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# HYDRO CARBON VS. CARBON DIOXIDE EXTRACTION

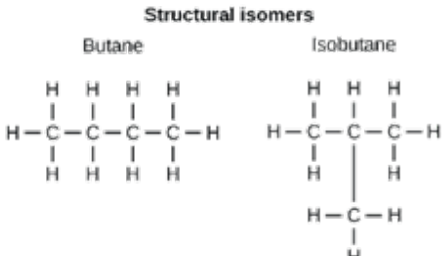
There are multiple current methods for extraction of oil from cannabis, using different solvents or techniques to obtain specific types of oil products like butter, shatter, wax, or liquid oil. Most of these methods involve use of dangerous means to create these extracts. Butane hash oil extraction is probably the most well-known of these methods. Supercritical carbon dioxide extraction has been designed as an alternative method to obtain high quality oil extracts without risking damage to the operator or environment. When the benefits of supercritical carbon dioxide as a solvent are compared against butane, it becomes clear why CO2 supercritical extraction is quickly gaining preference and taking over the extraction market.

## BHO BASICS

Butane hash oil, also known as BHO, is a cannabis-derived oil made using butane as the solvent. In a basic BHO extraction the first step, known as a 'wash,' involves passing butane through a column containing the plant material. The butane strips the cannabinoids, terpenes, waxes, lipids, and other chemical compounds from the plant material. The butane must then be separated, or 'purged' from the extracted plant oil. This can be done through heating, by vacuum, or through some combination of the two. Some producers will go one step further and pass the butane through cryogenic 'de-waxing' column after the wash step. The low temperature inside the column causes the waxes and lipids to become less soluble and precipitate out of the BHO solution as they are usually solids at cooler temperatures.

## BUTANE AS A SOLVENT

Butane is an organic hydrocarbon with the formula C4H10. It has a boiling point of around 0° C (31° F), making it a gas at normal room temperature and pressure. There are two isomers of butane, each with slightly different chemical properties; n-butane has 4 carbon atoms connected in a chain surrounded by 10 hydrogen atoms, and iso-butane has 4 carbon atoms arranged in a "T," surrounded by 10 hydrogen atoms. Unless otherwise specified, 'butane' refers to the n-isomer. Most BHO extraction operators prefer n-butane due to its lower operating pressure and low vapor pressure.




Butane is relatively non-polar; the molecule has a symmetrical arrangement and none of the bonds are significantly polar, meaning the molecule has almost no charge. As a rule, like dissolves like. In other words, polar solutes will to dissolve in polar solvents, and vice-versa. THC and CBD, along with a large variety of other terpenoids, are relatively non-polar and will readily dissolve in butane, along with lipids and waxes. Chlorophyll, a green pigment found in most plants, can contribute to foul taste and discolouration of cannabis derived extracts. Fortunately, chlorophyll is relatively polar and does not readily dissolve in butane.

## RUNNING A BHO EXTRACTION SYSTEM

BHO extraction time can vary depending on the size and model of the extraction equipment, though typical run times average from 5-10 lbs of plant material processed per hour. The yield of a BHO run will vary depending on the equipment and the quality or type of the starting material. Trim runs can yield anywhere from 5-15% return by mass, while popcorn or flower runs can yield as high as 15-27% return by mass.

Butane is usually shipped under pressure as a liquefied gas. There are several grades of butane available that vary in purity: Chemically Pure, 2.0, at 99% by weight, Instrument, 2.5, at 99.5% by weight, and Research, 4.0, at 99.99% by weight. The higher the grade of butane the less contaminants, though at higher cost. Producers should use the highest grade available. At Instrument grade, one 20 lb cylinder costs $250, and a 120 lbs cylinder will cost $1180. A significant price increase can be expected for Research grade.

Probably the most common BHO extraction systems are underground, home-made systems that utilize the principle of 'open-blasting'. In this method, a can of butane is "blasted" through a glass or PVC tube filled with cannabis. The butane gas escapes into the environment while the butane-infused cannabis oil collects into a dish. As blasting is inherently dangerous, most states that allow for BHO extractions require the use of closed loop systems, where butane is recycled for reuse instead of vented into the surrounding environment. The cost of a lab quality 40-200L closed loop BHO extraction system can range from $25,000 to $60,000 USD. This does not include the price of butane, ventilation, or a protected explosion proof environment. Although

the install can pose hazards, closed loop systems significantly decrease operating risks for owners.

Butane is a highly flammable colourless gas. The flash point, or the lowest temperature at which vapours will ignite when given an ignition source, is -60 °C (−76 °F). Thus, a spark from a light switch, an electric hand tool, or even a static charge can trigger an explosion. Furthermore, the autoignition temperature, or the lowest temperature at which a substance will spontaneously ignite in normal atmospheric pressure without an ignition source, is 288 °C (550 °F), which is a temperature easily reached by a stovetop or oven element. The National Fire Protection Association has assigned a flammability rating of 4 (on a scale of 0 to 4), classifying n-butane as extremely hazardous. For these reasons, most states that allow for BHO extraction systems require a properly ventilated Class 1/Division 1 explosion-proof room. Both the room and BHO extraction system must be inspected by a certified industrial hygienist or engineer to be sure they conform to regional and municipal codes and nationally recognized accreditations. Workers must be adequately trained and understand the hazards associated with working with closed loop BHO extraction systems.

Even with proper training, equipment, and environment, BHO extraction systems can be dangerous. Washington, Colorado, and Oregon have all reported an increase in BHO explosions since cannabis legalization, even though Colorado and Oregon have tight restrictions on BHO production. In 2014, there were 3 BHO extraction explosions, 30 injuries, and 32 explosion related deaths. This is in comparison to 12 explosions and 18 injuries in 2013.

## SUPERCRITICAL CO2 EXTRACTION (SCE)

Supercritical CO2 Extraction is quickly becoming the preferred solvent in the Cannabis industry. Despite having a more costly initial setup, CO2 is cheaper than butane, making the system more cost-effective to run. In a closed-loop supercritical extraction system, CO2 is constantly recycled- again, reducing cost. As CO2 is produced by natural means, if it is released back to the environment it does not have a negative impact on the atmosphere, making it a much safer and environmentally responsible choice than BHO. SCE does not require the same explosion-proof facility setup that BHO does, or safety equipment and training for operators to work with.

CO2 is also non-toxic- it is a natural waste product from human bodies and fermentation. Due to this and its gaseous state at atmospheric pressure, all extracts made from SCE are pure and completely clean of any potential toxic or heavy metal residues that can be left behind in BHO. Carbon dioxide is gaseous at atmospheric pressure, removing the need for an extra step to remove the solvent from oil extracts as in BHO. SCE extracts are FDA-approved, safe for use in products ingested by humans. Although both butane and CO2 are chemically inert, BHO is not a fully oxidized product, meaning that the cannabinoids obtained could continue to change structure and therefore lose the intended effect.

The pressure and temperature parameters of both extraction and separation will greatly influence the composition of your final oil product. The solubility and mass transfer properties of the target material within the solvent CO2 determine the operating conditions for that extraction. The conditions of a SCE system can be manipulated to fractionate desired compounds like terpenes, cannabinoids, waxes and esters out of the oil mixture in differing concentrations. This also provides the opportunity to refuse undesired compounds like chlorophyll from the extract. Manipulation in this manner makes SCE the perfect option for drug manufacturers looking to obtain higher concentrations of different biologically active components.

## CONCLUSION

Although BHO products may appear to be easy to make, the underlying risk involved with the extraction process and requirements for a Class 1/Division 1 explosion-proof room are additional factors that must be taken into consideration. BHO is still a viable extraction methodology, producing an extract that is sought out by some consumers. On the other hand, there has been some impressive technological advancement made with SCE, which provides a cleaner and safer option for operators to process cannabis, with the bonus of being able to produce a full spectrum cannabinoid-rich product with an enriched perceived value.

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