



Efficient Methods to Pressurize Liquid and Gaseous CO₂ Using 1 Kilowatt of Energy

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A technical assessment comparing four ways to apply 1 kilowatt of energy to pressurize carbon dioxide. Evaluates liquid pumping, mechanical compression, resistance heating, and cavitation discs, and identifies the most efficient method for both liquid and gaseous CO₂.



This webpage QR code

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Introduction

As industries increasingly rely on carbon dioxide (CO₂) for energy systems, cooling cycles, and supercritical processes, understanding how to efficiently pressurize CO₂ becomes critical. Whether the CO₂ is in liquid or gaseous form, the method of applying energy directly affects pressure, temperature, and system efficiency.

This article evaluates four ways to use one kilowatt of electrical power to increase CO₂ pressure and temperature:

1. Pumping liquid CO₂
2. Using resistance heat
3. Operating a refrigeration compressor
4. Using a cavitation disc

1. Pumping Liquid CO₂

When CO₂ is in liquid form, a liquid pump is the most efficient means of pressurization. Liquids are nearly incompressible, meaning the mechanical work needed to raise their pressure is minimal.

For example, with one kilowatt of electrical input and a pump efficiency of 70 percent, a liquid CO₂ flow of 0.01 kilograms per second can achieve a pressure increase of roughly 63 megapascals (about 9,000 psi). The temperature rise is minimal, typically just a few degrees.

Conclusion: Pumping liquid CO₂ provides extremely high pressure with minimal temperature gain, making it the most efficient option for pressurization.

2. Heating CO₂ by Resistance

Resistance heating directly converts electrical energy into heat. While this increases the temperature of CO₂, it does not effectively increase pressure unless the CO₂ is in a sealed volume.

In open or flow systems, resistive heating produces thermal expansion but negligible pressure increase. Thus, it is inefficient for pressurization but useful when the goal is to raise temperature.

Conclusion: Resistance heating increases temperature, not pressure.

3. Compressing Gaseous CO₂ with a Mechanical Compressor

For gaseous CO₂, a mechanical compressor is the correct tool. One kilowatt of power applied to a gas compressor with 70 percent efficiency can compress CO₂ from 1 bar to about 3 bar at a mass flow of 0.01 kilograms per second. The discharge temperature rises to roughly 140 degrees Celsius.



