Multi-Purpose Pilot Units for Supercritical Fluid Extraction of Liquids and Solids

<table>
<thead>
<tr>
<th>Standard Design</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. operating pressure 300 bar</td>
<td>500, 700 bar</td>
</tr>
<tr>
<td>Max. operating temperature 80°C</td>
<td>120, 150, 200°C</td>
</tr>
<tr>
<td>CO₂ flow 18 l/h</td>
<td>10, 30, 50, 100 l/h</td>
</tr>
<tr>
<td>Extractor capacity 1 litre</td>
<td>2, 4, 6, 10, 20 litres</td>
</tr>
<tr>
<td>Column interior diameter Ø 38 mm</td>
<td>Ø 50, 65, 90 mm</td>
</tr>
<tr>
<td>Column internal length 2 m</td>
<td>3, 4, 5 m</td>
</tr>
<tr>
<td>Liquid capacity 2 l/h</td>
<td>4, 10, 18 l/h</td>
</tr>
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</table>

Applications with solid raw material
- Production of natural extracts, e.g. hops, caffeine, spices
- Production of active agents for pharmaceuticals and cosmetics
- Degreasing of catalysts, microchips, medical implants
- Extraction of monomers from polymers
- Production of essential oils from blossoms, leaves and roots
- Regeneration of molecular sieves
- Decontamination of soils
- Production of natural colours e.g. oleoresins, carotene, bixin
- Conservation of antique books or wooden sculptures

Applications with liquid raw material
- Fractionated separation of oils and waxes
- Separation of polyunsaturated fatty acids (PUFAs)
- Removal of cholesterol from dairy products
- Refining of lecithin
- Non-alcoholic wine and beer

Related applications
- Impregnation of textiles and wood products
- Dyeing of textile fibres
- Tobacco expansion

Multi-purpose SFE pilot unit for solid and liquid raw materials built for 500 bar max. operating conditions designed for research (Russia). The system includes the options fractionated separation with fluid cyclone, modifier system and Coriolis mass flowmeter.
Multi-Purpose Pilot Units for Micronization and Spray Drying (RESS/GAS)

High-pressure micronization (RESS/GAS) is used to generate very fine and uniform powders or well defined geometries of solid particles by expansion of a high-pressure fluid.

**Advantages**
- Production of fine powders (nano-/microscale)
- Production of uniform powders
- Shape and size of crystals changeable in a wide range by modifying the process parameters
- Fine-tuning of particle-size distribution

**Features**
- For rapid expansion of supercritical solutions and gas anti-solvent recrystallization
- Closed CO₂ cycle
- Contaminant-free recirculation of supercritical solvent
- High-performance separation step

**Options**
- Semi-continuous discharging of solid products
- Diamond nozzle sets with different nozzle geometries
- Data acquisition system
- Process control and batch documentation with programmable logic controller (PLC)

**Applications**
- Formulation of pharmaceutical products
- Enrobing of active agents
- Production of colour pigments
System for fast determination of solubility data and for the observation of phase behaviour at high-pressure conditions, as base for supercritical fluid extraction processes.

Advantages
- Pressure-balanced optical cell allows to take samples without disturbing the equilibrium conditions
- Fast achievement of phase equilibria due to intense stirring
- Sapphire windows for the observation of the phase behaviour in function of pressure and temperature

Features
- Stirred phase equilibria cell with counterbalance piston
- Camera system with endoscope and cold-light source to represent the inside of the cell on a monitor
- Sampling valves for the upper and the lower phase

Options
- External recirculation of liquid and gas phase with high-pressure gear pump
- Larger cell capacities
- Sapphire windows up to optical width of Ø 28 mm

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<td>Max. operating temperature</td>
<td>80°C</td>
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<tr>
<td>Equilibria cell capacity</td>
<td>25 ml</td>
</tr>
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</table>

Phase equilibria cell with pressure-balanced piston.
Pilot unit built for reaction engineering research (Germany). This unit is equipped with a Berty-reactor for 450°C max. reaction temperature.

Performing a reaction at supercritical conditions enhances the conversion rates and the space-time yield. Smaller reactors can be used for the same amount of reaction product.

Advantages
- Improved space-time yield
- High selectivity
- Enhanced conversion rates
- Smaller reactors
- Higher catalytic activity
- Homogeneous reactions because of unlimited solubility of reactants
- Increased catalyst endurance

Features
- Fixed-bed tube reactors, slurry reactors, recirculation reactors, down-flow column reactors, Berty-type reactors
- Pressure generation for gases and liquids
- Mass flowmeters for gases and liquids

Options
- Data acquisition system
- Process control and batch documentation with programmable logic controller (PLC)
- External recirculation of reaction fluids

Applications
- Hydrogenations
- Polymerizations
- Isomerizations
- Oxidations
- Catalytic reactions
- Enzymatic reactions
- Synthesis reactions
- Hydrolysis

Standard Design
Max. operating pressure 50–1,000 bar
Max. operating temperature 20–500°C

Pilot unit designed for catalytic high-pressure reactions for a pharmaceutical company (Switzerland). The two reactors are fixed-bed catalytic reactors which can be operated up-flow, down-flow, in series or parallel.
Pilot Units for Supercritical Fluid Extraction of Solids

Modular SFE pilot unit built for 500 bar max. operating pressure designed for pharmaceutical research (Germany). The system includes the options fractionated separation, modifier system and Coriolis mass flowmeter.

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Selective separation of valuable thermolabile components from solid and liquid raw materials using a supercritical gas as solvent.

Advantages
- Low-temperature separation produces natural extracts
- Chemically inert and non-toxic solvents leave no residue in the extract
- Solubility variation achieved by changing extraction pressure and temperature
- High selectivity and diffusion rate

Features
- Closed CO₂ cycle
- Contaminant-free recirculation of supercritical solvent
- High-performance separation step
- Hand-operated quick-opening closures
- Continuous process with liquid raw materials

Options
- Fractionated separation with fluid cyclone
- Fractionated extraction
- Modifier system
- Multivessel design
- Preparation for retrofit with additional extractors, separators, etc.
- Data acquisition system
- Process control and batch documentation with programmable logic controller (PLC)

Sophisticated final separator with controlled liquid CO₂ level for the prevention of aerosol forming.

Level controller for liquid CO₂
Hand-operated quick-opening closure
Internal temperature measurement
Sapphire windows for visual observation of phase boundary
Heating jacket
Sampling valve for extract

Modular SFE pilot unit built for 500 bar max. operating pressure designed for pharmaceutical research (Germany). The system includes the options fractionated separation, modifier system and Coriolis mass flowmeter.