Process Intensification of Supercritical Fluid Extraction

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Problem Statement

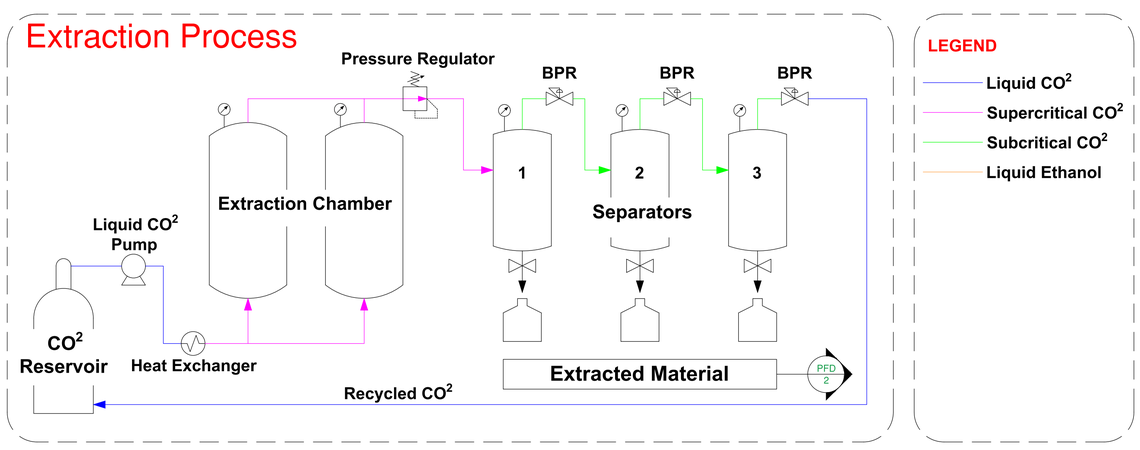
- There is no standardized method for industrial scale extraction of nutraceutical compound Dronabinol
- Current processes vary widely and use lab based methods not suitable for industrial scale
- A more efficient industrial scale process can be proposed utilizing process intensification techniques

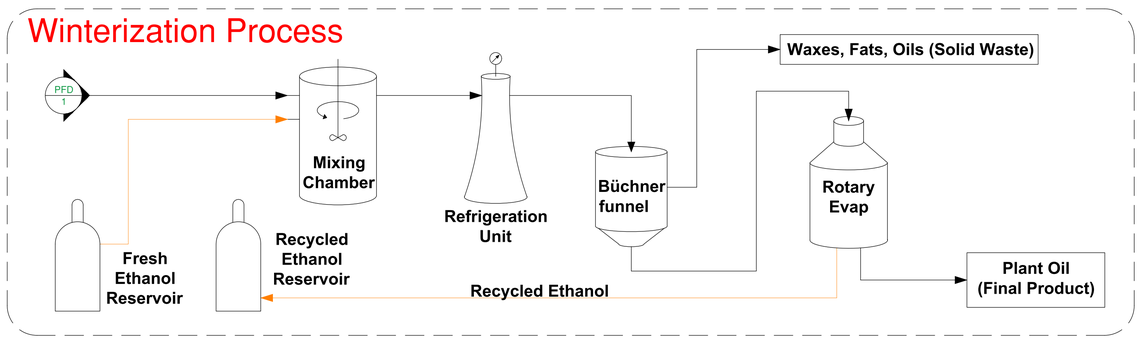
Scope & Objective

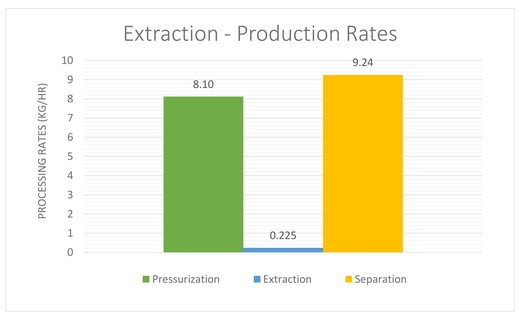
- Propose and design an intensified process with greater efficiency and production output for a typical Dronabinol extraction facility
- The supercritical fluid extraction (SFE) and winterization process will be intensified, specifically supercritical CO_2 (SC-CO_2) extraction
- Design is based on an extraction setup utlizing 2 x 45L SC-CO_2 system

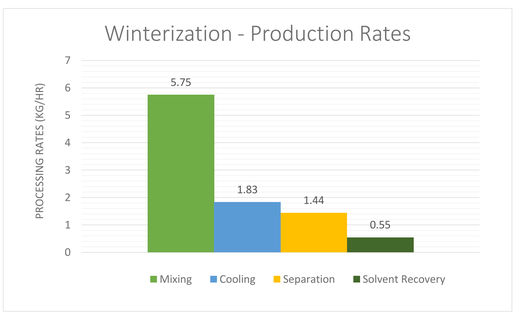
Current Process

- The figure below displays the current SC-CO_2 extraction and winterization process used in the industry
- The rate limiting step in the extraction process was identified to be the extraction chamber
- Rotary evaporators used in solvent recovery were identified to be the primary bottlenecks in the winterization process



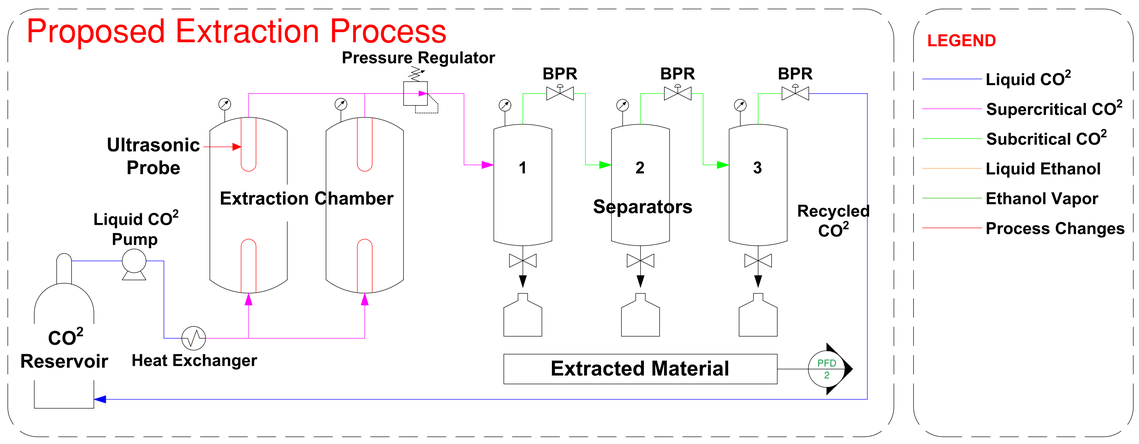


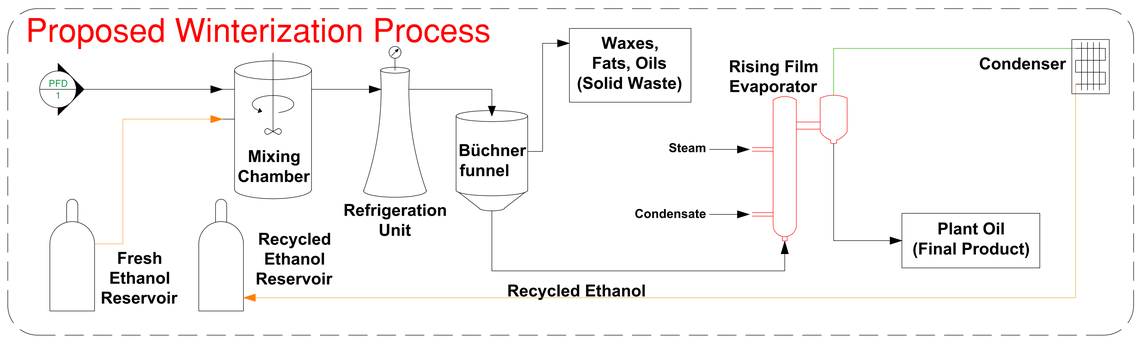




Proposed Process

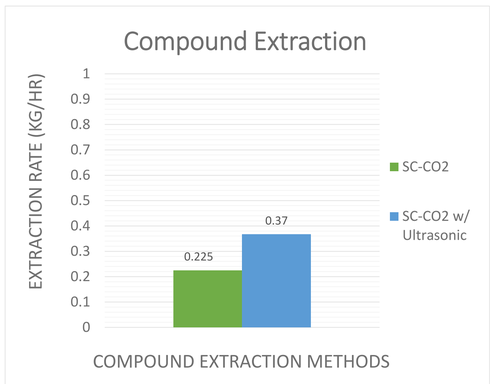
- Ultrasonic stimulation was added to the extraction chamber to increase extraction rate
- Experimental evidence has shown that micro-mixing from ultrasonic waves increases extraction rates in various SFE applications
- Extraction chamber is modified by adding an ultrasonic transducer and a control module to emit ultrasonic waves
- Rising film evaporators and a condenser can replace rotary evaporators to increase solvent recovery up to 7-fold
- Film evaporators are commercially available systems and are a turn key solution requiring minimal development

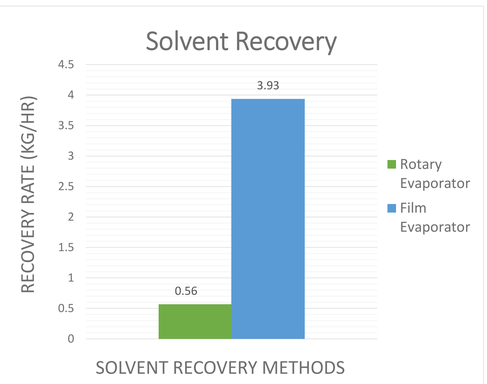




Results

- Extraction rates can be increased by 63% by applying ultrasonic waves
- Solvent recovery can be increased up to 7-fold by using rising film evaporators, increasing winterization output by 164%





Conclusion & Future Recommendations

- Based on calculations and experimental evidence, ultrasonic stimulation and rising film evaporators can increase process production
- Further research could be done by building and testing the proposed design at an industrial scale
- Promising technologies that can be explored in future :
  - Microwave Assisted Extraction
  - Podbielniak Contactor to replace refrigeration and Büchner funnel

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