High pressure preserves nature

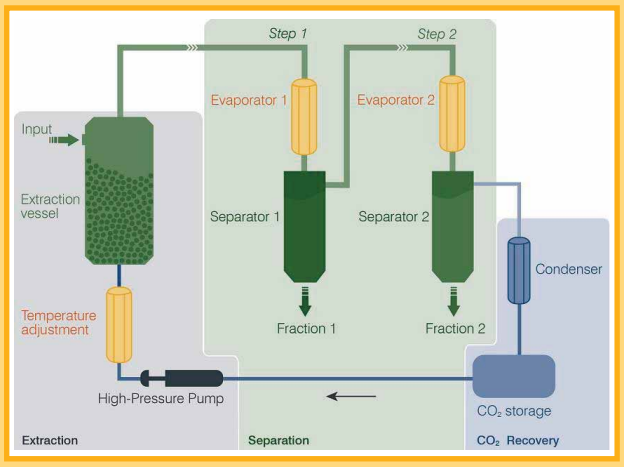
The separation of substances from natural materials to obtain standardized products plays a pivotal role in food technology. Traditionally organic solvents were used for extracting compounds from a mixture. It is hard to imagine that gases could also take over this challenge. However this process has been a reality on an industrial scale for several decades.

To convert gasses into effective solvents a liquid like density has to be created by applying pressure. In the field of this high pressure technology supercritical CO_2 emerged as the most suitable solvent. CO_2 extraction is used particularly in the food and beverage sector due to its manifold advantages and areas of applications.

Process

The principal of CO_2 extraction technology is illustrated in the technical chart:

To generate supercritical CO_2, liquid CO_2 is compressed with a pump and the temperature is adjusted. Then the supercritical CO_2 passes through the biomass in the extraction vessel and extracts the soluble substances. To separate the extract from the CO_2, the pressure is subsequently reduced. Thus the CO_2 converts to a gas again, loses its solvent properties and the extracts precipitate into separators. Optionally two fractions can be produced in one extraction process by regulating the conditions step by step. After the separation of all extracts from the CO_2, the recovered CO_2 is liquefied again in a condenser and recirculated.



CO_2-extraction process

One of the five industrial CO_2-extraction plants at NATECO$_2$

Process benefits

In comparison with conventional extraction methods using organic solvents, CO_2 extraction offers many benefits:

- No residues of any organic solvents remain in the product. Thus, the extracted materials as well as the extracts are immediately ready to use without the requirement of any additional processing step like the evaporation of any solvents.
- Due to the moderate temperatures and the absence of oxygen during the process, products are only exposed to minimal strain and active components and aromas are preserved.
- The solvent CO_2 is neither combustible nor explosive and is available in large quantities at reasonable prices.
- In one extraction step, different extracts can be produced by fractional separation.
- Working in an oxygen-free atmosphere leads to biocidal effects: The total germ count of products is reduced enormously by CO_2 -extraction.

The application of protective gasses during the packaging process of CO_2-extracts can be avoided. An inert atmosphere around the product is generated automatically by the small amount of CO_2 still dissolved in the extracts.

Therefore CO_2 extraction technology is already implemented on an industrial scale in producing hop extract, decaffeinating coffee or tea, degreasing cocoa, deoiling seeds or obtaining aromas.

Hops and CO_2

According to the German Beer Purity Law from 1516 it is only allowed to use water, barley and hops for brewing beer. The original reason to add hops to beer were their anti-microbiological properties. Hygiene standards in breweries have since improved significantly and nowadays the aroma is the crucial reason for mixing hops into beer. Alpha-acids (humulones) are the initiators of the bitter taste. Beta-acids, polyphenols and volatile aromas are further important hop ingredients. Modern brew masters mostly do not use the original hop cones, but rather hop pellets or extract. The reason for this is the enhancement of logistics by the concentration of all relevant ingredients and an extended shelf-life.

For the refining of hops, only a few solvents like CO_2 are allowed. With pressures of around 300 bar all important compounds for brewing beer are extracted.

Decaffeinated tea

Green and black tea contains 1-4 % of caffeine and is consequently not appropriate for caffeine- sensitive persons or pregnant women and children. For this target group decaffeinated tea is the alternative choice. By decaffeinating tea using CO_2-extraction instead of organic solvents, the final product still contains a lot of aromas and polyphenols. Especially the healthy polyphenol epigallocatechin gallate remains in the decaffeinated green tea after the CO_2 extraction process. Both resulting products - the decaffeinated tea as well as the natural caffeine in the separators - are used in the beverage and cosmetic industries.

Degreasing of cocoa

The original cacao beans consist of 50-60 % butter. After mechanical treatment of the beans a press cake with 10-12 % butter is produced. To remove this remaining butter, solvents are necessary and CO_2 is the agent of choice. After extraction with CO_2 the cocoa with less than 1% butter as well as the cacao butter is free from organic solvents and can be used directly in diet- or cosmetic products.

Deoiling sabal

The saw palmetto originates in the south-east of the USA. It is a small palm with long leaves which have the appearance of a saw. The valuable oil of the black berries from the palm is rich in phytosterols and free fatty acids. The extracts from the berries are believed to be active against hormones which stimulate the growth of the prostate. Consequently hyperplasia of the prostate might be slowed down. By extracting the berries with CO_2 in an oxygen free atmosphere, the active components are concentrated in the oil ready for use as additives in nutraceuticals.

Innovations using ultra-high pressure

The solubility of substances in supercritical CO_2 changes with the temperature and pressure of the solvents. Most industrial plants are designed for pressures of up to 500 bar but often the extraction of bigger molecules or special substances is not economical under these conditions. Therefore NATECO$_2$ has established an R&D plant with a maximum operating pressure of 1000 bar. As an intermediate stage, a self-developed 1000 bar pilot plant, which is adequate for R&D purposes as well as for small scale production, is also available. The 1000 bar unit is completed by a newly built production plant, to guarantee scale-up from kilogram to tons range, displaying unique capabilities. The demand for products which require extraction pressure of 1000 bar is constantly increasing.

Carotenoids

Most Carotenoids are highly sensitive to oxidation. Additionally the extraction of carotenoids only becomes economical at pressures higher than 700 bar. Consequently the ultra-high pressure plants at NATECO$_2$ are optimized for the CO_2-extraction of sensitive molecules in the absence of oxygen. Products like algae, marigold or paprika are already extracted on a large scale at NATECO$_2$.

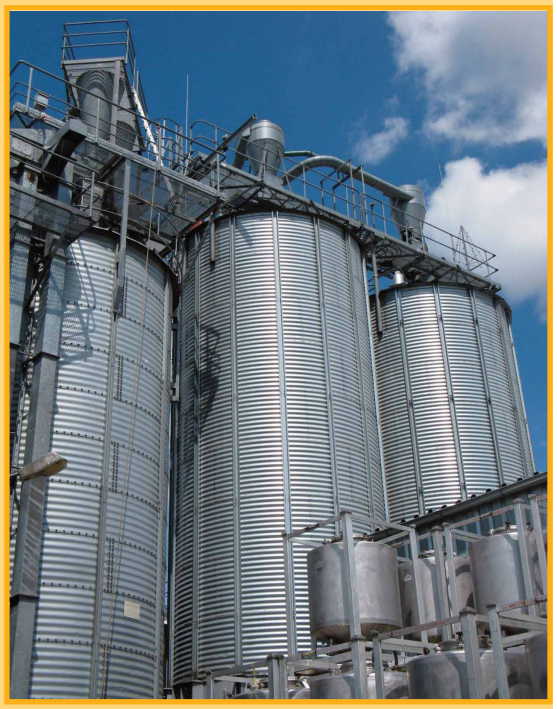
Xanthohumol

Xanthohumol is a polyphenol in hops which possesses anticarcinogenic properties. With a special patent protected technology NATECO$_2$ concentrates the valuable ingredient at pressures of around 1000 bar and extracts ready for pharmaceutical or nutraceutical applications are gained.

Conclusion

At NATECO$_2$ it's all about CO_2 – the green solvent. The absolute food grade CO_2 we use is gained from a chemical process as a by-product, and is therefore considered "neutral" concerning the eco-balance. NATECO$_2$'s extraction technology ensures its safe and effective application. Due to ongoing improvements in production and well-thought-out recycling processes, only minor losses of CO_2 prevail. Additionally, this proprietary high pressure technique allows the omission of organic solvents, which are often classified as hazardous and toxic and cause enormous problems and costs when dealing with their environmentally-friendly disposal. Besides this, there is no contamination of the products, so that they can be used right away in the appropriate field of application.

Just a few of manifold examples for the application of the CO_2-extraction process are mentioned above. NATECO$_2$ is also experienced in extracting a wide range of products industrially like piperine from pepper, aroma from vanilla, omega-3-fatty acids from algae or active compounds from Valerian or Mistletoe.



Hop silos

NATECO$_2$

Extracting the essence of nature

Extraction of natural products using supercritical CO_2

Since 1962

NATECO$_2$ GmbH und Co. KG I Auenstraße 18-20 I 85283 Wolnzach I Germany I Telephone +49 8442 660 I contact@NATECO2.de

www.NATECO2.de