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Review Paper

An Overview of Emission Sources, Separation Methods and Valuable Crops Producing from CO₂

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1. ABSTRACT

The increase in CO₂ emissions is the main cause of global warming and causes adverse environmental challenges. Based on this, finding ways to convert CO₂ into useful products can help reduce the harmful environmental effects of this substance on the one hand, and increase the economic efficiency of the process to produce valuable products on the other hand. Thus, in this article, the sources of CO₂ emissions were investigated first, and then the methods of separating this gas were described. Also, the use cases of this substance in various industries were discussed. The results obtained from various studies showed that membrane contactors are one of the effective technologies in CO₂ absorption. Also, the product that is currently produced in large quantities from CO₂ is urea. The obtained results indicated the production of 157,000,000 tons of urea in the world in 2010. Furthermore, electrochemical and photocatalytic methods were recognized as suitable methods for producing products from CO₂. Meanwhile, the primary challenges in the way of applying CO₂ recovery technologies in Iran include economic limitations and structural and institutional problems. By overcoming these challenges and applying CO₂ recovery technologies, Iran can significantly reduce its environmental greenhouse gas emissions and gain significant economic benefits.

Keywords: CO₂, the Environment, Valuable Chemicals, Membrane Contactors.

2. INTRODUCTION

Greenhouse gases are one of the most important and fundamental environmental pollutants that threaten human life in the form of a serious crisis. Greenhouse gas is a gas that exists in the atmosphere of a planet and absorbs and emits radiation in the infrared range. This process is the main cause of the greenhouse effect. Greenhouse gases in the earth's atmosphere that exist naturally include water vapor (H₂O), carbon dioxide (CO₂), methane (CH₄), dinitrogen monoxide (N₂O) and ozone (O₃). But human activities have increased the amount of many of these gases. Meanwhile, the most important greenhouse gas whose release in the atmosphere is widely related to human activities is CO₂. The increase in CO₂ emissions is the main cause of global warming and causes adverse environmental challenges such as climate change and acidification of seas and oceans [1-3]. Based on this, finding ways to convert CO₂ into useful products can help to reduce the harmful environmental effects of this substance on the one hand, and on the other hand, develop the economic efficiency of the process to produce products with high economic value. In other words, one of the basic ways to reduce CO₂ emissions is to separate and purify this gas and return it to the desired product production processes based on market demand. Thus, in this article, the emission sources and methods of CO₂ separation and the role of membrane contactors in its separation are stated, and the valuable chemical substances that can be produced from this gas are also discussed. It should be noted that the present research is one of the most recent review works in which emission sources, separation methods and valuable products that can be produced from CO₂ are simultaneously discussed.

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3. IDENTIFICATION OF CO₂ EMISSION SOURCES

The most important issue in controlling and reducing CO₂ is to identify emission sources and accurately estimate the amount of emission. Currently, many studies have been conducted on measuring the amount of greenhouse gas emissions in various industries, the purpose of which was to identify the sources of emissions, estimate the amount of emissions and formulate strategies to reduce or eliminate emissions from its sources.

Energy consumption seems to be the main cause of high CO₂ emissions. Meanwhile, power plants, which are one of the main energy producers in the world, are also considered among the most important CO₂ emitting industries. The conducted studies show that one third of the share of CO₂ emissions in 2013 in Iran was allocated to power plants with fossil fuel sources. After electricity and cement industry, the refining sector ranks third among fixed producers of CO₂ in the world.

4. CO₂ SEPARATION METHODS

It is possible to separate CO₂ from the mixture of gases sent to flares by several different processes. In the meantime, many factors are effective in choosing the right process for CO₂ separation. So far, various processes for CO₂ separation have been presented based on the mentioned factors, and the most important of these processes are solvent absorption, adsorption in fixed beds, and membrane processes [4]. In the meantime, due to the relative advantages of membrane processes compared to traditional solvent absorption methods, the use of this method has been expanding in the world in recent years. As the studies conducted indicate the successful application of different membrane technologies in the gas industry, especially the natural gas sweetening industry and the removal of greenhouse gases from flue gases. There are various membrane processes in the field of gas separation, among which membrane contactors are of special importance. Table 1 shows a comparison between different types of membrane processes, in which it can be clearly seen that the amount of energy consumption and operating cost in membrane contactors is low compared to other membrane processes, and on the other hand, the permeation rate in this The equipment is high [5].

Table 1. A comparison between types of membrane processes

Membrane type		Energyconsumption (pressure and temperature)	Permeability	Cost
Organic	Inorganic			
Gas permeation membrane		Normal- high	Low- good	Normal-high
Facilitated transport membranes		Normal	Good	Normal
Hollow fiber membrane contactor		Low	High	Low
	Ceramic membranes	High	High	High

5. CHEMICALS PRODUCED FROM CO₂

In recent years, compounds containing oxygen, nitrogen, carbon-carbon unsaturated substances and other substances have been investigated for the production of organic chemicals from CO₂, which studies show that a wide range of chemical products can be produced using CO₂. Meanwhile, the product that is currently produced in large quantities from CO₂ is urea. Table 2 shows the different amounts of organic chemicals produced from CO₂ around the world.

Table 2- Production of organic chemicals in the world using CO₂ [2]

Chemical	Production (ton)
Cyclic carbonates	80,000
Polypropylene carbonate	76,000
Polycarbonate (Asahi Kasei process)	605,000
Urea	157,000,000
Acetylsalicylic acid	16,000
Salicylic acid	90,000
Methanol	4000

Also, it should be noted that there are various methods for converting CO₂ into valuable chemicals or fuels, including photochemical, electrochemical, biochemical, thermocatalytic, chemical, and combined methods.



6. CONCLUSION

In this article, the sources of CO₂ production were investigated first, and then the use of this substance in various industries was stated. Studies have shown that membrane contactors have a high potential for CO₂ separation. An important point in this is that in choosing the right method to convert CO₂ into a product, the type of product, the biocompatibility of the method, the efficiency of the process and the operating cost are among the most important things that should be considered before be considered from product fabrication. Based on this, electrochemical and photocatalytic methods were recognized as suitable methods for producing products from CO₂.

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