Advanced Engineering Days

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Recent CO_2 capture and storage technologies and usage areas

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Cite this study: Kalay, E., & Özkul, İ. (2022). Recent CO_2 capture and storage technologies and usage areas. 5th Advanced Engineering Days, 46-47

Keywords
CO_2 capture
Global warming
Greenhouse gases
CO_2 storage

Abstract

Due to the increase in energy consumption, the increase in greenhouse gas emissions to the atmosphere day by day leads to global climate change. Global climate change means not only a slow rise in average temperature, but also a change in the way the earth system works. Carbon dioxide has the highest impact on this change with a share of 82%. Even a very small change in the carbon dioxide ratio affects the balance of the atmosphere. Reducing CO_2 emissions plays an important role in maintaining the atmosphere balance. In this study, the working principle, current status and use in industry of CO_2 capture and storage technologies developed to reduce CO_2 emissions are included.

Introduction

85% of human-produced CO_2 is released into the atmosphere as a result of burning fossil fuels such as oil, natural gas and coal. As the greenhouse gases (CO_2, CH_4, N_2O, O_3, chlorofluorocarbons, hydrofluorocarbons) in the atmosphere increase, the heat of the Sun is trapped in the atmosphere and causes global warming. For this reason, controlling greenhouse gas emissions has become an important issue in maintaining the atmosphere balance.

Carbon dioxide is the gas that has the biggest impact with a share of 82% among the greenhouse gases. In 2020, a new record was set for atmospheric CO_2 at 413 parts per million (ppm). This data shows that there has been an increase of approximately 12% since 2000. 413 parts per million may seem small, but even these levels are large enough to significantly increase global climate change. For this reason, countries are developing technologies to control CO_2 emissions with various technologies [1].

Related to the subject, various studies have been carried out on increasing fuel conversions, increasing energy savings, waste management and environmental protection. These studies mostly focused on keeping CO_2 at a certain rate. Today, in parallel with the developing technology, studies on the separation of carbon dioxide from the air or its storage in different material forms come to the fore. It is possible to trap the carbon dioxide in a mass and release it underground, or to separate the air by passing it through carbon dioxide-scavenging chemical liquids. These two methods are very effective in reducing the CO_2 rate. On the other hand, the use of CO_2 in the production of methanol, a biofuel, or its storage by pumping it into underground oil and natural gas deposits, are also effective in reducing carbon dioxide emissions into the atmosphere [2].

CO_2 capture and storage technologies

Carbon dioxide capture and storage technologies (CO_2CS) are a low-carbon technology that prevents carbon dioxide from large point sources, such as industrial plants using fossil fuels or biomass, from entering the atmosphere. It consists of the stages of capture, transportation, use or storage. Carbon dioxide originating from industrial facilities such as iron and steel, electricity production, cement, fertilizer and chemical production is captured by these systems. There are three main ways to capture CO_2: pre-combustion, post-combustion and oxy-fuel combustion. More than 93% of carbon dioxide can be captured with these methods. Other technologies include membrane capture and calcium cycling. Commonly used capture technologies are chemical absorption and

adsorption. The most efficient capture technologies are selected depending on many factors such as the composition and concentration of the flue gas, flow rate, operating pressure, temperature and cost. Captured carbon dioxide is compressed at high pressures and transported to the appropriate storage area or facility. Transport is done by pipelines and ships [3].

CO_2 is permanently isolated from the Earth's atmospheric carbon cycle, typically by injecting it several thousand meters (0.8-2 km) deep into a carefully selected geological reservoir, such as a depleted oil and gas field or brine aquifer. In addition, carbon dioxide can be used for an industrial purpose. The vast majority of captured CO_2 is used by oil companies. It also has many potential uses, such as being used as a raw material for the production of chemicals, building materials and fuels, or in the production of aviation fuel. The technique of converting CO_2 into useful chemicals (methane, methanol, ethanol, etc.) with the molecular conversion technique has been given great importance in recent years. In the electrochemical reduction method of CO_2, the fact that the studies can also be carried out with completely renewable electrical energy makes this process more advantageous [4].

Importance of CO_2 Capture and Storage Systems in Industry

In scenarios that limit global warming to 1.5°C, it is estimated that industry-sourced CO_2 emissions, which are currently 8 Gt per year, should be approximately 65-80% lower in 2050 compared to 2010. It is aimed to prevent about 60 Gt of CO_2 emissions by 2050 from heavy industries such as iron and steel, cement and chemistry, which are responsible for approximately 70% of CO_2 emissions, which will be jointly led by Austria and Australia. It does not seem possible to achieve this emission reduction with energy and process efficiency or renewable energy options. This goal can only be achieved through combinations of new and existing technologies, including electrification, hydrogen, sustainable bio-based raw materials, product substitution, carbon reduction, carbon capture and storage [5].

Conclusion

One of the main reasons why carbon capture technologies have not yet been widely adopted is the complexity and costs of these operations, which currently cannot be offset by the cost of carbon dioxide emissions. This is a particular problem for industries such as the cement industry, as the cost of carbon capture nearly doubles production costs. It is foreseen that technologies such as Carbon Capture Storage, Bioenergy and Direct Air Capture will be adopted in order to balance the emissions that cannot be eliminated from other sectors. In addition to the storage of CO_2 captured with these technologies, it is planned to be used in the production of synthetic fuel for use in aviation [5].

Although carbon capture and carbon sequestration techniques are extremely expensive in current conditions, it is thought that the costs can be reduced over time as a result of the studies. By the middle of this century, it is possible that carbon dioxide will be cleaned in fossil fuel thermal power plants by using new generation carbon dioxide capture and capture technologies and their costs will decrease to appropriate levels. Despite these developments, investments in renewable nature-friendly energy sources are considered to be the best solution and the most appropriate method for reducing global warming.

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