Using Pressurized CO_2 and Dry Ice for Cold Energy Storage: A Viable Alternative

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https://infinityturbine.com/infinity-turbine-sky-radiative-cooling-vs-solar-thermal.html

Can solar, thermal, or geothermal energy be used to pressurize CO_2 and produce dry ice for long-term cold storage? This article explores the feasibility and losses in the process, and whether it makes sense as a thermal cold storage strategy.

This webpage QR code

PDF Version of the webpage (maximum 10 pages)

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What if you could store cold like you store heat? This article investigates whether solar or geothermal-heated CO_2 can be converted into dry ice for long-term thermal energy storage—and what losses occur along the way.

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As the global demand for efficient cooling and energy storage rises, researchers and engineers are exploring new ways to store cold energy—a less commonly addressed counterpart to thermal (heat) storage. One novel concept proposes using solar, thermal, or geothermal energy to pressurize carbon dioxide (CO_2), then release it under controlled conditions to form dry ice, storing cold energy for later use. This article examines whether this method is viable, and how much CO_2 is lost during the process.

How the Process Works

1. Heat and pressurize CO_2:
Solar thermal, geothermal, or waste heat energy is used to compress CO_2 into a supercritical or high-pressure liquid state.

2. Release and expand CO_2:
The pressurized CO_2 is then allowed to expand and drop in pressure, either by venting or by directing it through a nozzle into a collection chamber. This rapid expansion causes a portion of the CO_2 to solidify into dry ice.

3. Capture dry ice in insulated medium:
The dry ice can then be stored in bags, tanks, or insulated containers for later use in cold storage, refrigeration, or chilled water systems.

Thermal Cold Energy Storage Potential

Dry ice sublimates at -78.5°C, making it a highly concentrated form of cold energy.
It can be stored in insulated environments with relatively low loss for hours to days, depending on insulation and volume.
Upon sublimation, it absorbs 571 kJ/kg (136 BTU/lb)—useful for passive cooling.

CO_2 Loss in the Process

CO_2 loss depends on system design, especially the ability to capture and recirculate gas during sublimation.
In open systems, 100% of the CO_2 will eventually be lost to the atmosphere as it sublimates.
In closed-loop systems, it is possible to recapture the gas after sublimation and recompress it, reducing losses significantly.
However, the initial release and solidification process can result in 30 to 50 percent loss depending on how well the system is insulated and enclosed.

Pros and Cons

Advantages

- High-density cold storage in small volumes
- Leverages renewable heat sources (solar or geothermal)
- Portable and modular
- No electricity required to discharge cooling
- No moving parts in storage phase

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Challenges