Gas vs. liquid pumping:

Gas beats liquid in product quality and energy savings

Comparing the pros and cons of gas and liquid pumping requires looking at the whole picture, especially the effects on the materials being extracted. Some CO_2 extraction equipment manufacturers claim liquid pumping is more efficient than gas. While it is easier to pump liquid CO_2 because liquid is 10 times denser than gas, liquid pumping actually consumes more energy over the entirety of an extraction run.

Aside from more energy consumption, the biggest downside to liquid pumping is that too much heat is placed in the separator vessel. This causes thermal degradation of the plant oils. Whereas, **gas pumping allows for cold separation processing which uses lower, plant-friendly temperatures to preserve the quality and potency of the volatile oils.**

Liquid

The combination of using warmer-operating chiller (approximately 65 degrees Fahrenheit) with a **liquid pump places harmful high temperatures in the separation vessel** to offset the CO_2 expansion cooling. This "cooks" the collected oil, producing dark, thermally-damaged oils. Mother Nature did not design plants to survive high temperatures.

Thermal degradation from excessive heat can be avoided by using a low-temperature chiller. However, costlier low-temp chillers consume significantly more energy, which is why extraction equipment suppliers using liquid pumping don't use them. But avoiding these additional costs **comes at the expense of the botanical extractions.**

Gas

Pumping gas allows for cold separation processing where the separation pressure and temperature are lower, resulting in **more consistent and potent oil extractions.** In addition, cold separation allows processors to decarboxylate (convert THCA to THC) on their own terms giving them **more control over the amount of THC** in their products.

Apeks systems utilizing **gas pumping allow the heat generated during the compression phase change to be captured via a closed-loop system for greater energy efficiency**. The captured heat is used in a regenerative heat exchanger to offset the cooling during the decompression of the CO_2.

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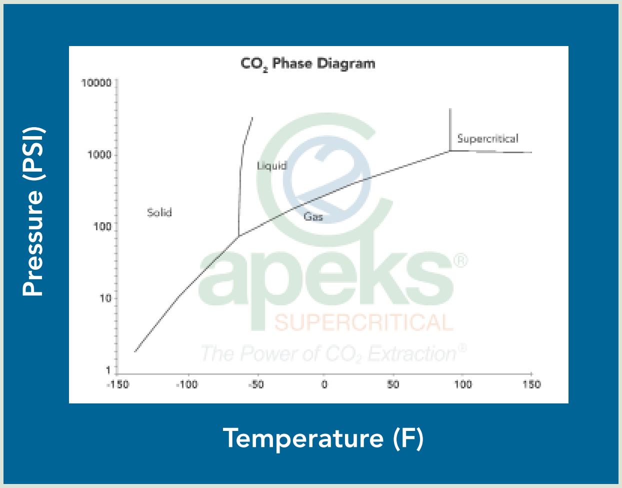


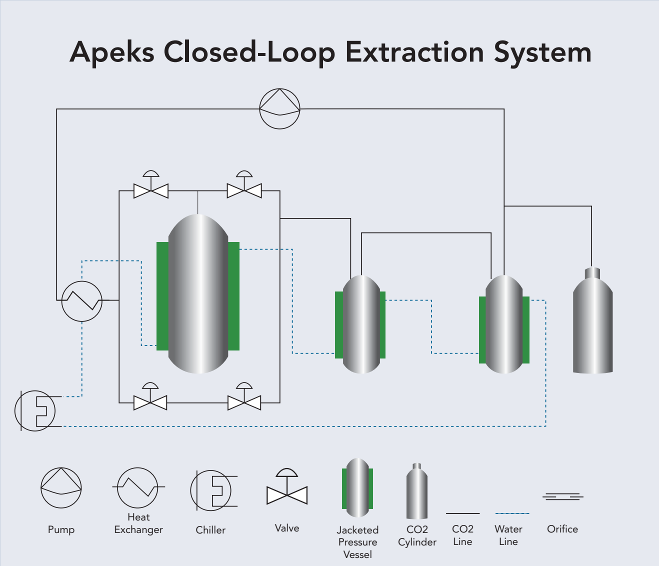
Liquid CO_2 must be converted to a gaseous phase in order to extract plant oils. Phase changes require a significant amount of heating and cooling. That's why the Apeks Diaphragm Compressor Technology gas pumping system with regenerative heat exchange is designed to capture the hot/cold air which offset each other. This eliminates the need for an additional heater/chiller and consumes 33% less energy than other manufacturers' extraction equipment.

Liquid and Gas

When extracting up to 2000psi, gas pumping is most efficient; whereas with higher pressures liquid pumping then becomes more efficient. For this reason, The Force™ series **utilizes both gas and liquid pumps.** The Diaphragm Compressor Technology gas pump allows for cold separation and energy efficiency up to 2000psi. Then the second phase liquid pump takes over for high CO_2 flows at higher pressures.

Greater consistency; higher potency. The lighter, purer extraction on the left is the result of cold separation processing. The darkened extraction from the very same extractor without using cold separation has been thermally degraded by high temperatures in the separator vessel.

Data from multiple tests conducted by an independent laboratory indicate that cannabis oil extractions from cold separation processing are far more consistent over consecutive runs and retain higher levels of THCA, by as much as 20%.



Energy-efficient closed-loop system recirculates heating/cooling. Pumping gas allows for capturing the heat generated during the phase change of the CO_2 during compression to be captured. This heat is used in a regenerative heat exchanger to offset the cooling during the decompression of the CO_2.

Conversely, liquid pumping requires an additional chiller/heater because the phase-change energy is not recaptured, consuming 33% more energy than Apeks extraction systems. Additionally, systems which do not recirculate or are not closed loop lose 10 times the amount of CO_2 during an extraction run.

CAUTION

Beware of pump-less extraction systems that vent. These systems operate by heating a vessel to a supercritical state, then vent it to perform the extraction. But as it begins to vent, the pressure and temperature drop such that the system can no longer perform an extraction.

Fundamentals of closed-loop extraction using CO_2 as a solvent

1. **Extraction** – Extraction of the plant oil occurs in the extraction vessel
2. **Separation** – Separation of the oil from the CO_2 in the separation vessel. This requires a phase change from liquid to gas (solvent to not solvent). The phase change creates a large amount of cooling.
3. **Recirculation** – What happens to the gas after separation and before extraction. Gaseous CO_2 must be re-compressed and temperatures increased to be a solvent again.

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