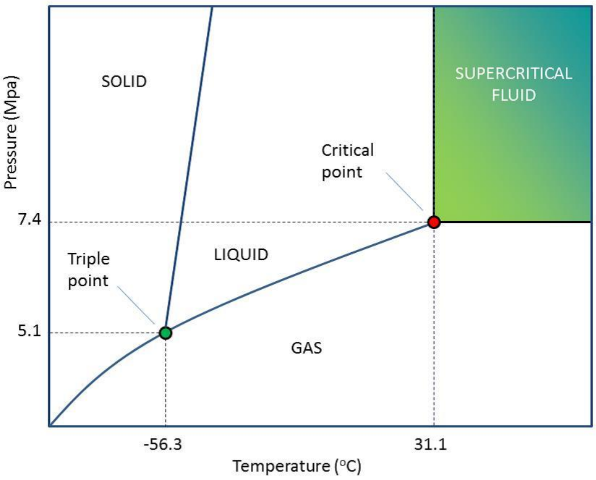
CO_2 as a Process Solvent



Carbon dioxide has attracted a 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. Carbon dioxide is generated from many everyday activities but the growth in the production of biofuels such as bioethanol provides an economic and sustainable supply of high purity CO_2. 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.
As a solvent, CO_2 is universally considered as a clean, green solvent and can be used for the preparation of "organic" extracts in many countries.

Carbon dioxide can be used in the liquid (sub-critical) or supercritical state. A supercritical fluid is a substance above its critical temperature (Tc) and pressure (Pc) which for CO_2 is 304 K (31.1 °C) and 7.4 MPa (73.8 bar), making the supercritical phase easily accessible compared to other solvents. Supercritical CO_2 has properties that are intermediate between gaseous and liquid CO_2 exhibiting both high diffusivity and low viscosity with variable density and polarity achieved through changing pressure and temperature.

Liquid and supercritical CO_2 are both weak, aprotic solvents and a comparison of physical properties with other commonly used extraction solvents shows that for most parameters liquid and supercritical CO_2 compare most closely to n-hexane. The range of molecules that can be extracted is more limited than with traditional organic solvents because of its low polarity, but this can be mitigated by the use of more polar co-solvents. Ethanol and water are most commonly used as co-solvents at Suprex. The low polarity of liquid and supercritical CO_2 allows selective extraction of less polar molecules. Sequential extraction of fractions at increasing pressure and temperature followed by the use of a co-solvent can enable relatively pure extracts containing a narrow range of compounds to be produced. For reactions, the stability and unreactivity of CO_2 provides a versatile and tuneable solvent.

From a legislative perspective carbon dioxide is universally accepted as a process solvent including for organic processing (EU Directive 88/344/EEC- as amended and Soil Association regulations clause 40.8.8 v16.4, 2011). Many of the current and new applications for supercritical CO_2 are driven by the replacement of current VOC usage and in many cases this results in a higher quality product without solvent residues. As the demand for natural products increases and the regulations on the use and disposal of solvents becomes more onerous, supercritical CO_2 presents a sustainable, economic and completely scalable alternative solvent.

Restricted by MRL*	Unrestricted	Organic
Diethyl ether	Propane	Water
Hexane	Butane	Carbon dioxide
Cyclohexane	Ethyl acetate	Ethanol
Methyl acetate	Ethanol	
Butan-1-ol	Carbon dioxide	
Butan-2-ol	Acetone	
Butan-2-one	Water	
Dichloromethane		
Methanol		
Propan-2-ol		
Propan-1-ol		
1,1,1,2-tetrafluoroethane		

* MRL – maximum residue level

www.suprex.uk info@suprex.uk 01286 840015