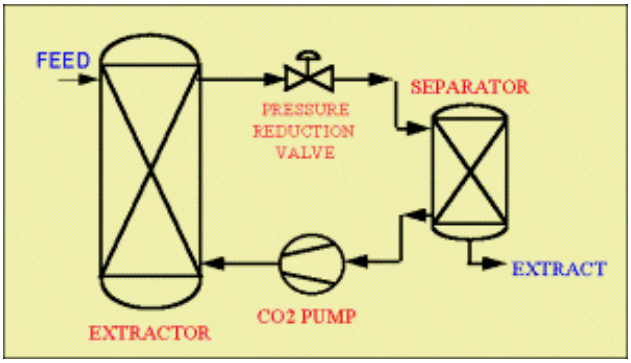
Supercritical Fluid-based Processing Technologies from IIT Bombay

Supercritical Fluid-based (SCF) Processing has been a significant research focus at the Department of Chemical Engineering at IIT Bombay (IITB) for over three decades. Currently IITB houses a wide range of experimental facilities: from bench-scale setups to pilot plant. The principal areas of research are:

- Extraction of natural products
- Micronization and Encapsulation of high-value nutraceuticals and pharmaceuticals
- Preservation of liquid and solid foods
- Reactions in supercritical fluids
- Pressurized Water-based extraction processes for natural medicinals and nutraceuticals

Key SCF systems available at IITB:

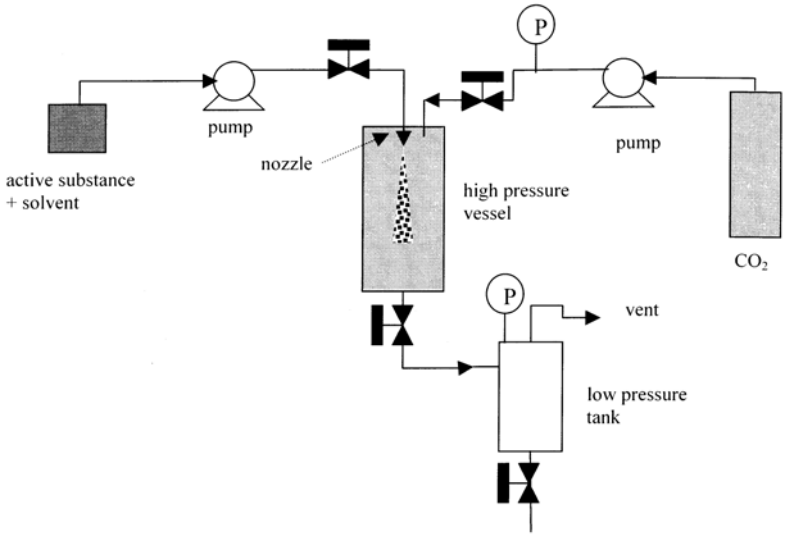
1. **Supercritical Fluid Extraction System:** SCFE is a two-step process (see schematic below) which uses a dense gas as a solvent e.g., carbon dioxide (CO_2) for extraction, above its critical temperature (31^{o}C) and critical pressure (74 bar). The feed, generally ground solid, is charged into the extractor. Supercritical CO_2 is fed to the extractor through a high pressure pump (100-500 bar). The extract laden CO_2 is sent to a separator (60-120 bar) via a pressure reduction valve. At reduced temperature and pressure conditions, the extract precipitates out in the separator. The extract free CO_2 stream, leaving the separator is then recycled to the extractor. In the case of liquid feed, the extractor is modified into a column through which feed and the supercritical CO_2 is fed either co-currently or concurrently.



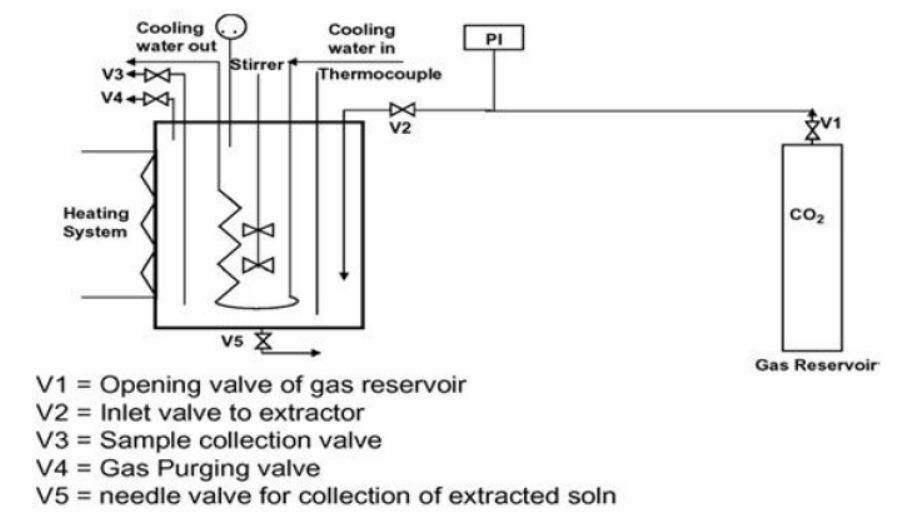
Supercritical Fluid Extraction Pilot Plant at IITB

2. **Supercritical Fluid Micronization/Encapsulation System:** Particle design (micronization and encapsulation) is presently a major development of supercritical fluids applications, mainly in the pharmaceutical, nutraceutical, cosmetic and specialty chemistry industries. Typically, the supercritical fluid is used as an anti-solvent that causes precipitation of the substrate(s) dissolved initially in a liquid solvent. The supercritical fluid is pumped to the top of the high pressure vessel (see schematic below) by a high pressure pump while the active substance solution is introduced into the high pressure vessel through a nozzle. To produce small liquid droplets in the nozzle, the liquid solution is pumped at a pressure higher than the vessel operating pressure. Particles precipitate due to thee anti-solvent action of the supercritical carbon dioxide, and are collected on a filter at the bottom of the vessel. The fluid mixture (supercritical fluid plus solvent) exits the vessel and flows

depressurization tank where the conditions allow gas-liquid separation.



3. **Pressurized Hot Water Extraction System:** At normal conditions the dielectric constant value of water is quite high, but at sub- or supercritical conditions, it is lowered water can mimic the behaviour of both polar and apolar solvents, and hence allowing the solubilization of a wide variety of moieties normally not very soluble in water. Subcritical water extraction or Pressurised Hot Water Extraction (PHWE) is based on this unique solvent property of water. A very wide range of herbal products may be extracted efficiently using this process. The PHWE system schematic is shown below.



Hot water is pressurized using gaseous CO2 at a moderate (2–20 bar) pressure. The pressurized water is then used to extract the analyte from the plant matrix. The extraction

efficiency depends upon: processing temperature and pressure, particle size of plant matrix, water to plant matrix ratio, etc. PHWE is suitable for a extraction of a various natural molecules: flavonoids, essential oils, saponins, etc.

Services offered to the industry:

The IIT, Bombay research team undertakes both fundamental and applied research in diverse areas of supercritical fluid technology. Apart from the study of a large variety of specific systems requiring SCF processing, the research experience has been translated into development of ***process*** and ***engineering designs*** of SCF systems (bench top to commercial scale) for:

(i) SCF-based extraction of natural products (spices, medicinal herbs, natural colours, flavours and fragrances, etc.)

(ii) SCF-based micronization and encapsulation of nutraceuticals and pharmaceuticals

(iii) Pressurized hot water extraction of herbals

The specific services offered to the industry are:

- *Technology Consultation*: Process Optimization; Selection / Choice of Viable Products; Selection of Optimum Process Plant Configuration, Feasibility Analysis
- *Generation of Extracts for Test Marketing*
- *Contract Research*

Contact:

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