produced is used as energy source for transportation, heat and electricity generation. Emission from burning petroleum derived fuels affected adversely both the environment and human health. To cope with this issue, almost every country in the world released emission legislation from this reason bio diesel came into action. Bio-diesel as an alternative fuel of diesel is described as fatty acid methyl or ethyl esters from vegetable oil or animal fat. It is renewable, biodegradable, non-toxic, eco-friendly and reduces the greenhouse gas emission. Also from many researches it is found out that bio-diesel can reduce CO and UHC emission. Biodiesel is obtained from the transesterification of vegetable oils and from animal fats. Variety of biodiesel applications have been used in transportation because of the low toxicity, its eco-friendly characteristics and almost no effect on the engine performance. Furthermore, in comparison with pure diesel, biodiesel can significantly reduce hydrocarbons (HC), carbon monoxide (CO) and particulate matter (PM) emissions and slightly adds to NOx emissions.

Mangalore is famous for exporting seafood. In which, the fish production with 1.2 million tons per year are exported. During fish processing, a large amount of fish was discarded, about 75% of the total fish weight. These by-products are usually not or very little processed, they are discarded. Therefore they become the source of environmental pollution. Consequently, the reuse of these by-products is really meaningful, which has enormous economic and environmental benefits. For that reason, the consideration of by-products as a source of raw materials for biodiesel production has attracted a great deal of researchers. This increases the value of fish and promotes the use of clean fuels. There is a growing interest in the use of bio-diesel fuels since bio-diesel offers several fuel advantages over petroleum diesel, including improved lubrication, a higher flash point, lower toxicity, biodegradability, and no net contribution to the greenhouse effect as it is made from renewable resources.

II. LITERATURE SURVEY

Rana Prathap Reddy et al, [1] had conducted analysis on Performance and emission characteristics of a Kirloskar HA394 diesel engine operated on fish oil methyl esters. Combustion tests for methyl ester of fish oil and its blends with diesel fuel were performed in a kirloskar H394 DI diesel engine, to evaluate fish biodiesel as an alternative fuel for diesel engine, at constant speed of 1500 rpm under variable load conditions.

Mostafa Mirsalim et al, [2] investigated a research on Effects of waste fish oil bio diesel on diesel engine combustion characteristics and emission. In this study, the combustion characteristics, performance and exhaust emissions of conventional diesel fuel and biodiesel produced from waste fish oil (WFO) and its blends (B25, B50, B75) were compared experimentally. A single cylinder E6 Ricardo engine was used to perform the tests under steady state conditions and engine load range.

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Rasim Behcet et al, [3] worked to determine the Performance and emission study of waste anchovy fish bio-diesel in a diesel engine. Waste anchovy fish oils transesterification was studied with the purpose of achieving the conditions for biodiesel usage in a single cylinder, direct injection compression ignition. With this purpose, the pure biodiesel produced from anchovy fish oil, biodiesel–diesel fuel blends of 25%:75% biodiesel–diesel (B25), 50%:50% biodiesel–diesel (B50), 75%:25% biodiesel–diesel (B75) and petroleum diesel fuels were used in the engine to specify how the engine performance and exhaust emission parameters changed. The fuel properties of test fuels were.

D. K. Ramesha et al, [4] studied on Performance, Combustion and Emission Characteristics of Compression Ignition Engine Using Fish Oil Bio-diesel Blends. In this experimental study, A computerized 4-stroke, single cylinder, constant speed, direct injection diesel engine was operated on fish oil-biodiesel of different blends. Three different blends of 10, 20, and 30 % by volume were used for this study. The data was recorded with the help of engine analysis software

Murari Mohon Roya et al, [5] tested an experiment on Performance and emissions of a diesel engine fuelled by bio-diesel–diesel, bio-diesel–diesel-additive and kerosene–bio-diesel blends. Biodiesel is produced from canola oil and the effect of a new biodiesel additive, Wintron XC 30 (2 vol. %), is examined for engine performance and emissions. Systematic tests are undertaken over different blends, such as 0, 5, 10, 20, 50 and 100 volume percent of biodiesel in biodiesel–diesel and biodiesel–diesel-additive blends, and 0, 5, 10, 20, 50 and 100 volume percent of kerosene in kerosene–biodiesel blends.

III.PRODUCTION OF BIO DIESEL BY TRANSESTRIFICATION

Potassium hydroxide (0.9775 g) was dissolved in a beaker containing 17.4 grams methanol and agitated continuously in a magnetic stirrer (made of REMI 1MLH) till the potassium hydroxide dissolves completely and forms potassium methoxide, a strong caustic. The above formed potassium methoxide was mixed with 87.5 ml of the fish oil under agitation for 1 hour. Then the mixture was transferred to a separating funnel. The content were allowed to settle down and the two distinct layers, top layer being bio-diesel and bottom layer that of glycerol were separated. After separating the glycerol, methyl ester was washed twice with 1:1 volume of water for 1 hour to remove excess methanol.

IV. RESULTS AND DISCUSSION

The extracted fish oil biodiesel blended with methanol as an additive, was tested on Common Rail Direct Injection Engine. The performance and emission tests on a single cylinder four stroke diesel engine were conducted with bio diesel blends of B5, B10, B15, B5 M3 and B5 M6 at different loads, where B is blend percentage of fish biodiesel and M is the percentage Methanol additive

TABLE 1: TEST RESULTS OF CRDI ENGINE WITH DIESEL

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	17.64	0.48	20143.77
6.00Kg	26.99	0.36	13339.28

TABLE 2: TEST RESULTS OF CRDI ENGINE WITH B5 BLEND

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	16.27	0.52	22133.33
6.00Kg	23.70	0.36	15192.29

TABLE 3: TEST RESULTS OF CRDI ENGINE WITH B10 BLEND

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	13.34	0.64	26981.38
6.00Kg	19.55	0.44	18412.44

TABLE -4: TEST RESULTS OF CRDI ENGINE WITH B15 BLEND

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	11.82	0.73	30462.46
6.00Kg	15.85	0.54	22710.52

TABLE -5: TEST RESULTS OF CRDI ENGINE WITH B5 M3

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	16.80	0.56	23133.33
6.00Kg	24.35	0.40	16192.29

TABLE -6: TEST RESULTS OF CRDI ENGINE WITH B5 M6

Load	BTE	BSFC	BSEC
0.00Kg	0.00	0.00	0.00
3.00Kg	17.03	0.58	24533.33
6.00Kg	25.02	0.41	17292.29

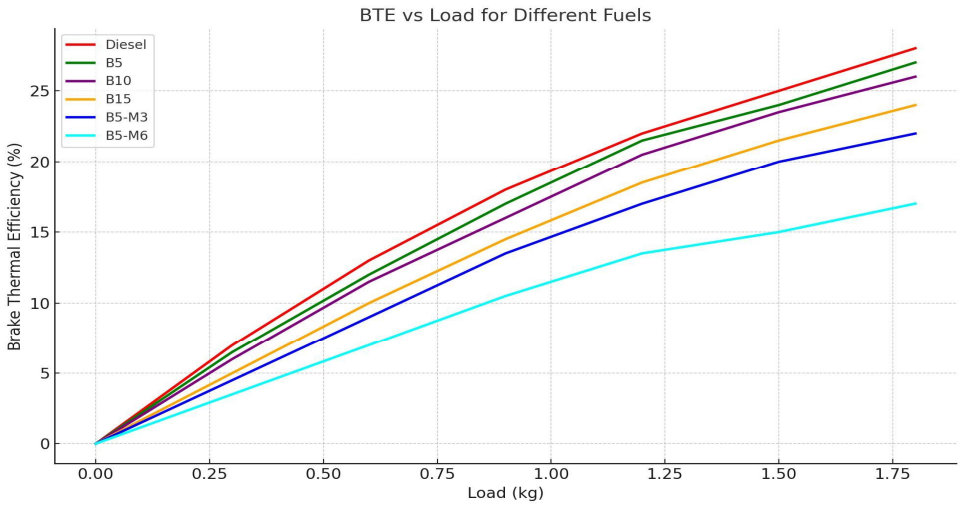


Figure 1. Comparison of brake thermal efficiency vs. Load for different fuels

Figure 1 shows the Brake Thermal Efficiency increases gradually with load. Low air-fuel mixing, higher viscosity and lower calorific value of biodiesel, at lower engine loads cause lower BTE in higher concentration of biodiesel compared to diesel due to its lower calorific value, high viscosity and low air-fuel mixing which could be the reason for its lower thermal efficiency. At higher engine loads, BTE of all the tested fuels shows a similar trend. On maximum brake power, Brake Thermal Efficiency of B05 is high when compared to other fish biodiesel blends. This is very close to diesel and attributed to the presence of more oxygen in the fuel, which improves combustion efficiency. The high temperature of the air at high engine loads also causes better evaporation and mixing of biodiesel.

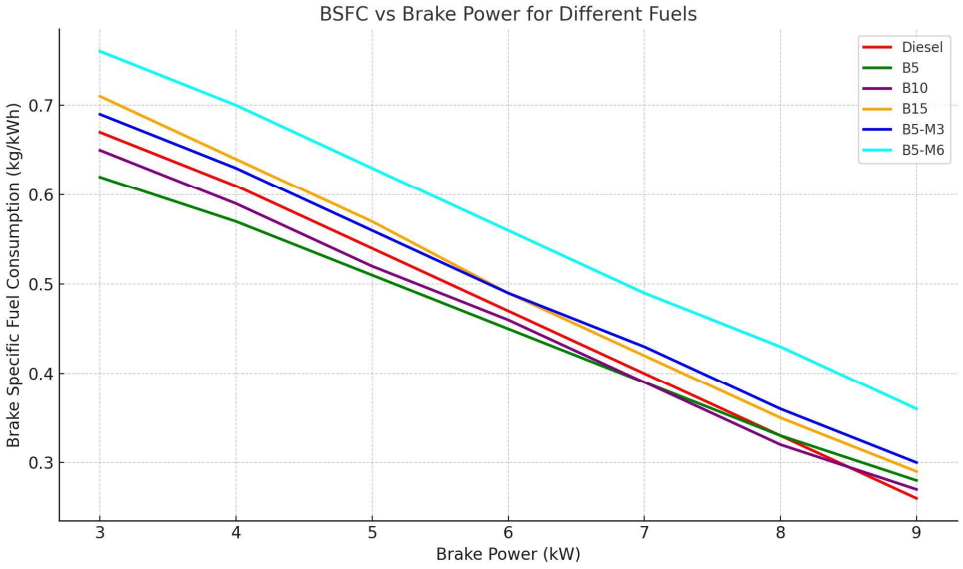


Figure 2: Comparison of brake specific fuel consumption vs. BP for different fuels

Figure 2 shows the variation of Brake Specific Fuel Consumption (BSFC) with Brake Power (BP) for different fuels. BSFC decreases as BP increases for all fuel types, indicating better fuel efficiency at higher loads. Among the fuels, Diesel consistently shows the lowest BSFC, making it the most efficient. B5 and B10 blends perform better than B15, while B5-M3 and especially B5-M6 show higher BSFC values, indicating reduced efficiency. This suggests that higher biodiesel content or certain modifications may negatively affect combustion efficiency. Overall, blending biodiesel up to a certain limit can be effective without significantly compromising fuel economy.

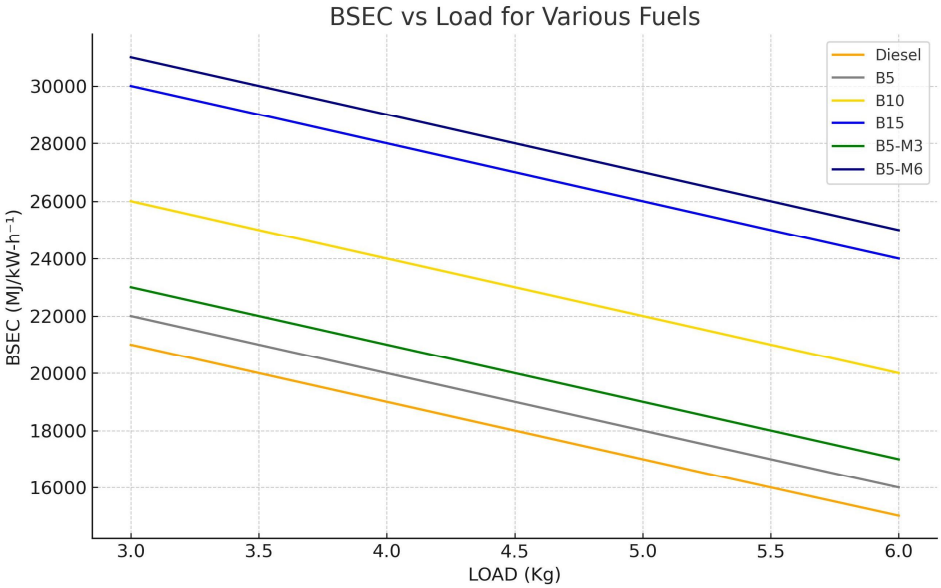


Figure 3. Comparison of brake specific energy consumption vs. BP for different fuel.

Figure 3. Shows the variation of Brake Specific Energy Consumption (BSEC) with load for different fuel blends. As load increases from 3 kg to 6 kg, BSEC decreases for all fuels, indicating improved combustion efficiency at higher loads. Diesel exhibits the lowest BSEC, suggesting superior energy conversion due to its high calorific value. Among blends, B5 and B5-M3 show better performance compared to B10, B15, and B5-M6. The higher BSEC in B15 and B5-M6 could be due to poor atomization and lower volatility of higher biodiesel and methanol concentrations, leading to incomplete combustion. Thus, moderate blending improves efficiency, while excessive blending hampers it.

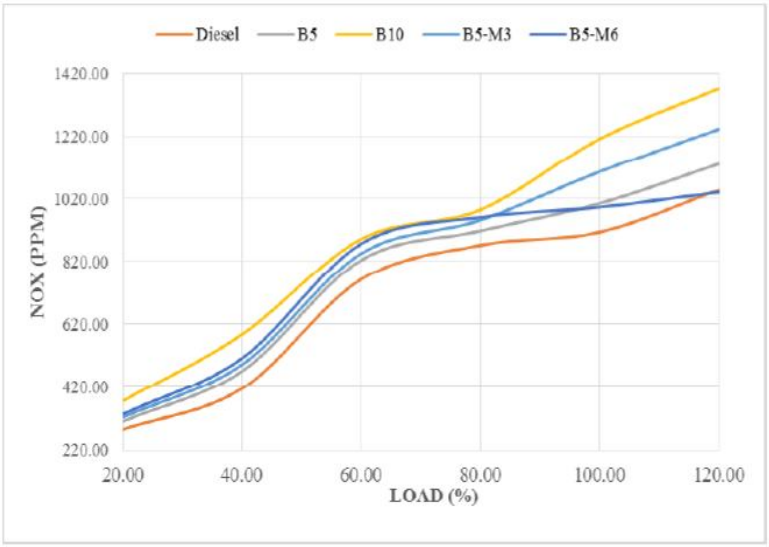


Figure 4. Variation of NOx emission with load

The NOx emissions increase with increasing engine load for all fuel types, indicating higher combustion temperatures at higher loads. Among the fuels, B10 and B5-M6 show the highest NOx levels, especially above 80% load, due to greater oxygen availability promoting higher combustion temperatures. Diesel emits the lowest NOx across most loads, likely due to its lower oxygen content compared to biodiesel blends. B5 and B5-M3 exhibit moderate NOx emissions, suggesting a balance between efficient combustion and controlled temperature rise. Therefore, while biodiesel improves combustion, excessive blending can lead to higher NOx emissions due to increased thermal intensity.

V. CONCLUSIONS

Bio diesel has become alternative fuel recently because of its environmental benefits and the fact that is made from renewable resources. The remaining challenges are its cost and limited availability of oil resources. Present utilization of fish waste as a feed stock reduces the cost of bio diesel. The base catalysed trans-esterification reaction for biodiesel production is often the method selected owing to its lower cost of production and simple processing conditions yielding higher conversion of oil to bio diesel. Biodiesel fuel also has its own advantages and disadvantages. The biggest advantage of bio diesel is that it can play significance role in reducing the harmful hydro carbon emissions. However there are still some drawbacks of biodiesel which may become a hindrance in the introduction of biodiesel as an alternative to the harmful carbon emitting fossil fuels. Biggest advantage of bio diesel fuel is that it is nontoxic and biodegradable, which makes it one of the most environment friendly alternatives of power generation.

The biodiesel energy content is affected by which oil it is produced out of. The results indicated that the different Fatty Acid Methyl Ester in each biodiesel does affect the energy output. There are many different types of fatty acids in them. The performance test is conducted on 4 stroke diesel engine using bio diesel and compared to diesel there was a good brake thermal efficiency and also the emission is less when compared biodiesel to fossil fuels. Compared to diesel, the smoke and ash content is less. The fish oil shown good combustion efficiency. BSFC for blends B5 and B10 were close to diesel.

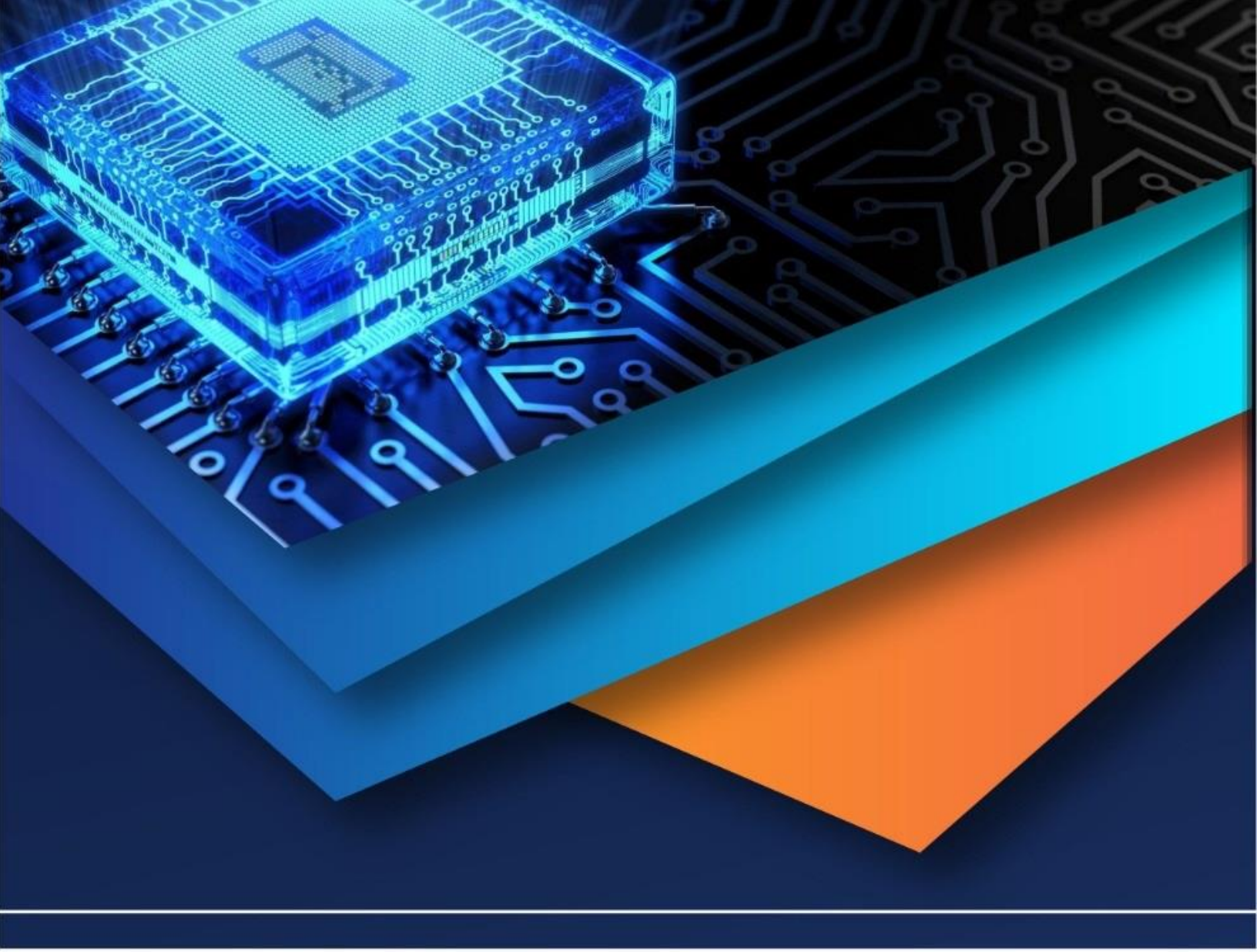
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