News Release

May 25, 2023
Electric Power Development Co., Ltd.

J-POWER Devises Novel CO_2 Underground Storage Technology Using Hydrate Mechanism

Patent Granted for New CCS Storage Method

Electric Power Development Co., Ltd. (J-POWER, headquartered in Chuo-ku, Tokyo; President: Toshifumi Watanabe) has devised and patented a new carbon dioxide (CO_2) underground storage technology using the hydrate[1] mechanism.
(Patent No. 7149712: Underground Storage Method for Carbon Dioxide and Underground Storage Device Therefor)

This technology relates to the underground storage of CO_2 in CCS.[2] It uses the hydrate mechanism, whereby CO_2 hydrates are formed under high-pressure, low-temperature conditions, such as in the deep waters around Japan, for underground storage of CO_2 in the sub-seabed bedrock (hereinafter, "CO_2 hydrate storage").

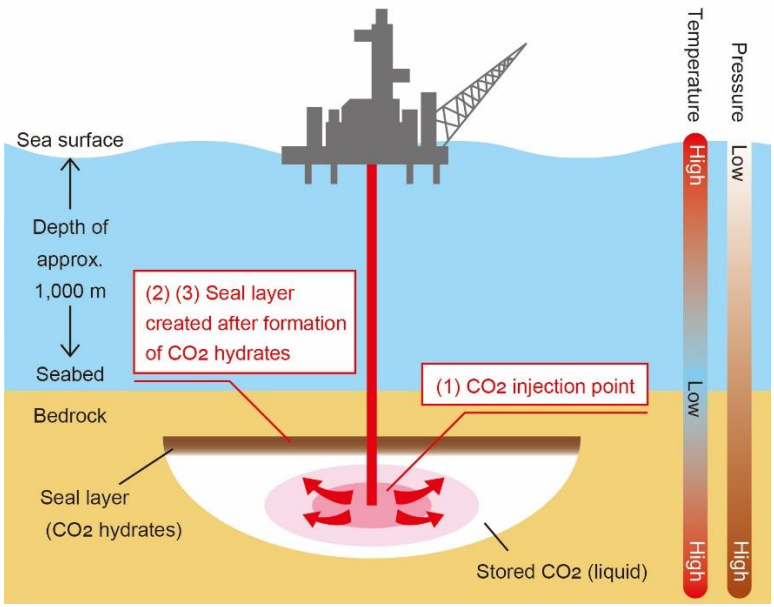


Illustration of CO_2 hydrate storage

Notes:

1. Hydrate: An inclusion compound with a lattice-like crystal structure, formed through the union of molecules of water (H_2O) and another compound or element
2. CCS: Carbon capture and storage

Already, underground CO_2 storage in aquifers, which requires a seal layer as part of the geological structure (as found in conventional oil and gas fields), is being increasingly adopted worldwide. In Japan, a large-scale CCS demonstration test in Tomakomai, Hokkaido Prefecture is under way and surveys of suitable sites are being conducted by the national government and other organizations.

Nonetheless, for the world to achieve carbon neutrality by 2050, it is thought that a large capacity of underground CO_2 storage will be necessary. CO_2 hydrate storage, which utilizes a mechanism similar to that involved in the formation of naturally occurring methane hydrates, was devised with the aim of further expanding suitable locations for underground CO_2 storage. Putting this technology into practical use can be expected to increase the number of suitable locations and capacity for CO_2 underground storage in Japan.

J-POWER, in pursuit of stable energy supply and carbon neutrality, has been working on a CCS project study in Japan (as announced on January 26, 2023) and has been developing CO_2 hydrate storage technology to expand the number of suitable locations for CO_2 storage. Moving forward, we will continue our intensive research efforts toward the practical application of CO_2 hydrate storage.

Attachment:
Concept of CO_2 Underground Storage Using the Hydrate Mechanism (CO_2 Hydrate Storage)

Attachment

CO_2 Underground Storage Using the Hydrate Mechanism (CO_2 Hydrate Storage)

Features

By injecting liquid CO_2 below a seal layer of CO_2 hydrates, this novel storage method ensures injection efficiency (i.e., that CO_2 can be smoothly injected without forming blockages) and seal performance, as the CO_2 rises due to its buoyancy and forms additional hydrates.

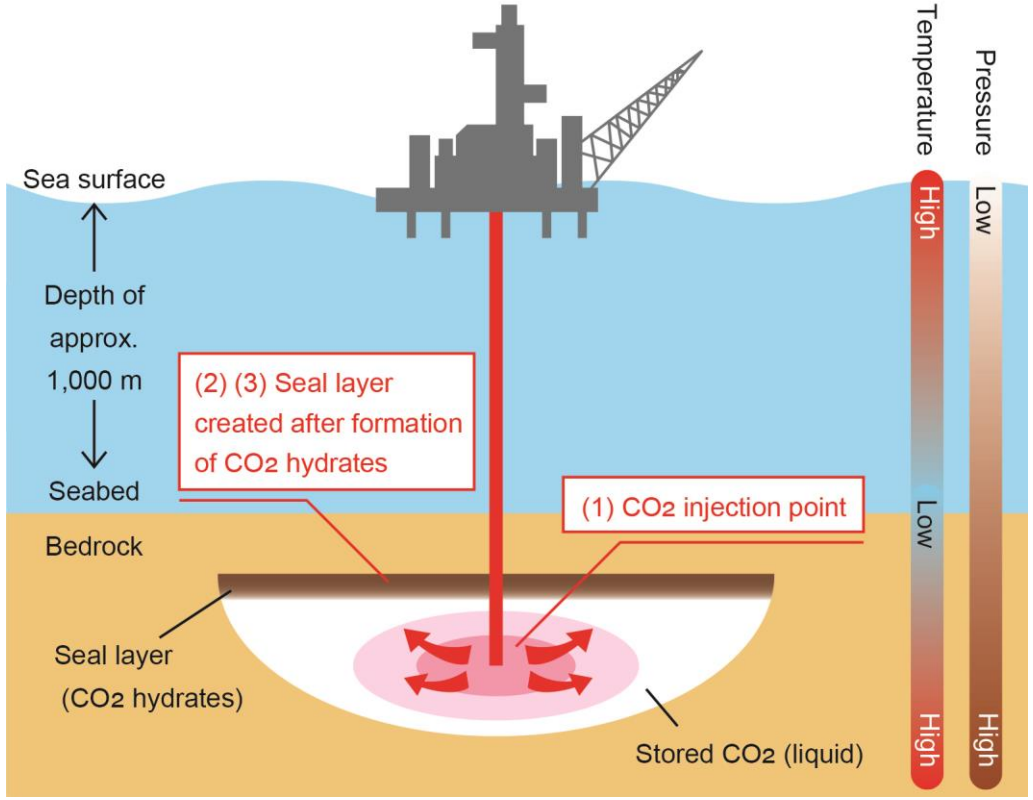
Explanation of the figure

(1) When liquid CO_2 is injected into the sub-seabed bedrock, it rises because its density is less than that of seawater.

(2) The liquid CO_2 rises to a depth with a low temperature, high pressure environment* conducive to hydrate formation, where it forms CO_2 hydrates.

(3) The pore spaces between the grains of the sub-seabed bedrock fill with CO_2 hydrates, forming a seal layer (which prevents CO_2 leakage). This enables the storage of CO_2 in liquid form below the seal layer created by CO_2 hydrates.

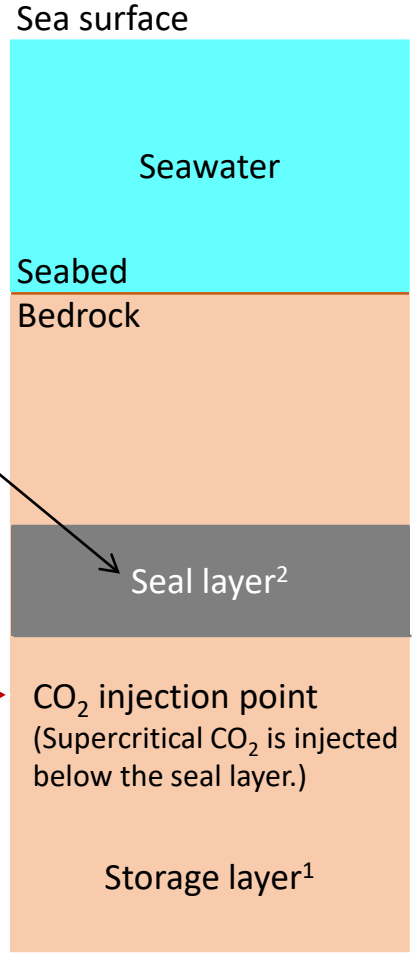
* The formation of CO_2 hydrates requires the presence of water and certain temperature and pressure conditions (for example, temperatures below 10°C and pressure above 4.5 MPa (i.e., a depth of 450 m or more)).



Attachment

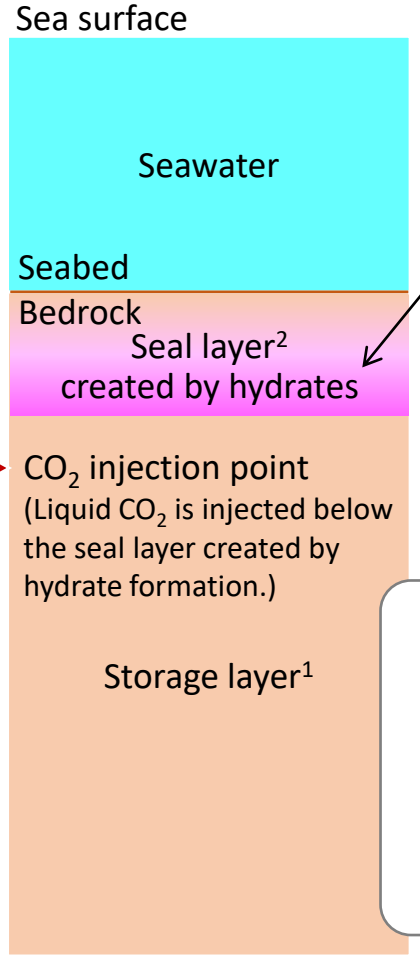
Differences between Aquifer Storage and CO_2 Hydrate Storage

Aquifer Storage



Seal layer as a natural geological structure (e.g., mudstone)

CO_2 Hydrate Storage



Region where CO_2 hydrates form (i.e. has seal performance due to hydrate formation)

For example, CO_2 forms hydrates at temperatures below 10°C and pressures above 4.5 Mpa.

CO_2 forms hydrates, blocking pore spaces in the stratum and providing seal performance

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No need for a seal layer as part of the geological structure

Notes:
1. Storage layer: A stratum with high permeability and porosity for storing CO_2
2. Seal layer: A stratum with very low permeability to prevent CO_2 leakage

Source: Based in part on T. Tobase and Y. Ikegawa, *A proposal of CO_2 underground storage using hydrate*, Electric Power Civil Engineering No. 396, July 2018.