

CO2 Conversion Based on Plasma Technologies: Review

Aliaa H. Abbas ¹, Wasan A. Wali ¹

¹ Department of Computer Engineering, University of Basrah, Basrah, Iraq

*Corresponding Author pgs.aliaa.hussain@uobasrah.edu.iq

Abstract— The increasing concentration of carbon dioxide gas in the world has led to exploring solutions and alternatives to reduce these concentrations or benefit from carbon dioxide gas and use it as an environmentally friendly fuel and in other applications. There are many ways to decompose gas into oxygen, carbon, or carbon monoxide, including chemical and thermal methods. This can also be done using plasma techniques. A review of the literature related to plasma-based carbon dioxide dissociation will be presented. It also describes some different types of plasma, in addition to explaining the results of recent scientific research in this regard. The results of recent conclusions have shown that through plasma technology, high energy efficiency can be achieved, which indicates the efficiency of plasma in its use in converting carbon dioxide gas.

Keywords— CO2 Conversion; plasma; CO2 Dismantling; Microwave (MW); Dielectric Barrier Discharge (DBD).

I. INTRODUCTION

Carbon dioxide (CO₂) which is a basic element in the Earth's atmosphere, is useful in balancing the environment. Carbon dioxide levels have gone up due to activities such as the use of fossil fuels deforestation and different industrial practices since the industrial revolution. [1]. Increasing amounts of CO₂ are primarily responsible for global warming which causes many environmental problems. Recognizing and dealing with the effects of this growth in carbon dioxide emissions on Earth is of great importance as they are increasing globally. [2]

The existing state of anthropogenic pollution and the careless release of greenhouse gases into the atmosphere have the potential to worsen desertification, ocean acidification, global warming, and weather variability. However, some of the immediate effects of climate change are health issues, migration, increased economic damage, rising sea levels, and strong storms that harm coastal communities [3]. Table 1 shows the problems of increasing the percentage of carbon dioxide gas.

TABLE I. Problems Resulting from Increasing CO₂ Levels[4]

Problem	Description	Impact
Climate Change and Global Warming	CO ₂ traps heat in the atmosphere, causing global temperatures to rise.	More frequent and severe weather events, melting ice caps, and rising sea levels.
Ocean Acidification	CO ₂ is absorbed by oceans, making them more acidic.	Dissolution of calcium carbonate shells of marine organisms,

		disrupting marine ecosystems.
Health Impacts	Increased CO ₂ levels can exacerbate respiratory conditions and cognitive function.	Aggravated asthma, reduced cognitive function, heat-related illnesses, and spread of diseases.
Agricultural Impact	Climate change affects temperature and precipitation patterns.	Droughts, floods, reduced crop yields, lower nutritional value of crops.
Biodiversity Loss	Climate change and ocean acidification threaten various species.	Habitat loss, increased risk of extinction, and disruption of ecosystems and services.

II. CO2 REDUCTION TECHNIQUES

There are many techniques to reduce or limit the percentage of carbon dioxide gas by fragmenting it and dividing it into its basic components, such as Photovoltaic Industry Association [5], photocatalysis, the electrochemical method, the thermochemical method, plasma, and others [6]. Table 2 shows some of the carbon dioxide reduction techniques.

TABLE II. Reduction Techniques for CO₂ gas.

Techniques	Method
Photocatalytic Reduction	uses light, usually ultraviolet or visible light, to initiate a chemical reaction that transforms CO ₂ into alternative substances. The reaction is facilitated by the titanium dioxide photocatalyst. This way of reducing carbon dioxide mimics photosynthesis and can potentially serve as an atmospheric carbon capture technique that converts it to other compounds like carbohydrates.[7]
Electrochemical Reduction	In this process, CO ₂ is reduced to other products using electrical energy. Electrochemical cells or reactors use electrodes to drive the reaction, often producing compounds like carbon monoxide, methane, or ethylene. This method can be integrated with renewable energy sources to create a sustainable CO ₂ reduction process.[8]
Thermochemical Reduction	This method involves using high temperatures to drive the chemical reduction of CO ₂ . Typically, it employs a thermal catalyst to facilitate reactions at elevated temperatures, converting CO ₂ into useful chemicals or fuels. This approach is energy-intensive but can be efficient for large-scale applications.[9]

