SUPERCRITICAL FLUIDS EQUIPMENT & PROCESS DEVELOPMENT
ER INGENIERIE PROPOSES TAILOR MADE EQUIPMENT TO ENTER SUPERCRITICAL FLUIDS TECHNOLOGY DEDICATED TO NATURAL PRODUCTS EXTRACTION AND FURTHER PROCESSES

SUPERCritical CO₂ ADVANTAGES:
❖ GREEN CHEMISTRY
  - Non-flammable, non-toxic, non-organic solvent
  - Mild conditions: integrity of the raw material
  - Extracts free from residual solvent
❖ SUSTAINABLE ALTERNATIVE to conventional Production Methods
❖ OPTIMIZE your Manufacturing Processes

CO₂ PHASE DIAGRAM

Natural Product Extraction using Supercritical CO₂

60 TONS/YEAR BRM* EXTRACTION UNIT
PHARMACEUTICAL INGREDIENTS PRODUCTION
cGMP EQUIPMENT

Gaseous CO₂
Liquid CO₂
Supercritical CO₂
Supercritical CO₂ + Extracts
Extracts
*Botanical Raw Material

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**WHAT IS A SUPERCRITICAL FLUID?**

Any fluid has a critical point which is reached at specific conditions of pressure and temperature. The fluid is considered as “Supercritical” since it is submitted to a temperature and a pressure higher than its critical point.

Placed into the supercritical domain, the fluid has particular physicochemical properties, at the interface between the liquid phase and the gaseous phase.

Supercritical Fluids particularly possess a high density (like liquids), low viscosity (like gases) and a diffusivity coefficient intermediate between those of gases and liquids.

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**SUPERCRITICAL CO₂**

Carbon dioxide is the most commonly used supercritical fluid:

- Cheap, easily available at high purities
- Chemically inert, non-toxic, non-flammable, free of bacteria
- Low critical point: 31°C and 74 bar
- Allows the fluid to be used at mild conditions of temperatures: integrity of thermo-sensitive materials
- Recycled CO₂ from industrial waste
- Selective molecules extraction with pressure variation
- Products are protected from oxidation
- Products and residues are solvent free

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**PROCESS DEVELOPMENT & IMPLEMENTATION**

For any Supercritical Processes, Supercritical Fluid is always chosen as an alternative to traditional organic solvents.

**EXTRACTION:**

From a solid raw material placed into an Extraction’s Autoclave, simple variation of Temperature and Pressure parameters allows to modify the solubilizing power of CO₂: selective molecules extraction is then possible. As soon as the desired compound is dissolved into Supercritical CO₂, pure extracts can easily be recovered via a depressurization through a Back Pressure Regulator and an Evaporator Heat Exchanger. Effluents, containing extracts and CO₂, are then precipitated and separated into one or several well-designed heated Separator(s), in which extracts can be collected into liquid form, and gaseous CO₂ recirculated and liquefied again to the Work Tank.

Any porous solid material can be treated using Supercritical Fluid Extraction in order to recover valuable compounds (essential oils, fragrances, pigments, active substances) or undesired compounds (wax, binders used for ceramic or metallic powders, pollutants, residual solvents ...)

Subcritical Water Extraction can also be used to extract hydrophobic compounds from various plant materials.

**FRACTIONATION:**

Using a Fractionation Column equipped with several stages including independent temperature control and internal packing, counter current flows of Supercritical CO₂ and Liquid Feed to be treated allows Extracts Fractionation and High Grade Purification.

**ENCAPSULATION – POWDER FORMATION:**

Specific and patented processes using Supercritical Fluids allow to perform Encapsulation of ingredients and polymers, as well as powders generation: crystallization, micro and nanoparticle generation, precipitation, micronization of inorganic, organic, pharmaceutical, and polymeric materials.

AND FURTHER PROCESSES LIKE DRYING, DYEING, IMPREGNATION, CLEANING, CHROMATOGRAPHY, REFRIGERATION, SUPERCRITICAL WATER OXIDATION DEDICATED TO WASTE TREATMENT....

PLEASE ASK OUR EXPERTS!
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EQUIPMENT DESIGN & REALIZATION: EXAMPLE OF 60 TONS/YEAR BOTANical RAW MATERIAL EXTRACTION UNIT

❖ cGMP DESIGN & CONSTRUCTION, QUALITY PLAN
❖ INSPECTION BY A NOTIFIED BODY
❖ COMPLETE QUALIFICATION OF THE PLANT (F.A.T., S.A.T., IQ, OQ, PQ)
❖ DESIGN, ASSEMBLY, PIPING, WELDINGS, FUNCTIONAL TESTS, QUALIFICATION DONE BY HIGHLY-QUALIFIED ER INGENIERIE TEAM MEMBERS

❖ FULL AUTO UNIT INCLUDING PROGRAMMABLE LOGIC CONTROLLER AND x2 THIN CLIENTS HMI’s
❖ SUPERVISORY CONTROL AND DATA ACQUISITION: ACCESS CONTROL (LOG IN/LOG OUT) AUDIT TRAIL RECIPE MANAGEMENT BATCH REPORT DATA LOGGING REAL TIME PROCESS PARAMETERS DISPLAY ALARM MANAGEMENT ❖ GAMP5 & 21 CFR PART 11 COMPLIANT

❖ QUICK AND SAFE ASSISTED CLAMPS CLOSURE SYSTEM
❖ OPTIMIZED EXTRACTION BASKETS
❖ FULL EX-PROOF UNIT
❖ 316L STAINLESS STEEL SYSTEMATICALLY USED
❖ P.T.F.E. AND COMPATIBLE ELASTOMERS USED: FDA COMPLIANT
❖ 3.1 & 2.2 MATERIAL CERTIFICATES
❖ 850L LIQUID CO₂ WORK TANK, 300L EXTRACTOR, 150L SEPARATOR
❖ CLEAN-IN-PLACE (CIP) USING ETHANOL

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EQUIPMENT DESIGN & REALIZATION: EXAMPLE OF SUPERCritical FLuids REACTION, DRYING, PARTICLES FORMATION & MICRO-ENCAPSULATION LAB UNIT

- 400 BAR & +300°C MAX. OPERATING CONDITIONS
- CODAP 2010 – ASME VIII
  COMPUTATION CODES, PED
  APPLIED DIRECTIVES AND STANDARDS
- 300 mL SOLUBILIZING AUTOCLAVE, EQUIPPED WITH SAPPHIRE WINDOWS
- 1L ATOMIZATION AUTOCLAVE, EQUIPPED WITH DYNAMIC MAGNETIC COUPLING MIXER, BASKET WITH SINTERED DISCS FILTERS AND SPRAYING NOZZLE
- 1L ATMOSPHERIC & HEATED GRAVITY SEPARATOR
- 1L SPECIFIC ATMOSPHERIC COLLECTOR FOR PARTICLES COLLECTION
- EQUIPPED WITH LIQUID CO2 PUMP, LIQUID CO-SOLVENT HPLC PUMP AND A GAS COMPRESSOR FOR NITROGEN INJECTION
- ALL REQUIRED UTILITIES AND INSTRUMENTATION FOR EASY & SAFE OPERATIONS
- FULLY DESIGNED, MOUNTED & TESTED BY HIGHLY-QUALIFIED ER INGENIERIE TEAM MEMBERS
- METALLIC C-RING SEALING FOR HIGH-PRESSURE & HIGH-TEMPERATURE OPERATIONS
- 316L STAINLESS-STEEL & HASTELLOY C-276 USED FOR PROCESS-CONTACTING PARTS
- ELECTRICAL CABINET INCLUDING GENERAL POWER ON/OFF, HEATERS ON/OFF, DEFAULT LIGHT BUTTONS, EMERGENCY STOP, RESET BUTTONS, AND ALL ELECTRONIC INDICATORS AND REGULATORS FOR PROCESS PARAMETERS MONITORING