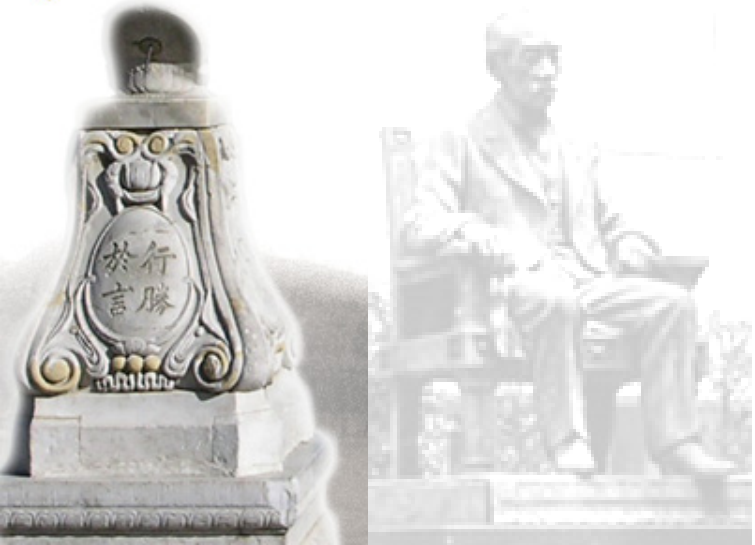
Microchannel Flow of SC-CO_2+H_2O system for SEE Process Design



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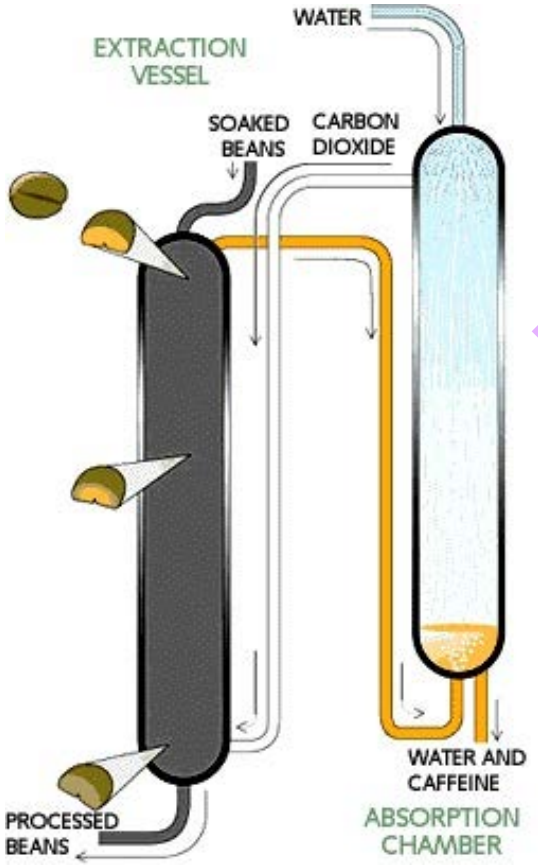
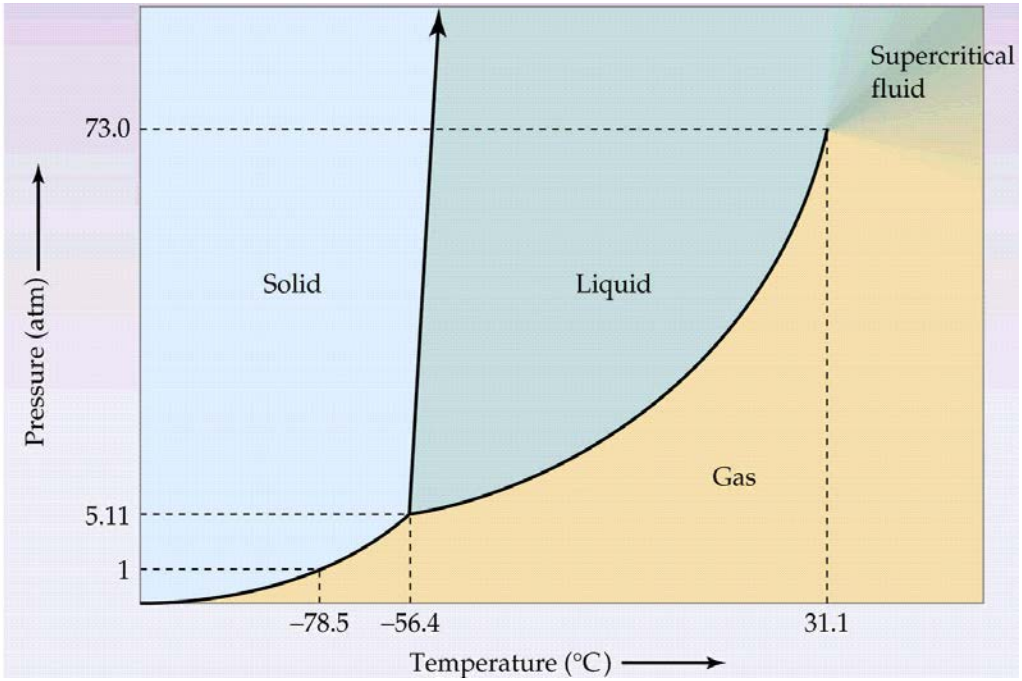
Group Photo

1. Background

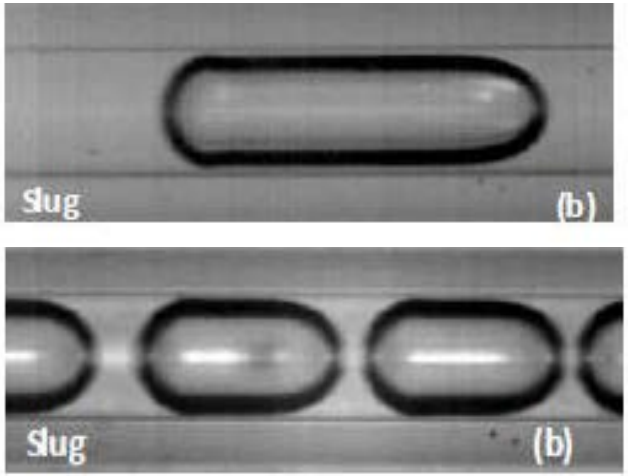


SC-CO_2 Extraction
for de-caffeine process ↑
http://www.beannorth.com/our-beans/the-quality/decaffeination-process/

Slug Flow
in a microchannel →
http://www2.egr.uh.edu/~dli9/research.htm



Phase diagram of CO_2



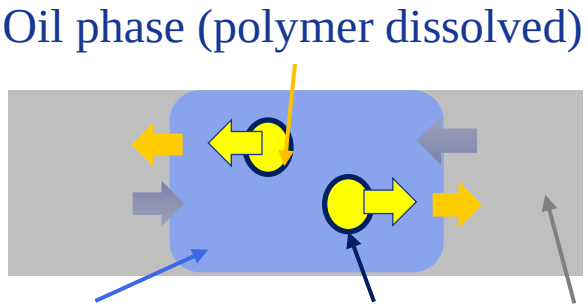
NEW PROCESS DESIGN

Nanoparticle System

- Mean diameter between 100 nm and 500 nm, SD/Mean < 0.1 (monodispersion).
- Biomedical use – drug release, drug targeting, injectable scaffolds.

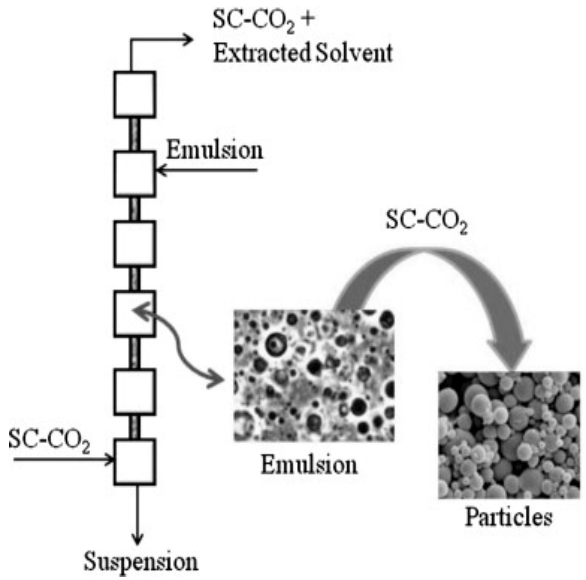
Supercritical Emulsion Extraction (SEE)

- Fast extraction preventing ***aggregation***.



Principle of SEE

Adapted from a ppt of Mr. Seiji Shinoda



Previous Work

Continuous SEE Process

G. D. Porta et al.

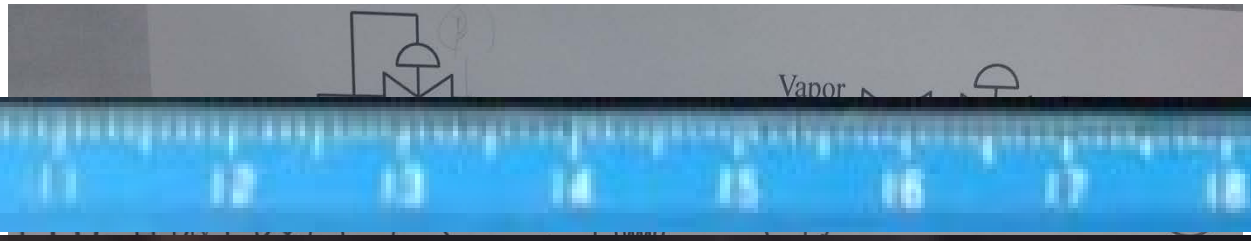
J of Supercritical Fluids, 76 (2013): 67-73.

Aim of the process – to prepare monodispersed ***nanoparticles*** by means of ***supercritical emulsion extraction*** (SEE) in a ***microchannel***.

Purpose of this research – to study the effect of ***liquid/gas ratio*** & ***temperature*** over ***slug length***, using SC-CO_2+H_2O as a ***simulation*** system.

→ → mass transfer in the process.

2. Method



Conditions

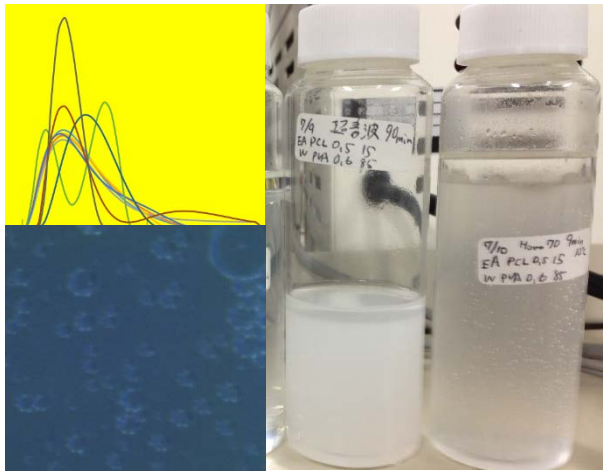
slugs, calculate the mean.

Electronic balance.
→→ L/G ratio calculation.

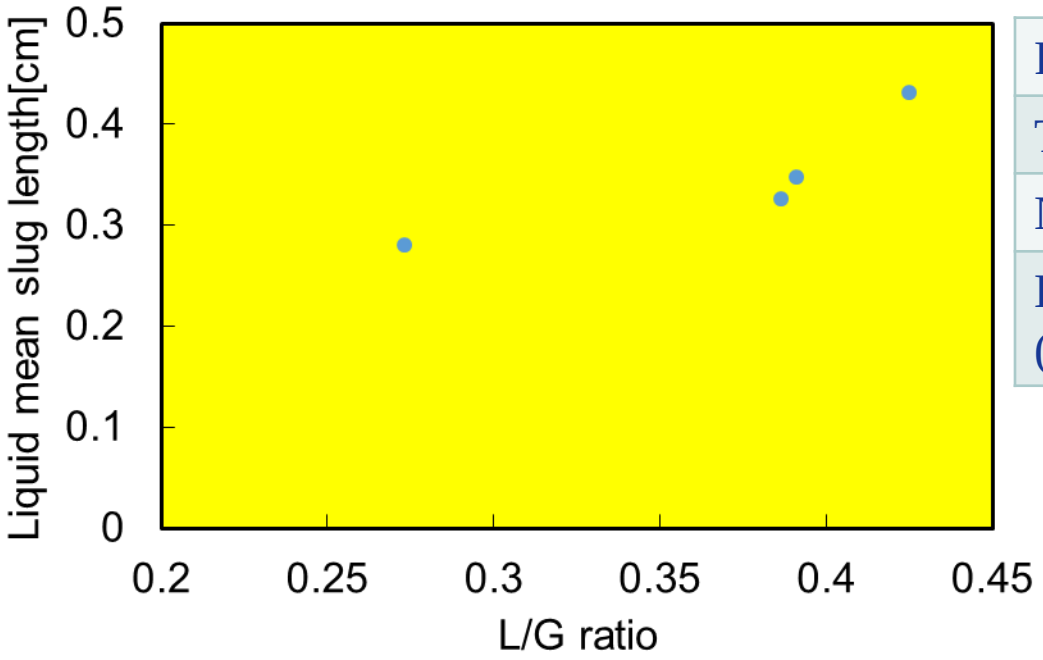
3. Results

- Main concerns – mean size & distribution.
- Instruments – homogenizer, ultrasonic washer, ultrasonic homogenizer (emulsion preparation), X-ray diffraction, digital microscope (diameter detection).
- Results – ultrasonic washer gives single-peak curve; *changed surfactant* stabilizes emulsion.

* Emulsion Preparation



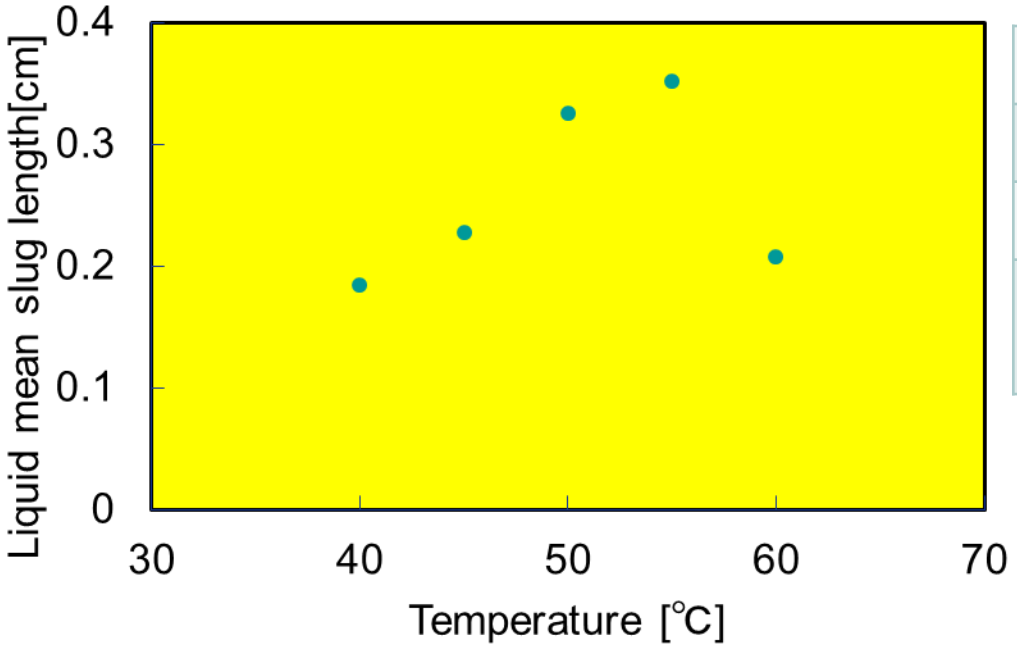
Effect of L/G (Mass) Ratio



Pressure (Mpa)	8
Temperature (ºC)	40
Needle Valve	0.10
Liquid Pump (mL/min)	0.25, 0.30, 0.35, 0.40

Mean slug length increases with increasing L/G ratio.

Effect of Temperature



Pressure (Mpa)	8
Temperature (ºC)	40, 45, 50, 55, 60
Needle Valve	0.05
Liquid Pump (mL/min)	0.30

Mean slug length does not change monotonously with temperature.

Upward tendency

Decreased surface tension (σ); …

Downward tendency

Increased volatility (P_S) of liquid;
Decreased viscosity (μ) of liquid; …

$$\frac{\langle L \rangle}{D} = \left(\frac{\mu_L^2}{\rho D^2 P_S}\right)^{\alpha} \left(\frac{\mu_L^2}{\rho D \sigma}\right)^{\beta} \left(\frac{\mu_L}{\mu_G}\right)^{\gamma} \left(\frac{L}{G}\right)^{\delta}$$

Further study …

- Minimizing experimental error.
- How operational parameters affect slug length.(simulation → real system)
- How slug length affects the efficiency of the SEE process.

→…→ Insight into the mass transfer for new process design.

~ Thanks for your attention ~