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Generation of Biogas energy and its uses

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Abstract— This paper deals with generation of biogas and its uses as a alternate source of energy . The primary elements of biogas are methane (CH_4) and carbon dioxide (CO_2) and may have small amount of hydrogen sulphide (H_2S). biogas is a product of the natural decomposition of organic substance of animal or plant .biogas refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. The gas is useful as a fuel substitute for firewood, dung, agricultural residues, petrol and electricity. Biogas, a clean and renewable form of energy could very well substitute (especially in the rural sector) for conventional sources of energy (fossil fuels, oil, etc.) which are causing ecological– environmental problems biogas digester involves anaerobic fermentation process in which different groups of bacteria act upon complex organic materials in the absence of air to produce biogas.
Keywords-Biogas ,Methane,alternate,Waste, Digester,Energy

I. INTRODUCTION

Biogas is a mixture of methane (CH_4), 50 to 70% carbon dioxide (CO_2), 30 to 40% hydrogen (H_2); 5 to 10% nitrogen (N_2) and 1 to 2% hydrogen sulphide (H_2S) .Water vapor (0.3%) air is 20% heavier than biogas .and the ignition temperature of biogas is in the range of 650^0C to 750°C. Biogas is a colorless and odorless gas that burns with 60% efficiency in a conventional biogas stove.

This paper using different types of waste as feedstock in a small-scale bioreactor to produce methane gas which is used for cooking and heating. With the help of this paper we can make a household reactor and biogas plant that instead utilizes human and different types of waste. When organic material (including animal waste, and human feces, plants) is digested in plant digester in the absence of oxygen a gas is released is called biogas.Biogas is conventional source of energy

A. BIOWASTE

Waste includes all items that people no longer have any use , which they either intend to get rid of or have already discarded. Additionally, wastes are such items these are require to discard, for example by lay it has hazardous properties. Many items can be considered as waste e.g., sewage sludge, household rubbish, Liquid wastes from manufacturing items and packaging items, old televisions, discarded cars, garden waste, old paint ,containers, plastic materials etc. Thus all our daily activities can give rise to a large variety of different wastes arising from different sources.Biological waste are arising from human or animal activities

Biowaste consists of livestock manures, the biodegradable part of municipal solid wastes including food and treated sewage, garden wastes, sludge, organic industrial wastes such as paper and textiles.

B. Different forms of biowaste :

1) Municipal solid waste
2) Agricultural waste
3) Industrial waste
4) Household waste
5) Hazardous waste
6) Hospital waste
7) Kitchen waste

C. Source of Biogas

The main source for production of biogas are night soil, agricultural residues, poultry or piggery dropping, animals manure, cattle dung, wood waste from forestry and industry, Residues from food and paper industries, sewage sludge, municipal green wastes dedicated energy crops such as short rotation (3 to 15 years) grasses, sugar crops, starch crops (corn, wheat) and oil crops ,kitchen waste, household waste, green waste, human waste.

Biomass is organic matter derived from plants, algae; animal etc the energy obtained from biomass is called biomass energy.

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II. BIOMASS CONVERSION PROCESS

Direct Combustion
Thermo Chemical Conversion
Biochemical Conversion
Direct Combustion
The process of burning in the presence of oxygen to produce heat and by products is called combustion & complete combustion to ashes is called is incineration. The process of combustion is equally applicable to solid, liquid and gaseous fuel, such as wood dung, vegetable waste can be dried and burnt to provide heat or can be converted into low calorific value gas by "pyrolysis".

A. Pyrolysis Process

In the pyrolysis process organic material is converted to gases solid and liquids by heating to 500^0C to 900^0C. In the absence of oxygen the products of wood pyrolysis are methanol, charcoal and acidic acid all forms of organic materials including such as rubber and plastic can be converted to a fuel gas which contains CO , CH_4, other hydrocarbons (C_nH_m) CO_2 and N_2.

B. Thermo chemical conversion

Thermo chemical conversion process converts the biomass and its residues to fuels , chemical and power using gasification and Pyrolysis technologies .

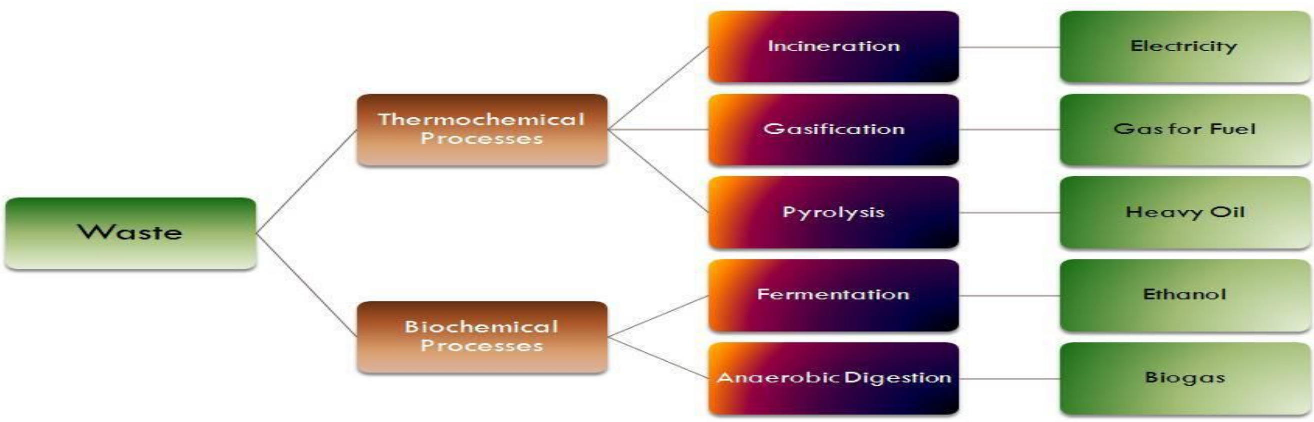

Fig 2.1 : Thermo chemical conversion

Biochemical conversion by micro-organisms converts biomass to biofuels is a slow process that takes place at low temperature. The principal conversion process is fermentation.
The fermentation is the process of decomposition of organic matter by micro-organism. e.g- decomposition of sugar to form ethanol and carbon-dioxide by yeast & ethanol forming acetic acid in making vinegar.

C. Gasification

The heating of biomass requires about one-third of the oxygen for complete combustion produces a mixture of carbon dioxide and hydrogen known as syngas.
In pyralysis heating biomass in the absence of oxygen produces liquid pyrolysis oil both syngas and pyrolysis oil can be used as fuel. Both can be chemically converted to other valuable fuels and chemicals.
" Gobar Gas" is called so because cow dung has been the material for its production. It is not only the excreta of the cattle, but also the piggery waste as well as poultry droppings are being very effectively used for biogas generation. Other material through which biogas can be generated are algae, crop residues (agro-wastes), garbage, kitchen wastes, paper wastes, sea wood, human waste, waste from sugarcane refinery, water hyacinth etc, apart from the above mentioned animal wastes. Any cellulosic organic material

of animal or plant origin which is easily biodegradable is a potential raw material for biogas.

Biogas is mainly produced by digestion, pyrolysis or hydrogasification. Digestion is a biological process that occurs in the absence of oxygen and in the presence of anaerobic organisms at ambient pressures and temperatures of 35-70^{0}C. The container in which this digestion takes place is known as the digester.

D. Anaerobic Digestion.

Biogas technology is concerned with microorganisms. These are living creatures and are microscopic in size and are invisible to naked eyes. There are different types of microorganisms. They are called bacteria, fungi, virus etc. Bacterias are classified into two types' beneficial bacteria and harmful bacteria. Bacteria can be divided into two major groups which is based on their oxygen requirement. Those which grow in the presence of oxygen are called aerobic while the others grow in absence of gaseous oxygen are called anaerobic. When the fermentation(i.e process of chemical change in organic matter brought about by living organisms) of organic matter undergoes through anaerobic digestion, gas is generated. This gas is known as bio-gas. Biogas is generated through fermentation or bio-digestion of various wastes by a variety of anaerobic and facultative-organisms. bacteria are capable of growing both in presence and absence of air or oxygen. Table 3.3.4 shows the biogas conversion process.

III. ADVANTAGES OF BIOGAS

Biogas are generated from anaerobic digestion processes. It is a clean and environmentally friendly renewable fuel. But it is important to clean, or upgrade, biogas before using it to increase its heating value and to make it useful in some gas appliances such as engines and boilers.

A. Renewable Source of Energy

Biogas is considered to be a renewable source of energy. It is produced from materials that form sewage and waste products, the only time it will be depleted is when we stop producing any waste.

B. Non-Polluting

Biogas is also considered to be non-polluting in nature. The production of biogas does not require oxygen, which means that resources are conserved by not using any further fuel.

C. Reduces Landfills

Biogas also uses up waste material found in landfills, dump sites and even farms across the country, allowing for decreased soil and water pollution.

D. Cheaper Technology

Applications for biogas are increasing as the technology to utilize it gets better. It can be used to produce electricity and for the purpose of heating as well. Compressed Natural Gas (CNG) is biogas that has been compressed and can be used as a fuel for vehicles. Production can be carried out through many small plants or one large plant.

E. Large number of Jobs

Work opportunities are created for thousands of people in these plants. In fact, biogas can easily be decentralized, making it easier to access by those living in remote areas or facing frequent power outages.

F. Little Capital Investment

Biogas plants are easy to set up and require little capital investment on a small scale basis. Many farms can become self sufficient by utilizing biogas plants and the waste material produced by their livestock each day. A single cow can provide enough waste material within a day to power a light bulb the entire day.

G. Reduces Greenhouse Effect

It also reduces the greenhouse effect by utilizing the gases being produced in landfills as forms of energy. This is a major reason why the use of biogas has started catching on. It recycles most forms of biodegradable waste and works on simple forms of technology.

IV. THE THREE STEPS OF BIOGAS PRODUCTION

The three-stage anaerobic fermentation of biomass from: Production and Utilization of Biogas in Rural Areas of Industrialized and Developing Countries.

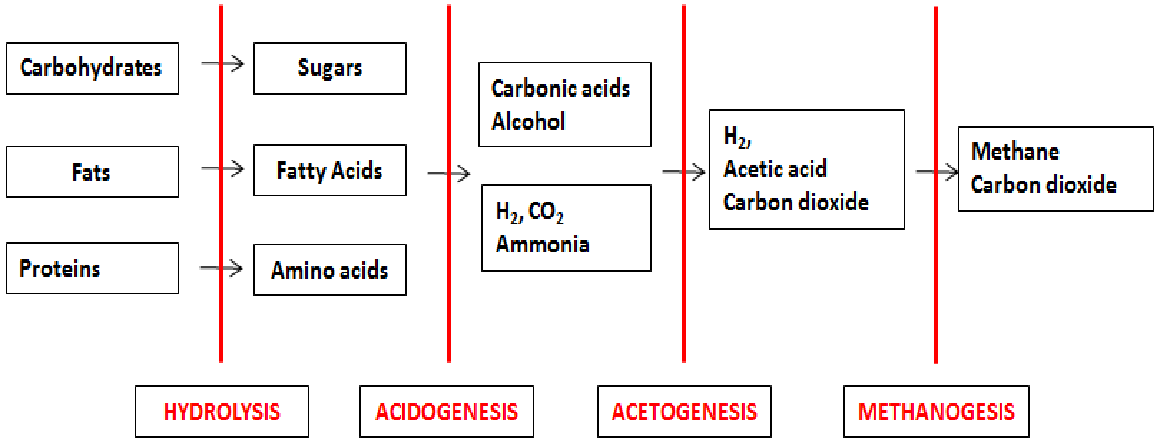

Fig.3.7 : three-stage anaerobic fermentation

A. Hydrolysis.

In the first step (hydrolisis), the organic matter is enzymolyzed externally by extracellular enzymes (cellulase, amylase, protease and lipase) of microorganisms. Bacteria decomposes the long chains of the complex carbohydrates, proteins and lipids into shorter parts. For example, polysaccharides are converted into monosaccharides. Proteins are split into peptides and amino acids.

B. Acidification

Acid-producing bacteria, involved in the second step, convert the intermediates of fermenting bacteria into acetic acid (CH_3COOH), hydrogen (H_2) and carbon dioxide (CO_2). These bacteria are anaerobic and can grow under acid conditions. To produce acetic acid, they need oxygen and carbon. They use the oxygen solved in the solution or bounded-oxygen.

The acid-producing bacteria create an anaerobic condition which is must for the methane producing microorganisms. they reduce the compounds with a low molecular weight into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane, as bacteria alone are not capable of sustaining such type of reaction. Acid-producing bacteria, involved in the second step, convert the intermediates of fermenting bacteria into acetic acid (CH_3COOH), hydrogen (H_2) and carbon dioxide (CO_2). The three-stage anaerobic fermentation of biomass is shown by fig 3.7.

To produce acetic acid, we need oxygen and carbon. For this, we use the oxygen solved in the solution or bound oxygen. The acid producing bacteria create an anaerobic condition which is essential for the methane producing microorganisms. Moreover, we reduce the compounds with a low molecular weight into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane.

C. Methane formation

Methane-producing bacteria, involved in the third step, decompose compounds with a low molecular weight. For example, they utilize hydrogen, carbon dioxide and acetic acid to form methane and carbon dioxide. Under natural conditions, methane producing microorganisms occur to the extent that if anaerobic conditions are provided.

They are anaerobic and very sensitive to environmental changes. In contrast to the acidogenic and acetogenic bacteria, the methanogenic bacteria belong to the archaebacter genus, i.e. to a group of bacteria with a very heterogeneous morphology and a number of common biochemical and molecular-biological properties that distinguish them from all other bacterial general. The main difference is in the makeup of the bacteria's cell walls.

D. Symbiosis of bacteria

Methane and acid producing bacteria act in a symbiotical way. Acid producing bacteria create an atmosphere with ideal parameters

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for methane producing bacteria (anaerobic conditions, compounds with a low molecular weight). Also methane producing microorganisms use the intermediates of the acid producing bacteria. Without consuming them, toxic conditions for the acid-producing microorganisms would develop. In practical fermentation processes the metabolic actions of various bacteria all act in synchronism . A single bacteria is not able to produce fermentation products alone.

V. PARAMETERS AND PROCESS OPTIMIZATION

The metabolic activity involved in microbiological methanation is dependent on the following factors:

A. Substrate temperature
B. Available nutrients
C. Retention time (flow-through time)
D. pH level
E. Nitrogen inhibition and C/N ratio
F. Substrat solid content and agitation
G. Inhibitory factors

Each of the various types of bacteria responsible for the three stages of the methanogenesis is affected differently by the above parameters. Since interactive effects between the various determining factors exist, no precise quantitative data on gas production as a function of the

above factors are available. Thus, by discussion of the above stated various factors is limited to their qualitative effects on the process of fermentation.

VI. TYPES OF BIOGAS PLANTS

The three main types of simple biogas plants are shown in Figure 4:
More information about the different types of biogas plants is provided under digester types.

Balloon plants

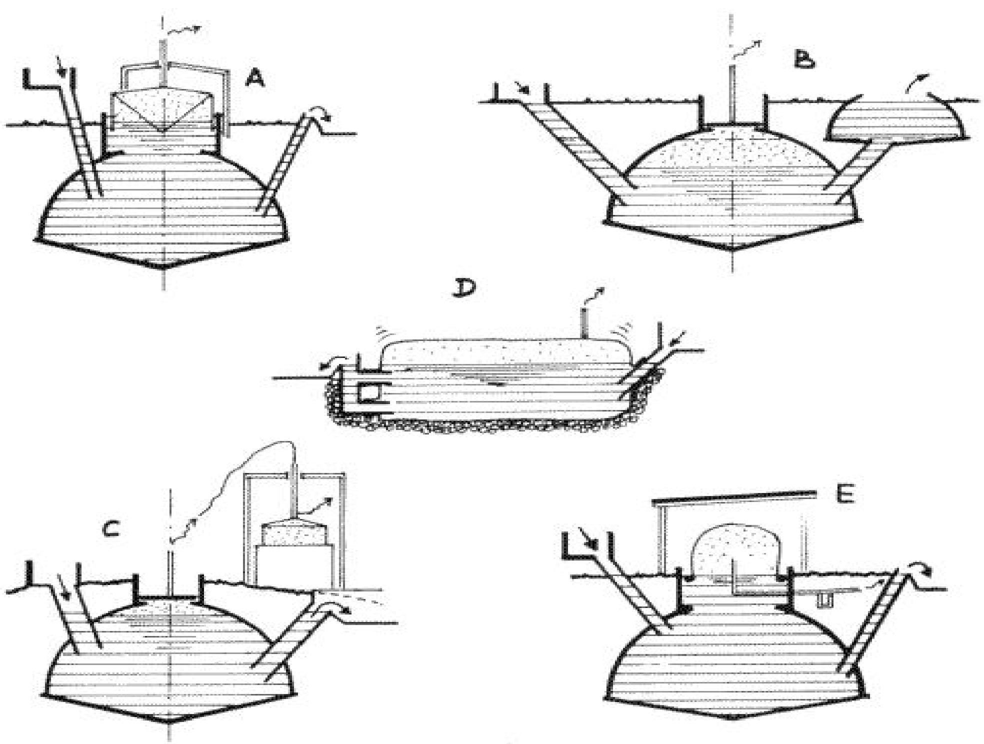

Figure 6.1:Simple biogas plants. Floating-drum plant (A), fixed-dome plant (B), fixed-dome plant with separate gas holder (C), balloon plant (D), channel-type digester with plastic sheeting and sunshade (E).

A. Balloon plants

The balloon plant consists of a digester bag (e.g. PVC) in the upper part of which the gas is stored. The inlet and outlet are attached directly to the plastic skin of the balloon. The gas pressure is achieved through the elasticity of the balloon and by added weights placed on the balloon.

1) *Advantages:* These are low cost, ease of transportation, low construction sophistication, high digester temperatures, uncomplicated cleaning, emptying and maintenance.
2) *Disadvantages:* Can be the relatively short life span, high susceptibility to damage, and little creation of local employment and, therefore, limited self-help potential. A variation of the balloon plant is the **channel-type digester**, which is usually covered with plastic sheeting and a sunshade Balloon plants can be recommended wherever the balloon skin is not likely to be damaged and where the temperature is even and high.

B. Fixed-dome plants

The fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester. When gas production starts, the slurry is displaced into the compensation tank. Gas pressure increases with the volume of gas stored and the height difference between the slurry level in the digester and the slurry level in the compensation tank.

1) *Advantages:* are the relatively low construction costs, the absence of moving parts and rusting steel parts. If well constructed, fixed dome plants have a long life span. The underground construction saves space and protects the digester from temperature changes.The construction provides opportunities for skilled local employment.
2) *Disadvantages:* are mainly the frequent problems with the gas-tightness of the brickwork gas holder (a small crack in the upper brickwork can cause heavy losses of biogas). Fixed-dome plants are, therefore, recommended only where construction can be supervised by experienced biogas technicians. The gas pressure fluctuates substantially depending on the volume of the stored gas. Even though the underground construction buffers temperature extremes, digester temperatures are generally low.

C. Floating-drum plants

Floating-drum plants consist of an underground digester and a moving gas-holder. The gasholder floats either directly on the fermentation slurry or in a water jacket of its own. The gas is collected in the gas drum, which rises or moves down, according to the amount of gas stored. The gas drum is prevented from tilting by a guiding frame. If the drum floats in a water jacket, it cannot get stuck, even in substrate with high solid content.

1) *Advantages:* are the simple, easily understood operation - the volume of stored gas is directly visible. The gas pressure is constant, determined by the weight of the gas holder. The construction is relatively easy, construction mistakes do not lead to major problems in operation and gas yield.
2) *Disadvantages:* are high material costs of the steel drum, the susceptibility of steel parts to corrosion. Because of this, floating drum plants have a shorter life span than fixed-dome plants and regular maintenance costs for the painting of the drum.

VII. CONCLUSIONS

In this study, a method for generation of biogas is proposed. The proposed method has a relatively low construction costs, the absence of moving parts and rusting steel parts. If well constructed, fixed dome plants have a long life span. The underground construction saves space and protects the digester from temperature changes.

The biogas process provides opportunities for skilled local employment

In this study the proposed method will be beneficial for the people living in villages as they normally have cows and buffaloes and hence cow dung also.so with the help of simple method the villagers can generate electricity for the domestic applications as well as the fertilizer for the agriculture needs.

VIII. ACKNOWLEDGMENT

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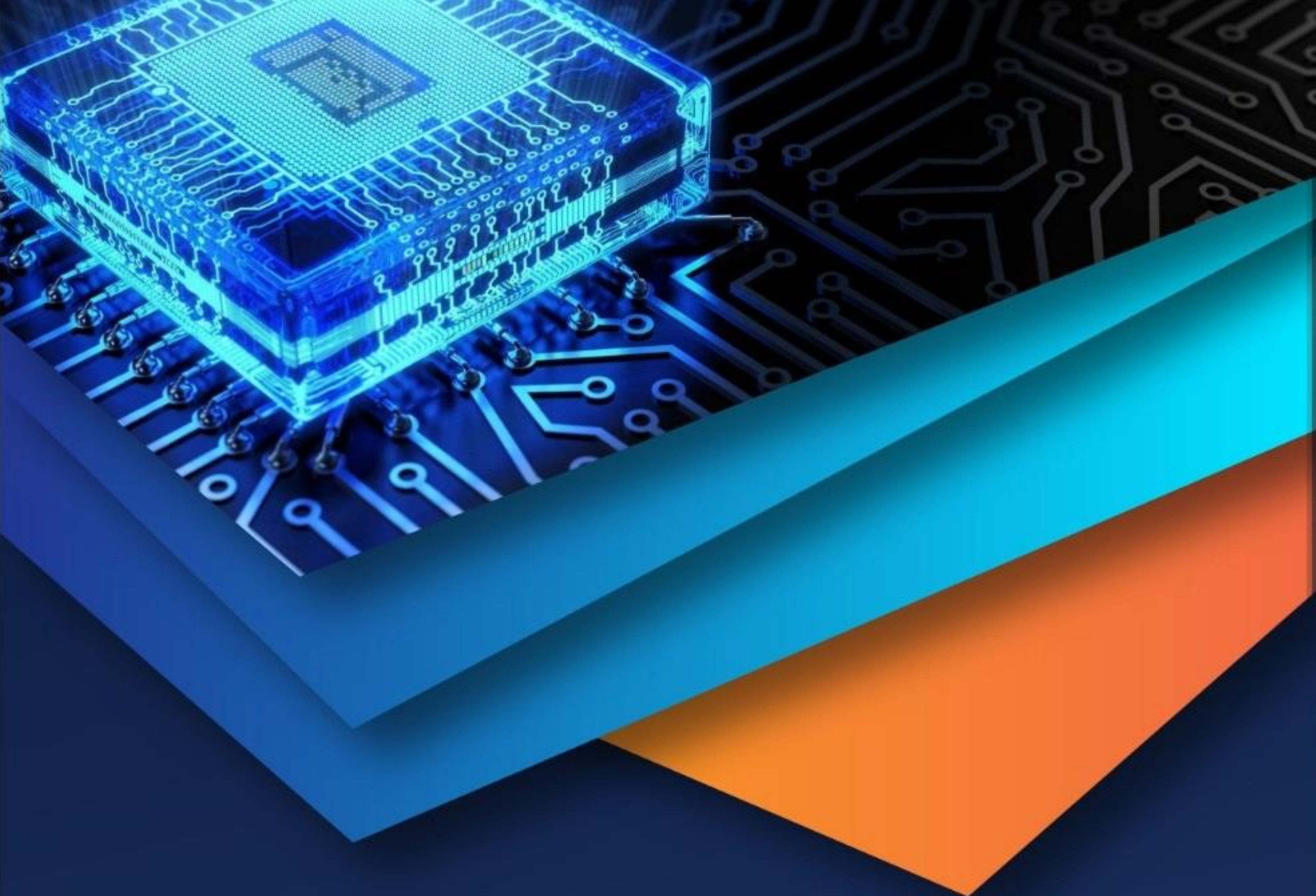

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