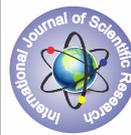


Cryogenic Carbon Capture and Sequestration to Control Climate Change Effects



Engineering

KEYWORDS: Carbon Dioxide, Carbon Capture, Sequestration

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ABSTRACT

Carbon dioxide gas is well known greenhouse gas and can be captured to prevent polluting the atmosphere by various technologies like membrane separation, absorption, air separation units and cryogenic capture. Apart from other technologies Cryogenic Capture is very effective and userfriendly for carbon dioxide capture and its sequestration. Cryogenic Carbon Capture technique can be applied to major sources emitting carbon dioxide like thermal power plant and natural gas production which are discussed here. Low cryogenic temperature facilitates pressurization of carbon dioxide to store in earth crust or in deep seat to enhance oil and gas recovery.

1. Introduction

Global warming is challenging climate change effect caused by green house gases like carbon dioxide. So its emission in atmosphere require to control for sustainable development worldwide for ensuring the earth as pleasant as today for upcoming generations. Developed countries already implemented carbon capture techniques and other have to pay immediate attention to learn this techniques for their development. Cryogenic Carbon capture process dries and cools flue gas from existing systems, modestly compresses it, cools it to a temperature slightly above the point where carbon dioxide forms a solid, expands the gas to further cool it, precipitating an amount of carbon dioxide as a solid that depends on the final temperature. Pressurizes the carbon dioxide, and reheats the incoming gases. The final result is the carbon dioxide in a liquid phase. carbon dioxide capture efficiency depends primarily on the pressure and temperature at the end of the expansion process. Cryogenic Carbon Capture and its sequestration involves following steps:

- Cryogenic Capturing Carbon Dioxide from a source such as a power plant, natural gas production
- Transporting compressed Carbon dioxide to the injection site
- Injecting compressed Carbon dioxide into a deep subsurface rock formation for sequestration
- Monitoring sequestered Carbon Dioxide while it undergoes a series of natural processes to become permanently integrated into the geologic environment.

2. Cryogenic Capturing Carbon Dioxide from Thermal Power Plant

Cryogenic carbon capture process is a retrofit, post-combustion technology for power plant. The process (Figure 1) first dries and cools flue gas in condensing heat exchanger. Then compresses flue gas in the range of 5 bar to 7 bar in compressor. After compressing cools flue gas in a heat recovery heat exchanger to nominally -107 °C. May extract condensed contaminants such as mercury, SO₂, NO_x, Hg, and HCl at various stages during cooling and condenses most about 75% of the Carbon dioxide during cooling. Expands the remaining light gas to further cool it to -120 °C for 90 % capture to -135 °C for 99 % capture. Separates the remaining solid CO₂ that forms during cooling from the remaining gas in solid gas separator. Pressurizes the solid CO₂ to 70-80 bar. Reheats the CO₂ and the remaining flue gas to near ambient conditions (15 °C) by cooling the incoming gases, and Compresses and pressurized the now melted CO₂ stream to final delivery pressure nominally 150 bar.

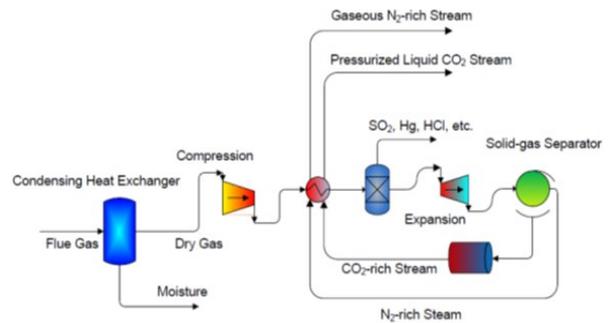


Figure 1: Schematic diagram of cryogenic carbon capture process for thermal power plant

3. Cryogenic Carbon Capture in Natural Gas

The process configuration for capturing carbon dioxide from natural gas is shown in Figure 2. The feed gas is initially dehydrated to low water specifications 5 ppm to handle downstream cryogenic operations. The gas is then heat exchanged with treated gas and cold carbon dioxide prior to cooling to a temperature just above the carbon dioxide freeze point. The liquid is then expanded across a Joule-Thomson valve entering the separator as a three-phase mixture. The solid carbon dioxide collected in the bottom of the separator is melted by a heater and separated with the liquids. The gas is compressed to sales gas specifications and the liquid pumped to the required disposal pressure. This process configuration is considered as the base case design for the process and subsequent modifications are discussed below.

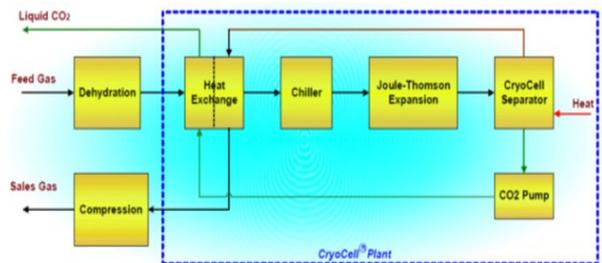


Figure 2: Schematic diagram of cryogenic carbon capture process for natural gas

4. Carbon Dioxide Sequestration

Carbon Dioxide can be sequestered in deep underground formations of porous rock at least 2,500 feet below ground surface. For carbon dioxide sequestration porous formations must lie under layers of impermeable rock that will provide a cap or seal to prevent upward migration of the carbon dioxide. Following types of geologic formations are suitable for sequestration.

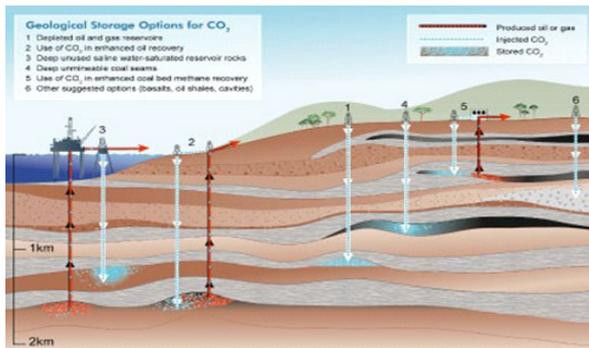


Figure 3: Schematic diagram for various Carbon Dioxide Sequestration

a. Oil and gas reservoirs

Oil and natural gas have been held in numerous natural oil and gas fields around the world for millions of years. Once empty of the oil and gas, these same rock formations could hold injected carbon dioxide. For decades, the oil and gas industry has been injecting carbon dioxide into natural gas and oil fields to assist in maximizing production levels. For economic reasons, the carbon dioxide is usually recovered and re-injected however once all of the gas or oil in a field has been recovered, the carbon dioxide could be left underground, where the oil and gas had been held for millions of years. Through these operations techniques have been advanced to ensure that carbon dioxide could be sequestered safely and effectively.

b. Deep coal seams

During enhanced coal bed methane recovery operations carbon dioxide is injected into these seams. The carbon dioxide displaces methane from the coal, and the methane can be recovered as an energy source. While coal seams could be effective reservoirs to sequester small volumes of carbon dioxide, other formations would be needed to sequester the amounts of carbon dioxide being generated today.

c. Saline formations

The most likely rock formations to be targeted for carbon dioxide sequestration are saline formations. Saline formations are abundant and have the necessary capacity to sequester the large amounts of carbon dioxide being generated today. Because of this, they are considered one of the best choices for carbon dioxide sequestration. Saline formations are porous, saltwater-bearing rock formations that are located thousands of feet below the earth's surface. Because the water in these formations is very salty, it has no value as drinking water.

d. Shale formations

Some shales have the potential to sequester carbon dioxide. Currently, natural gas is produced from a type of rock called organic shale. Due to the chemical properties of the shale, natural gas and carbon dioxide, it is possible that injecting carbon dioxide could enhance the production of natural gas and sequester carbon dioxide at the same time.

5. Conclusion

Cryogenic capturing of carbon dioxide from flue gases in thermal power plant and natural gas production represents a cost effective and energy efficient alternative to providing a pure and highly efficient separation of carbon dioxide from flue gas. Sequestration of captured carbon can be done in many way for improving oil and gas recovery.

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