Supercritical CO_2 Technology

cleaning and catalyst impregnation

超臨界CO_2技術　-洗浄，触媒担持プロセス

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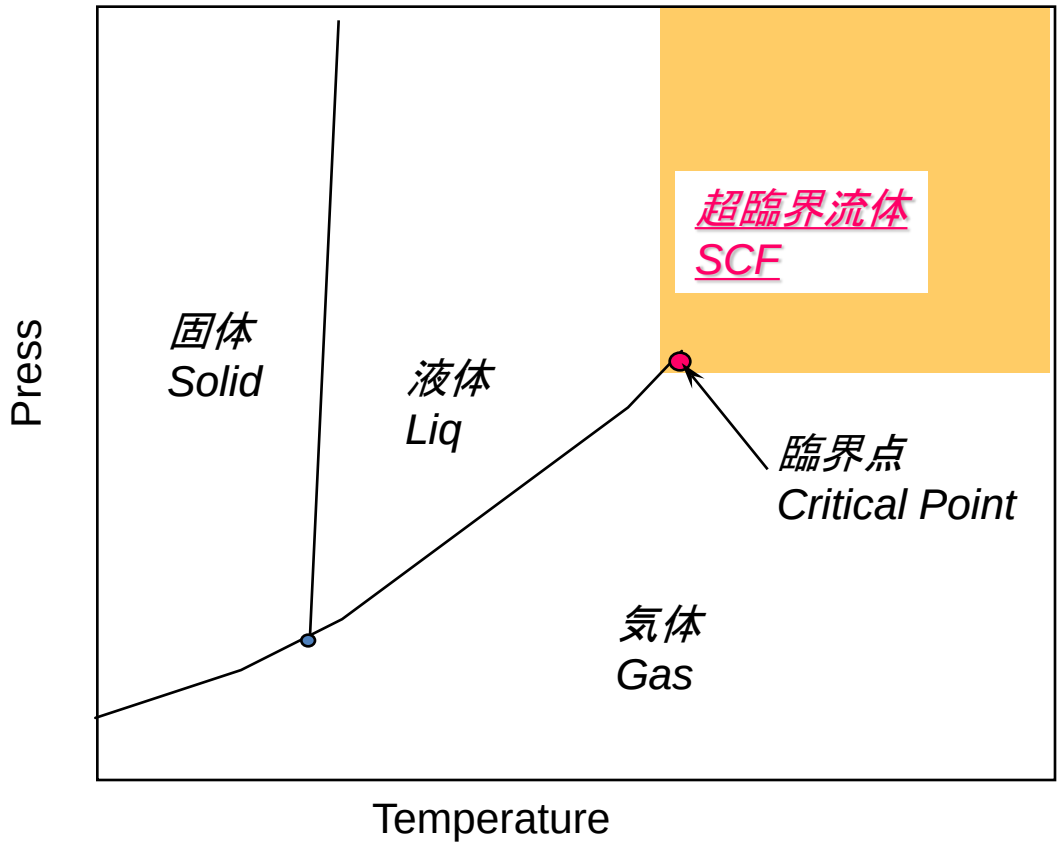
What is SCF ？

Non-condensable dense fluid above its critical temperature

Capable of controlling various properties widely
by tuning temperature and pressure conditions



General features of supercritical fluids

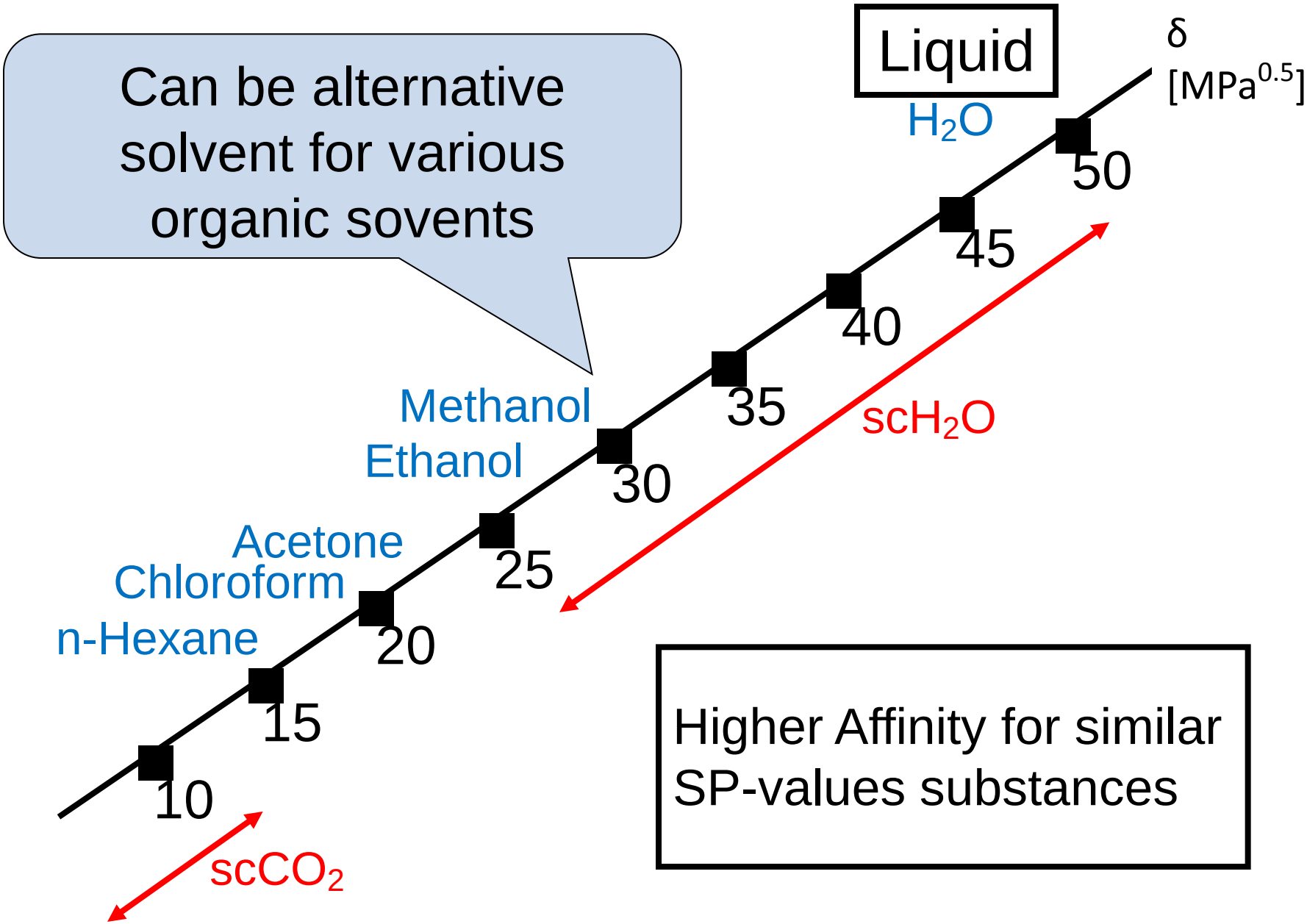
○Non-condensable dense fluid

Can vary its density continuously from gas-like to liquid-like values.

○intermediate between gas - liquid

Property	Gas	SCF	Liquid
Density [kg/m^3]	0.6~2	300~900	700~1600
Viscosity [10^{-5} Pa･s]	1~3	1~9	200~300
Diffusivity [10^{-9} m^2/s]	1000~4000	20~700	0.2~2
Kinematic Viscosity [10^{-7}m^2/s]	100	1～10	10

Solubility Parameter – index of solvent property-



Higher Affinity for similar SP-values substances

Applications

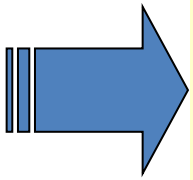
1. Cleaning of metal parts and clothes

2. Metal particle impregnation for catalyst preparation

No needs of DRYing process -

1. Pump-less circulating

⇔ Reciprocating Pump: generating particles

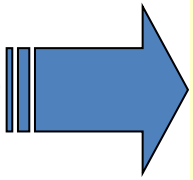


Solvent recycle during circulation

Solvent renewing

Rinsing System

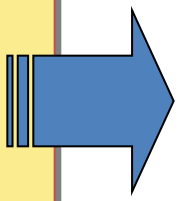
2. High penetrating and low surface tension



Porous supported catalysts

Benefits of CO_2 as a cleaning solvent

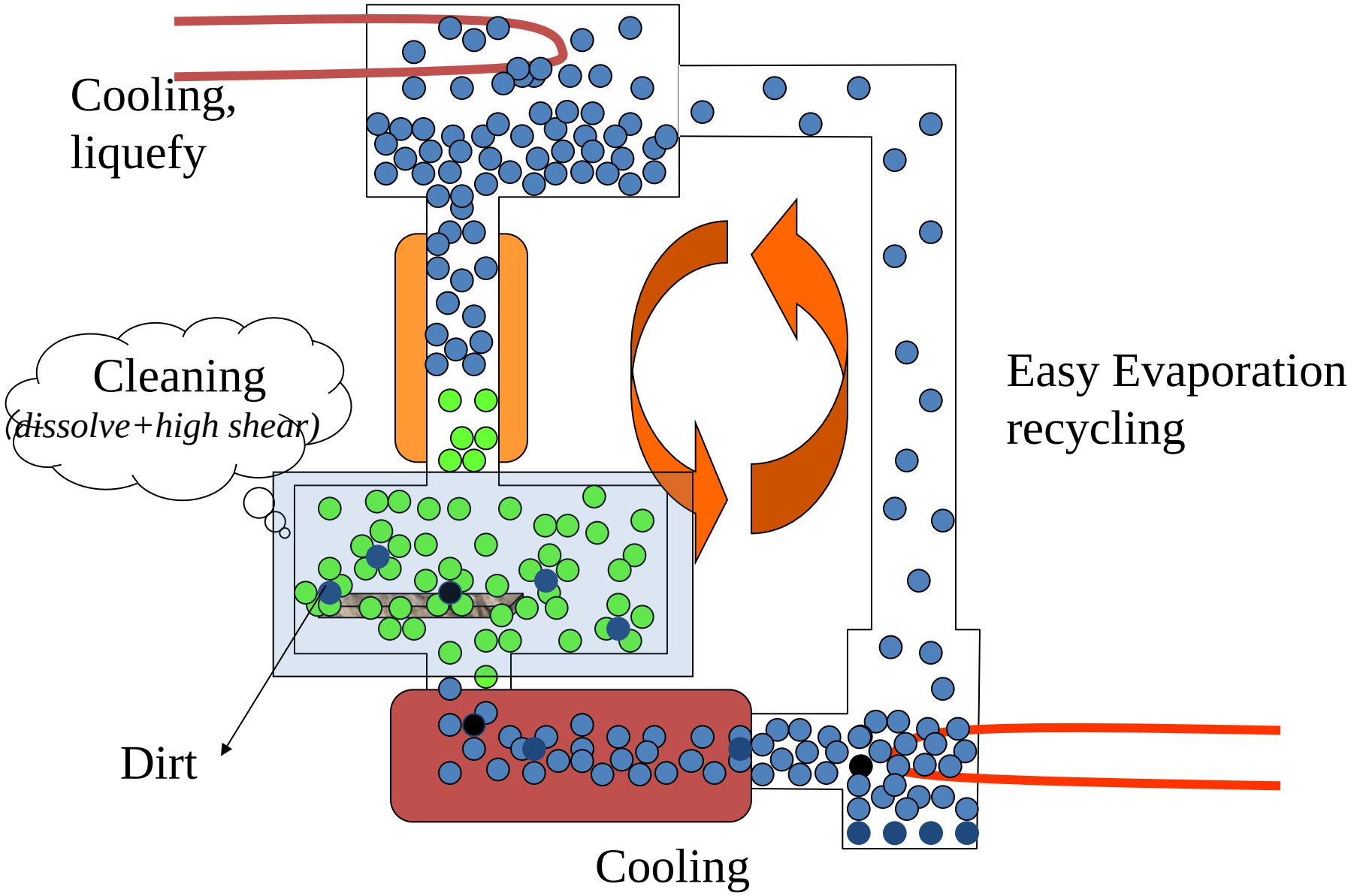
1）Environmental Friendly
2）Non-toxic, Stable
3）Inert (Less reactive)
4）Dissolve lipophilic
5）High diffusivity
　＋Low surface tension
6）Easy separation from dirt
7）Expect sterilization



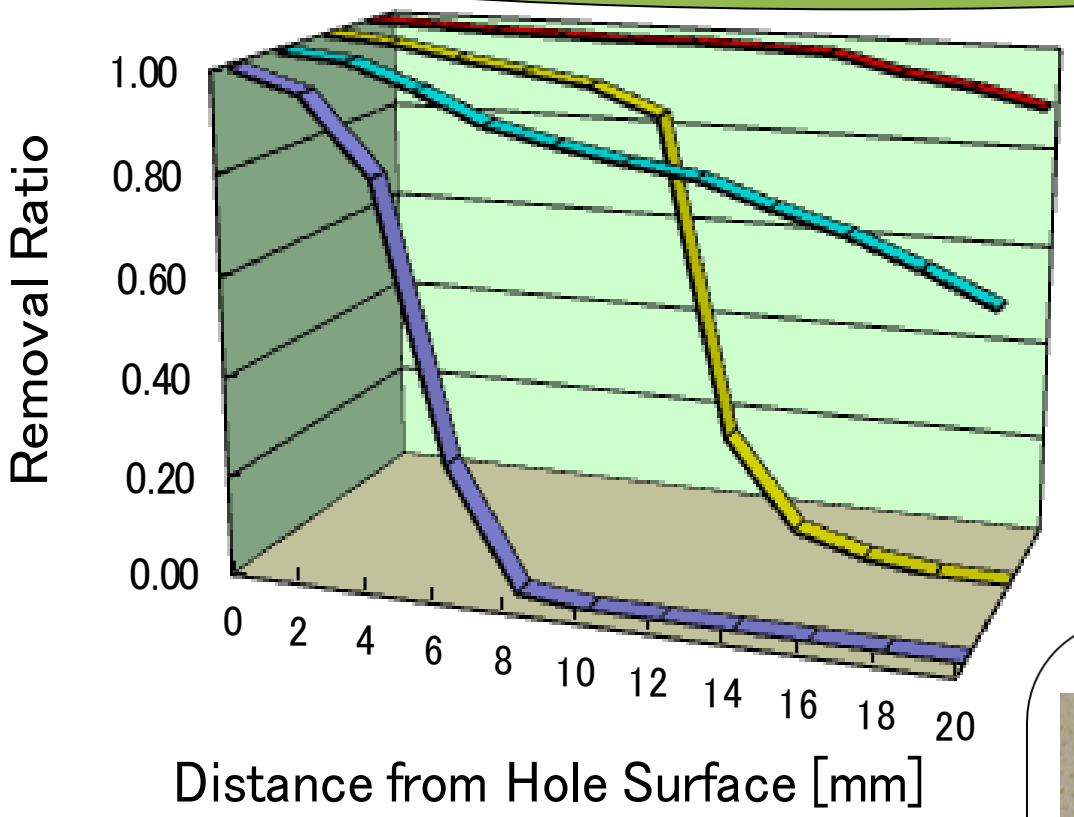
- precise machine
  - complicated (integrated) device
- water sensitive materials
- requiring long drying time
- solvent residual problem

Pump-less Solvent Circulation Method

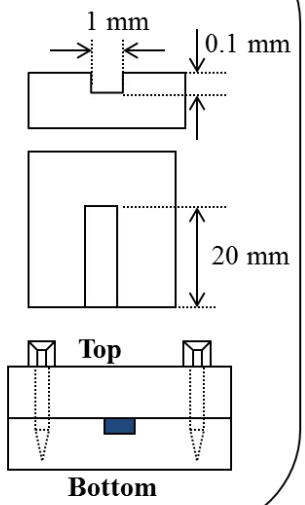
ポンプレスの溶媒循環機構



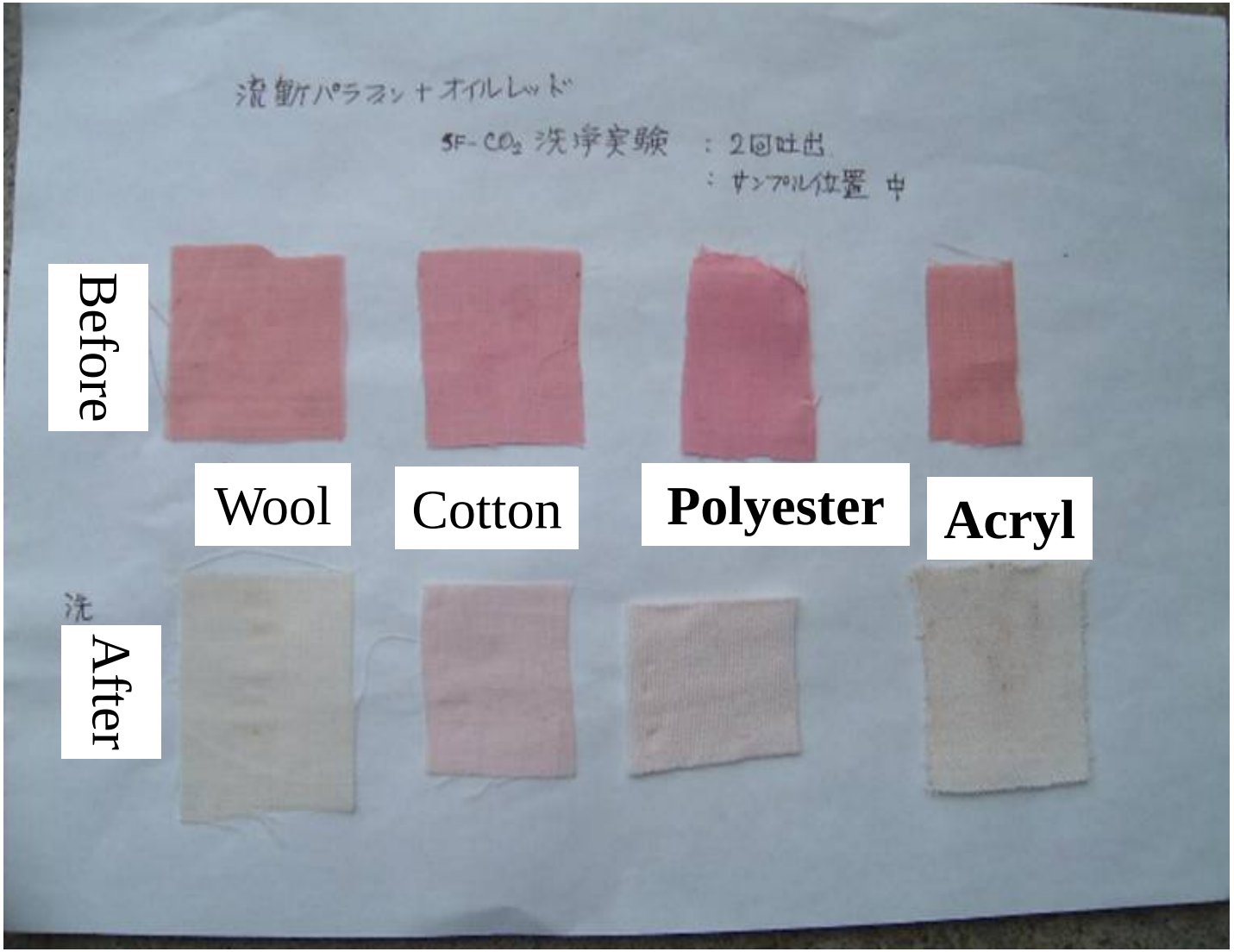
Test Cleaning Results —Flux—



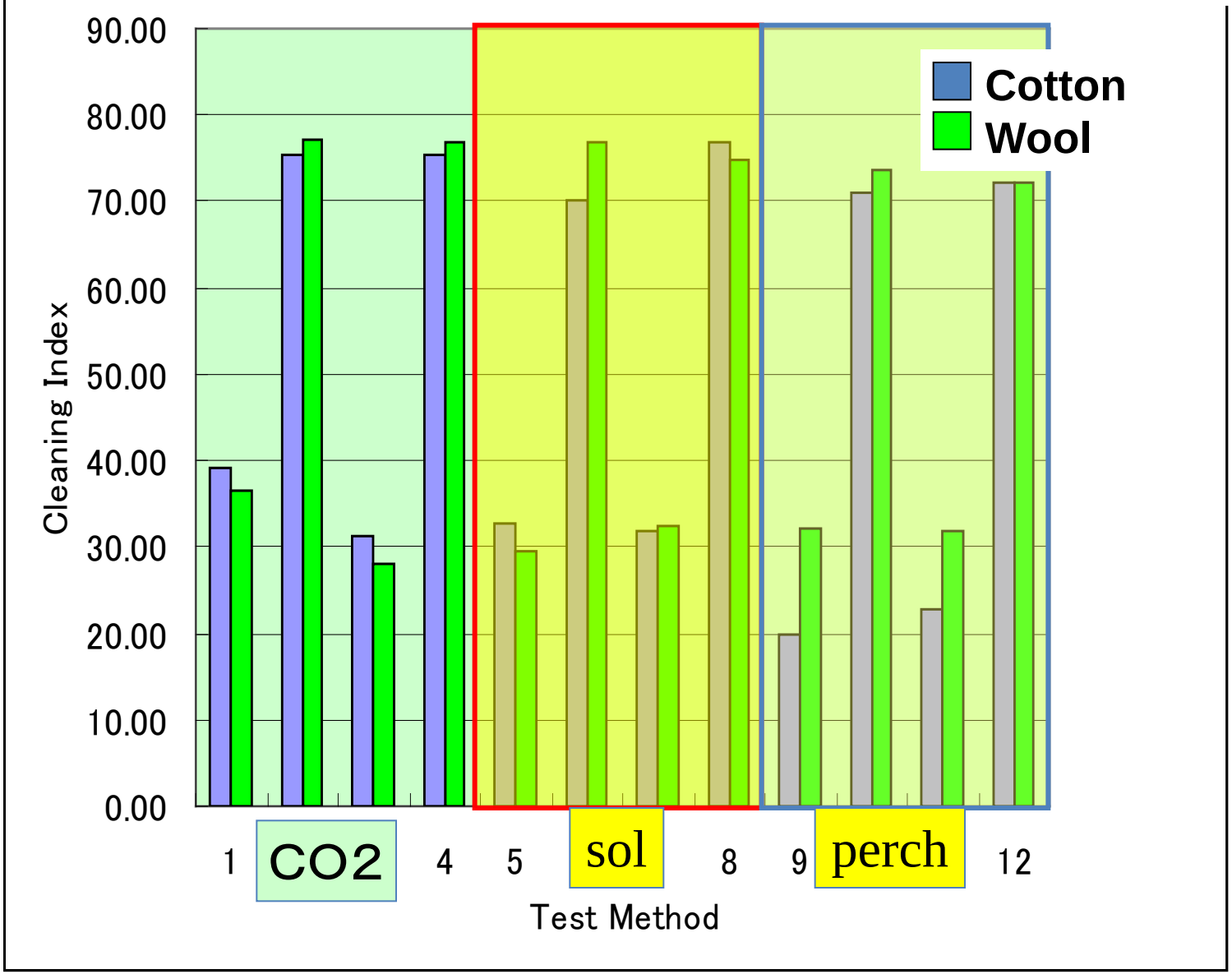
- Sub_critical at 25℃
- Sub_critical at 25℃ & Ultrasound (400 W, 250 kHz)
- Supercritical at 32℃, 7.7MPa
- Supercritical at 40℃, 9.3MPa



Comparison of Cleaning Performance
〔 Parafines+ Oil Red〕



Comparison with the conventional methods

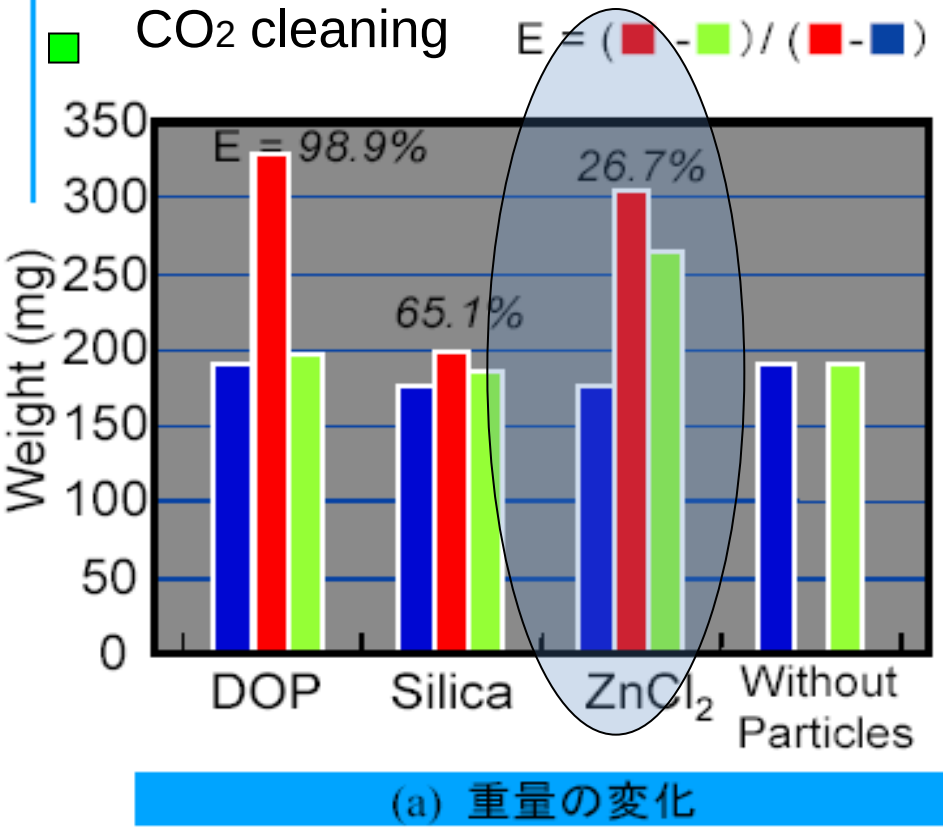


Almost same ＜Ps：No detergent for CO2 cleaning＞

HEPA Filter Recycle（Exp.Results）

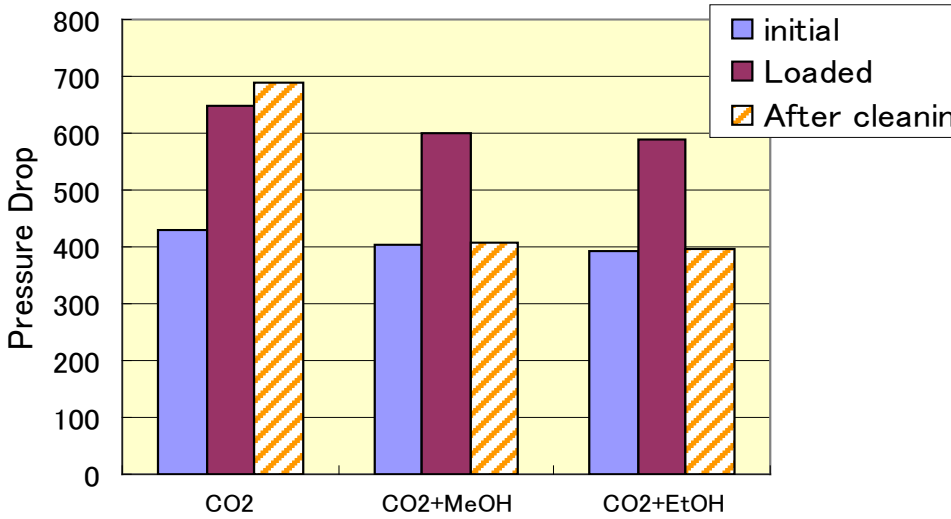
CO2:40℃, 20MPa, 120 min 6 L/min(STP)

- brand new
- used
- CO_2 cleaning



(a) 重量の変化

Entrainer Addition



Conclusions

- Cleaning is a promising field for supercritical CO_2 (sc-CO_2) technology because of its high diffusivity, low surface tension and no residual risk.

- High diffusivity and low surface tension are nice features for impregnation into porous meterials such as supported catalysts.

- Environmental friendly feature of sc-CO_2 is also suitable as a cleaning solvent.