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CO2 CONVERTER AS A CLEAN AIR PRODUCER BASED ON IOT, HIGHVOLTAIC, AND PLASMA GASIFICATION WITH ENVIRONMENTALLY FRIENDLY RENEWABLE ENERGY RESOURCES

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ABSTRAK

CO_2 memiliki dampak positif bagi kehidupan manusia. Akan tetapi, kadar CO_2 yg berlebihan dapat menimbulkan dampak buruk bagi manusia dan lingkungan (global warming). Menurut WINCONSIN DEPARTMENT of HEALTH SERVICES, batas CO_2 yang sesuai untuk udara bersih adalah sekitar 350 – 400 parts per million (ppm). Jika lebih dari 400 ppm, udara sudah dianggap tercemar. Ada beberapa hal yang menyebabkan kadar CO_2 dapat melebihi batas yang sesuai, seperti asap pabrik, asap kendaraan, dan asap pembakaran. Salah satu cara untuk mengurangi emisi CO_2 pada lingkungan adalah dengan menggunakan alat pengubah CO_2 menjadi O_2. Penelitian ini bertujuan untuk menunjukan kemampuan alat dalam mendeteksi kadar CO_2 di udara dan mengubah CO_2 menjadi O_2 dengan menggunakan teknologi Hybrid yaitu highvoltaic, plasma gasification, dan IoT (Internet of Things). Metode yang digunakan dalam penelitian ini adalah dengan melakukan studi literatur untuk pengumpulan data. Berdasarkan penelitian yang dilakukan, CO_2 akan melalui proses pembakaran di dalam pipa yang dialiri lilitan induksi bertegangan tinggi (highvoltaic). Kemudian PCB positif dan negatif dalam rangkaian akan bertemu sehingga menghasilkan plasma yang akan menguraikan CO_2 menjadi C dan O_2 (plasma gasification), O_2 yang terurai akan dialirkan ke lingkungan. Alat ini nantinya akan melaksanakan proses pem-filter-ansecara otomatis berbasis IoT (Internet of Things) saat gas CO_2 di lingkungan sudah melebihi batas aman. Berdasarkan penelitian juga, alat ini akan membutuhkan daya listrik sebesar 12 Volt, yang mana daya ini akan berubah menjadi 10 kVolt ketika proses highvotaic berlangsung. Sumber daya alat ini adalah energi listrik yang dihasilkan oleh energi terbarukan (renewable energy) yang ramah lingkungan.

Keywords: Emisi CO_2, *Highvoltaic*, *Internet of Things*, Gasifikasi Plasma, Energi Terbarukan.

ABSTRACT

CO_2 has a positive impact on human life. However, excessive CO_2 levels can have negative impacts on humans and the environment (global warming). According to the WINCONSIN DEPARTMENT of HEALTH SERVICES, the appropriate CO2 limit for clean air is around 350 – 400 parts per million (ppm). If it is more than 400 ppm, the air is considered polluted. There are several things that cause CO_2 levels to exceed the appropriate limits, such as factory smoke, vehicle smoke and combustion smoke. One way to reduce CO_2 emissions in the environment is to use a tool to convert CO_2 to O_2. This research aims to show the tool's ability to detect CO_2 levels in the air and convert CO_2 into O_2 using Hybrid technology, namely highvoltaic, plasma gasification, and IoT (Internet of Things). The method used in this research is to conduct a literature study to collect data. Based on research conducted, CO_2 will go through a combustion process in a pipe that is powered by a high voltage induction coil. Then the positive and negative PCBs in the circuit will meet to produce plasma which will decompose CO_2 into C and O_2 (plasma gasification), the decomposed O_2 will flow into the environment. This tool will later carry out an automatic filtering process based on IoT (Internet of Things) when CO_2 gas in the environment exceeds safe limits. Based on research, this tool will require 12 Volts of electrical power, which will change to 10 kV when the highvotaic process takes place. The resource for this tool is electrical energy produced by environmentally friendly renewable energy.

Keywords: *CO_2 Emission, Highvoltaic, IoT (Internet of Things), Plasma Gasification, Renewable energy.*

1 INTRODUCTION

The problem of greenhouse gas emissions is no longer strange in Indonesia. Indonesia itself is included in the list of 10 countries that contribute the largest greenhouse gas emissions, which is around 2% of world emissions. Not only in Indonesia, this problem is also an issue that is quite a difficult challenge for many countries to overcome. A lot of research has been carried out to create tools to overcome this problem, but in the end the tools designed were not in accordance with the research results and the implementation in carrying out their duties to overcome greenhouse gas emissions also failed. This is where the role of each individual human being is needed to continue to process information, observe the situation, and continue to contribute to solving this problem.

The worsening condition of the earth is caused by two factors, namely natural factors and human factors. Water vapor is a natural factor beyond human control and other factors are caused by humans themselves. Excessive industrial activities without being accompanied by awareness to care for the environment also cause increasingly serious air pollution due to greenhouse gas emissions or what we usually know as pollution. The production of greenhouse gases can come from many things, such as motor vehicle exhaust gas, factory exhaust gas, burning waste and burning forests. Human actions that seem to hide behind the guise of 'industrial revolution' actually cause the issue of global warming. The issue of global warming itself emerged at the end of 1980 where greenhouse gases such as CO2 (Carbon dioxide), CH4 (Methane), CO (Carbonmonoxide), N2O, CCl4, NOx, and others caused climate change which had a bad impact on the earth, such as the melting of ice. at the poles and increasing sea water volume.

One of the largest contributors to greenhouse gas emissions is CO2, which is around 9 to 26 percent. It cannot be denied that many human needs require factories to process something and produce toxic exhaust gases such as CO2. The effect of this gas not only causes greenhouse gas effects, but also causes air pollution which has a negative impact on human health if its presence exceeds standard limits. The appropriate CO2 limit for clean air is around 350-400 ppm (parts per million). If it is more than 400 ppm, the air is considered polluted

Tools that can naturally convert CO2 gas into O2 are plants. Contribution of Working Group I to Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2013), states that plants can absorb around 30 percent of total carbon dioxide emissions. However, in today's modern conditions, especially in urban areas, a lot of land can no longer be used for crops. Most of the urban land is filled with buildings for human habitation. Therefore, to overcome the problem of CO2 gas, it is necessary to innovate a tool to convert CO2 gas into O2 which is equipped with a shape and dimensions that allow it to be applied in narrow areas such as urban areas.

Utilizing a CO2 to O2 converter will be an alternative solution to overcome the issue of global warming which has a negative impact on human life due to carbon dioxide (CO2) waste gas accumulating in the air. The working system of this tool has the ability to detect CO2 levels in the air and convert CO2 into O2 using Hybrid technology, namely highvoltaic, plasma gasification, and IoT (Internet of Things). CO2 will go through a combustion process in a pipe that is powered by a high voltage induction coil (highvoltaic), then the positive and negative PCBs in the circuit will meet to produce plasma which can decompose CO2 into C and O2 (Plasma gasification). The decomposed O2 will be released into the environment. This tool will later carry out an automatic filtering process based on IoT (Internet of Things) when CO2 gas in the environment exceeds the specified safe limit. This tool is also planned to use electrical energy sourced from renewable energy as its main electricity supplier. Apart from being safe for the environment and reducing emissions, renewable energy can also be used for a very long period of time, so that human life in the future can still be guaranteed. In this way, this tool carries out its task of converting CO2 into O2 and indirectly also supports the use of renewable energy, thus providing more benefits for the environment.

2 LITERATURE REVIEW

2.1 Highvoltaic

Voltage is electrical pressure, namely a potential force or difference in electric charge at two different places. Voltage (in Ohm's law it is written with the symbol E) is measured in volts (V). The presence of a potential or voltage difference can cause electric current to flow through a conductor that connects one point with a high potential (+) to another point with a low potential (-) (Sigit, 2012). Based on the electric potential difference, electric voltage is divided into 4 and one of them is high voltage.

The definition of highvoltaic itself is an

electric voltage with a voltage of 36 kV – 150 kV. So, the type of cable used for high voltage electricity must be capable of being used at electrical voltages above 36 kV – 150 kV. The highvoltaic process itself is a requirement and advantage for the plasma gasification process to take place. The results of high voltage measurements are obtained from the results of current and resistance calculations using the electric voltage formula. The formula is the electric voltage formula as follows:

V = I x R

Keterangan:

V : Tegangan/potensial listrik (V)
I : Arus listrik (A)
R : Hambatan listrik (Ω)

2.2 Plasma Gasification

Plasma gasification is an effective method for breaking down various organic and inorganic compounds into the basic elements of a compound, so that these elements can be reused and recycled. In this research, the plasma technology focused on undergoing the plasma gasification process is NTP (Non-Thermal Plasma) plasma technology. Plasma gasification occurs after CO2 undergoes a dissociation or ionization process due to the high voltage induction combustion process.

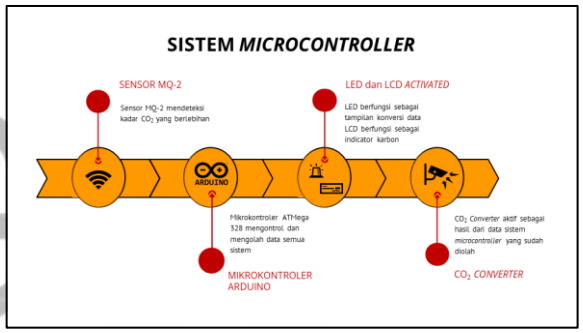
2.3 Non-Thermal Plasma (NTP) Technology

Plasma can be called the fourth phase element in nature after the solid phase, liquid phase and gas phase. In contrast to the normal gas phase, plasma contains gas where the components of the atomic nucleus (ions) and electrons have been separated due to the energy received and has reactive properties. Plasma can be formed by providing high energy into a gas medium which causes the gas to undergo a dissociation and/or ionization process (Toto, 2017).

According to Sirui (2021), plasma, especially NTP (Non-Thermal Plasma) technology, has been considered a promising method for CO2 conversion because plasma technology has several advantages, such as fast reaction, instant control, and most importantly environmentally friendly.

2.4 Microcontroller Mechanism

The MQ-2 sensor is a sensor that monitors air quality to detect gases in the air. This sensor reports the results of air quality detection in the form of changes in the analog resistance value at its output pin. This output pin can be connected to the ADC (analog-to-digital converter) pin on the Arduino microcontroller / analog input pin by adding just one resistor (Arduino Playground, 2015). In practice, this sensor is used in the use of a CO2 to O2 converter because this sensor can detect the presence of carbon dioxide gas (CO2) around our environment, especially in densely populated areas such as city centers, stations, terminals and other busy places that are often used by vehicles. motorbikes passing by. On the MQ-2 sensor module there are 2 indicator LEDs, namely a red indicator LED and a green indicator LED. In principle, if the air level is still in normal condition, the green indicator LED will continue to light, but if the air level has exceeded the predetermined CO2 level limit, the red indicator LED will light up and the MQ-2 sensor will send the data to the microcontroller so that it will be forwarded. back to LCD. It is on this LCD that data on CO2 levels that have exceeded the limit is displayed.



Picture 1 CO2 Converter Mechanism Flowchart

Microcontroller System Mechanism:

- The MQ-2 sensor functions to detect CO2 gas levels in the environment
- ATMega 328 microcontroller controls the system on all devices. Apart from that, the microcontroller also functions to process analog data from sensors into digital data to activate the LCD, LED and CO2 converter.
- The LCD functions as a data display resulting from the microcontroller's conversion from analog signals to digital signals
- LED functions as an indicator of gas levels displayed on the LCD. There are 2 types of LEDs in the design tool. The green LED is an indication that the gas level is still safe, while the red LED is an indication that the CO2 gas level has exceeded the specified limit.
- The relay functions as a connecting switch between the microcontroller and the CO2 converter.

2.5 Internet of Things (IoT)

IoT (Internet of Things) is a concept or idea that allows us to expand the benefits of continuously connected internet connectivity to connect machines, equipment and other physical objects with network sensors to obtain data and manage their own performance, thus allowing us to control the machine or tool wherever we are. In this era of increasingly advanced technology, there are many applications of IoT-based technology, such as smart home systems, which allow home owners to control the lighting and security of the home remotely according to the home owner's wishes. Basically, this IoT system consists of sensors as a data collection medium, an internet connection as a communication medium and a server as a collector of information received by the sensors for analysis. The initial idea of the Internet of Things was first raised by Kevin Ashton in 1999 in one of his presentations. Now many large companies are starting to explore the Internet of Things, such as Microsoft, Oracle, and many others.

2.6 Renewable Energy

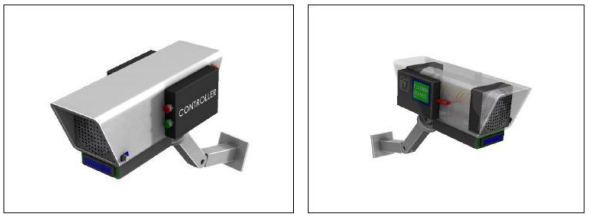
Renewable energy, as stated in Law No. 30 of 2007 concerning energy, is energy that comes from renewable sources, including geothermal heat, wind, bioenergy, sunlight, water flows and waterfalls, as well as movements and temperature differences in the sea layers. Renewable energy utilizes environmentally friendly energy sources that do not pollute the environment and do not contribute to climate change and global warming. This is because the energy obtained comes from sustainable natural processes, such as sunlight, wind, water, biofuel and geothermal.

In 2018, national use of new and renewable energy only reached 11.68%. Electrical energy sourced from renewable energy sources can be used for a very long period of time. Using renewable energy sources can also indirectly reduce carbon emissions. This also supports Indonesia in realizing several SDG's (Sustainable Development Goals), such as Climate Action and Affordable and Clean Energy.

3 METHODOLOGY

The concept of CO2 Converter Design requires several stages of completion. The stages of the research carried out include literature study, namely collecting data from reference books and journals that are relevant to the research topic, then problem identification, namely by formulating the background of the problem in the research carried out as well as the objectives and benefits of conducting the research. This. Tool design is useful for seeing how the tool works, knowing the components used, and how to make a prototype. Meanwhile, to test this tool, make a simulation video to show the effectiveness of the CO2 Converter tool.

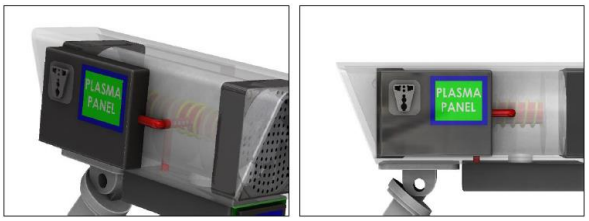
3.1 Design Prototype



Picture 2 CO2 Converter Design Prototype

The design of the tool consists of 4 technological systems, namely Highvoltaic for the combustion process with high voltage induction, Plasma Gasification using NTP (Non-Thermal Plasma) plasma technology, Microcontroller System as a CO2 level detector and automatic activation of the tool based on IoT (Internet of Things).), as well as the Electricity System as a resource and converter of electric current from AC to DC. This tool also has minimalist dimensions, namely 30cm x 12cm x 10cm.

3.1.1 Plasma Panel



Picture 3 Plasma Panel Design for Plasma Gasification and Highvoltaic Mechanism

In the CO2 conversion system, the highvoltaic components used are Metal Oxide Semiconductor Field-Effect Transistors (MOSFET) as semiconductor transistors made from silicon and germanium (SiGe) as channels, Diodes as converters of AC current to DC so that the highvoltaic process can run, Inductors as energy storage electricity to support IoT functions, and an ATMega 8 microcontroller as an electronic circuit controller and can also store programs in it.

Then, the highvoltaic circuit used in this research is a closed circuit. The electricity required for the highvoltaic process is 10kVolt and for the highvoltaic working mechanism, namely using high voltage induction to burn CO2 to undergo a dissociation or ionization process. The results of this combustion process are continued in the plasma gasification process or the combustion results in the form of O2 can be directly distributed to the environment.

In the CO2 converter system, plasma gasification is used as an effective method to decompose CO2 into C (carbon) and O2 (oxygen) by separating the chemical bonds between C and O2 through high-voltage electrons produced from the highvoltaic ionization process. The plasma technology used for plasma gasification in this research is NTP plasma (Non-Thermal Plasma). The effectiveness of the plasma gasification process is also influenced by the area, material, and reaction surface area or pipe where the highvoltaic and plasma gasification processes occur, because this can stabilize and change the reaction pathway that occurs to support the CO2 conversion process, and selectively, can direct the resulting product. conversion to the target product, namely C which decomposes into solids so that it sticks to the PCB electrode and the decomposed O2 will be distributed into the environment.

3.1.2 Controller System

Picture 4 Controller System Design

This tool is controlled by the MQ-2 sensor and assisted by other components, such as LCD, LED, and Arduino. The function of the MQ-2 sensor is to detect how much carbon dioxide (CO2) is around. The MQ-2 sensor is connected to an Arduino device that has been coded for safe and maximum CO2 limits. When the CO2 level exceeds the limit, the sensor will send a signal to the Arduino, then the indicator light (LED) will light up as a sign that the conversion process will be carried out. The LCD also functions as an indicator that shows how much CO2 levels are around. This tool is also equipped with an emergency button. This button is used when there are urgent matters, such as inspections when there is damage or routine checks. The function of this button is to disconnect the converter device from the electrical energy source, so that the device stops operating and is safe to check.

The electrical system in the controller system uses AC electricity and in the highvoltaic circuit it uses DC electricity which is the result of converting AC electricity to DC using diodes. This functions so that electric current can be used in highvoltaic technology. To forcibly deactivate the equipment's electricity, you can use the emergency button located behind the controller circuit.

3.2 Protoype Test

Tool testing was carried out using SolidWork simulation. Based on equipment testing, the CO2 Converter converts excessive levels of carbon dioxide (CO2) in the environment into carbon (C) and oxygen (O2) by utilizing new and renewable resources (renewable energy) through environmentally friendly Hybrid technology processes, namely Highvoltaic and Plasma Gasification based on IoT (Internet of Things). In this way, the CO2 Converter has a big impact on nature and humans because the technology used is environmentally friendly and the output distributed to the environment is very beneficial for human life, namely oxygen (O2).

4. RESULT AND DISCUSSION

4.1 The Urgency of Prototype Innovation

Basically, almost all human activities contribute to the increase in air pollution and greenhouse gas emissions in the atmosphere. This is because most human activities use energy sourced from fossil fuels, such as petroleum, natural gas, coal and other natural resource extraction. For example, driving a car for 12,000 miles assuming 10 liters of fuel per 100 km will produce 2780 kg of carbon dioxide (calculated using a carbon footprint calculator). Then using 10kWh of electricity at home will produce 10 kg of carbon dioxide in a month. If this continues, it will worsen the condition of the atmosphere and environment. Therefore, innovation needs to be made to overcome this problem, namely a CO2 to O2 conversion tool.

4.2 The Use of The Prototype

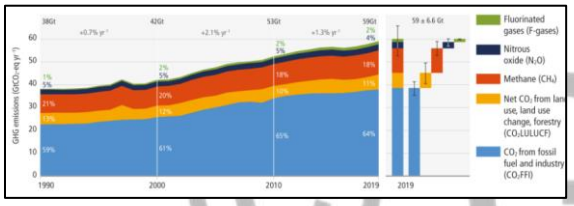
Using this CO2 to O2 conversion tool is very useful for reducing greenhouse gas emissions and pollution in the environment. Apart from its very useful function, this tool also uses electrical energy sourced from renewable energy sources.

This proves that this tool can indirectly reduce the use of fossil fuels. Not only that, this tool looks elegant, modern, and doesn't require a large space. Therefore, this tool can work in dense areas.

4.3 The Application of The Prototype

One application of using hybrid highvoltaic and plasma gasification technology based on IoT (Internet of Things) is to convert CO2 into O2 in densely populated environments, such as big cities, to deal with the problem of CO2 gas emissions in various sectors of life.

Based on the results of a literature study, air pollution data was obtained due to CO2 gas emissions from various sectors in Indonesia, especially in big cities, such as the IPPU/household sector, buildings, transportation, industry, resources, and others. In 2019, each sector contributed to CO2 emissions in Indonesia, which totaled 617.51 MtCO2 (Metric tons of Carbon Dioxide).



Picture 5 Indonesia's CO2 Emissions Data

Based on the results of previous research, there is a similar tool and it can be used as a reference for testing the feasibility of the CO2 Converter tool. This tool uses a power input of 12 Volts, then the power is converted to +- 10 kVolt by the electric coil in the pipe to burn CO2. This tool is also designed to be waterproof, so it can work in various weather conditions.

Therefore, with the CO2 Converter, which will later be applied to street lights and electricity poles, it is hoped that it will have a significant and greater effect on the surrounding environment, especially in large/densely populated cities. CO2 Converter can also be a solution for improving SDG's 2030.

5. CONCLUSION

5.1 Conclusion

- CO2 Converter uses a closed circuit with an AC current source which will be converted to DC current as a condition for using highvoltaic technology. The CO2 Converter also uses waterproof components and materials so that it can minimize the occurrence of errors/electric shorts.
- One application of using hybrid highvoltaic and plasma gasification technology based on IoT (Internet of Things) is to convert CO2 into O2 in densely populated environments, such as big cities, to deal with the problem of CO2 gas emissions in various sectors of life.
- The hybrid technology system on the CO2 Converter by combining highvoltaic and plasma gasification technology based on IoT (Internet of Things) is feasible because the input/resource used is renewable energy and the output produced is also environmentally friendly.) and can help optimize the realization of the SDGs, especially in the fields of affordable and clean energy, industry, innovation, and infrastructure, as well as climate action.
- The working mechanism of the CO2 Converter begins with automatically detecting CO2 emission levels in the environment when CO2 gas in the environment has exceeded safe limits using an IoT (Internet of Things) based microcontroller system, then the air will be sucked into the device by a fan. Next, CO2 will go through a combustion process in a pipe that is fed by a high-voltaic induction coil to undergo dissociation or ionization. Then the positive and negative PCBs in the plasma panel circuit will meet to produce plasma which will decompose CO2 into C and O2 (plasma gasification). After the plasma gasification process takes place, C which breaks down into solids will be released along with O2 through the holes in the pipe where the plasma gasification process takes place and will be sucked in by the fan in the carbon filtration device. Next, in the filtering process, the C which becomes a solid will stick to the PCB electrode and the decomposed O2 will be distributed to the main pipe to flow into the environment.

5.2 Advice

The execution and completion of this research was certainly not free from various shortcomings and weaknesses. To correct these deficiencies, the suggestion given is that there is a need for further development in this research, especially in the selection of materials, capacity calculations, and optimization of the hybrid technology system of highvoltaic and plasma gasification based on IoT (Internet of Things) which is used for the designed CO2 Converter. and created in this research is the first design. This is needed in order to produce maximum output expanding and assisting in the problems of CO2 gas emissions, the use of

renewable energy, and the realization of SDG's.

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