iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.44431

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Experimental Analysis of Power Generation from waste heat in Automobiles Vehicles

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Abstract: ***The increasingly worldwide problem regarding rapid economy development and a relative shortage of energy, the internal combustion engine exhaust waste heat and environmental pollution has been more emphasized heavily recently. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work; the remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy rise and serious environmental pollution, so it is required to utilized waste heat into useful work. In recent years, global warming and the limitations in use of energy resources increase environmental issues of emissions. Also In industry, most of the expenses are due to energy (both electrical and thermal), labour and materials. But out of them energy would relate to the manageability of the cost or potential cost savings and thus energy management will help in cost reduction.***
Keywords: Waste heat, waste heat Recovery, TEGs, Temperature Measurement, Voltage Measurement, Electricity etc.

I. INTRODUCTION

Recent trend about the best ways of using the deployable sources of energy in to useful work in order to reduce the rate of consumption of fossil fuel as well as pollution. Out of all the available sources, the internal combustion engines are the major consumer of fossil fuel around the globe. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work. The remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy rise and serious environmental pollution, so it is required to utilized waste heat into useful work.
The Internal Combustion Engine has been a primary power source for automobiles and automotive over the past century. Presently, high fuel costs and concerns about foreign oil dependence have resulted in increasingly complex engine designs to decrease fuel consumption. In this project we are generating electrical power as non-conventional method by heat energy non-conventional energy systems very essential at this time to our nation. Non-conventional energy using is converting mechanical energy into the electrical energy. Here in this project a mechanical arrangement is made. Use of embedded technology makes this system efficient and reliable. Micro controller (AT89S52) allows dynamic and faster control. Liquid crystal display (LCD) makes the system user-friendly. AT89S52 micro controller is the heart of the circuit as it controls all the functions.

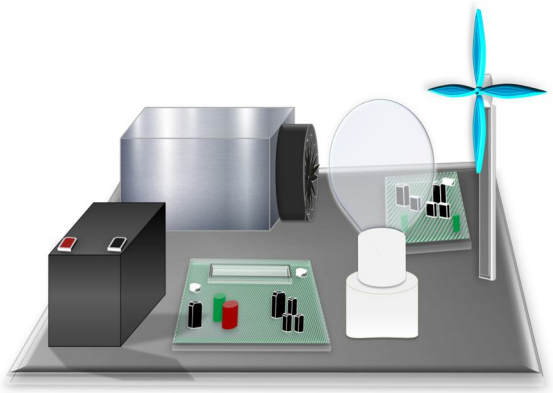
II. PROBLEM DEFINITION

Energy Intensive industries require high temperatures to process their product. There is often still heat 'energy' left as a byproduct of processing that is frequently simply wasted, vented through smokestacks, and into the air. In same manner lots of heat is extracted engine from automobiles vehicles which will be crated pollution. In such platform this type technique is useful to control the pollution, also wastage heat to be utilized in the form of power. The possibilities of thermoelectric systems' contribution to "green" technologies, specifically for waste heat recovery from industry exhausting flue gases. Vast quantities of waste heat are discharged into the earth's environment much of it at temperatures which are too low to recover using conventional electrical power generators. The proposed structure is a distributed multi-section and multi-stage network. The target is to tackle problems facing the traditional single-stage system and to advance TEG application in automotive settings.

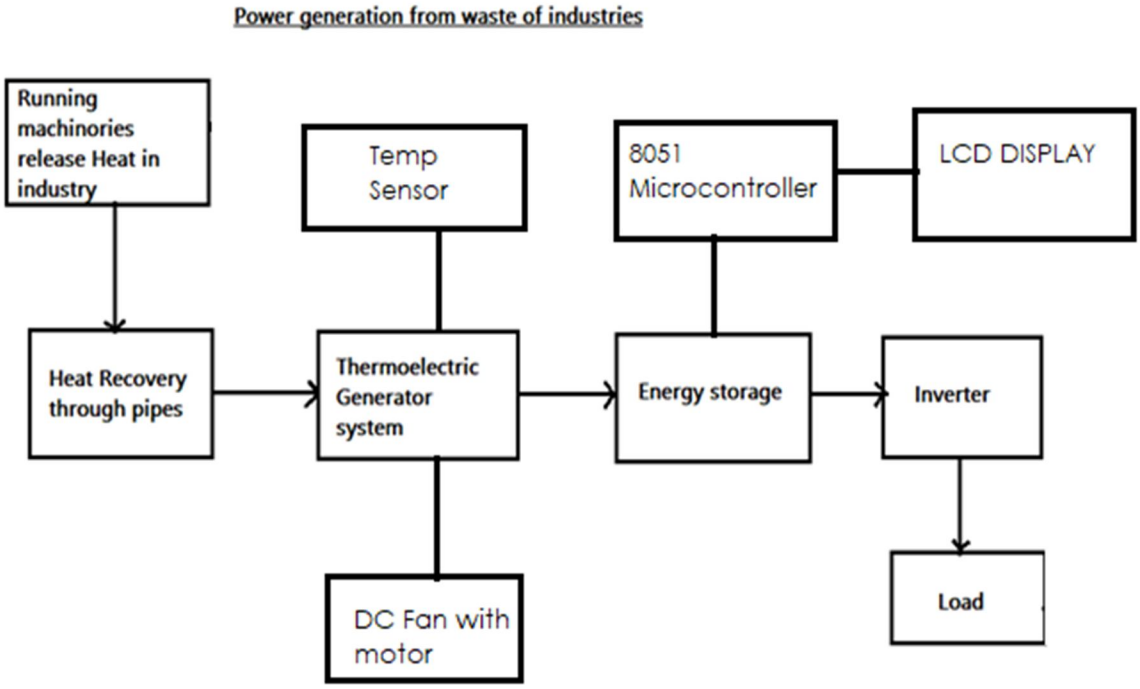
III. OBJECTIVES

1) To study the available literature and research on TEG application and its performance
2) To find out the suitable working of Heat to electricity through TEG Module and solar and collect the literature on the studies
3) To develop the experimental setup for the investigation
4) To conduct testing and sample run
5) To conduct final experimentation and compile
6) To analyze the Result.

IV. CAD MODEL OF SYSTEM



V. WORKING FLOW DIAGRAM



VI. WORKING

In this project we are generating electrical power as non-conventional method by heat energy. Non-conventional energy systems very essential at this time to our nation. Non-conventional energy using is converting mechanical energy into the electrical energy. Here in this project a mechanical arrangement is made. Use of embedded technology makes this system efficient and reliable.

In this project the conversion of the Heat energy in to electrical energy. By using the one heat source at input (e.g. heat blower (work as engine of vehicle) exerts the waste heat continually.

This waste heat is collected at transfer towards thermoelectric generator system. This thermoelectric generator system consists of thermoelectric generator module with aluminum heat sink and exhaust fan. When heat is applied this thermoelectric generator converts heat into electric energy.

This electric energy produce it drive the dc motor with blade. When temperature of heat regulates the speed of dc motor is also regulates. At input end one temperature senor is also placed to measure the temperature.

This electric energy is also stored into battery. After which it connected to inverter module. It converts DC voltage to AC voltage. And output connected to AC load which operate on power which is produce form whole operation.

In this way we are using TEP Transducer. Transducer is a device which converts one form of energy in to another form of energy. This includes electrical, mechanical, light and heat energy also. While the term transducer commonly implies the use of sensors/detector any device which converts energy considered as Transducer.

Following steps have been follow:

1) Non-conventional energy using is converting mechanical energy into the electrical energy. Here in this project a power generation arrangement is made. Use of thermoelectric principle makes this system efficient and reliable.

2) In any vehicles continuously run for their production. It releases large amount of heat.

3) This is wastage heat. We utilized this wastage heat to produce electricity. In this way we can minimize some amount air pollution also.

4) When we apply TEG with Heat sink module to wastage heat through heat pipe executed from machine. Then at the same time TEG starts converting Heat energy into Electrical energy. We can measure this heat with the help of temperature sensor attached to the system.

5) One DC fan is attached to system to indicates the flow and conversion of heat energy into Electrical energy. As the amount of temperature is increases, the flow of fan is also increases.

6) Generated electrical energy is stored in battery. This stored energy is supply to inverter to convert DC to AC.

7) At the output AC load is obtain. This AC load is utilized to run various loads in same industry like, fan, AC, light etc.

8) We also attached 8051 microcontrollers (AT89S52) with LCD display to measure the amount of voltage stored and remaining in battery.

9) In this way, whole system work. Start from wastage of heat dissipated in silencer of vehicles through running process. Then conversion of heat into electricity. Indication of conversion electricity through DC fan and motor. Storage of electricity in battery. Conversion of DC voltage to AC voltage with help of inverter. Microcontroller attached to show the voltage present at battery. And last AC load attached to inverter.

10) If such system utilized in automobiles, the amount of wastage heat we can utilize it. And also minimized air pollution problem cussing through vehicles

11) *Working Principle of TEG:*TEG consists of one hot side and one cold side. The hot side with higher temperature, will drive electrons in the n-type leg toward the cold side with lower temperature, which cross the metallic interconnect, and pass into the p-type leg, thus developing a current through the circuit as sown in Fig.14. Holes in the p-type leg will then follow in the direction of the current. The current can then be used to power a load [6].

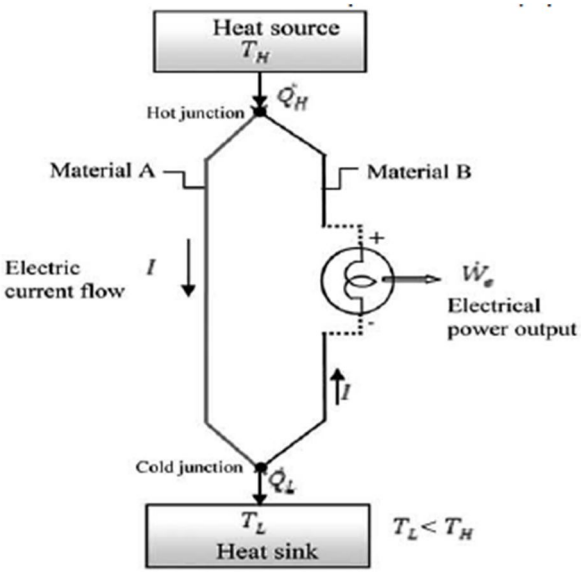


Fig. Principle of thermoelectric generator

If temperature difference is kept constant, then the diffusion of charge carriers will form a constant heat current, hence a constant electrical current. If the rate of diffusion carriers were equal, there would be no net change in charge within the TE leg.

VII. COMPONENTS SPECIFICATION

1) Components
2) Thermoelectric plate
3) Exhaust fan with Aluminum heat sink
4) Silencer
5) Heat source (Engine considered device)
6) DC motor with fan
7) Battery
8) Inverter module
9) Temperature sensor
10) Controller board (8051 controller)
11) LCD display (16*2)
12) wiring
13) switches
14) LED bulb
15) Metallic Frame
16) connector circuit board
17) Adapter
18) Other material

A. *Lead Acid Battery*

Fig. Battery

Lead-acid batteries are the most common in PV systems because their initial cost is lower and because they are readily available nearly everywhere in the world. There are many different sizes and designs of lead-acid batteries, but the most important designation is that they are deep cycle batteries. Lead-acid batteries are available in both wet-cell (requires maintenance) and sealed no-maintenance versions.

AGM and Gel-cell deep-cycle batteries are also popular because they are maintenance free and they last a lot longer.

Lead acid batteries are reliable and cost effective with an exceptionally long life. The Lead acid batteries have high reliability because of their ability to withstand overcharge, over discharge vibration and shock. The use of special sealing techniques ensures that our batteries are leak proof and non-spillable. Other critical features include the ability to withstand relatively deeper discharge, faster recovery and more chances of survival if subjected to overcharge. The batteries have exceptional charge acceptance, large electrolyte volume and low self-discharge, which make them ideal as zero- maintenance batteries.

Lead acid batteries are manufactured/ tested using CAD (Computer Aided Design). These batteries are used in Inverter & UPS Systems and have the proven ability to perform under extreme conditions.

The batteries have electrolyte volume, use PE Separators and are sealed in sturdy containers, which give them excellent protection against leakage and corrosion.

B. Exhaust Fan With Aluminum Heat Sink

Fig. Exhaust fan with Aluminum heat sink

The geometry of the heat-sink chosen also greatly affects the performance of the fan. A rotary fan slapped on top of your typical linear finned heat-sink will actually be quite inefficient. In fact the region directly under the cans normally where the thing you are trying to cool is located. Further, unless the fins are quite deep the airflow is badly distributed in general. Too shallow, and the resultant back-pressure can actually "stall" the fan. In those circumstances, installing the fan in the "suck" direction can actually improve the situation since the air will enter the sides of the heat-sink more linearly to fill the void in air pressure created by the fan. It is used to maintain or cool down the temperature of thermoelectric.

C. DC Motor

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

It is used to rotate the fan which is powered by thermoelectric module.

Fig. DC Motor

D. Aero Dynamic Wind Blade

Fig. Wind Turbine

It is used for rotation with dc motor, it indicates the power generation from TEG.
Wind turbine blades are shaped to generate the maximum power from the wind at the minimum cost.
Primarily the design is driven by the aerodynamic requirements, but economics mean that the blade shape is a compromise to keep the cost of construction reasonable. In particular, the blade tends to be thicker than the aerodynamic optimum close to the root, where the stresses due to bending are greatest. The blade design process starts with a "best guess" compromise between aerodynamic and structural efficiency.

E. Inverter Module

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control carts.Solid-state inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.
There are two main types of inverters. The output of a modified sine wave inverter is similar to a square wave output except that the output goes to zero volts for a time before switching positive or negative. It is simple and low cost and is compatible with most electronic devices, except for sensitive or specialized equipment, for example certain laser printers. A pure sine wave inverter produces a nearly perfect sine wave output (<3% total harmonic distortion) that is essentially the same as utility-supplied grid power. Thus, it is compatible with all AC electronic devices. This is the type used in grid-tie inverters. Its design is more complex, and costs 5 or 10 times more per unit power. The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters were made to work in reverse, and thus were "inverted", to convert DC to AC.
It is used convert DC to AC, DC voltage received from battery and convert into AC. which is further used to start AC load.

Fig. Inverter module

F. Temperature Sensor

The most commonly measured physical parameter is temperature whether in process industry applications or in laboratory settings. Exact measurements are critical part of success.

A temperature sensor is a device, usually an RTD (resistance temperature detector) or a thermocouple, that collects the data about temperature from a particular source and converts the data into understandable form for a device or an observer. Temperature sensors are used in many applications like HV and AC system environmental controls, food processing units, medical devices, chemical handling and automotive under the hood monitoring and controlling systems, etc.

The most common type of temperature sensor is a thermometer, which is used to measure temperature of solids, liquids and gases. It is also a common type of temperature sensor mostly used for non-scientific purposes because it is not so accurate.

Fig. Tmeprature sensor module

VIII. RESULTS AND DISCUSSION

`Benefits of 'waste heat recovery' can be broadly classified in two categories

1) *Direct Benefits:* Recovery of waste heat has a direct effect on the combustion process efficiency. This is reflected by reduction in the utility consumption and process cost.
2) *Indirect Benefits*

a) *Reduction In Pollution:* A number of toxic combustible wastes such as carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM) etc, releasing to atmosphere. Recovering of heat reduces the environmental pollution levels.
b) *Reduction In Equipment Sizes:* Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gas produced. This results in reduction in equipment sizes.
c) *Reduction In Auxiliary Energy Consumption:* Reduction in equipment sizes gives additional benefits in the form of reduction in auxiliary energy consumption.

In industrial machineries significant amount of heat is released to the environment. For example, As much as 35% of the thermal energy generated from combustion in an machine for production is lost to the environment through exhaust gas and other losses. The amount of such loss, recoverable at least partly or greatly depends on the machine load. Among various advanced concepts, Exhaust Energy Recovery for Internal machine has been proved to not just bring measurable advantages for improving energy consumption but also increase machine power output (power density) or downsizing, further reducing CO2 and other harmful exhaust emissions correspondingly. This was predicted that if 6% of the heat contained in the exhaust gases were converted to electric power, 10% reduction of fuel consumption can be achieved.

IX. ADVANTAGES

1) Clean, Noise less, Cost is less.
2) This is a non-conventional system, no fuel is required
3) Easy maintenance, portable, charging time is less (maximum temp)
4) Promising technology for solving power crisis to an affordable extent.
5) Simple in construction, Pollution free, Reduces transmission losses.
6) Wide areas of application# Required less space
7) It can be use at any time when it necessary.
8) Less number of parts required.
9) we can charge any electronic devices
10) Electricity can used for many purposes
11) Efficient and eliminate the grid searching.

X. DISADVANTAGES

Improper variation of temperature gradient difference may damage the TEG, Complex design.

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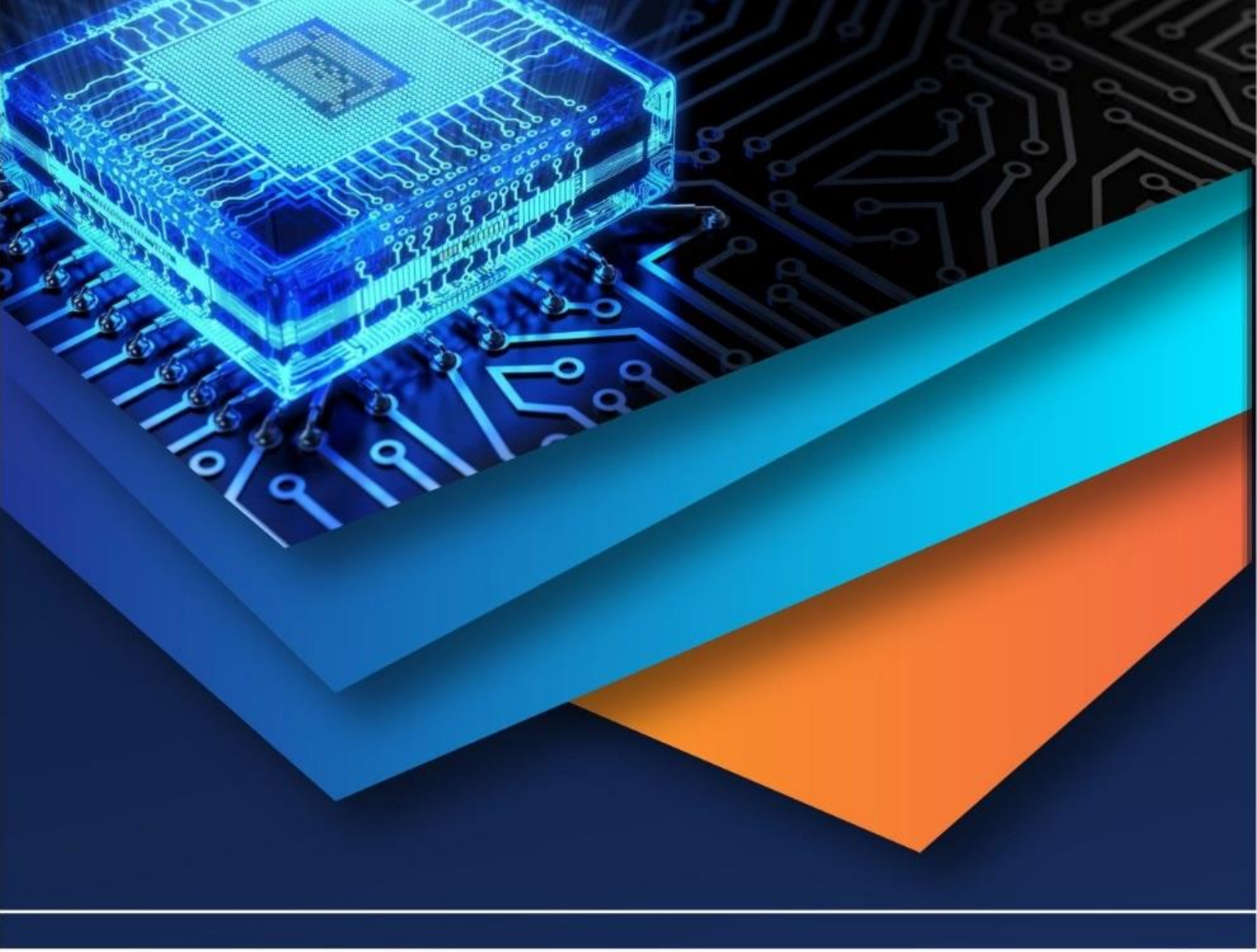

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