Liquid CO2 Storage

Carbon capture and storage (CCS) and carbon capture utilization and storage (CCUS) reduce carbon emissions and help mitigate the threat of global warming.

CB&I's liquid C02 storage technology is a critical component in a carbon capture three-step process:

1. Capturing carbon dioxide produced by power generation or industrial activity
2. Transporting the carbon dioxide and storing in a temporary above-ground storage site or terminal
3. Storing it deep underground (CCS) or reusing it (CCUS) to reduce carbon footprint

CB&I offers state of the art large-scale liquid carbon dioxide high pressure storage technology to support the world's most ambitious CCS and CCUS projects.

Inside the Design

Capacity: CB&I offers basic designs up to 25,000 m3 (~ 27,500 MT). Larger designs are possible, and CB&I is eager to discuss larger sizes with customers to determine the optimal capacity for your project.

Design Code: CB&I routinely designs large-scale pressurized storage to ASME Section VIII, Division 2 standards to provide the most economical designs. Designs for other pressure vessel codes are available upon request.

Design Pressure: Liquid carbon dioxide (LCO2) is typically stored between 165 psig (1138 kpag) and 350 psig (2413 kpag). Design pressures vary widely based on the unique thermodynamic properties of CO2 and a variety of temperature and pressure combinations envisioned in the facility process design.

Minimum Design Metal Temperature (MDMT): The unique thermodynamic properties of CO2 results in significant variability in MDMT, based on operational factors, owner risk profiles and consideration of out of equilibrium conditions. CB&I's world-class engineering group provides expert guidance on the application of code principles, material selection, structural analysis, fracture mechanics and fatigue, welding technology and heat treatment application, to help owners determine the right design conditions to suit their plant performance needs.

Post Weld Heat Treatment (PWHT) – Large-scale LCO2 storage typically requires PWHT of thick steel shells required to safely store the product at the design pressure. CB&I uses proprietary design and construction techniques to safely carry out this complicated PWHT process. CB&I pioneered field PWHT and is the most experienced field contractor in the world, having post weld heat treated more than 300 completed vessels in the field.

Global Project Execution – CB&I has built high pressure storage spheres in 100+ countries. CB&I's global footprint and proven project delivery model enable cost and schedule certainty anywhere in the world.

Pressurized and Refrigerated Storage

CB&I has built more than 265 storage vessels and spheres for pressurized, refrigerated service.*

**Number includes ethane and LCO2 service, which have similar design conditions, material requirements, design and construction techniques.*

Foamed in Place Insulation

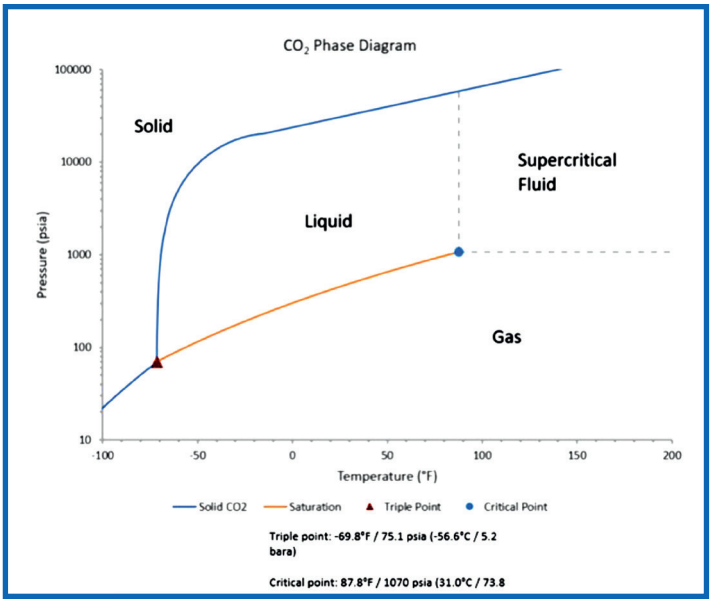
Effective insulation is crucial to maintaining the low temperatures required for LCO2 storage. CB&I designs offer reliable and efficient storage solutions that minimize boiloff and energy consumption. CB&I has been a leader in self-performing foamed in place insulation of refrigerated storage for over 40 years.

	# of Structures		
	Automated Foamed-in-Place	Hand Sprayed Foam Insulation	Horizontal Foamed - in Place
North America	44	83	61
Europe, Africa & Middle East	44	50	61
Central, South America & Caribbean	1	10	39
Asia and Australia	5	3	13
TOTAL TO DATE	94	146	174

Low Temp Carbon Steel

CB&I has performed extensive research, development and testing in their Welding Technology Laboratory on the most state of the art low temperature carbon steel (LTCS) available and can offer MDMT as low as –65° C with LTCS materials.** CB&I's Welding Technology group brings many decades of experience achieving high toughness not just in the plate but in the most critical heat affected zone of the weld joint. CB&I constantly engages industry partners, end users and steel mills to develop optimal low temperature solutions for LCO2 storage.

***Dependent on thickness, weld processes and final heat-treated conditions of the sphere.*



CO2 remains as a liquid in the storage vessel, meaning the temperature and pressure must remain above the triple point of -69.8°F and 75.1 psia (~60 psig) and below the critical point of 87.8°F and 1070 psia (1055 psig)

Storage conditions remain on the saturation line unless superimposed pressure is applied in a transient condition

Phase Diagram

Since it is possible for the stored CO2 to reach the triple point state (-56.6 C / 5.2 barg) under certain conditions, special challenges are presented when storing liquid CO2 that require the consideration of out-of-equilibrium states. This includes possible local effects from solids formation in the sphere. CB&I's pressure vessel design and welding technology teams are ready to help our customers navigate the trade offs in selecting the proper design parameters and welding solutions to ensure safe and reliable storage.

Process Technology

CB&I also offers process technology solutions related to liquid CO2 storage.

Refrigeration Systems Available:

- CO2 liquefaction by closed loop propane or ammonia cycle
- Tank pressure control with closed loop refrigeration cycle (typical) or open loop CO2 cycle

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