Thomas Zemb

lecture n°3:

Coexistence of fluids: lessons from phase diagrams

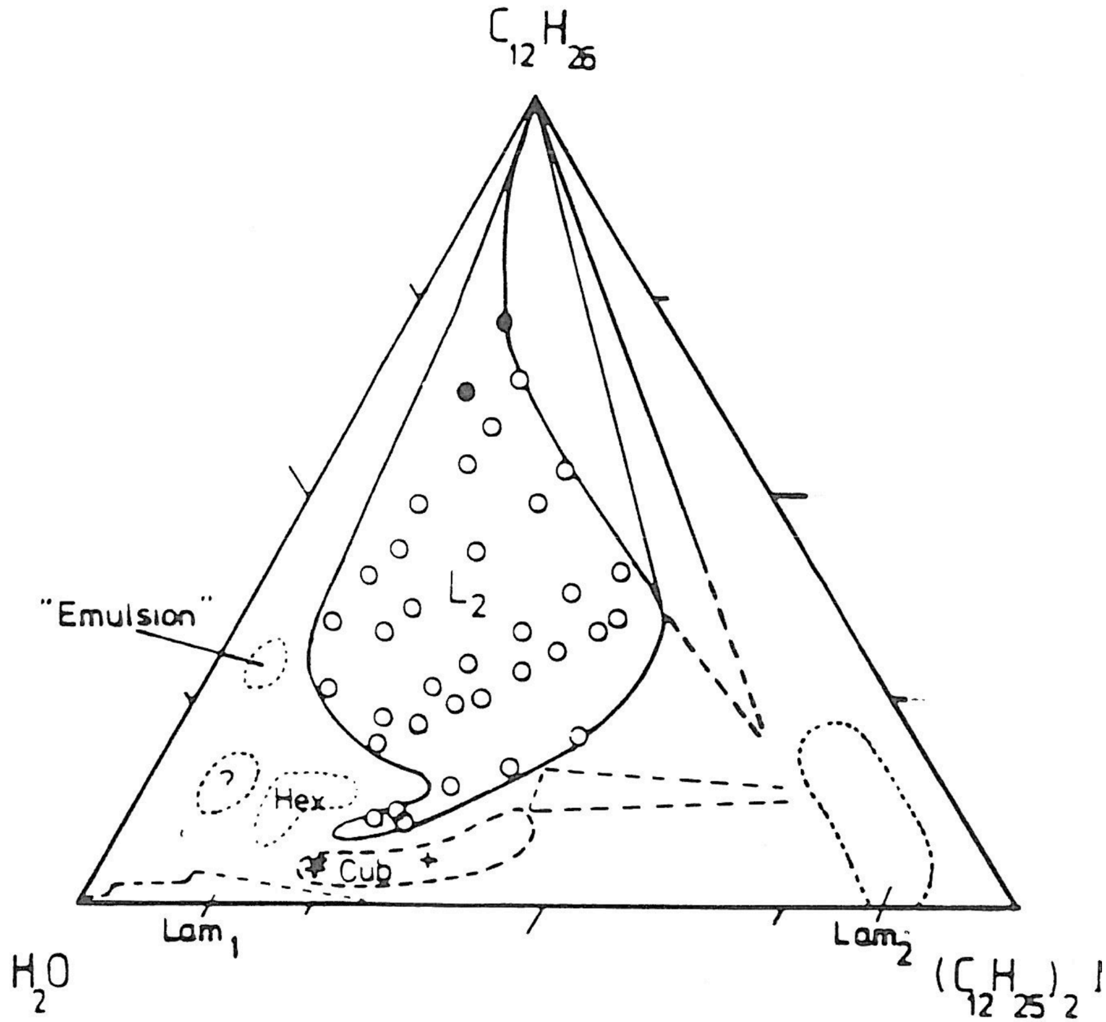
Ternary phase diagrams : Winsor II extraction

2014-2015

Content

- **Ternary phase diagram:**
- „Flexible" and „rigid" case
- The extended Winsor II regime
- The formulation limit and phase boundaries
- The „alternating cascade" for separation

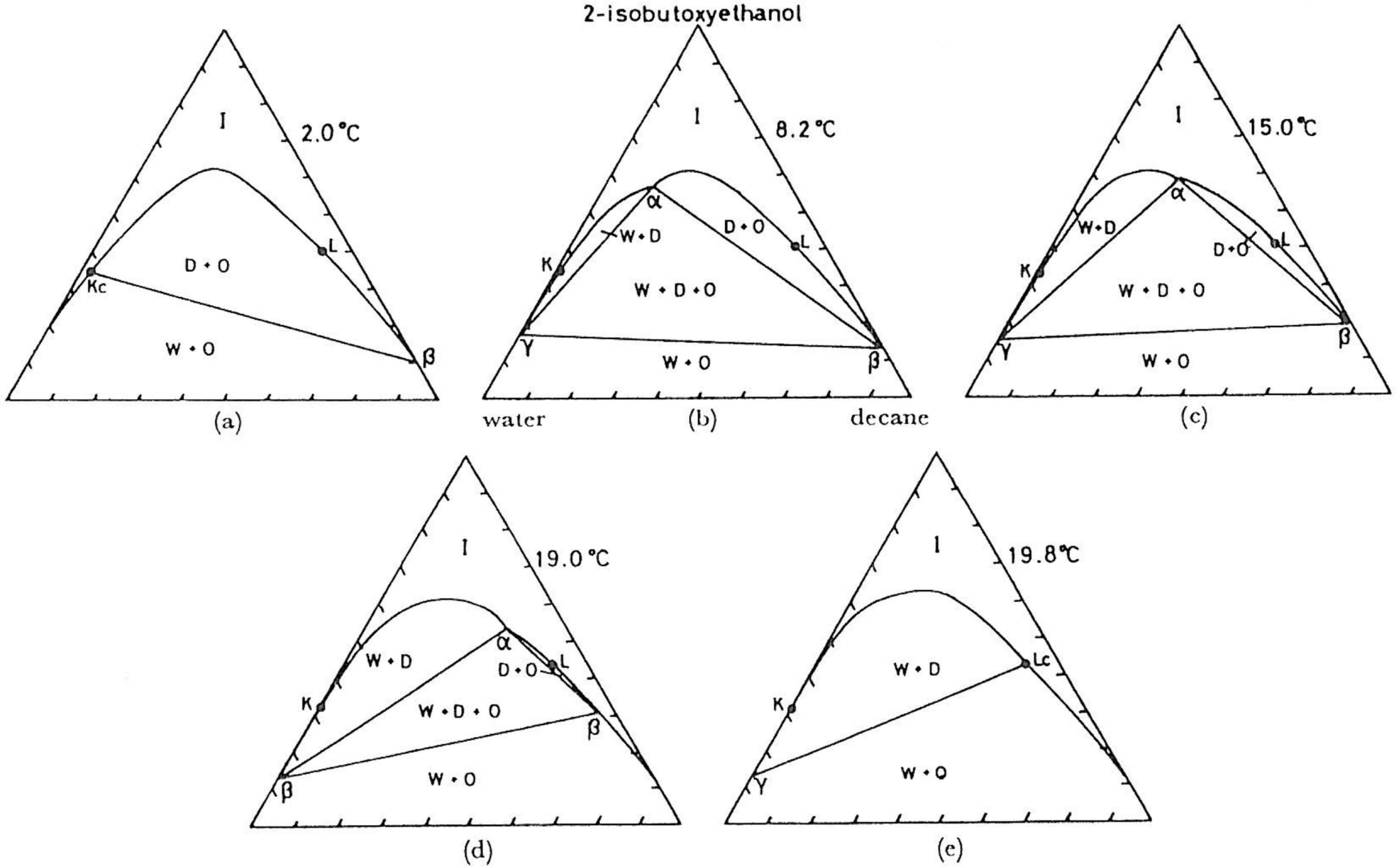
Lecture of a phase diagram: Experimentalist/ Engineer



Colloidal/"nano"/Meso eye :surfaces curvature

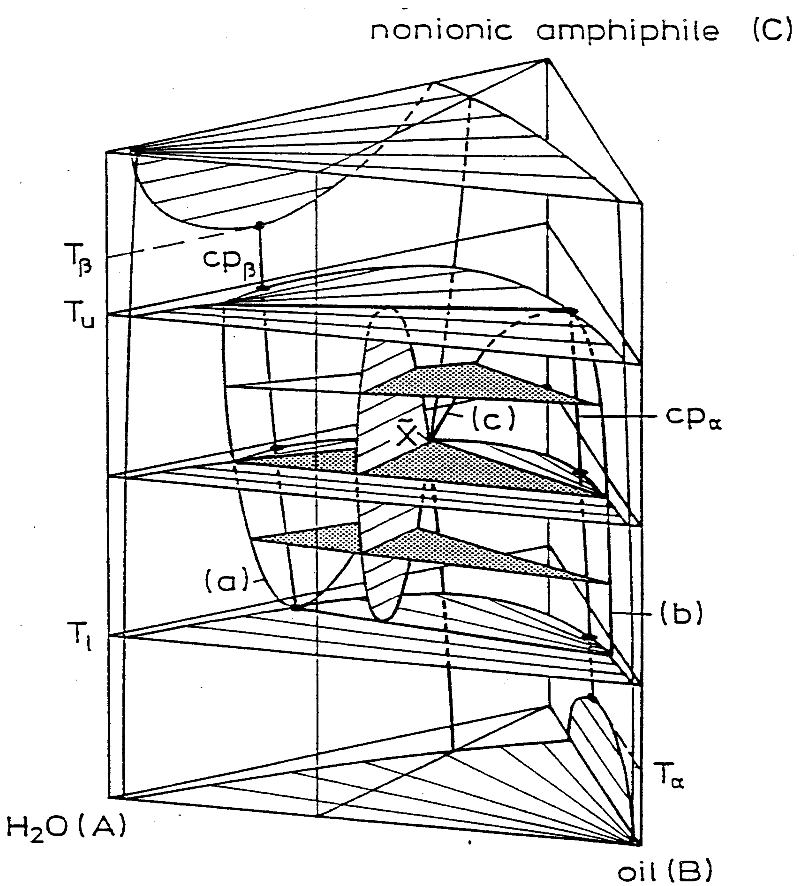
Interaction/Foreces/Potentials: free energy

Ternary phase diagram: reading



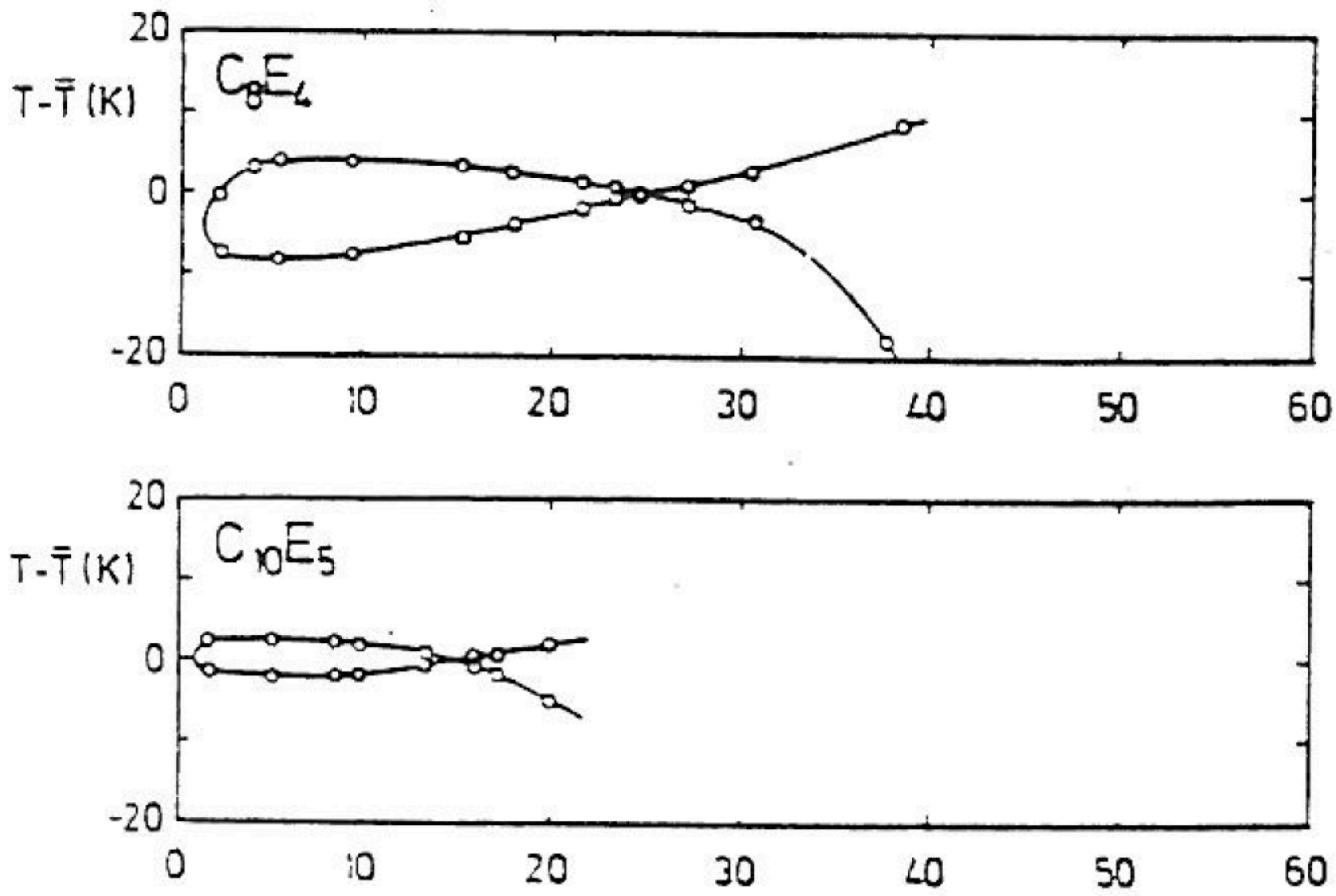
Kunieda Hand Shinoda-1980

Ternary phase prism: versus temperature



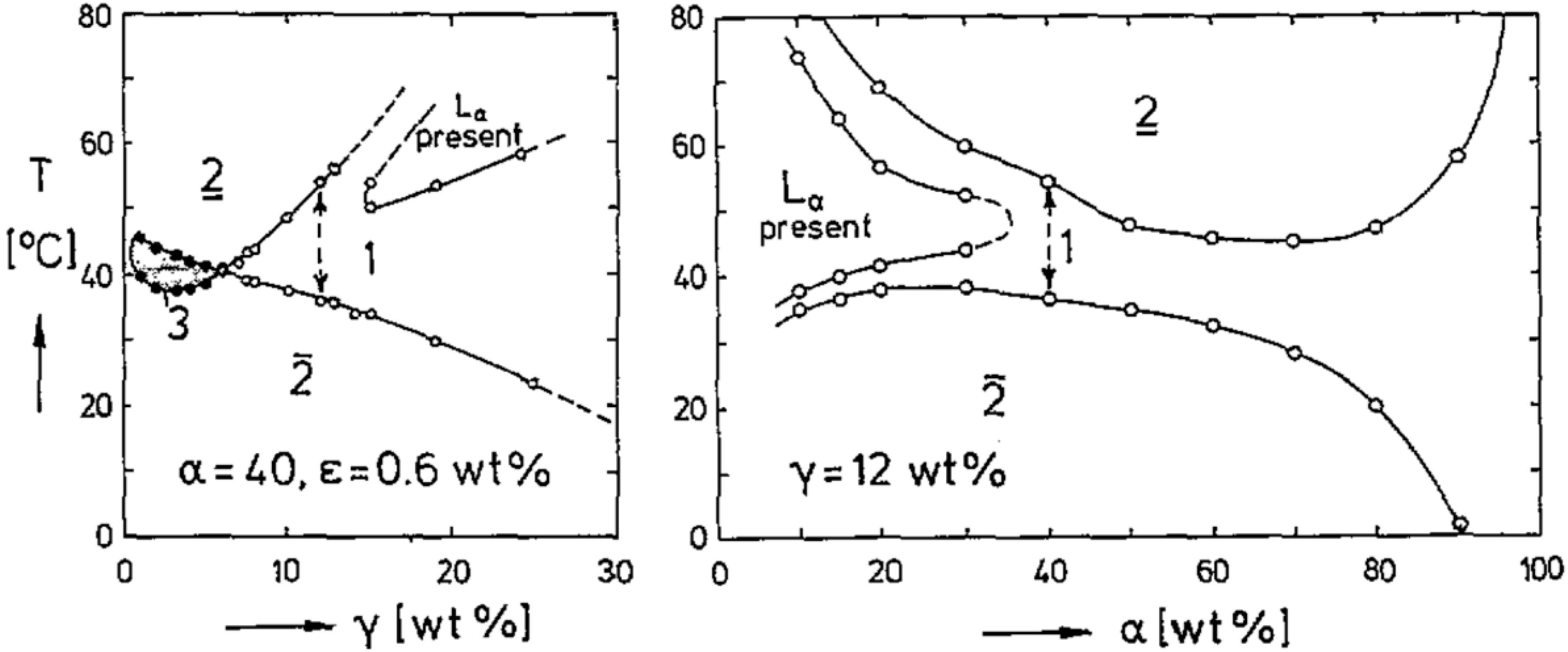
M. Kahlweit and R. Strey (1985)

Flexible case : curvature (fish) cut



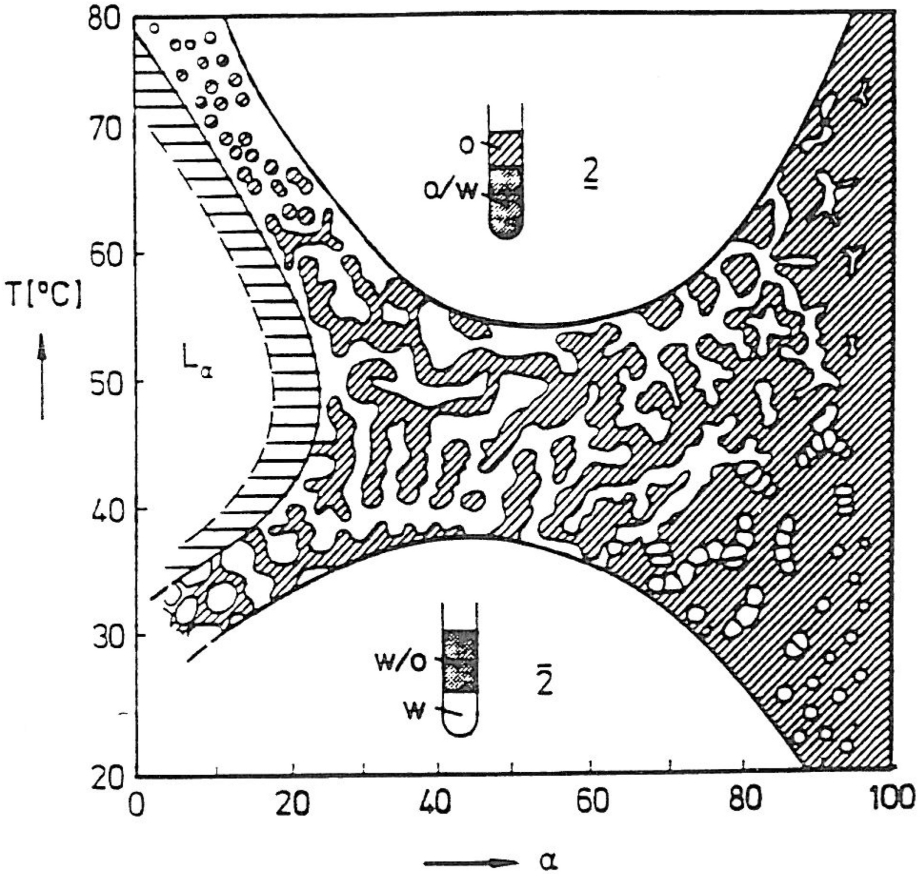
Kahlweit M, Strey R and Busse G.; Phys Rev E47 (1993) 4197

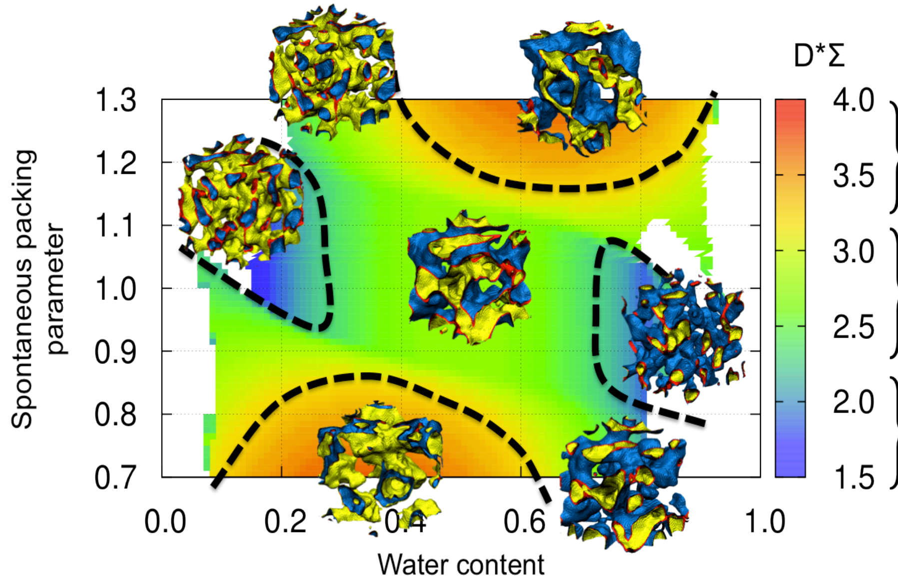
Cut used in liquid-liquid extraction



Chen SH, Chang SL and Strey R, J Phys cond. Mat.(1991)

Flexible case : topology cut

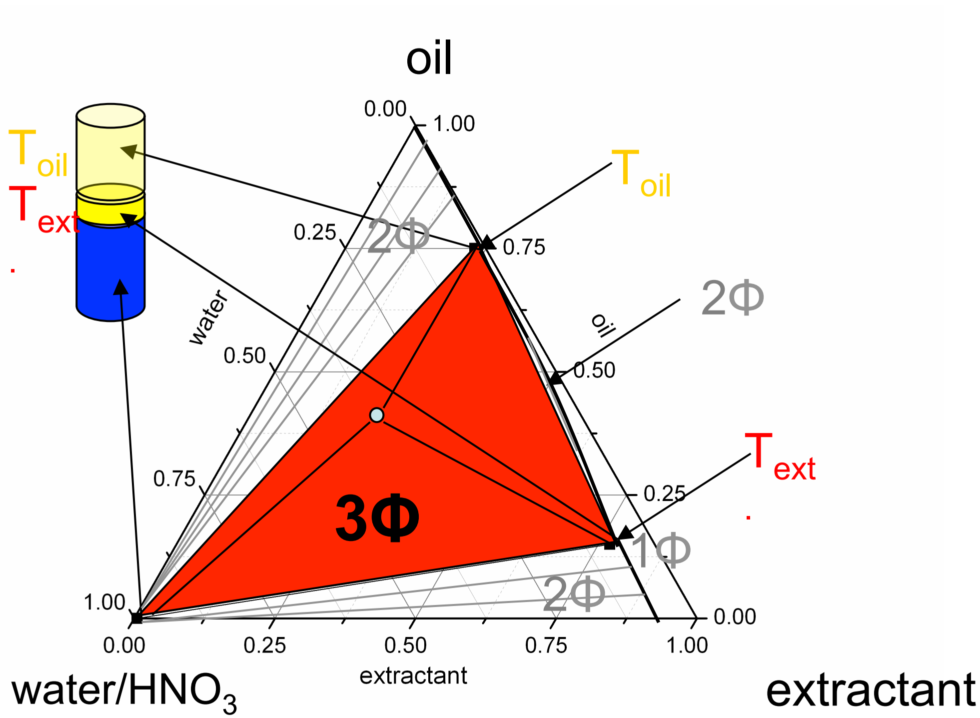


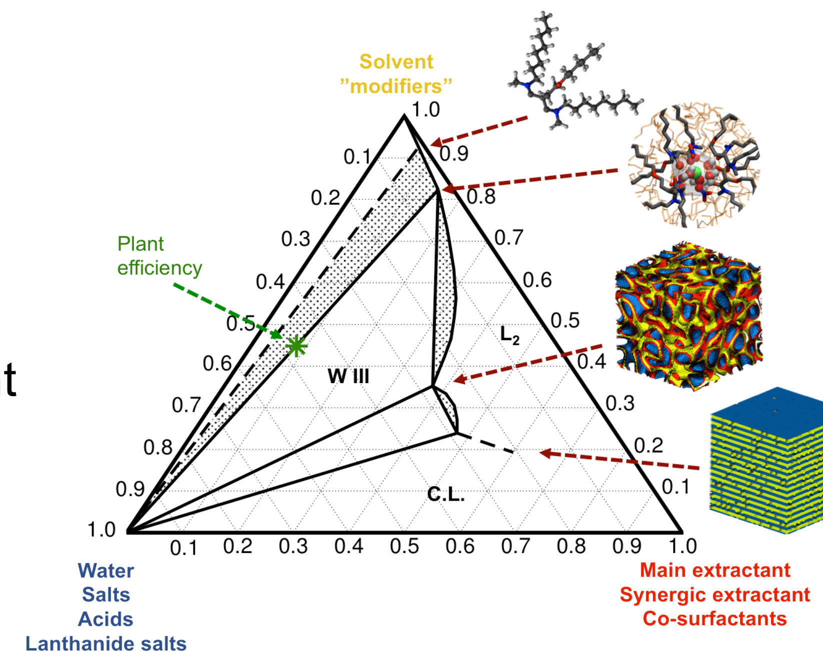


M. Duvail, JFD, ThZ 2013

S. H. Chen, S. L. Chang et R. Strey
Journal of Chemical Physics 93 p. 1907 (1990)

Microemulsions containing extractants ?

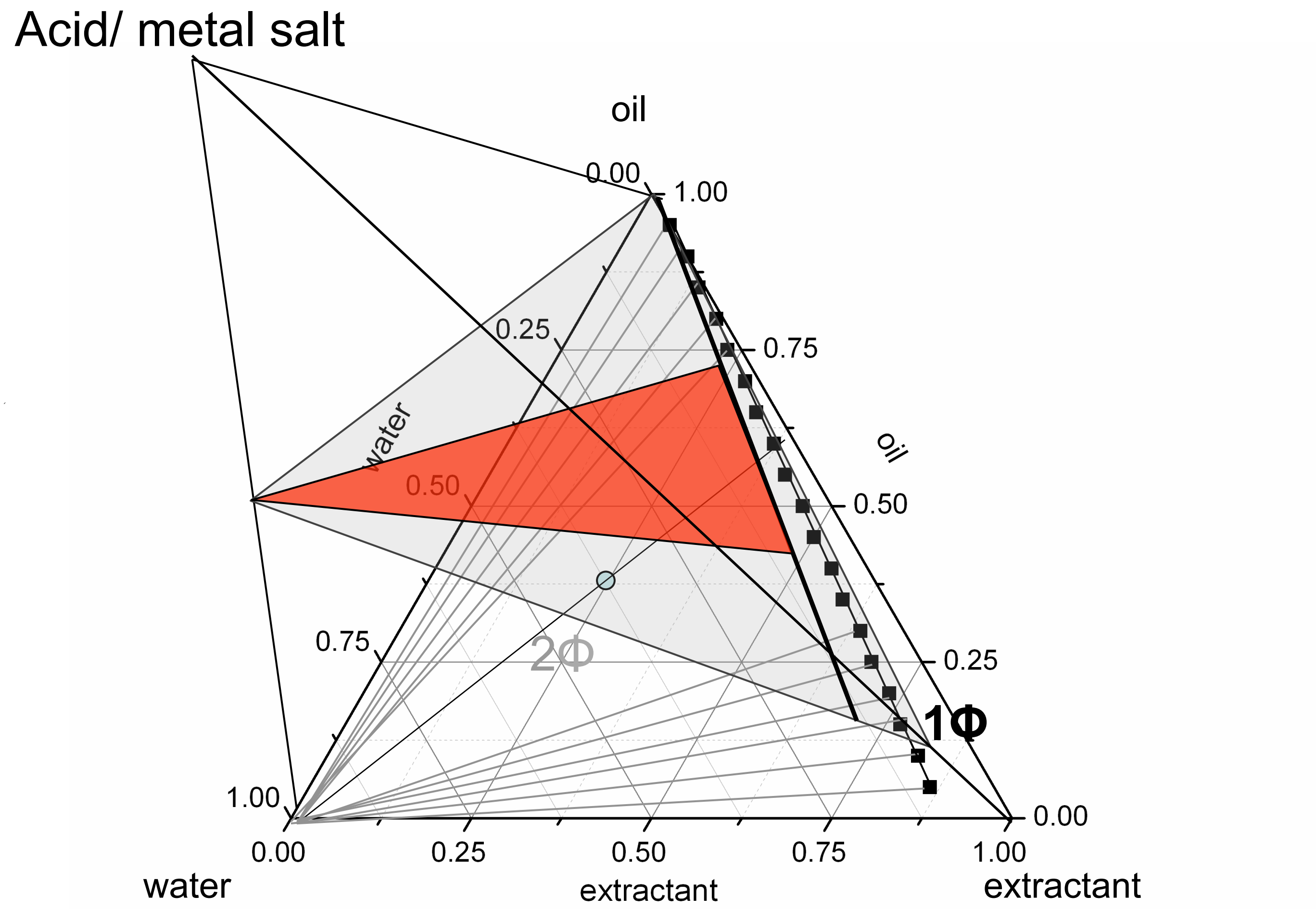




Formulation : Extractant (p_0=2) and detergent (p_0= 1/3) ?

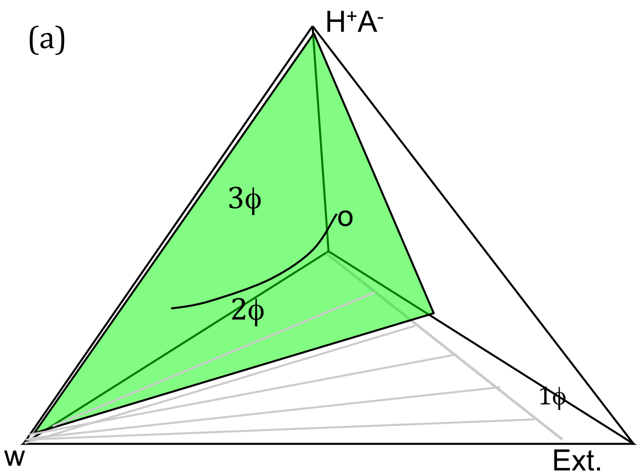
C. Bauer and O.Diat

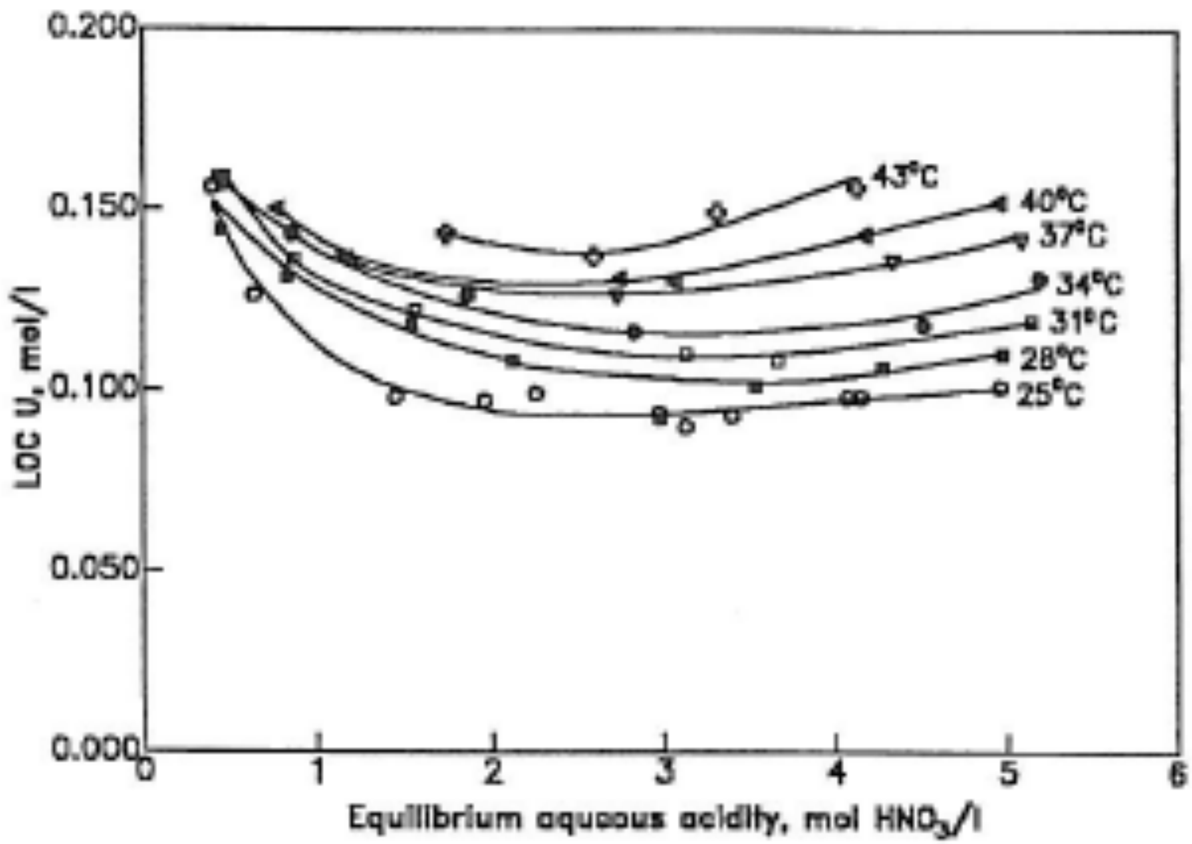
Microemulsions containing extractants ?



Formulation : Extractant (p_0=2) and detergent (p_0= 1/3) ?

C. Bauer and O.Diat

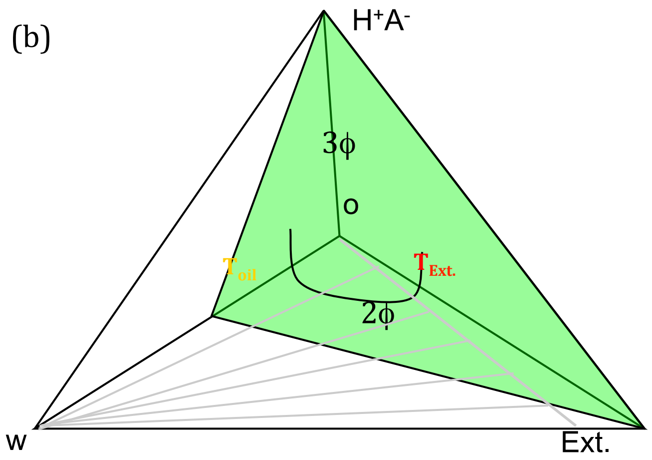


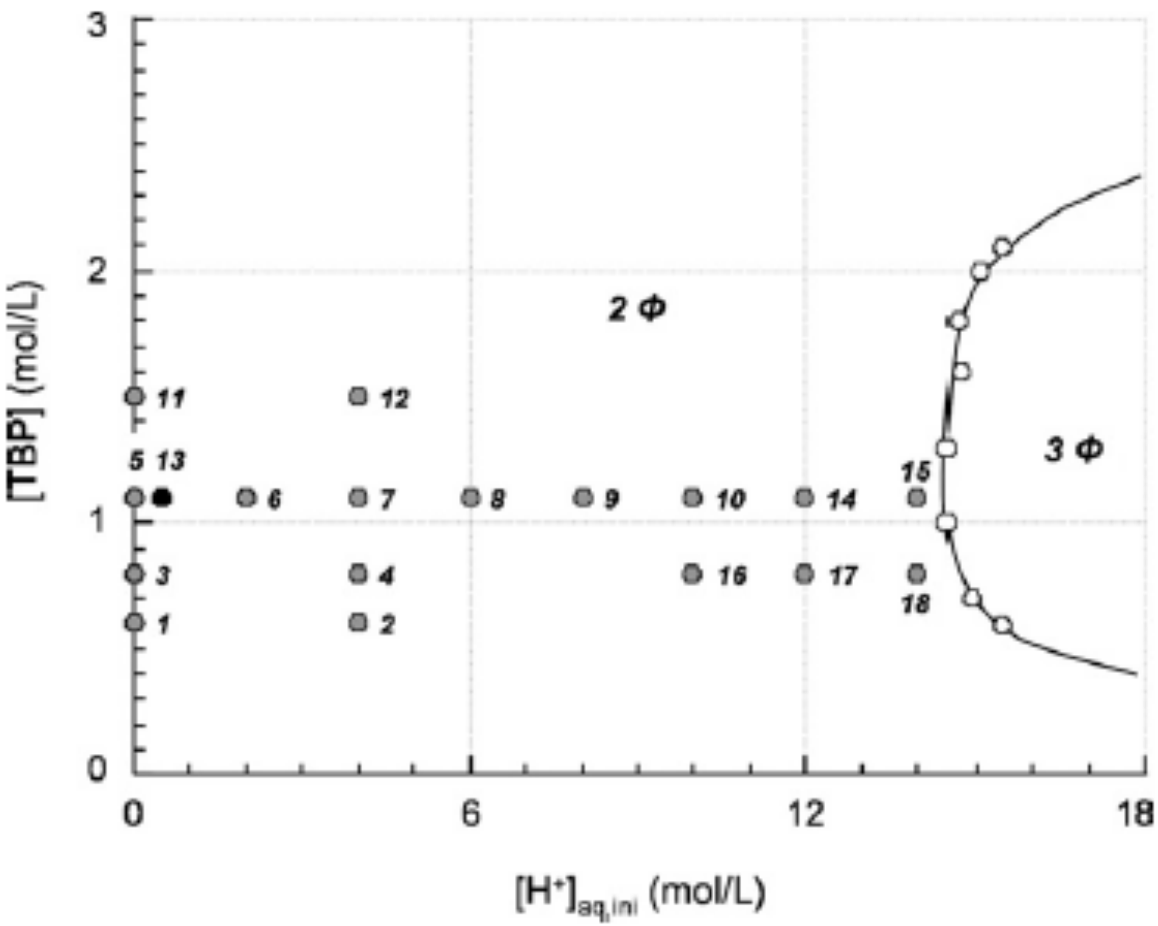


Bauer C et al., Liquid/liquid metal extraction:
Eur Phys J Spec Top 2012;213:225–41.

Identification of phase limits in chem. engineering

(b)





Bauer C et al., Liquid/liquid metal extraction:
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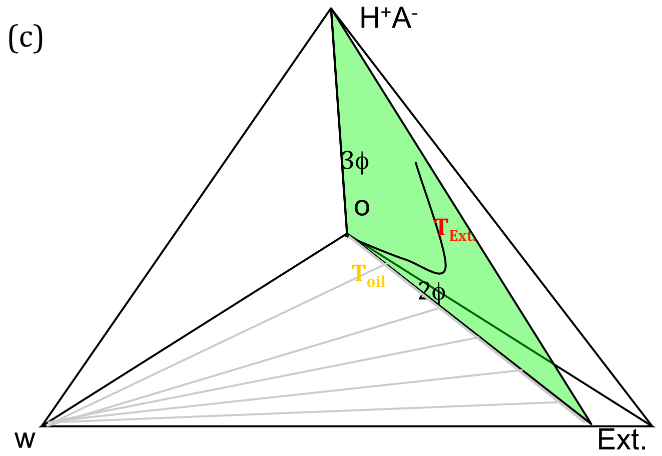
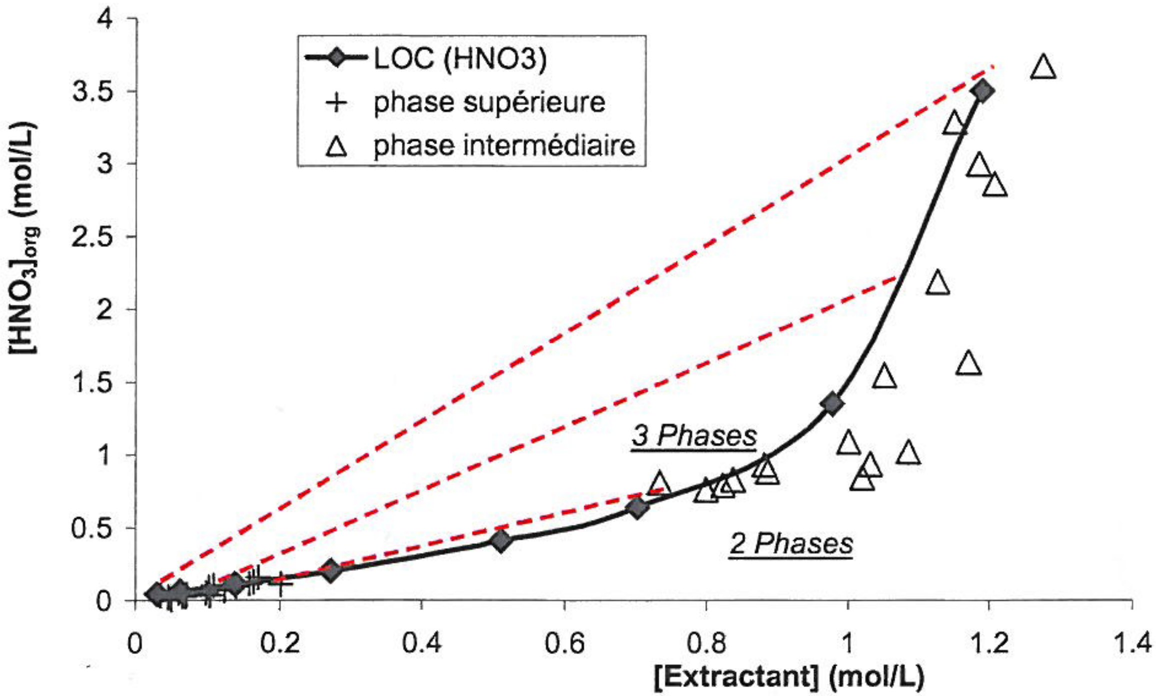
Identification of phase limits in chem. engineering





Bauer C et al., Liquid/liquid metal extraction:
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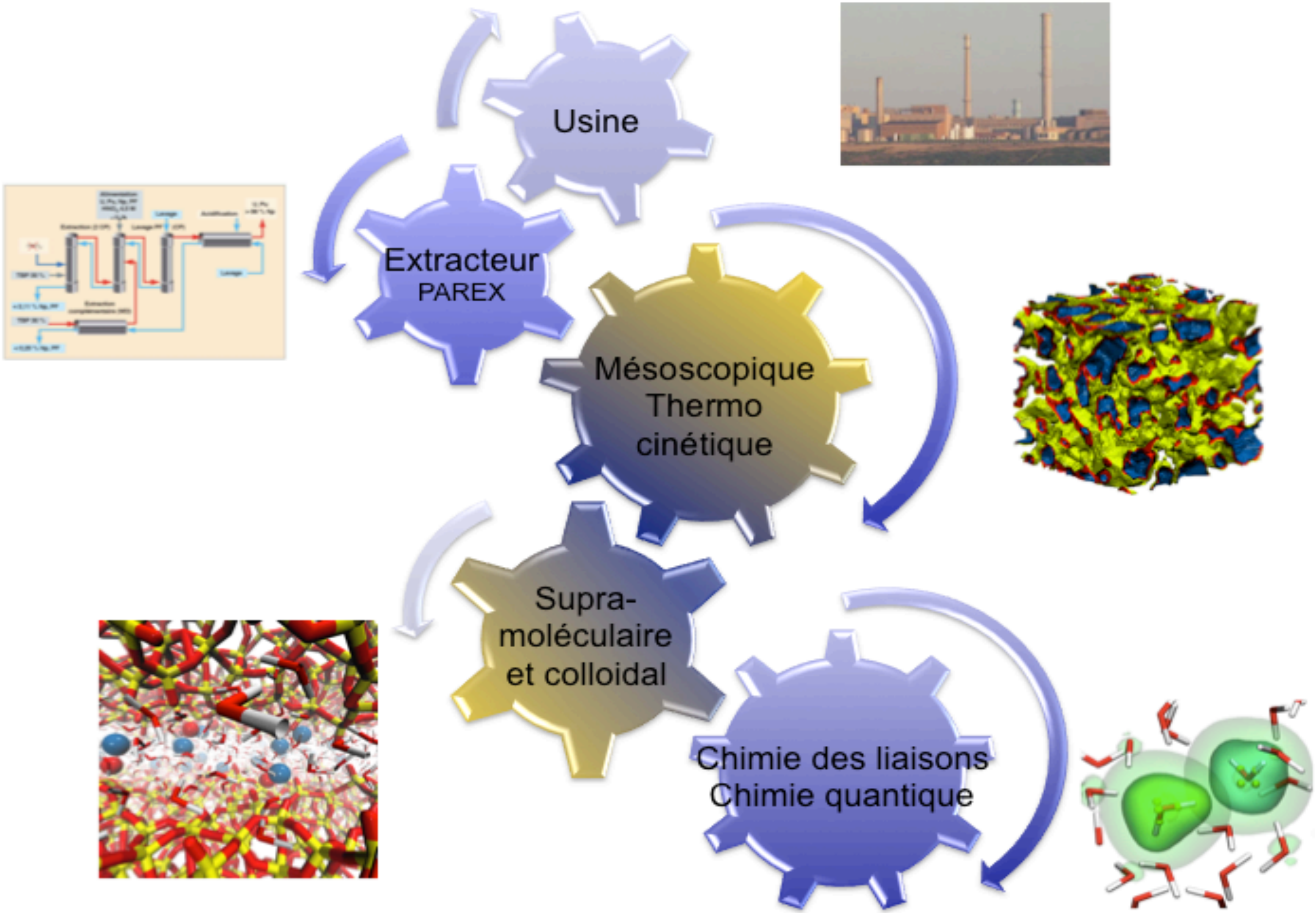
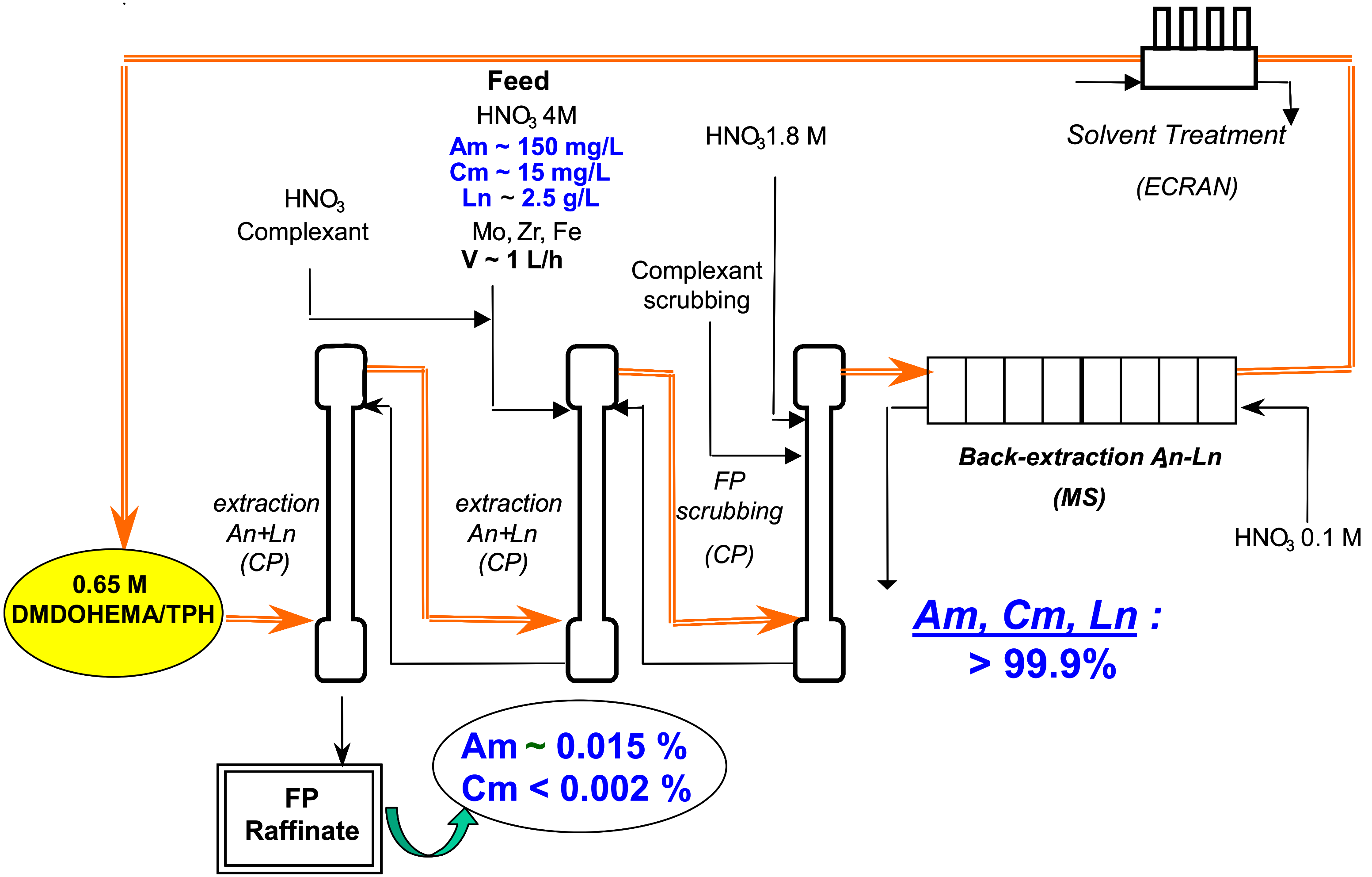
An intrinsic multi-scale approach :

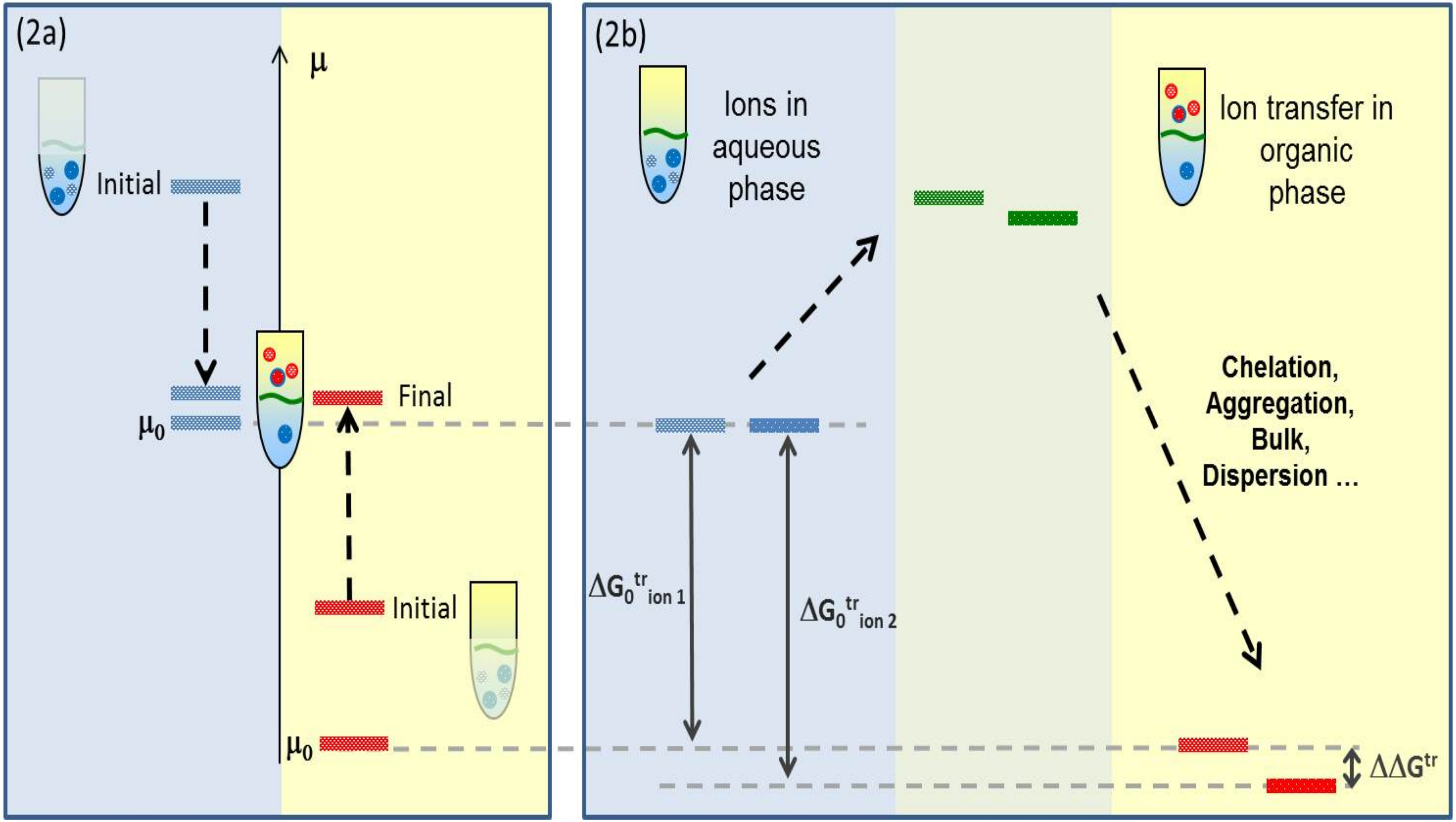


The coupled cascades and solvent treatment



P. Baron et al., , Global 2007

(2 and 3): the ienaic point of view



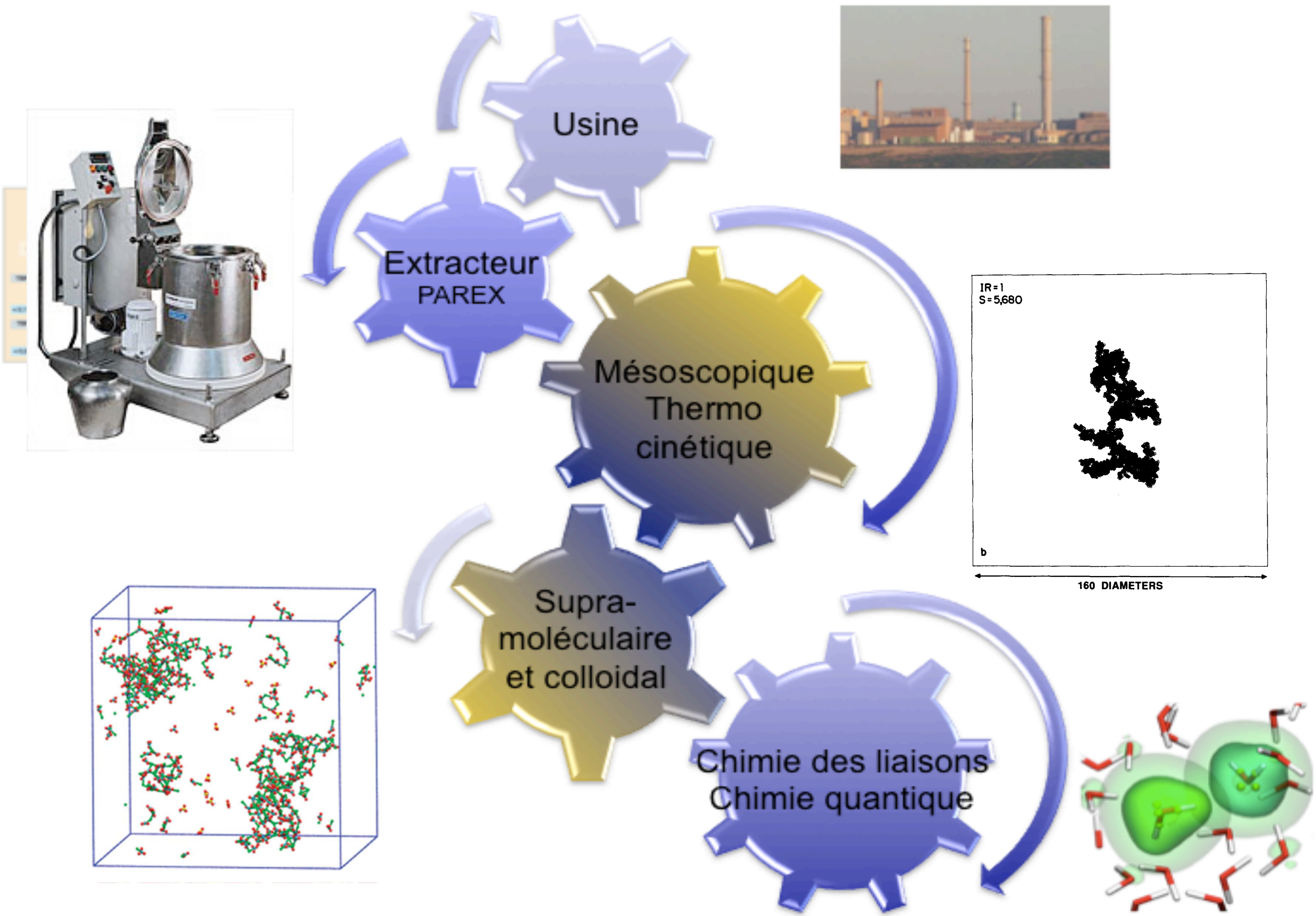
Thomas Zemb

lecture n°4:

Basics of solid-liquid separation processes

2014-2015

An intrinsic multi-scale approach :



Content

- **The three scales of liquid-solid separation :**

- Nucleation and growth
- Coagulation and flocculation driving sedimentation
- Solid-liquid separation at engineering scale

WHAT ARE INITIAL NUCLEI ?

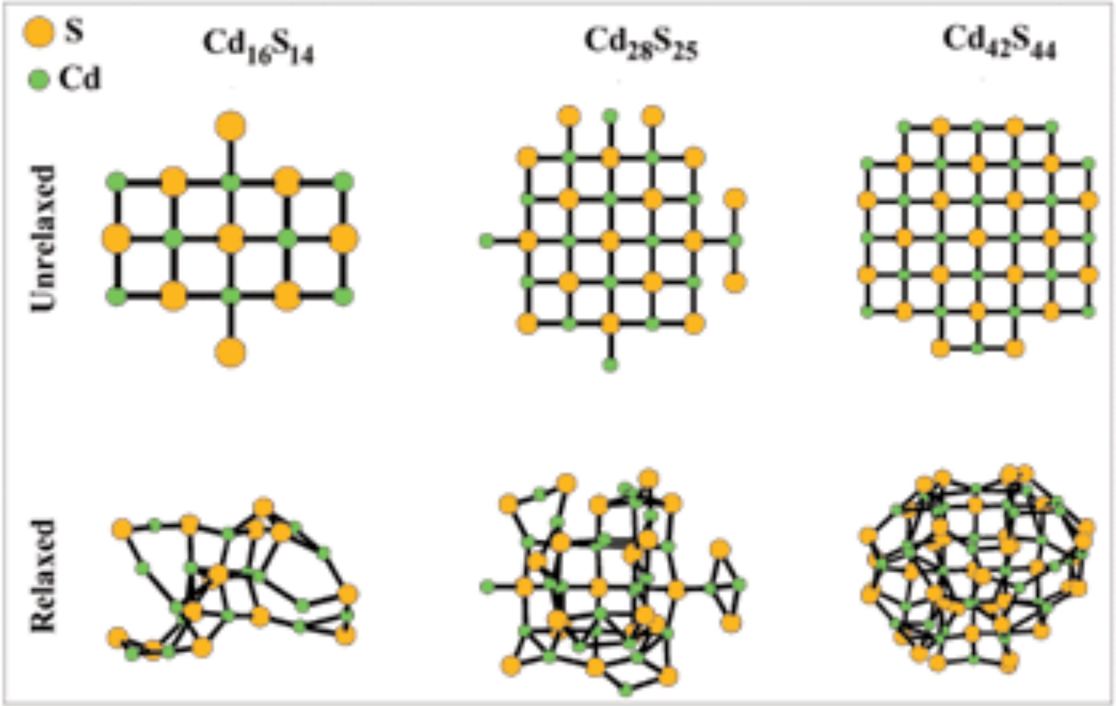
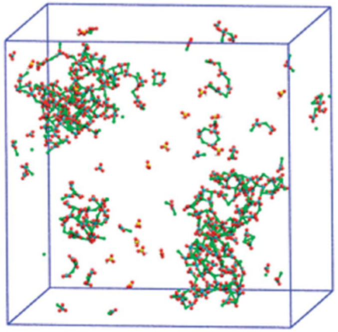
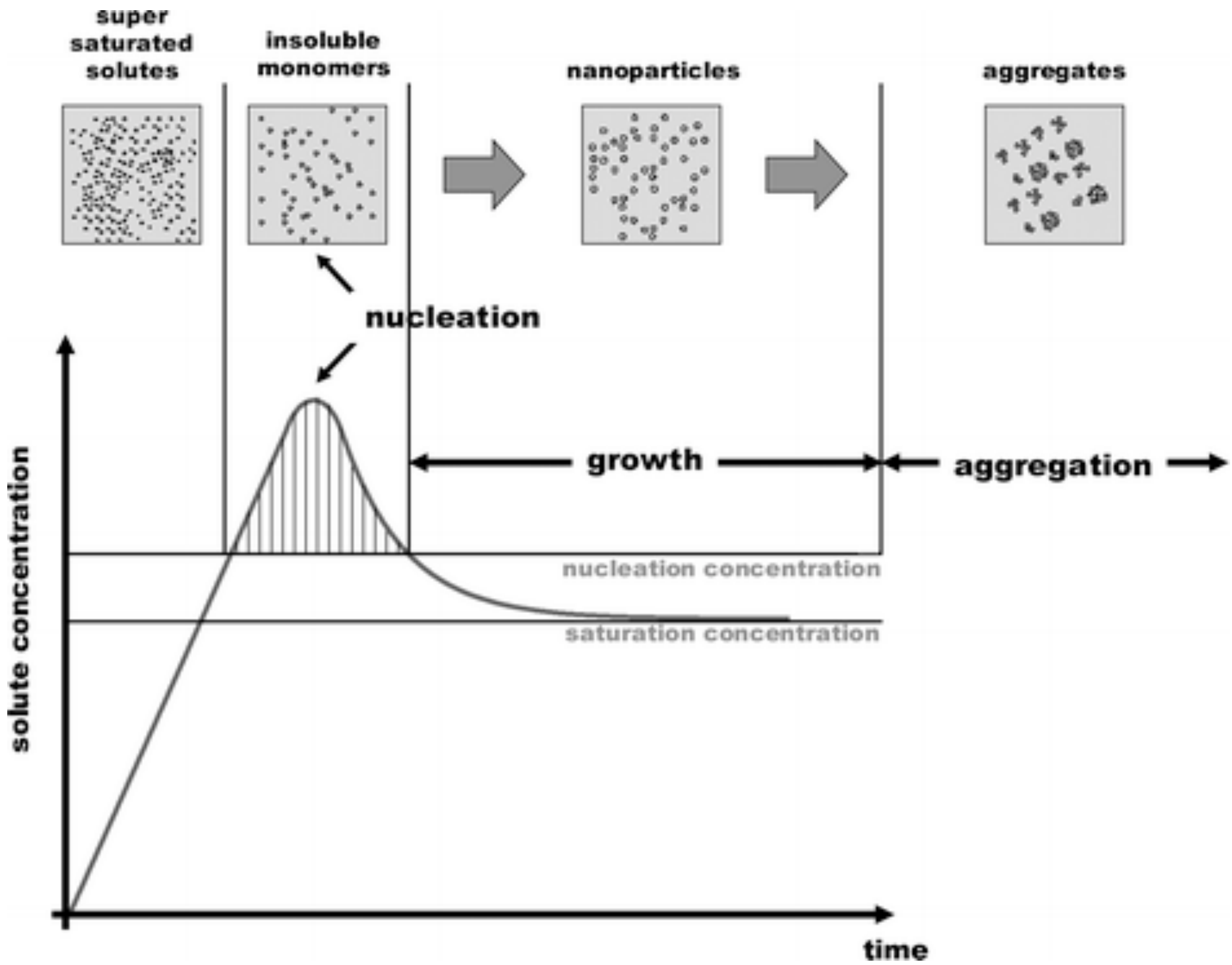


FIG. 2: Representation of (a) unrelaxed and (b) relaxed cubic CdS nanoparticles.

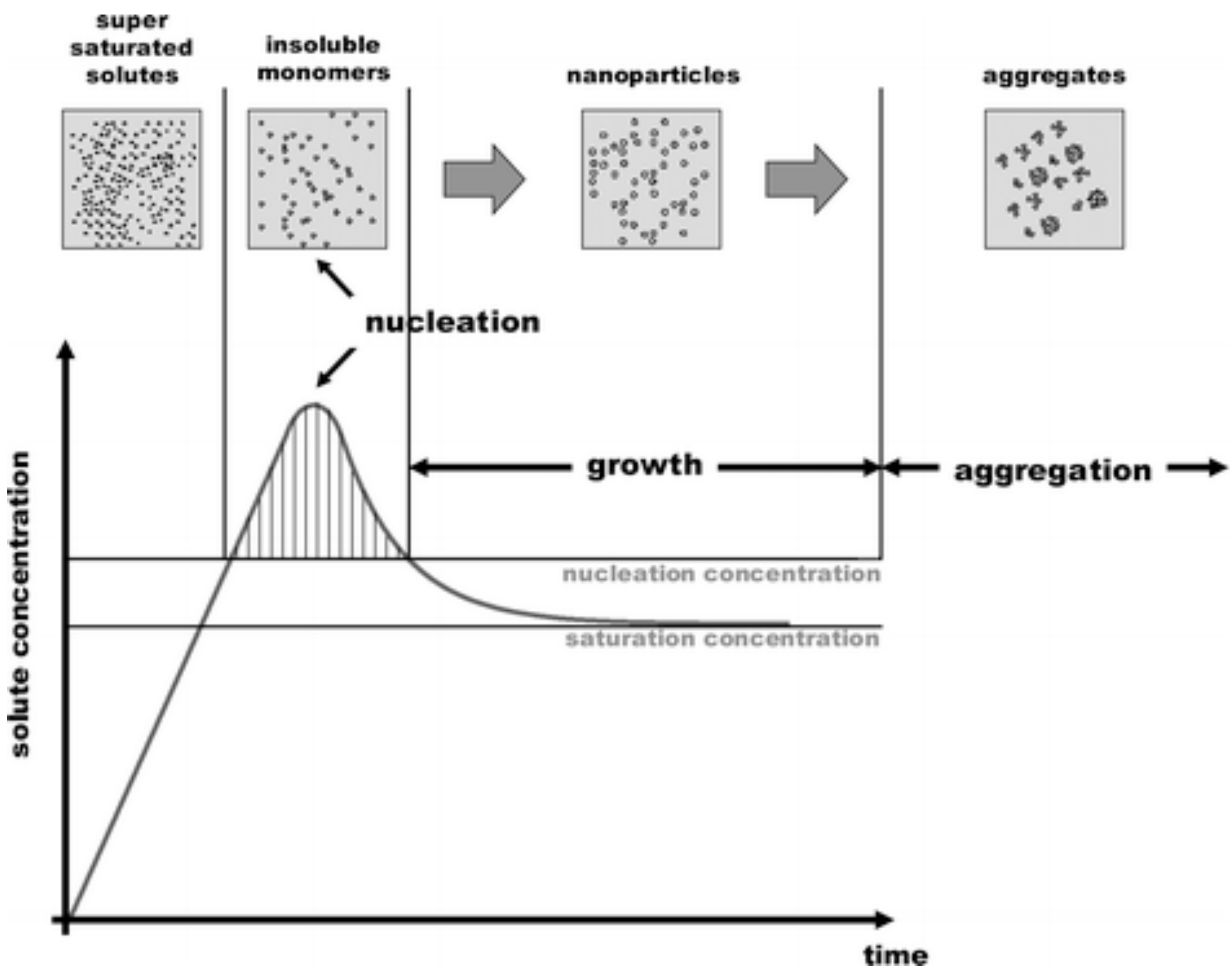


Overbeck, Kruyt, Verwey … Philips/Eindhoven
D. Gebauer, H. Cöelfen, P. Baglioni

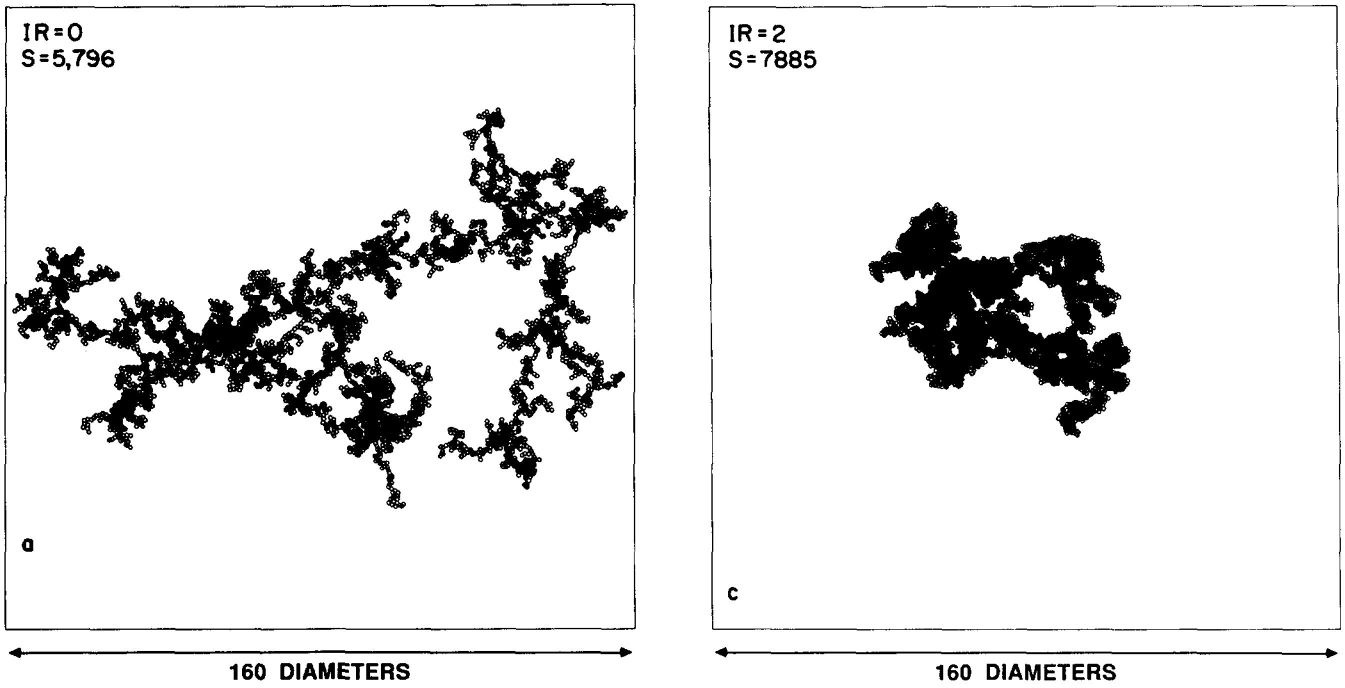
Nucleation and growth



Nucleation and growth



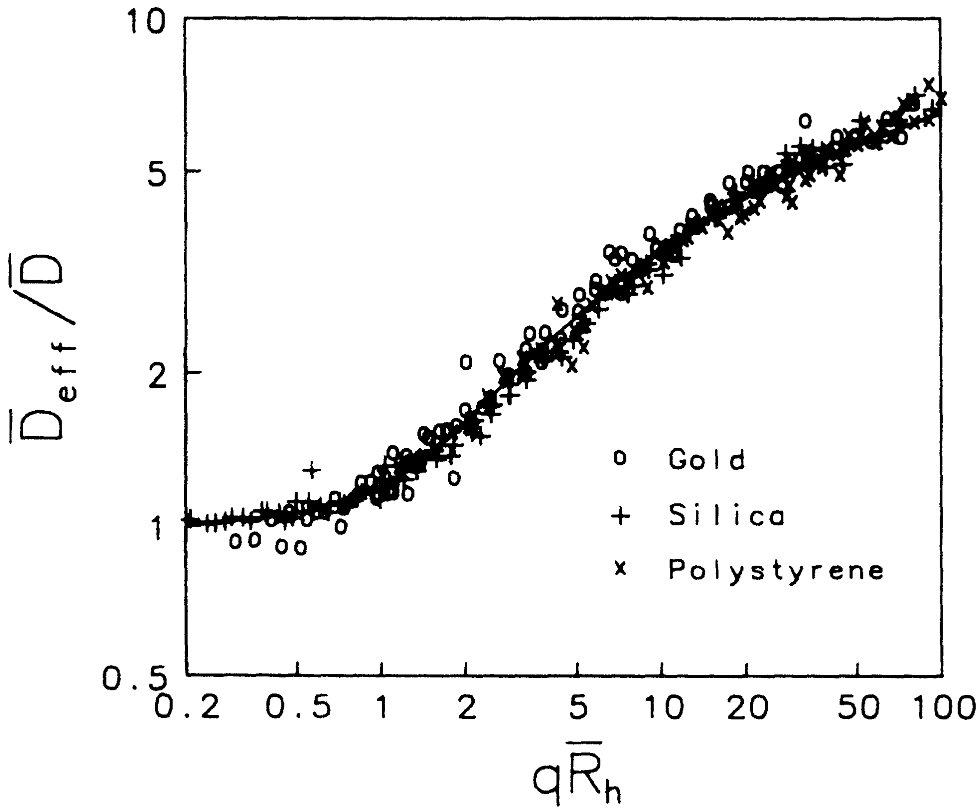
(BALLISTIC), DLA, RLA… WITH REORGANISATION



Macroscopic :FLOCCULATION, COAGULATION, COMPACTION/ »RIPENING »

P. Meakin, R. Jullien: J. Chem. Phys 89, 246-258

UNIVERSAL TRACES FRACTAL 1.5



Lin, Lindsay, Weitz, Ball, Klein, Meakin, Phys Rev A (1990), 41, 2005-2020

SOLID-LIQUID SEPARATION : methods

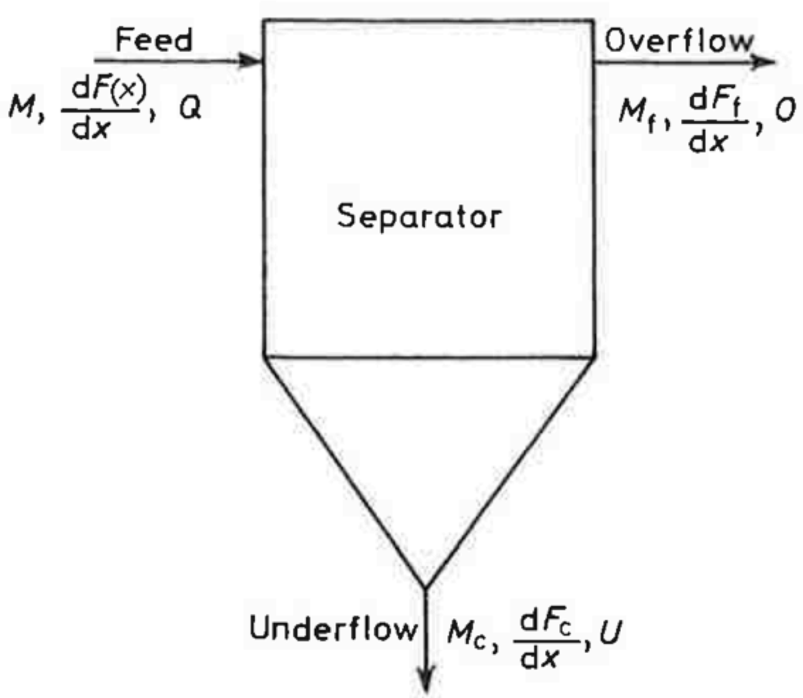


Figure 3.1. Schematic diagram of a separator

$$M = M_c + M_t$$

$$M \frac{dp}{dx} = M_c . \frac{dp_c}{dx} + M_t . \frac{dp_t}{dx}$$

L. Svarosky : « solid-liquid separation » Butterworth – 4th ed. 2001

MODELLING : « SIZE » DISTRIBUTION COUNTS !

CHARACTERIZATION OF PARTICLES SUSPENDED IN LIQUIDS

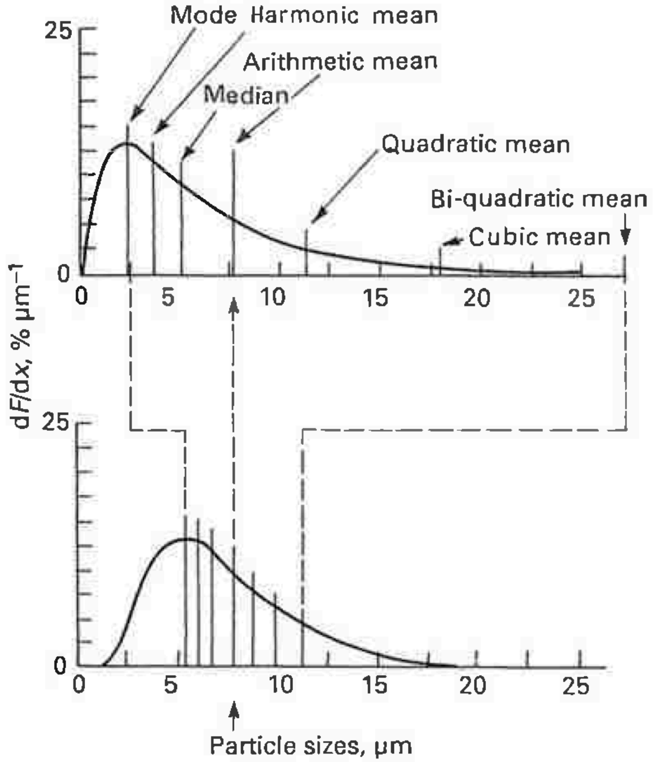


Figure 2. A1.1. Two different size distributions with the same arthmetic mean

$$x_{st} = \sqrt{\frac{18.\eta V_s}{g.\Delta\rho}}$$

DISTRIBUTION AND RIGHT AVERAGE IMPORTANT

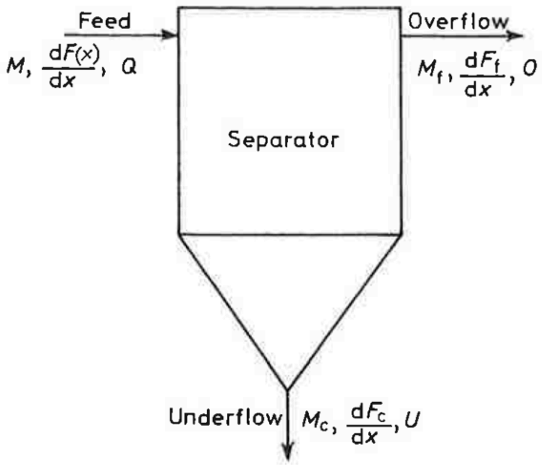


Figure 3.1. Schematic diagram of a separator

$$G(x) = \frac{G_1(x)G_2(x)}{1 - G_1(x) + G_1(x)G_2(x)}$$

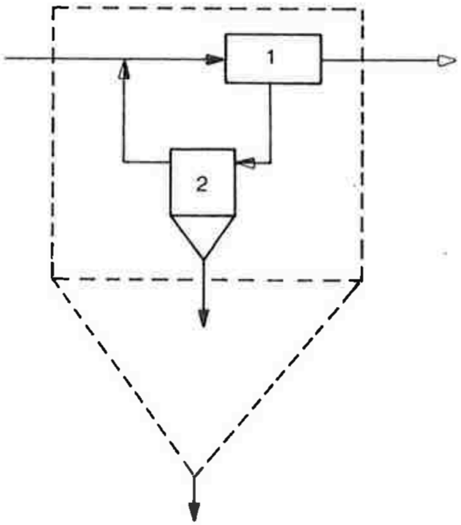


Figure 3.17. A concentrator with a separator in series, with feedback

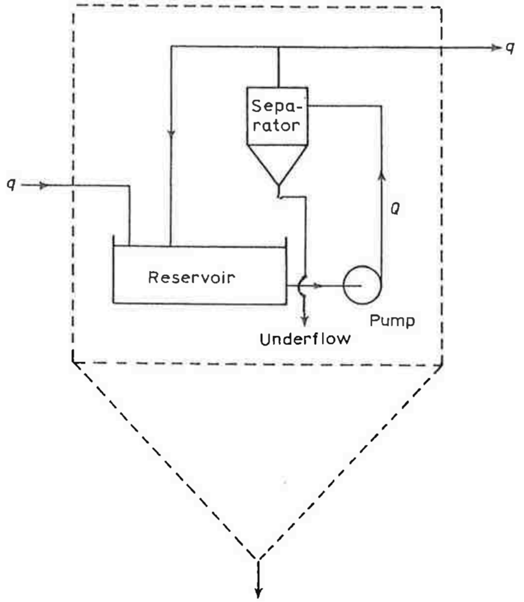
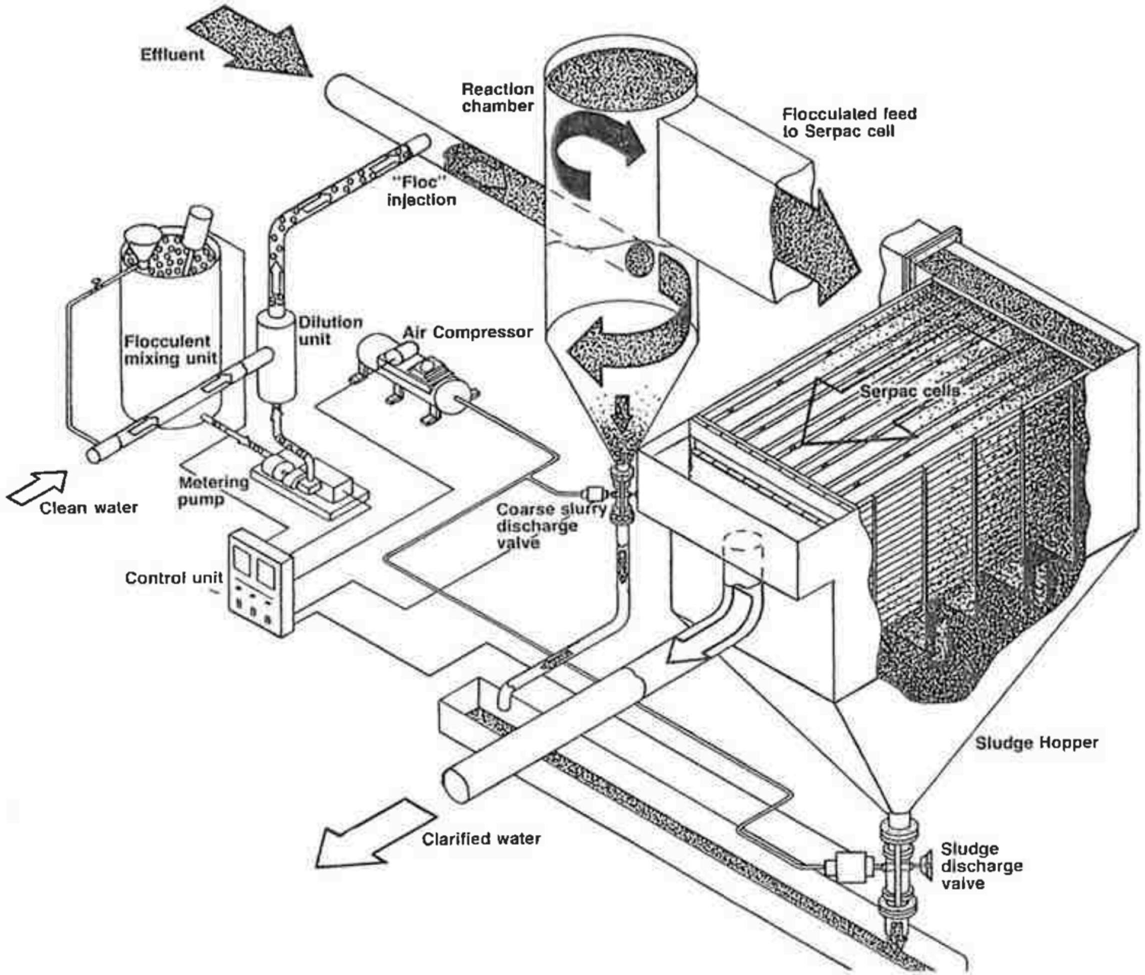


Figure 3.18. A multiple pass system

L. Svarosky : « solid-liquid separation » Butterworth – 4th ed. 2001

ITERATIVE PROCEDURES : PLANT MAP



L. Svarosky : « solid-liquid separation » Butterworth – 4th ed. 2001

An intrinsic multi-scale approach :