Green Technology Applications for Carbon Dioxide at the BioComposites Centre, Bangor University

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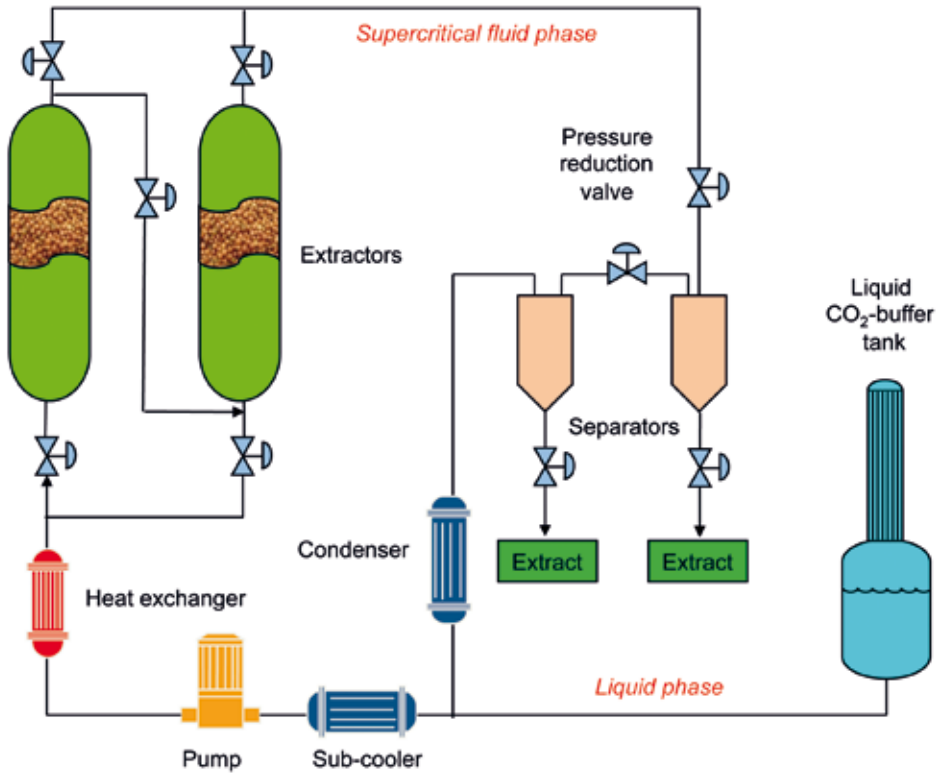
Carbon dioxide has attracted a very negative image as a "Greenhouse gas" over the last few years but it can be successfully used as a highly tunable solvent to replace traditional petrochemical solvents. The Biocomposites Centre (part of the Welsh Institute for Natural Resources, Bangor University) promotes the development and implementation of green and sustainable chemistry and related technologies in order to create new products and processes. The Centre has invested in one of the most versatile small-scale CO_2 extraction plants in the UK, to make this technology available to commercial companies and academic groups.

Carbon dioxide is generated from many everyday activities, and is a by-product in the chemical and brewing industries. The recent growth in the production of biofuels such as bioethanol means that a sustainable supply of high purity CO_2 is now readily available. The use of liquid or supercritical CO_2 provides an alternative to conventional organic solvents in a wide range of applications including extraction and fractionation of botanical materials, reactions with conventional or bio-catalysts, product cleaning and the production of micro particles. For extraction applications, CO_2 is universally considered to be a clean, green solvent (cheap, non-toxic, non-flammable and recyclable) and is used for the preparation of "organic" extracts in many countries. In addition, CO_2 is tasteless, odour free and does not leave residues in the extract or extracted material, making it suitable for food or nutraceutical based applications.

Extraction can be carried out using CO_2 in a liquid or supercritical state and the choice largely depends on the solubility of the molecules to be extracted. Liquid CO_2 is significantly less polar than supercritical CO_2 and is applicable only to small, non-polar molecules. In the supercritical state CO_2 is a highly tuneable solvent and the manipulation of temperature and pressure allows selective extraction of a wide range of molecules. Supercritical CO_2 has low surface tension and viscosity and therefore high mass

Typical commercial CO_2 extraction equipment



transfer rates can be achieved. These properties provide ideal conditions for extracting compounds with a high degree of recovery in a short period of time and with easy separation of products.

Some of the applications already developed using CO_2 as a solvent include:

- Extraction of bioactive molecules from herbs and spices for food and beverage use
- Extraction of waxes and oils for cosmetic, personal care products and neutraceuticals
- Extraction and fractionation of pharmaceutical molecules
- Recovery of valuable molecules from end-of-life electronics
- Synthesis of flavour and aroma molecules using biocatalysts to meet new EU legislation

The equipment within the Biocomposites Centre allows trials to be carried out on as little as 25g of material and is supported by excellent pre-treatment facilities and analysis of raw materials and products. Extraction protocols can also be scaled up in order to supply materials for formulation trials. The Biocomposites Centre also works closely with large scale extraction companies, to provide opportunities for the production of commercial quantities of target compounds.

To find out more about the application of these technologies in your business or research area contact the Biocomposites Centre.

The main benefits of carbon dioxide extraction technology include:

- *More efficient and environmentally friendly than traditional organic solvent based extraction techniques, with comparable or lower operating costs and energy requirements*
- *Highly selective isolation of different classes of plant chemicals by varying temperature and pressure, leading to pure, stable extracts with high levels of bioactive molecules*
- *Low temperature and pressures generally used for processing ensure that neither the extracts or residual material are degraded during the procedure*
- *Solvent free process with the potential to recycle the solvent for continued reuse*
- *Extracts produced using this technology are safe for use in both food and medicinal applications*

The Welsh Institute for Natural Resources is the leading business-facing unit in Bangor University, utilising the quality research expertise of the College of Natural Sciences and facilitating knowledge exchange between the University and a wide range of business and other organisations. Our internationally recognised research and knowledge base assistance ranges from blue-sky research to off-the-shelf solutions for our clients. Our headquarters and laboratories are in the Alun Roberts Building, with further laboratories in the Thoday Building, a commercial greenhouse at Henfaes, Abergwyngregyn and pilot scale facilities at Mona on Anglesey. We also have offices in Kathmandu, Nepal and Nairobi, Kenya.

Our focus is on the major challenges facing mankind in the coming decades: the need for global food security under conditions of climate change and sourcing alternative materials and energy in an oil-starved world together with a need to put sustainability at the heart of decision making at all times.

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