Fractionation of oils and fats

Why and How?

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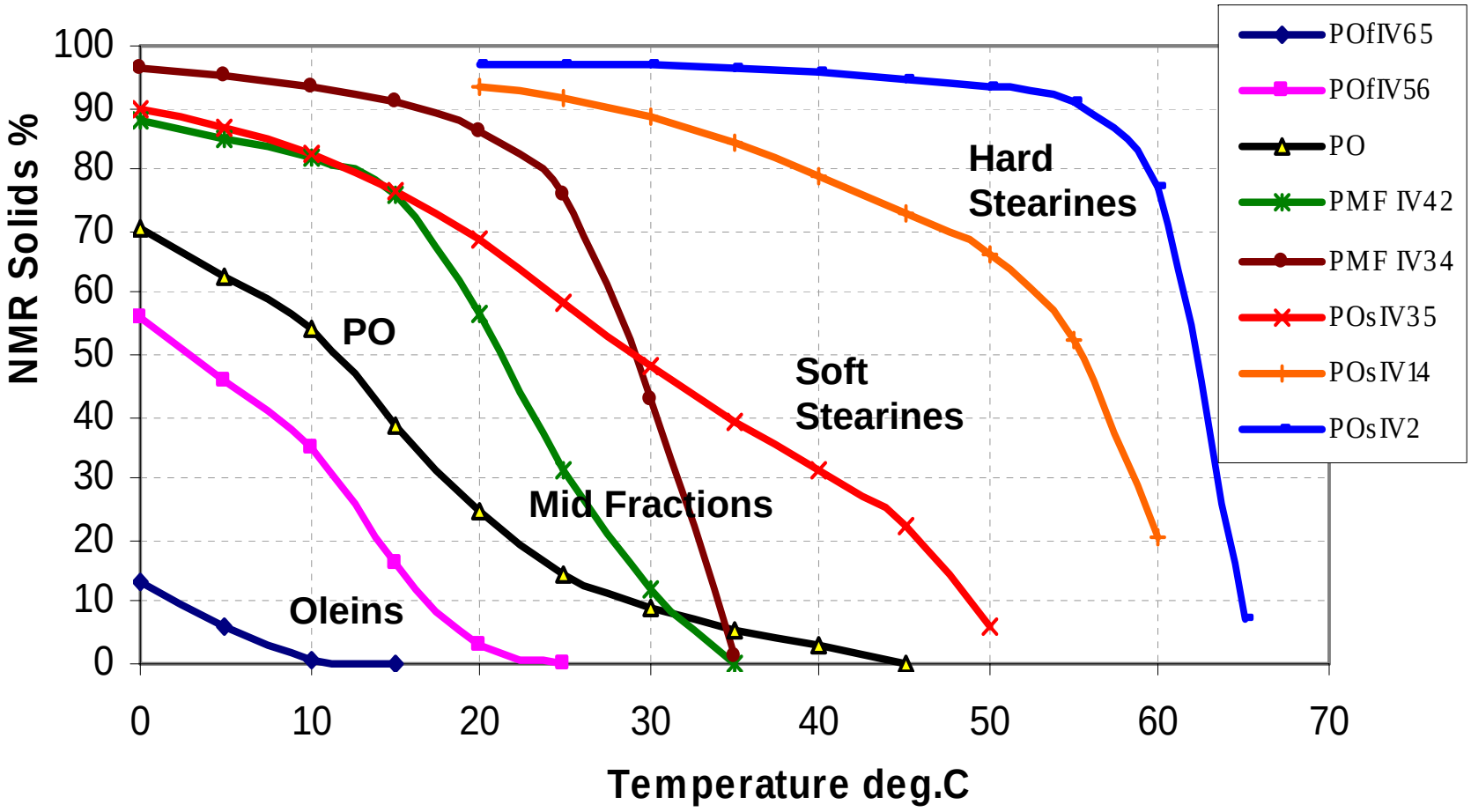
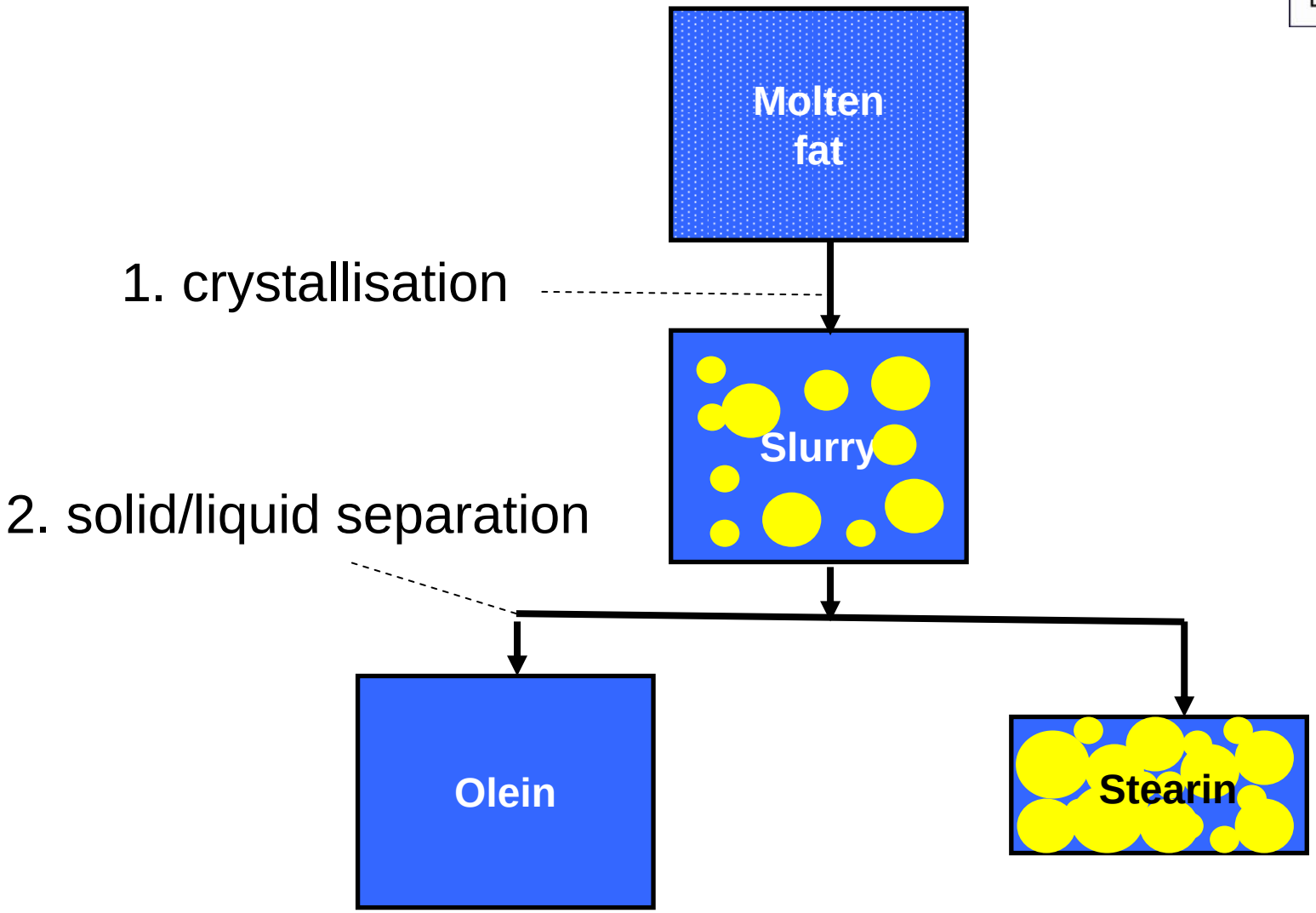
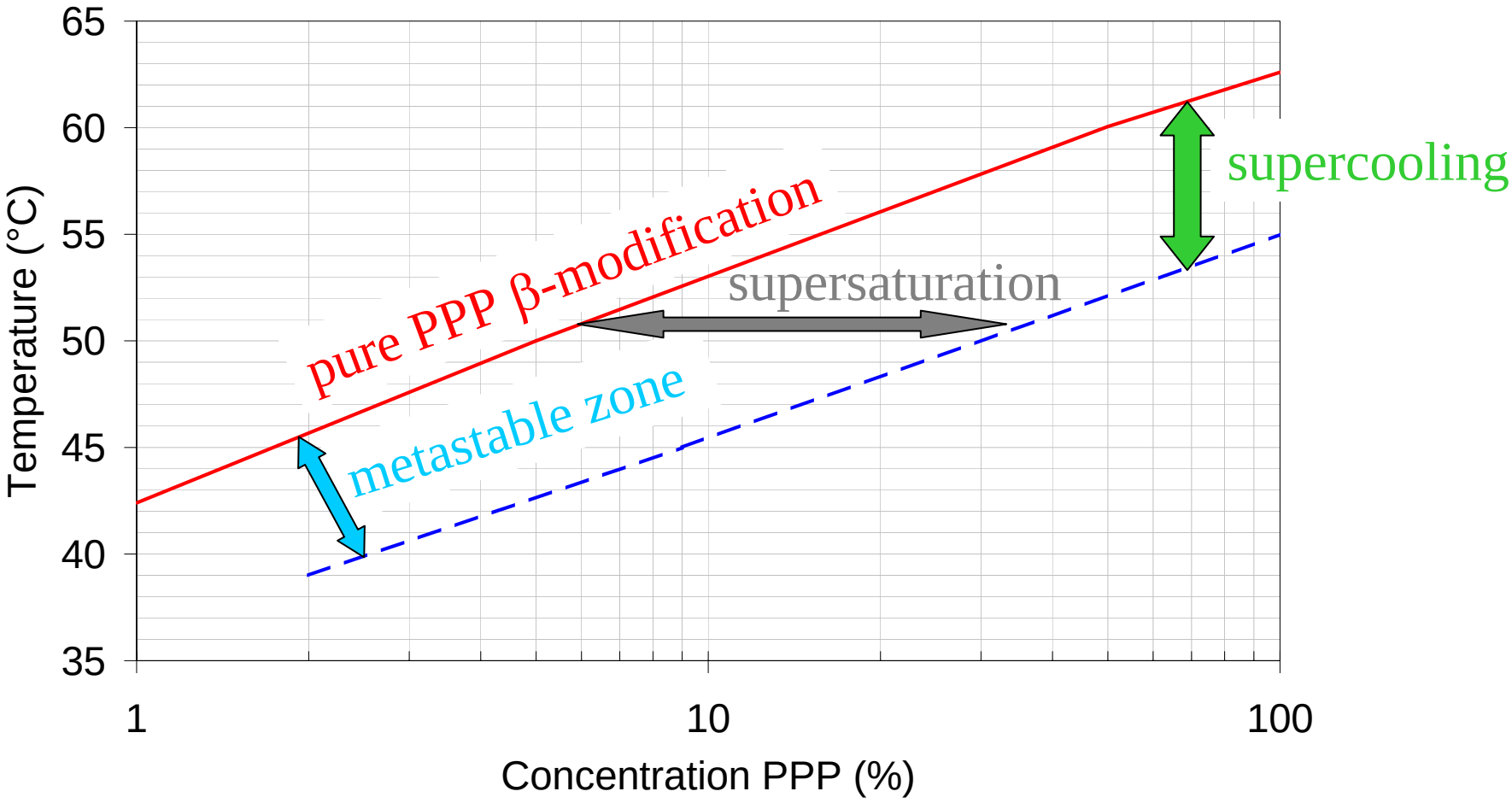
Why? --- eg. Fractions from palm oil give added value!!



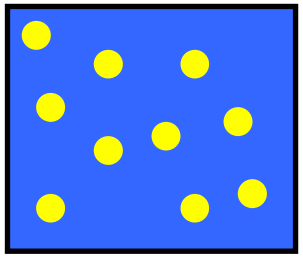
How? --- Fractionation Process principles



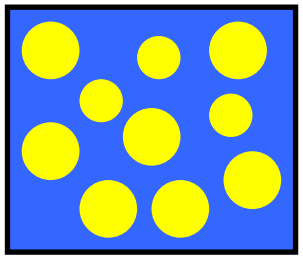
Importance of Solubility, eg. PPP in Palm



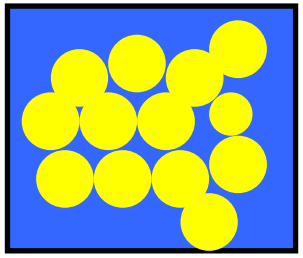
Crystallisation Processes



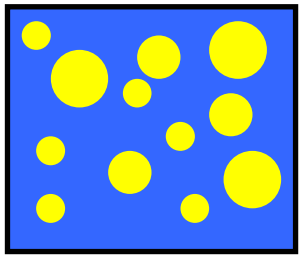
1’ nucleation ---- birth of new small crystals



growth ---------- size of crystals increases



agglomeration --- crystals stick together



attrition ---------- agglomerated crystals break into small pieces, 2’ nucleation

“Theory” of crystallisation

Supersaturation σ

$$\sigma = \frac{c - c^*(T)}{c^*(T)}$$

Primary nucleation rate

$$\frac{dN_P}{dt} \approx k_{np} \times 10^{\frac{-A_{np}}{(\log(1+\sigma))^2}}$$

Secondary nucleation rate

$$\frac{dN_S}{dt} \approx K_s \times M^a \times \sigma^b \times N^c$$

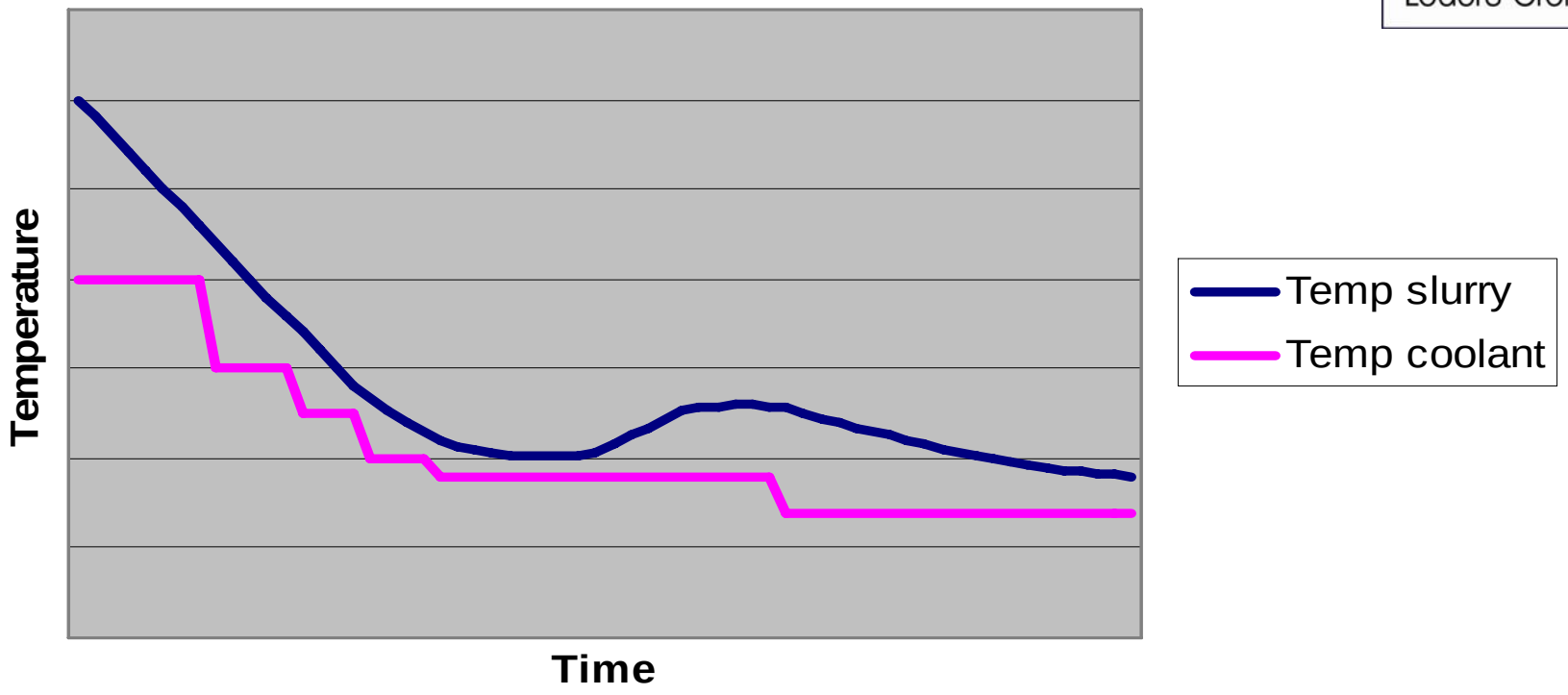
K, A, a, b, c:	constants,
M:	crystal mass
N:	stirring rate and type

Approximate crystal mass growth rate

$$\frac{dm}{dt} \approx \sigma^k * N$$

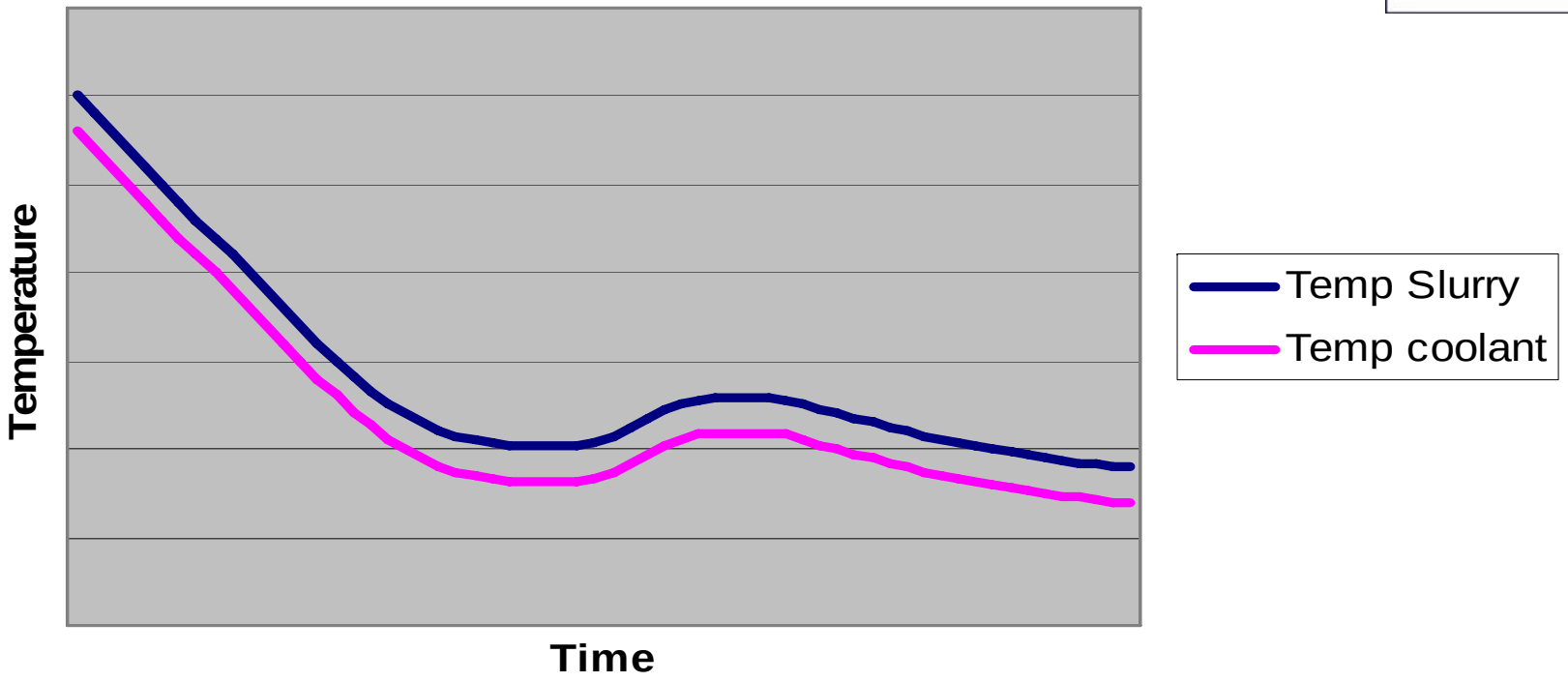
N: No. of nuclei or crystals per unit volume

Step-wise cooling



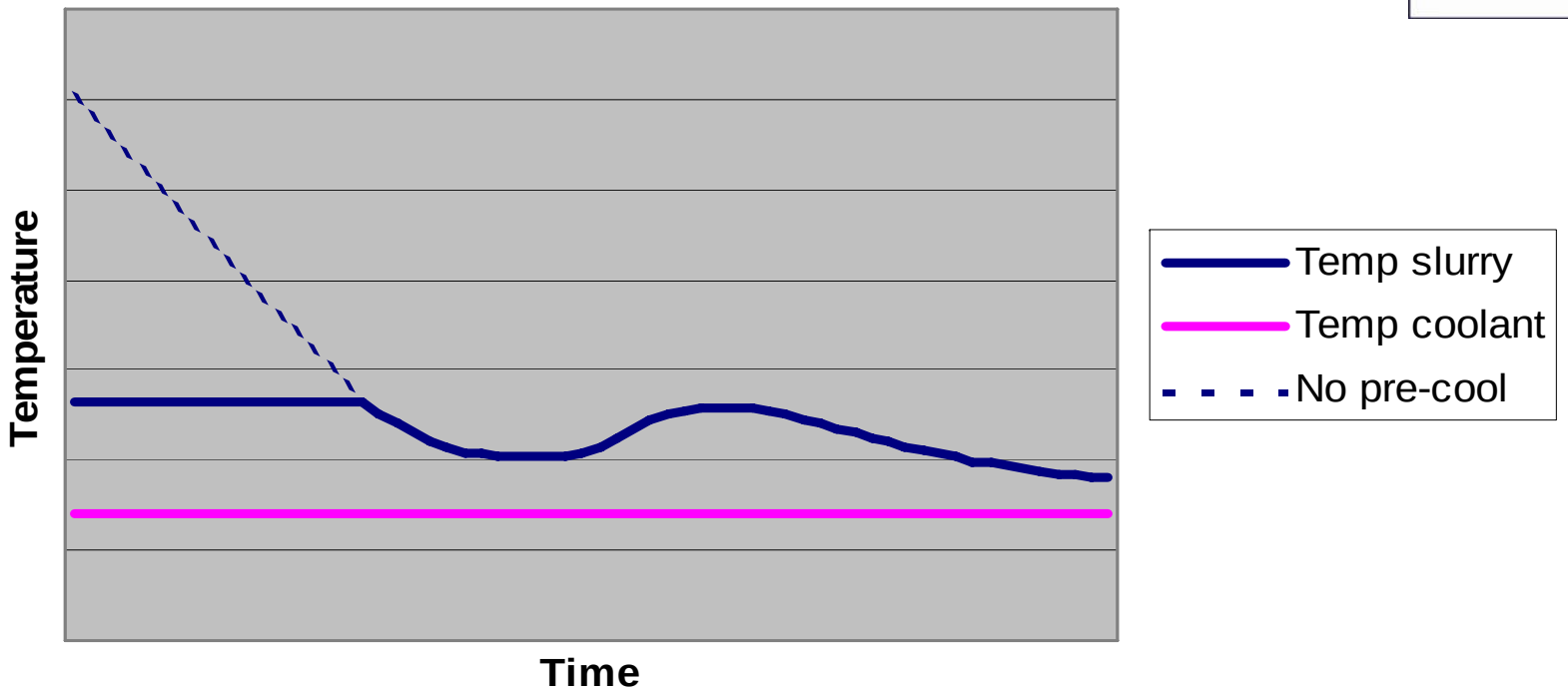
- Step-wise cooling.
  - Coolant inlet temperature is changed following time program
  - Crash cooling is with one fixed coolant temp ie. one step!

Delta cooling



- Delta cooling.
  - Maintain delta between slurry temperature and average coolant temperature.

Pre-cooling



- Oil feed is pre-cooled near to the temperature of heat of crystallization

Stirred Crystallisers eg.

- Lipico
- De Smet
- Alfa Laval
- Tirtiaux / JJ Lurgi
- and various other suppliers

Coil type crystalliser

Tirtiaux style with Thermoplates

De Smet concentric crystalliser

Stirred crystallising slurry

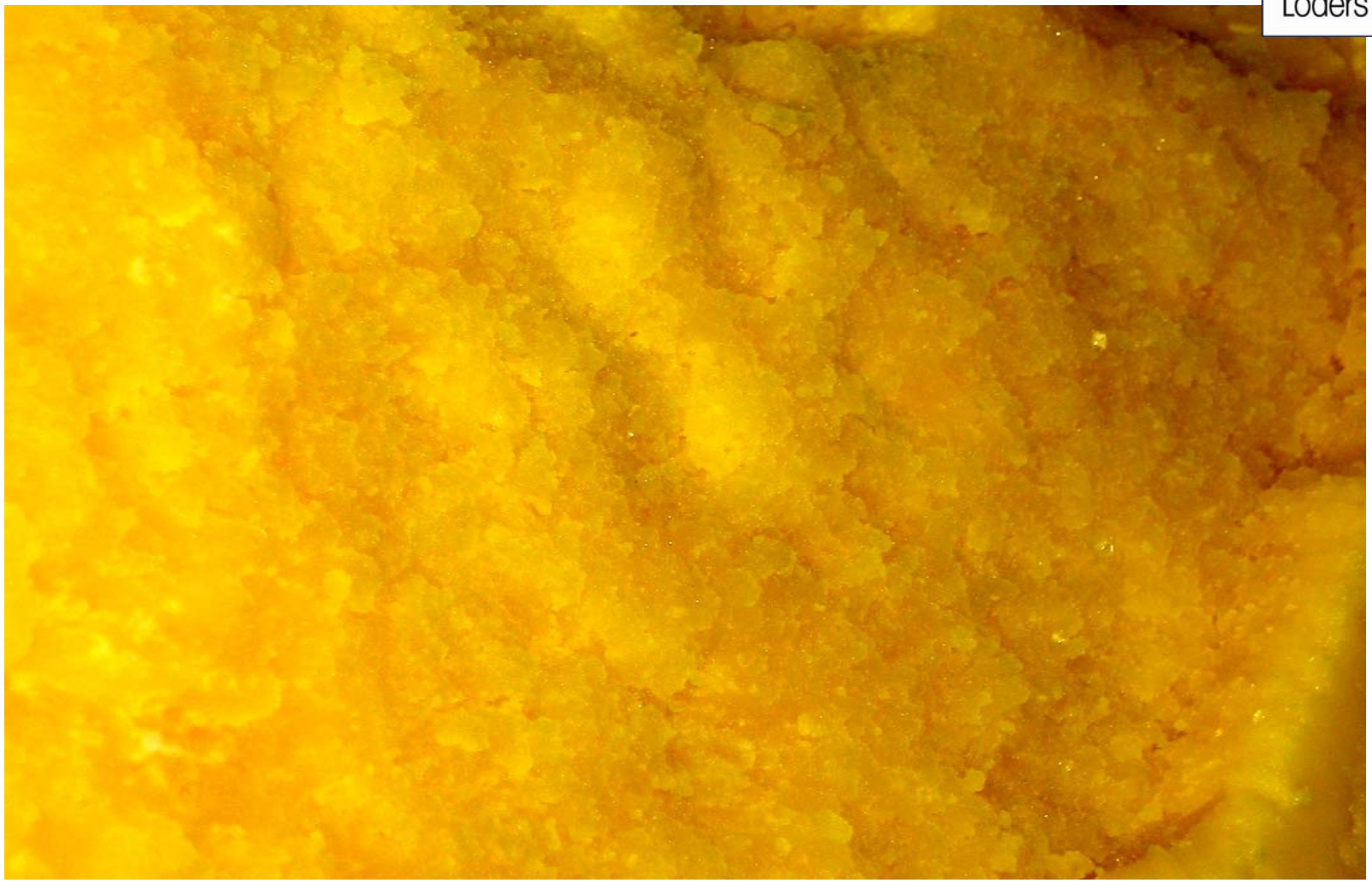
Static or Quiescent crystallisers

- De Smet
- Oiltek
- and others

Static crystallisation – cooled plates

Quiescent crystallising in trays

Quiescently grown crystal “slurry”



Separation techniques

- Lipofrac with addition of water and detergent. Use of centrifuges for water (and crystals) from olein separation
- Florentine and rotary drum – now obsolete
- Membrane filter presses from 6 to 30 bar
- New use of centrifuges for crystals from olein
- Solvent slurry, filtration and washing with clean solvent

Separation efficiency (SE)

$$SE = \frac{SPC_{cake}}{100} = \frac{IV_{stearin} - IV_{olein}}{IV_{slurry} - IV_{olein}} \; x \; \frac{SPC_{slurry}}{100}$$

$$Stearin \;\; yield \;\; \% = \frac{weight \;\; stearin}{weight \;\; slurry} \; x \; 100 = \frac{SPC_{slurry}}{SE} \; x \; 100$$

Separation efficiency strongly depending on

- crystallisation process
  - crystal size / size distribution / entrapped olein
- solid phase content of the slurry
- For membrane filter presses:

  Pressure increase with time / maximum pressure / cake thickness

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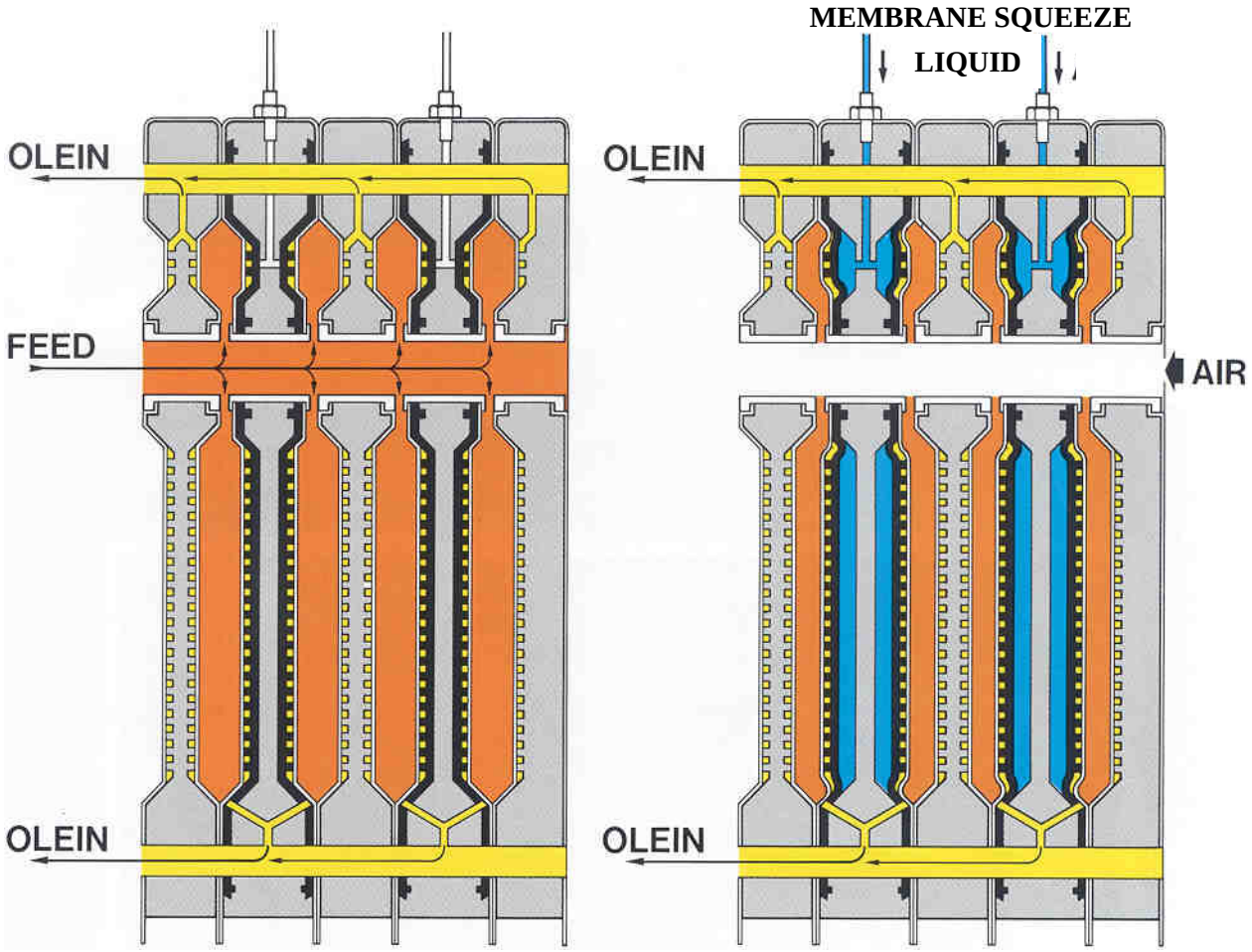
Membrane filter press

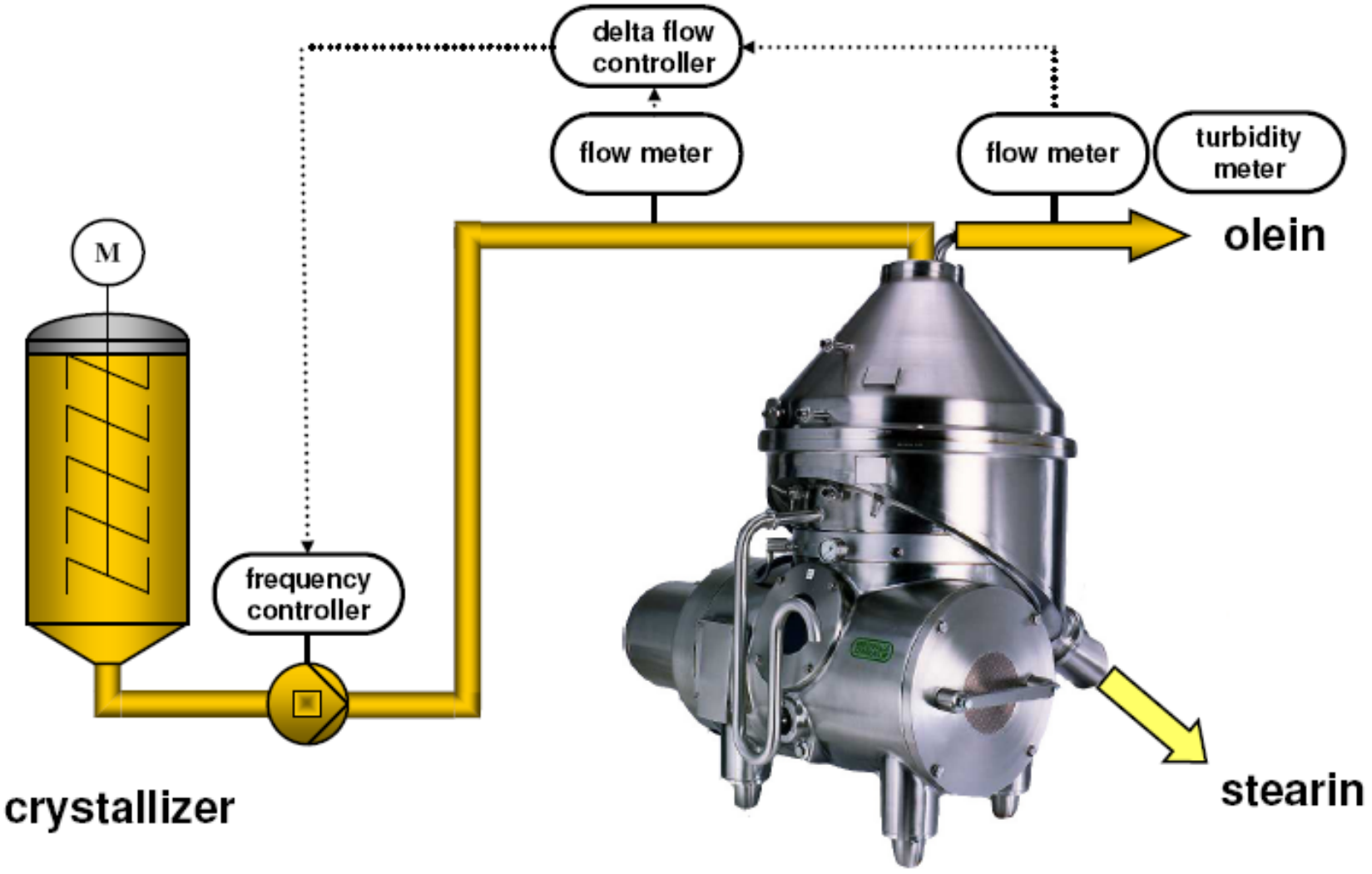
Membrane filter press



Continuous separation with centrifuge

Westfalia Patented Process

The operation of a centrifuge is fully automated and easy to be handled.



Separation concept with centrifuge

Westfalia Patented Process

mass balance :

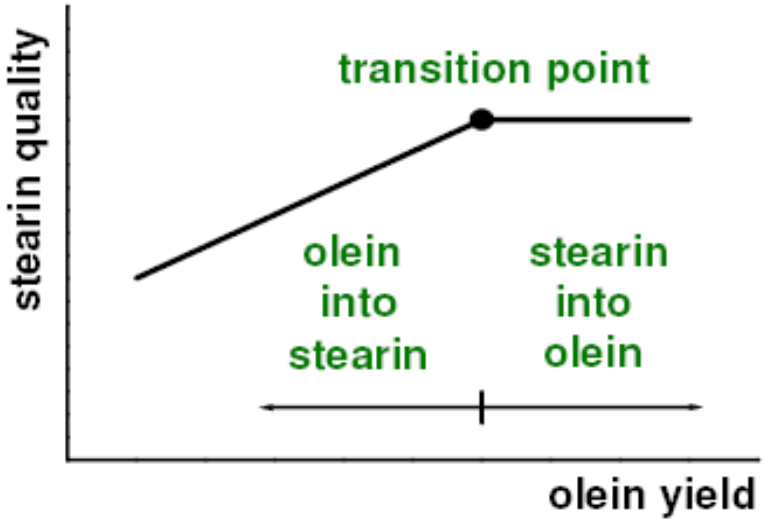
$m_{feed} = m_{olein} + m_{stearin}$

$= m_{light\ phase} + m_{nozzle}$

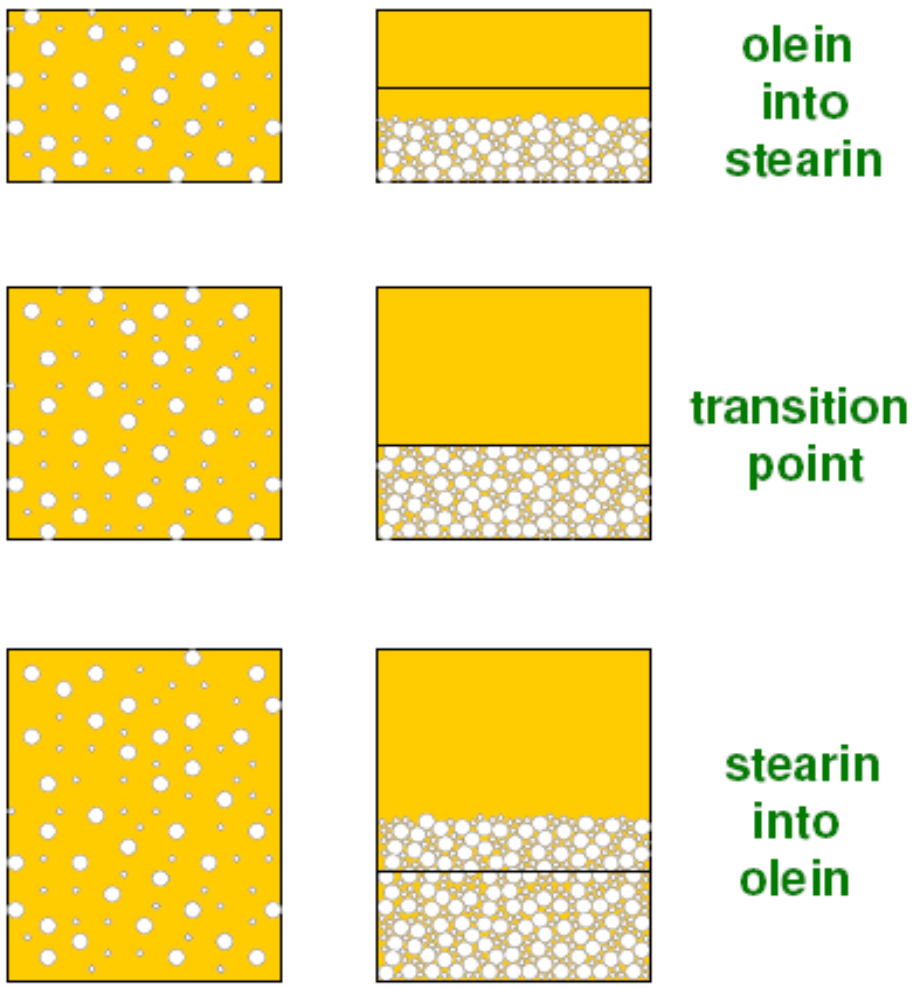
nozzle capacity constant :

$m_{nozzle} = const.$

$m_{olein} = m_{feed} - const.$

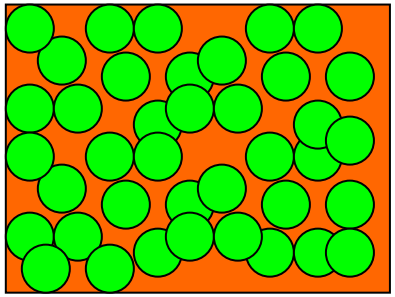


centrifuge => operation line



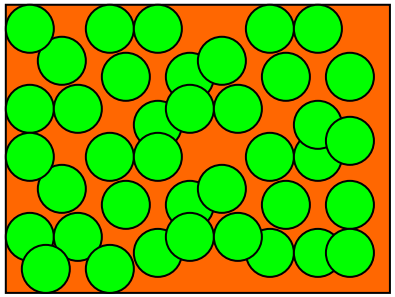
Solvent Fractionation: What if 75% crystals??

- Dry Fractionation



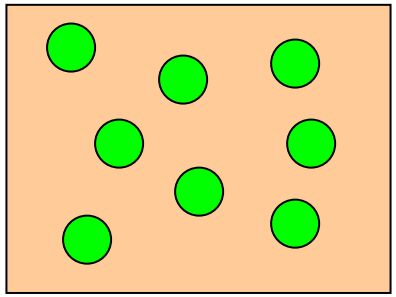
75% crystals

Filter and press for 75% SE



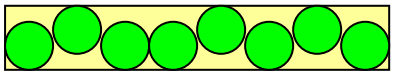
the same

- with Solvent Fractionation



eg. 7.5 : 1 Solv:Oil

Filter and wash



< 80% yield of high quality stearine

Fractionation is:-

- a Natural, Value adding, Physical oil modification process creating no undesirable byproducts

- From:
  - Simple, low stearine yields and low efficiency S/L separation
- To:
  - Sophisticated, high stearine yields and efficient S/L separation

Why? --- eg. Fractions from palm oil give added value!!