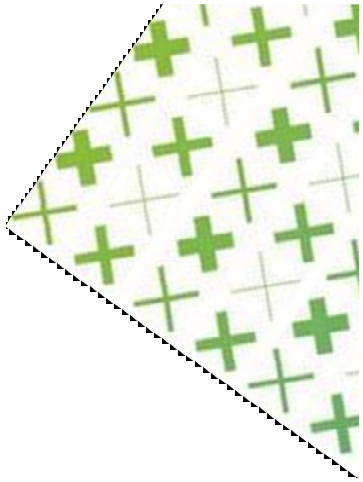
CLEXTRAL INNOVATION SUMMIT 2016
CELEBRATING 60 YEARS OF PIONEERING IN INDUSTRY
19+20 OCT. 2016

Introduction to food powders

Production and characterization methods

LIS France
LESAFFRE INGREDIENTS SERVICES



Contents

- LIS France is part of Lesaffre Group
- Drying: a way to preserve food
- How to transform liquid in powder
- Caracterisation of powder
- A new way to make powder: EPT

Lesaffre Group

LIS France
LESAFFRE INGREDIENTS SERVICES

Using yeast and other fermentation products, Lesaffre develops, produces and delivers solutions that are tailored to the specific needs of each of our markets:

- Bakery products
- Taste and pleasure of food
- Human, animal and plant well-being, nutrition and health
- Industrial biotechnology

LIS

Our business

LIS LESAFFRE INGREDIENTS SERVICES

LIS is a wholly-owned subsidiary of the Lesaffre group.

We are the European leader for contract drying :

- **50 years of experience with several hundred different products, Food & Food grade only.**
- **2 plants in Europe (France – Poland),**
- **A large range of industrial and pilot equipments (14 spray-driers – 1 vacuum drier – powder blending),**
- **Expertise for large-scale spray-drying production as well as for development projects.**
- **R&D team for co-development projects with customers.**

LIS

2 plants in Europe

LIS
LESAFFRE INGREDIENTS SERVICES

LIS France (1936)

220 employees

LIS POLSKA (2000)

50 employees

LIS

Products

LIS
LESAFFRE INGREDIENTS SERVICES

50 years experience on thousands different products:

- Flavors,
- Natural colourings,
- Fruit and vegetable powders,
- Hydrocolloids and fiber,
- Sugar derivatives,
- Raw materials for pharmaceutical use,
- Enzymes,
- Yeast extracts,
- Proteins and hydrolysed proteins,
- Minerals and vitamins,
- Plant extracts,
- Speciality dairy products, etc.

LIS

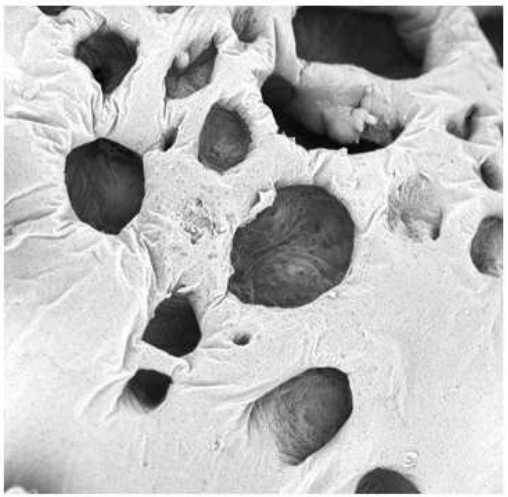
Pilot EPT Europe

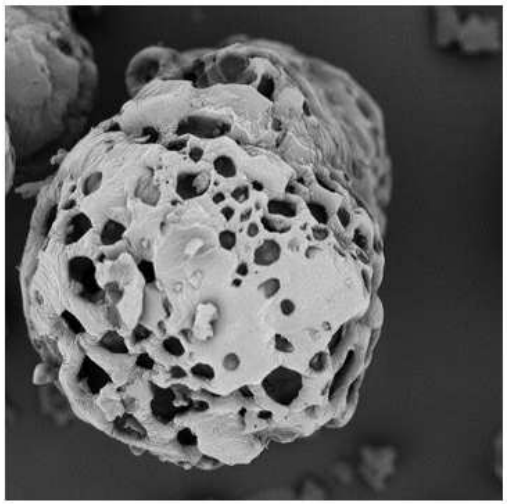
LIS
LESAFFRE INGREDIENTS SERVICES

New 2016 ! EPT™ (Extrusion Porosification Technology).

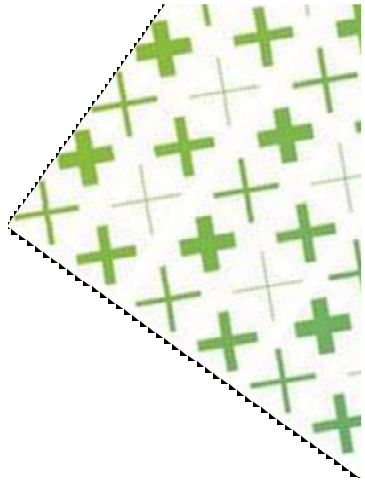
LIS is proud to welcome in its Cérences plant (France) the « EPT™ Europe" pilot unit.

EPT™, a breakthrough innovation patented by Clextral, will open new horizon in the powder business.





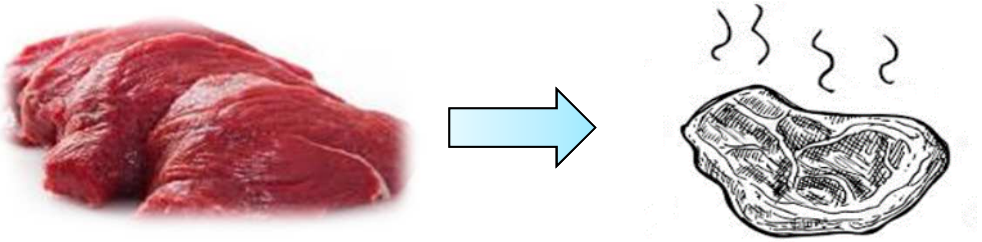
Drying: a way to preserve food

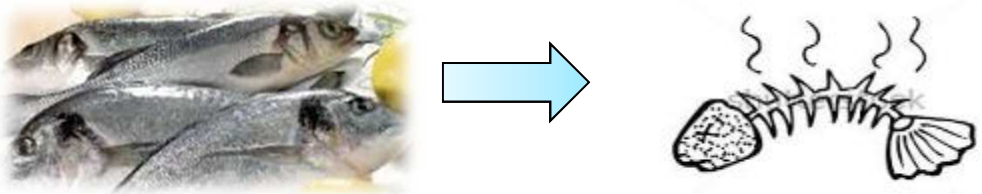


- Food shelf life
- Different way to preserve food
- Importance of water in food preservation

Perishable foods degradation

Fermentation, oxydation





Modify to preserve food

Fermentation, cooking, salting & drying








History of food preservation

Antiquity

- Fermentation
- Cooked on fire and smoked
- Dehydratation (by heating and salting)

1790

Nicolas Appert: discovers canning, a method to preserve food by heating a closed recipient

1860-1898

Louis pasteur: shows how micro-organism can damage food.

In 1898, pasturization is define, for exemple 63°C 30min or 73°C during 16sec.

1865-1913

1865, Charle Tellier invents refrigeration with amoniac

1876, Carl Von Linde invent the first domestic fridge

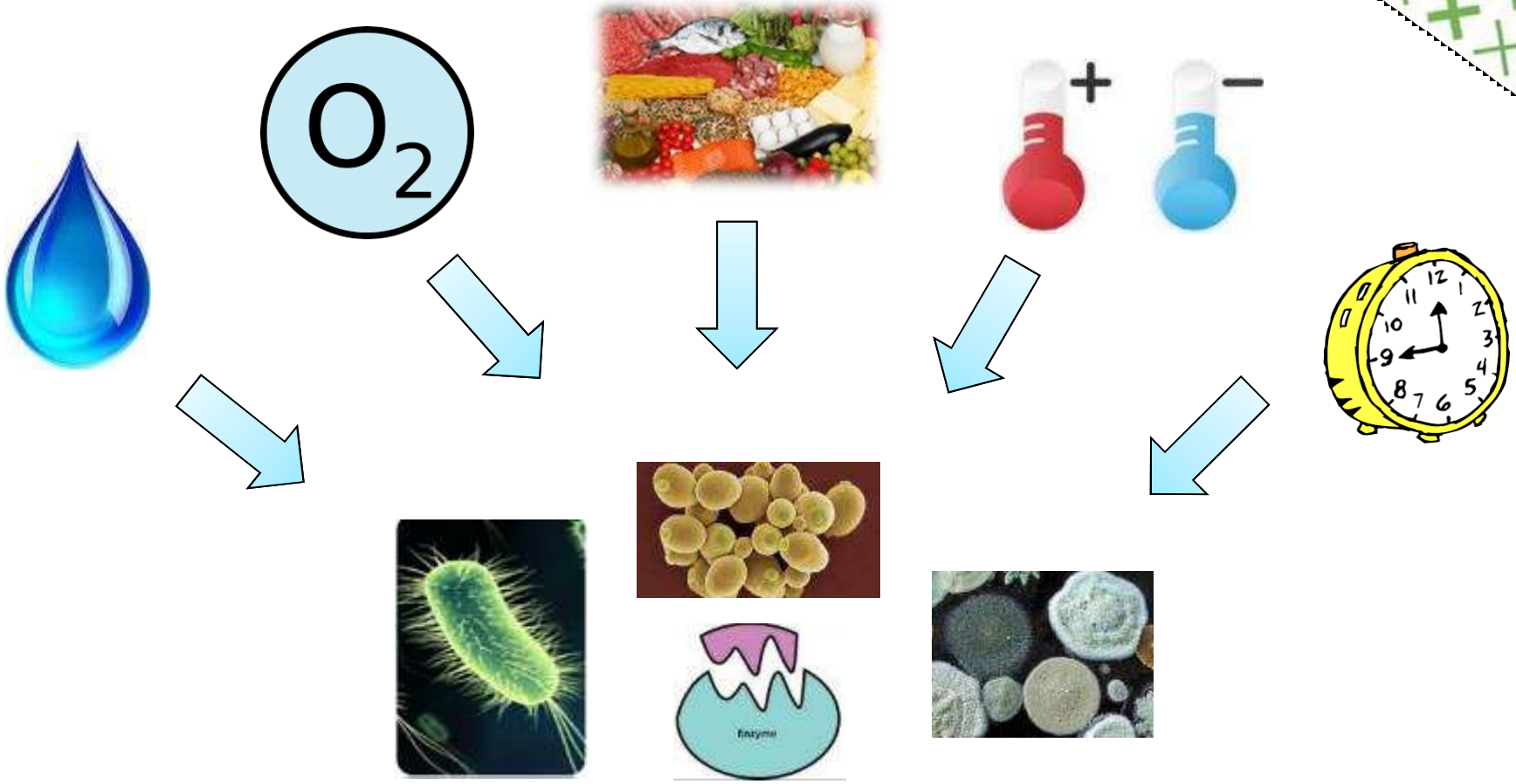
1913, commercialization of the first domestic fridge

Since 1960

Nowdays, tens of industrial processes exist for food preservation:

- Lyophilization
- Micro-wave
- Modified atmosphere
- UHT
- Spray drying

Key parameters to control food preservation



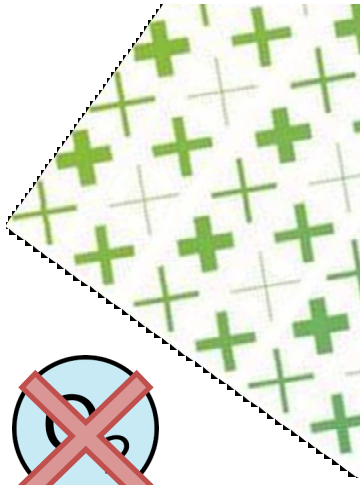
Food preservation: temperature and oxygen

Refrigeration (4°C to 8°C)
Freezing (-18°C)
Deep-freezing (-35°C, then -18°C)

- Lower the microorganism and enzyme activity
- Allow a longer preservation of food (from some days to several months)

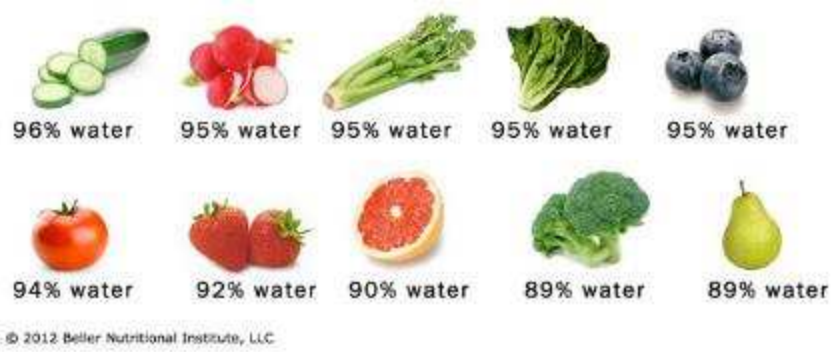
Pasteurization (65°C to 100°C)
Sterilization (>100°C)

- Destroy or inactivate the microorganism and enzyme
- Allow a longer preservation of food



Food preservation: Water

Water content



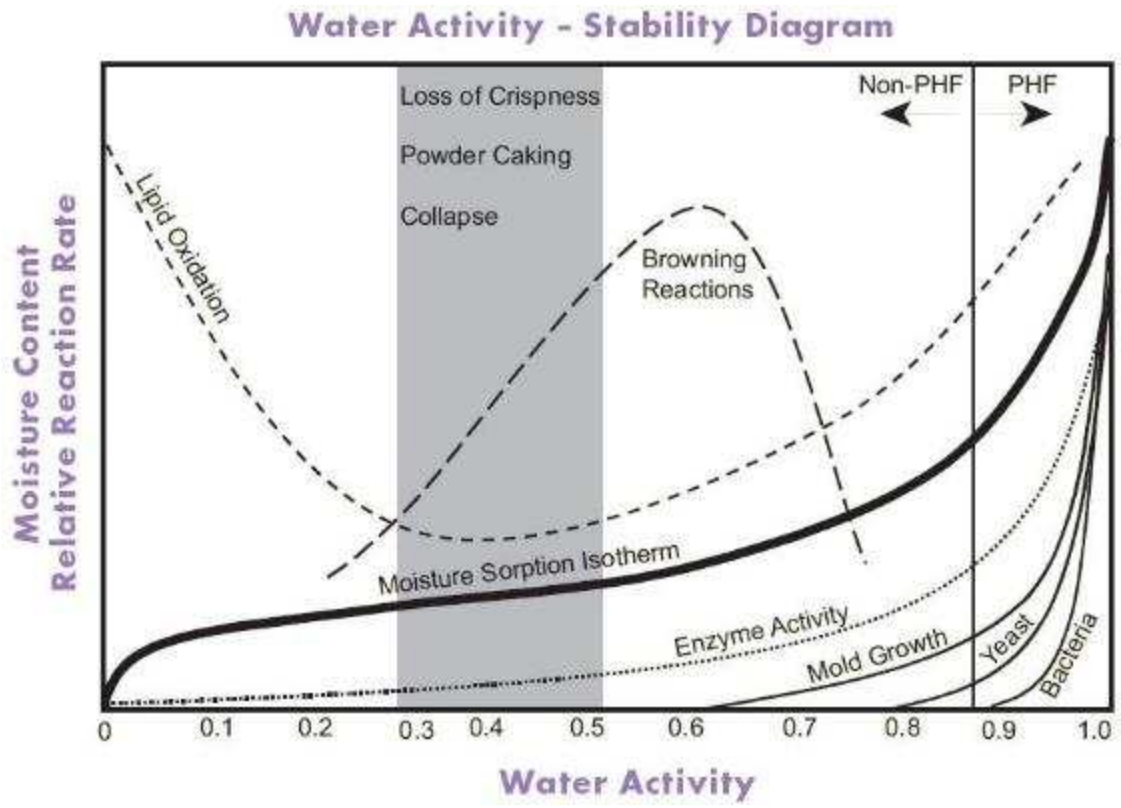
Water activity

$$a_w = \frac{P}{P_0}$$

P = vapor pressure in food
P_0 = vapor pressure of pure water

- The moisture content simply defines the amount of water in the food.
- The water activity defines how the water is available for microorganisms or enzyme activities.
- The higher the water activity, the faster microorganisms like bacteria, yeast, and mold will be able to grow.

Food preservation: Water activity



Reducing the water activity is also a way to avoid microorganism acitvity and reduce enzyme activity.

A way to reduce the water activity is to remove water from the food.

Process to transform liquid in powder

- Different drying mode: convection and conduction
- Spray Drying
- Vacuum Belt Drier
- Fluid bed Drier

Different drying mode

Convection

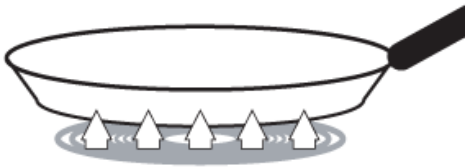
Hot Air

Liquid

Convection Drying

Wet Air

Powder



Conduction

Liquid

Conduction Drying

Vaccuum + water vapour

Powder

Heat

Spray Drying

A long story and evolution

1865: Charles La Mont /Egg

UNITED STATES PATENT OFFICE.

CHARLES A. LA MONT, OF NEW YORK, N. Y., ASSIGNOR TO C. A. LA MONT AND DAVID A. BURR, OF WASHINGTON, D. C.

IMPROVEMENT IN PRESERVING EGGS.

Specification forming part of Letters Patent No. 51,962, dated November 28, 1865.

C. E. GRAY.
PROCESS OF DESICCATING.
APPLICATION FILED NOV. 10, 1913.

1,107,784. Patented Aug. 18, 1914.

Fig. 1.

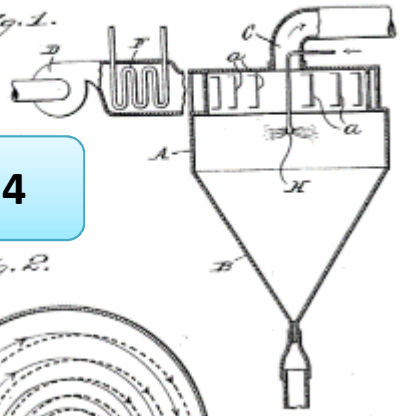


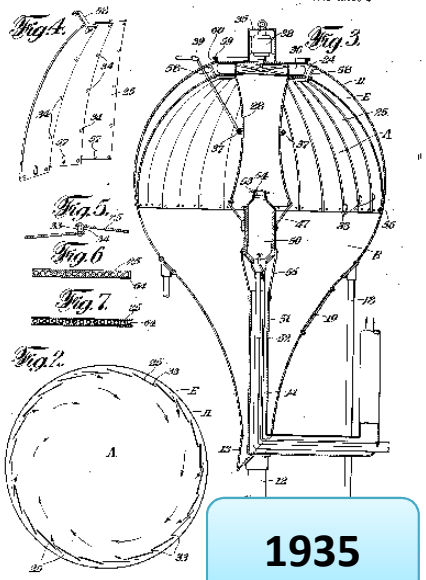
Fig. 2.

1914

Jan. 29, 1935. A. K. DOOLITTLE 1,989,406

SPRAY DRYING APPARATUS

Filed July 30, 1931 3 Sheets-Sheet 2



1935

1872: Samuel R. PERCY

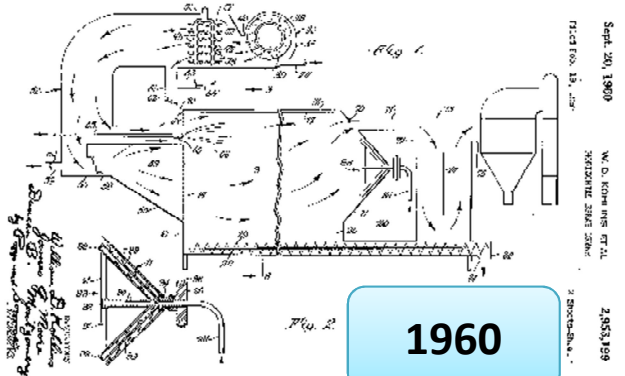
125,406

UNITED STATES PATENT OFFICE.

SAMUEL R. PERCY, OF NEW YORK, N. Y.

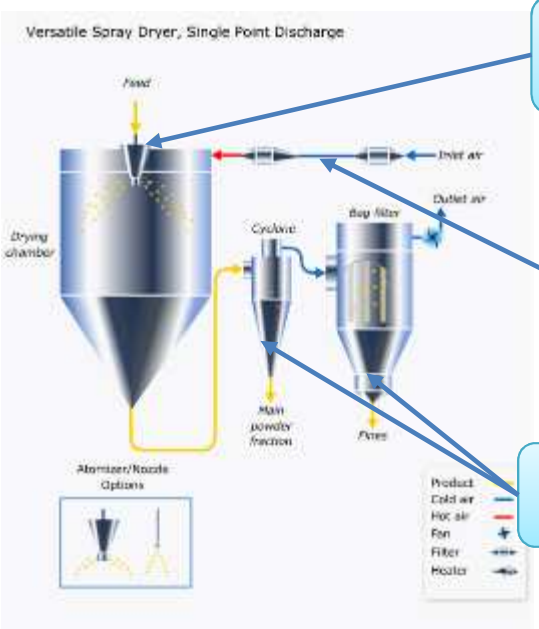
IMPROVEMENT IN DRYING AND CONCENTRATING LIQUID SUBSTANCES BY ATOMIZING.

Specification forming part of Letters Patent No. 125,406, dated April 9, 1872.



1960

Differents actuals spray dryers

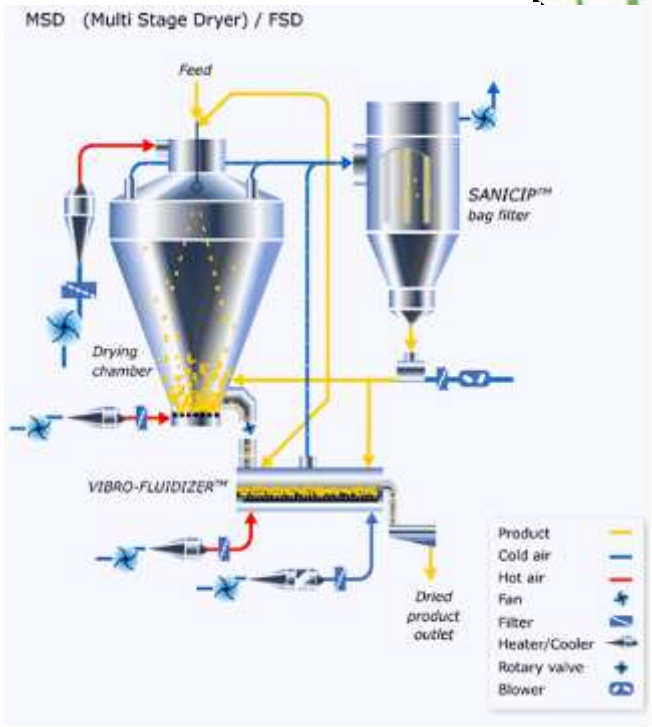


Spray the liquid in small droplet

Hot air

Separate air and powder

One stage drier

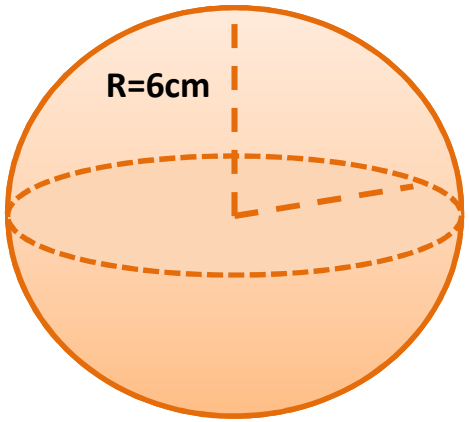


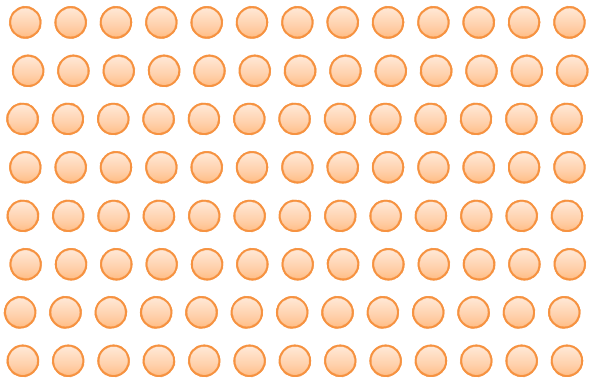
Multi stage drier

Spray Drying

Spray the liquid in small droplet

Why?





R=25 µm

A sphere with a volume of 1 liter has a diameter of around 12.5cm.

The surface is 0.05 m2

Spraying this liter in droplet with a diameter 50µm (around 15 billions of droplet), the total surface is around 120 m2.

The surface was multiple by 2 500! This mean the evaporation will be much faster.

Spray Drying

Spray the liquid in small droplet

How?

Centrifuge

Liquid Pressure

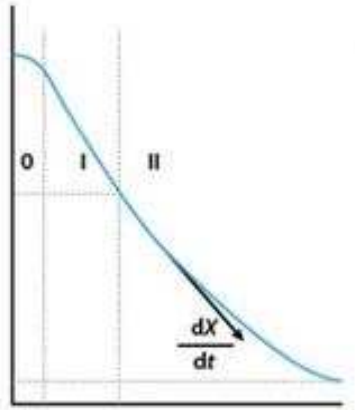
Compressed air

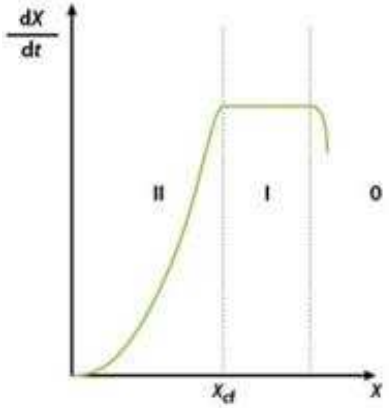
Different technologies are available to spray a liquid.

Spray Drying: hot air to dry

The main goal:

- to have the droplet dried before it touches the wall of the drier.
- to have the right temperature, flowrate and speed of air for a quick evaporation of water.





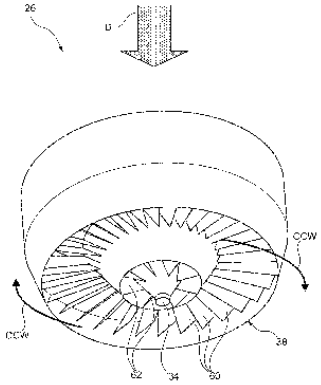
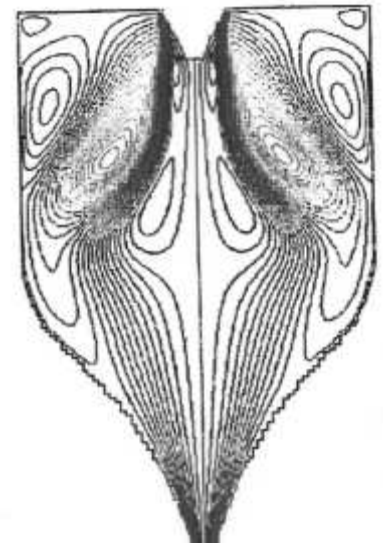


Fig. 2



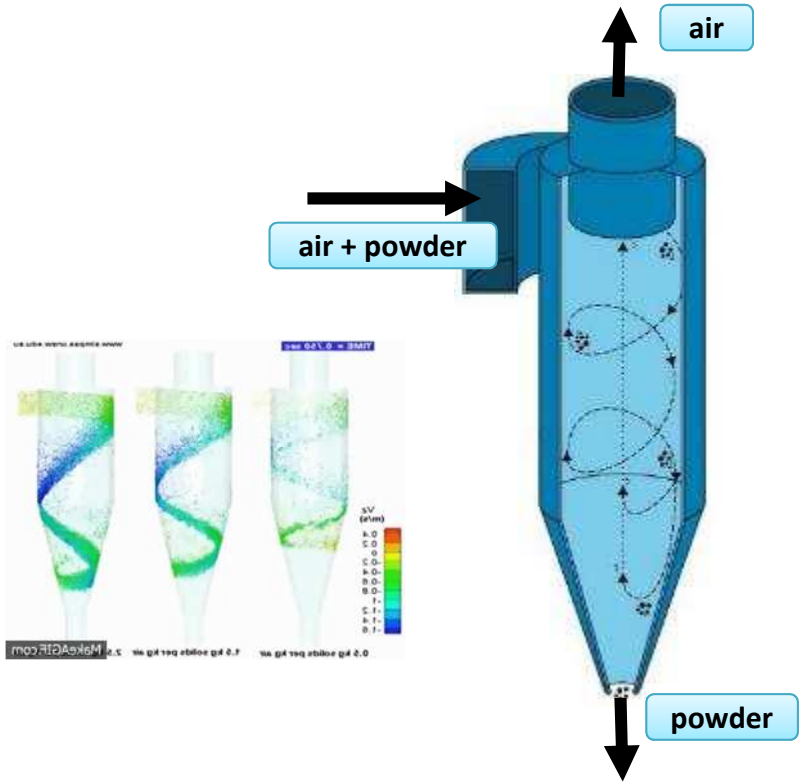
Evaporation of water:

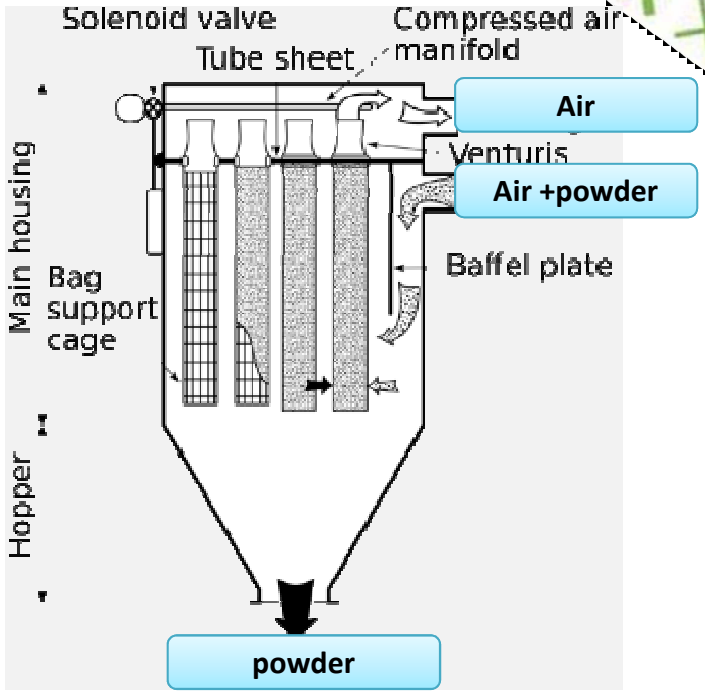
- Phase 0: heating of the product to evaporation temperature
- Phase 1: constant rate of evaporation, aw is 1.
- Phase 2: decreasing phase of evaporation aw <1

Drying air:

- The design of the air distributor will define the speed and air direction.
- The air must transport the droplet in the spray drying chamber having a resident time long enough for the drying

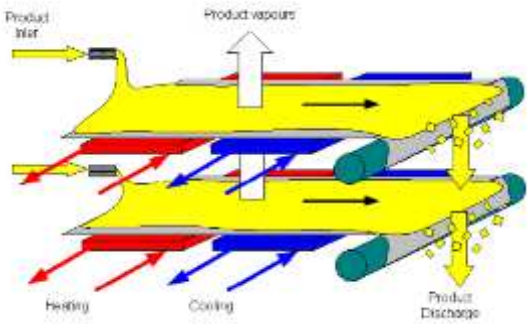
Spray Drying: separate air and powder

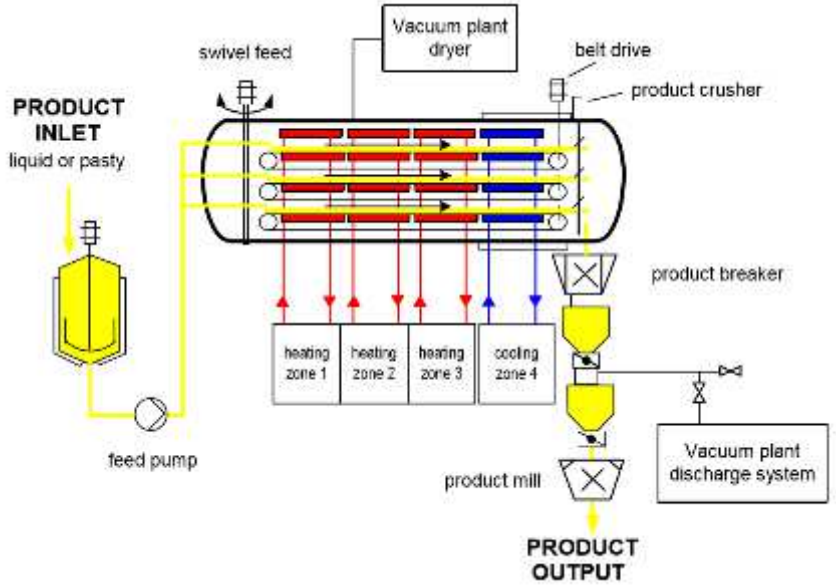


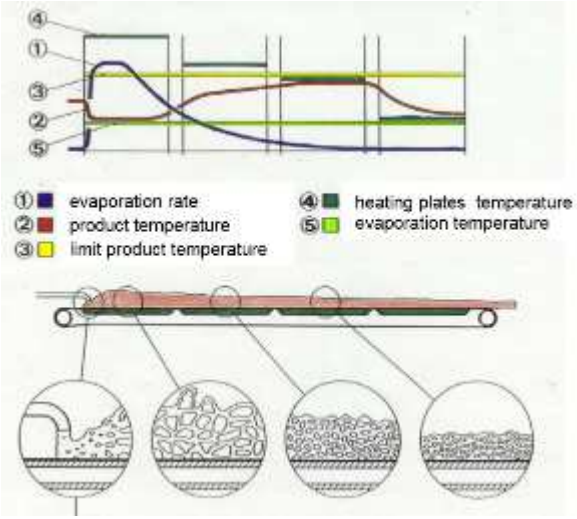


The design of a cyclone allows the separation of air and powder.
It is also possible to use a baghouse, in this case the separation is done with filters

VBD: Vacuum belt drier



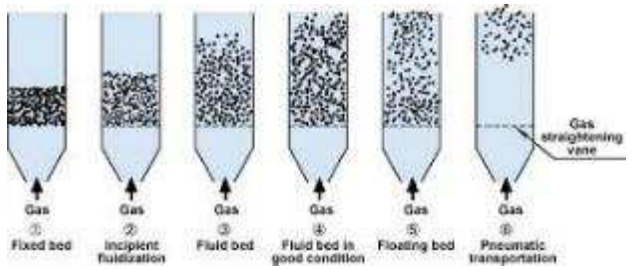


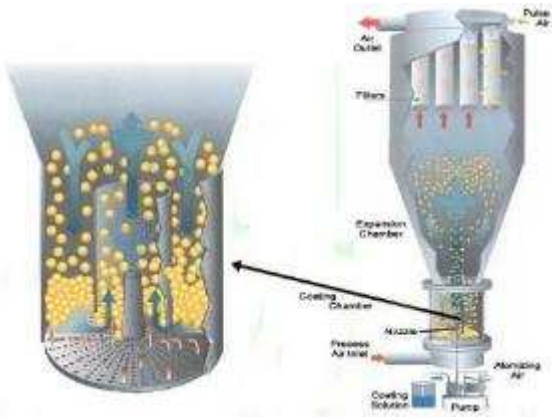


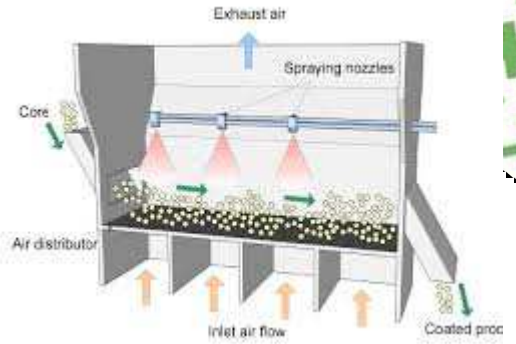
Vacuum belt drier main advantages:

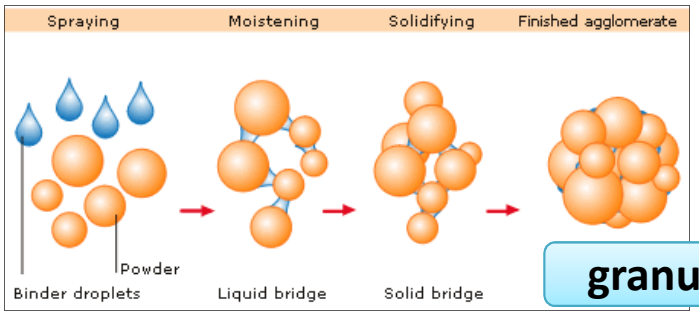
- Suitable for hygoscopic, high viscous and sticky product.
- Low drying temperature
- Aroma retention or improvement (maillard reaction)
- No oxidation of the product

Fluid Beb drier



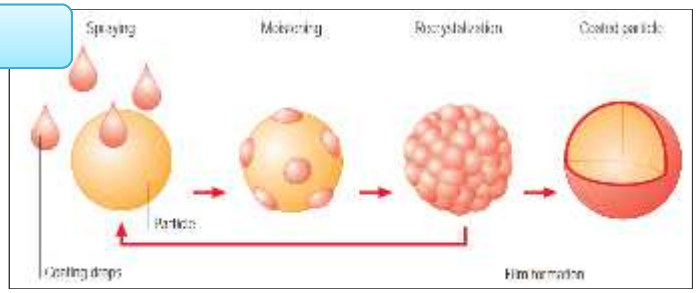






granulation

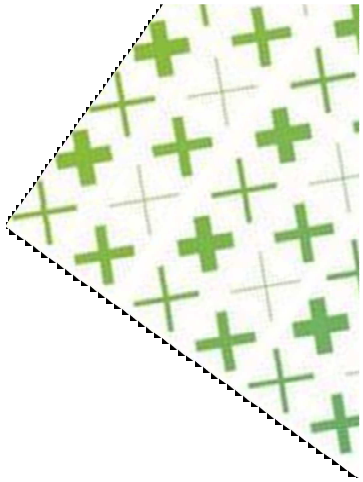
coating



Fluid Bed main advantages:

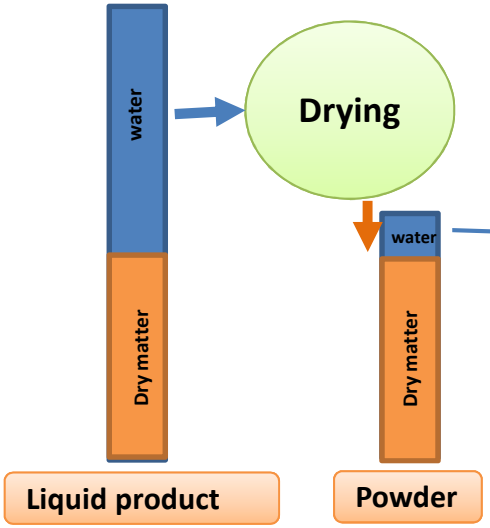
- The Fluid Bed ensures a uniform and gentle drying for all particles.
- The Fluid Bed allows shaping of the powder by granulation, powder coating and pelletizing.

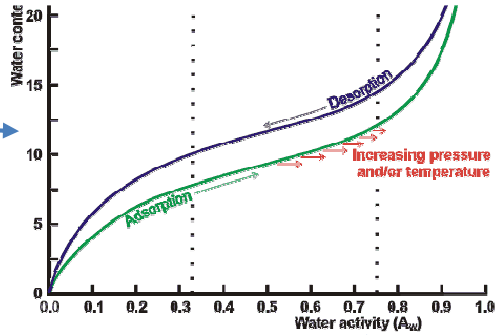
Characterization of powder

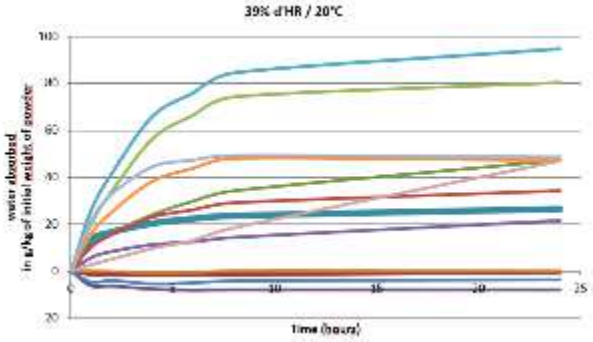


- Hygroscopicity and dry matter
- Granulometry and morphology
- Density and porosity
- Flowability
- Wettability, solubility, dispersibility
- Observation

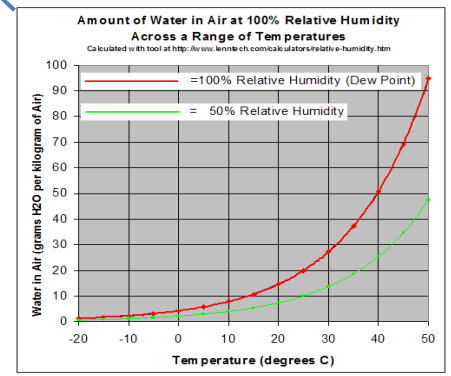
Hygroscopicity and dry matter





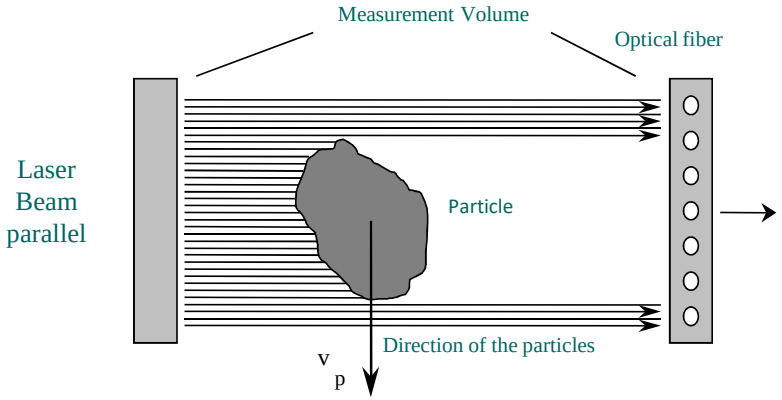


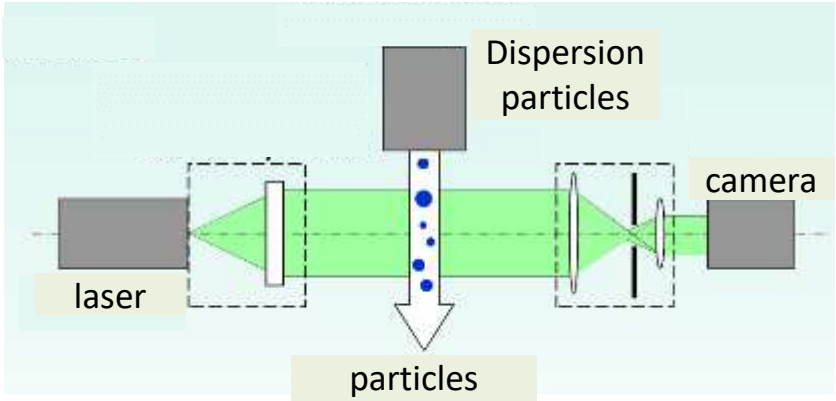
Dry matter: after drying, a powder still contain few percentage of water. Generally around 2 to 8%.
Water activity: The water activity defines how the water is available for microorganisms or enzyme activities.
Both are linked by the sorption-desorption curve of the product.
Hygroscopicity: It is the tendency of material to absorb moisture from atmosphere and get dynamic equilibrium with water in the atmosphere

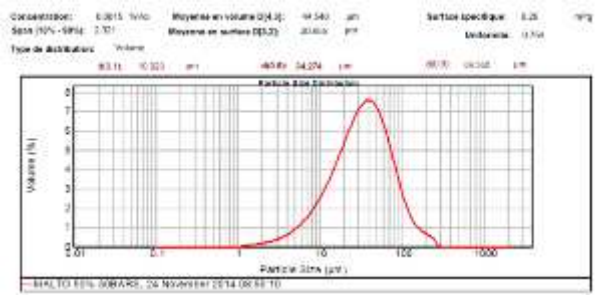


Granulometry and morphology

Particle size: study of the distribution of the size of particles present within samples



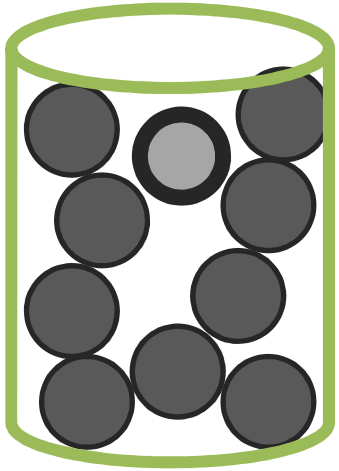


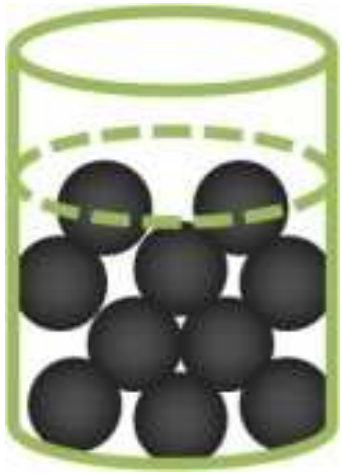


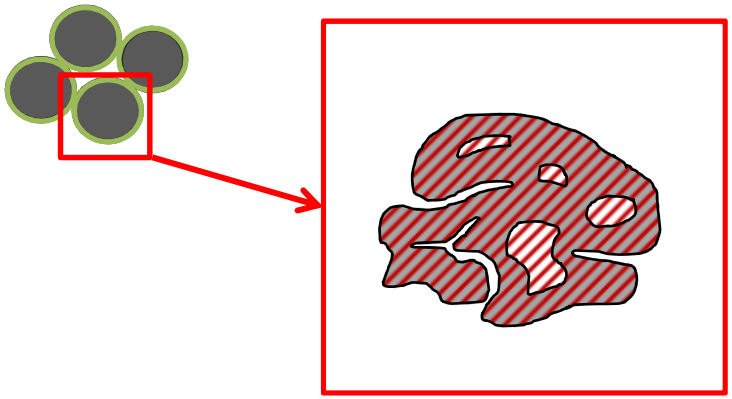
Laser diffraction granulometry: this technique uses the principle of diffraction and scattering of a laser beam striking a particle.

Morpho-granulometry: this technique uses a camera to analyze the shape of all the particles of a sample.

Density and porosity





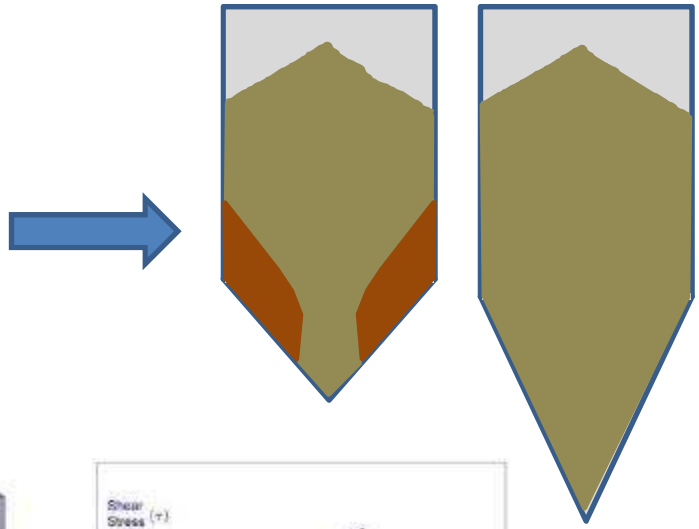


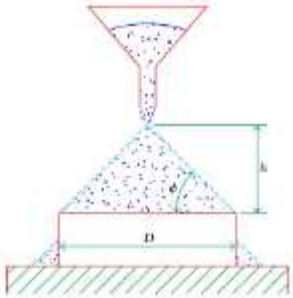
Bulk density: The bulk density of a powder is the ratio of the mass of an untapped powder sample and its volume including the contribution of the interparticulate void volume.

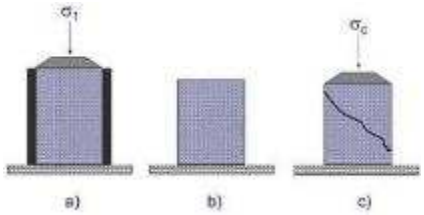
Tapped density: The tapped density is an increased bulk density attained after mechanically tapping a container containing the powder sample.

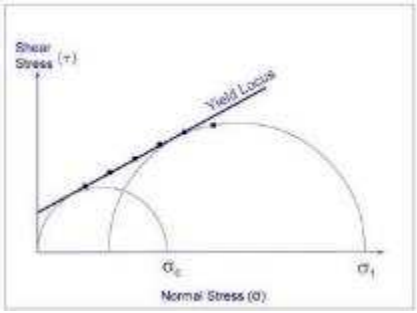
Porosity: Ratio of the volume of voids between particles, plus the volume of pores, to the volume occupied by the powder, including voids and pores.

Flowability







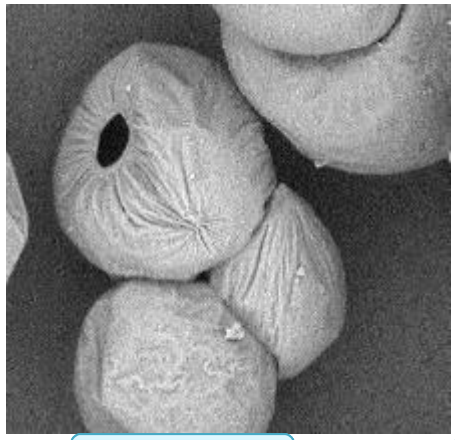


Powder flowability: is defined as the ease with which a powder will flow under a specified set of conditions. Some of these conditions include: the pressure on the powder, the humidity of the air around the powder and the equipment the powder is flowing through or from.
To mesure it is possible de use analyse like Angle Response ou Shear Stress.

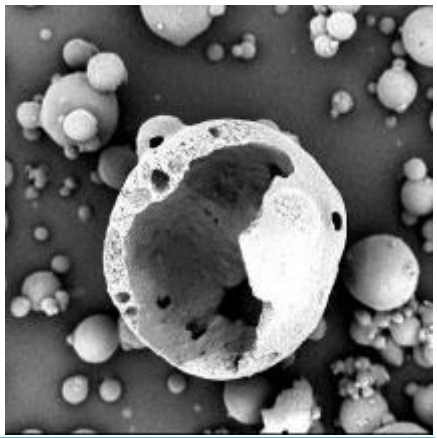
Wettability, solubility, dispersibility

Powder wettability: The wettability is defined as the time required for all the particles of sample to become wetted when placed on the surface of water. It can be evaluate with different method.
Powder dispersibility: the dispersibility is the ability of the powder to be in suspension after a short agitation
Powder solubility: the solubility is the global ability of the powder to be solved in water. The sediment percentage is considered (insoluble part)

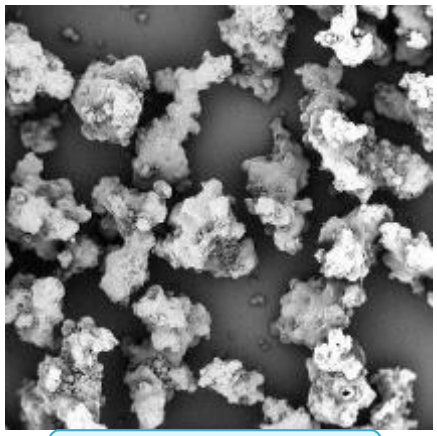
Observation



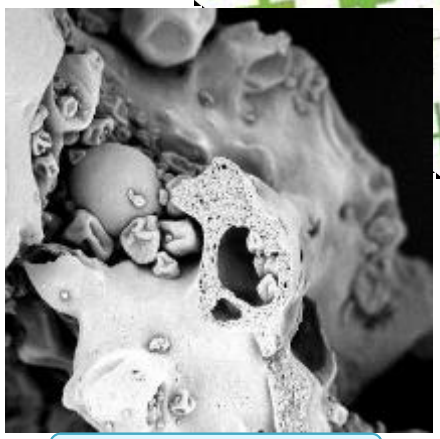
particles



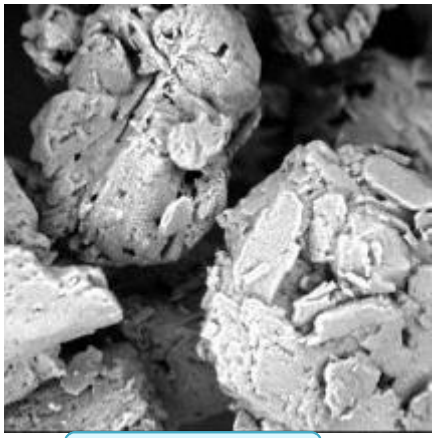
Broken and vacuole



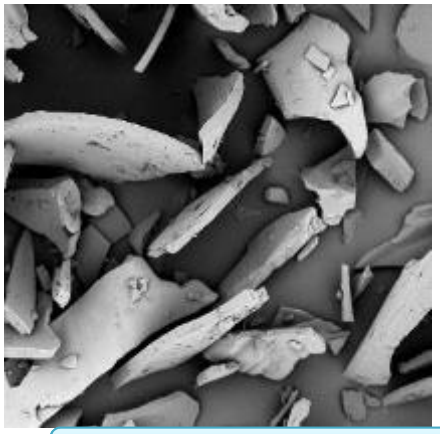
agglomerated

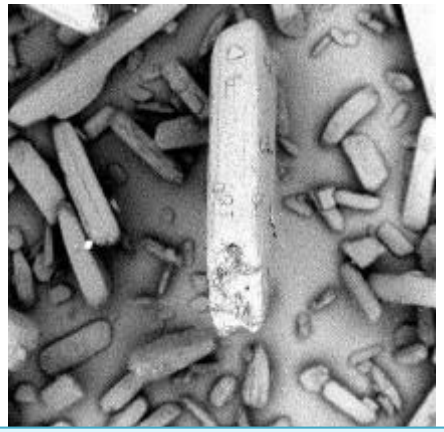


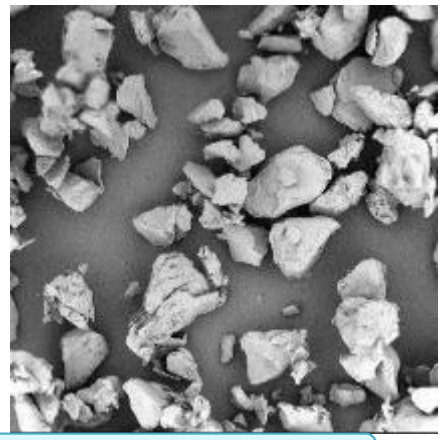
emulsion



cristallized



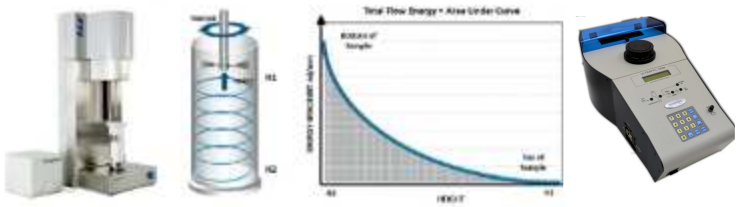




different technologies to obtain powder, crystals, crushed….

LIS laboratory in Rennes

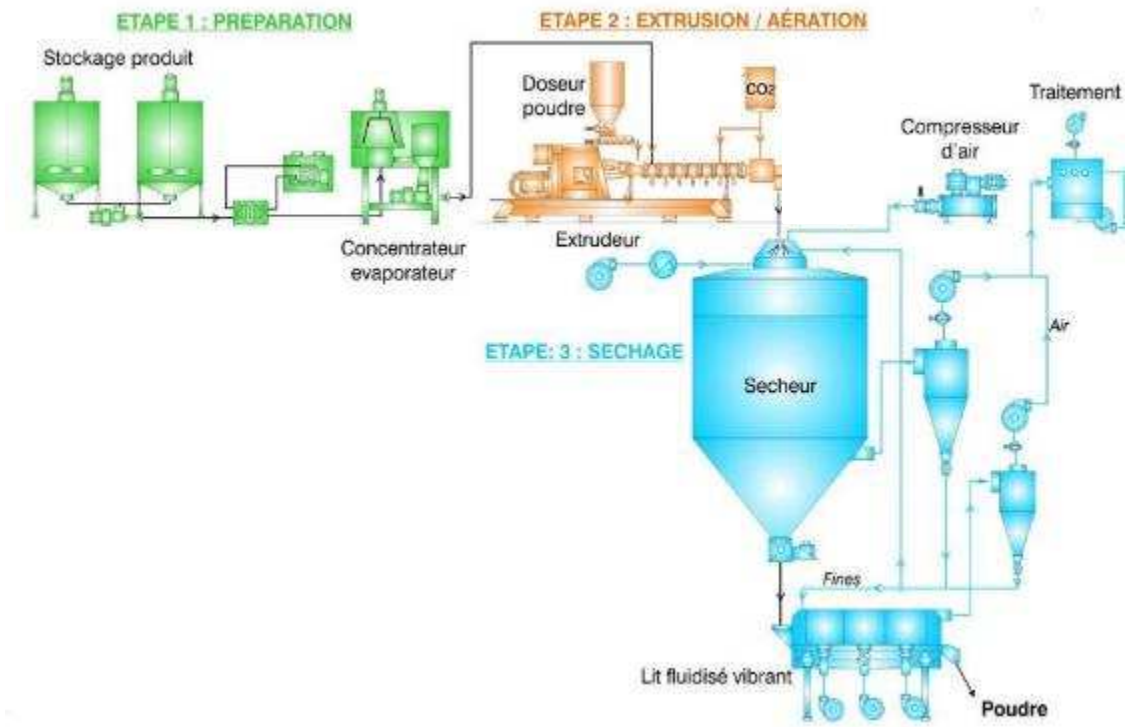
- We can help you to caracterize the powder obtained with our lab in Rennes:
- Physical properties: granulometry, hygroscopicity, % of critical humidity before caking of the powder, porosity (pycnometer)…
- Observation: optical microscope, binocular loupe and SEM (with metal coating)
- Rheology: Freeman FT4 rheometer.



A new way to make powder: EPT

- How it works
- EPT powder structure
- EPT advantages

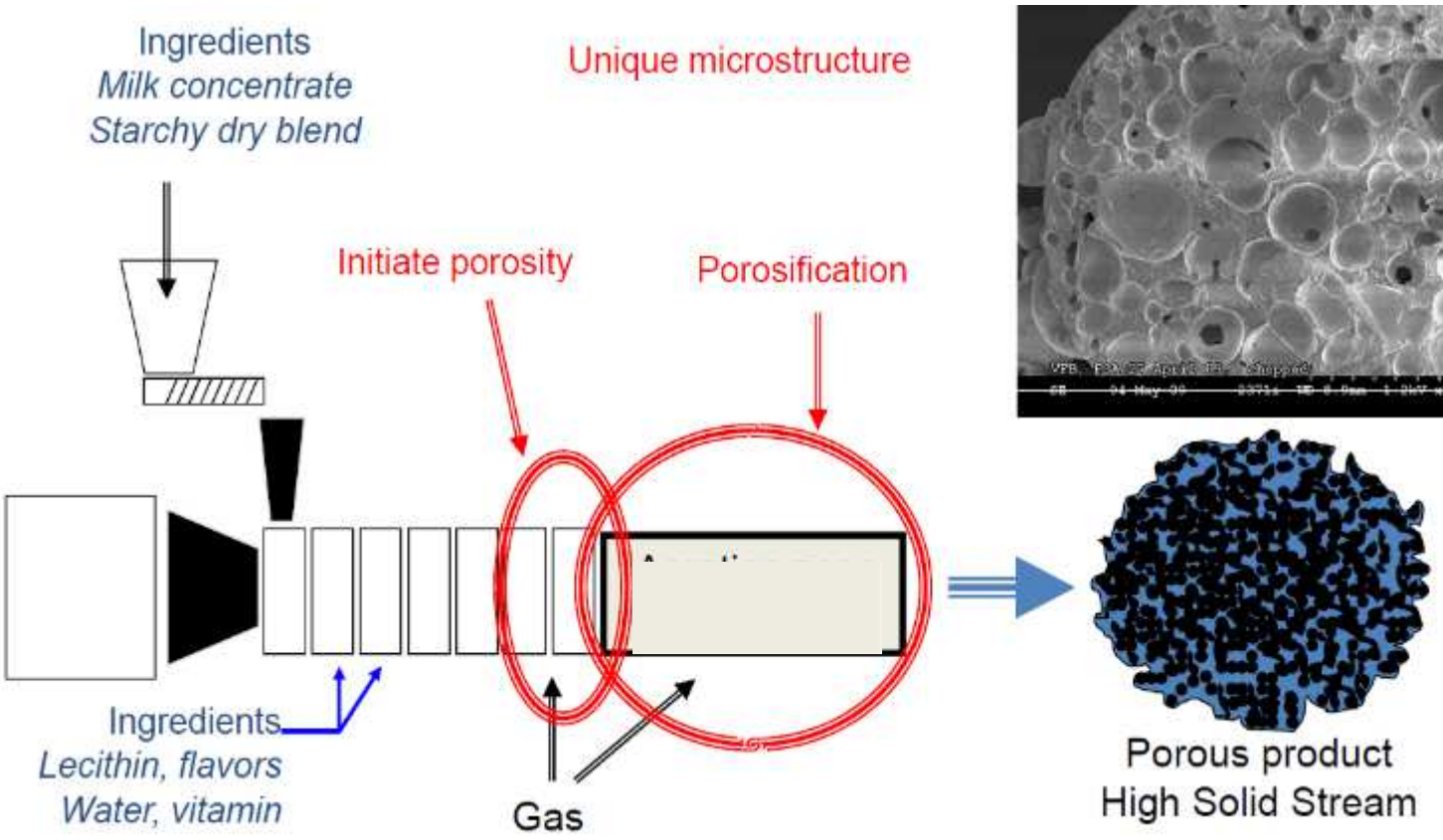
How EPT™ Europe works



Drying with EPT™ uses:

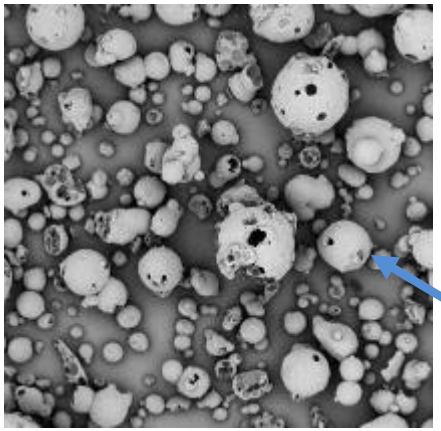
- A high viscosity liquid to dry allowing a higher dry matter for the feed and relatively low drying temperature
- The extruder can be fed with powder and/or liquid material with an optional side injection to add flavor, probiotics, or thermo-sensitive actives at low temperature just before the dryer

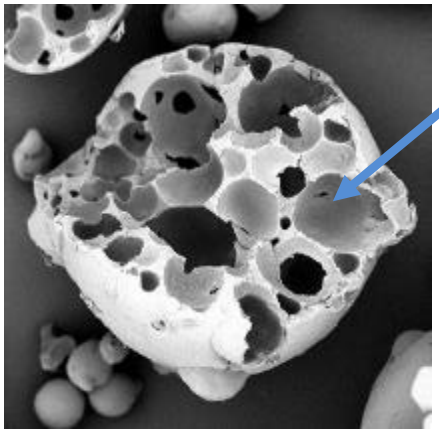
How EPT™ Europe works



EPT™ powder structure

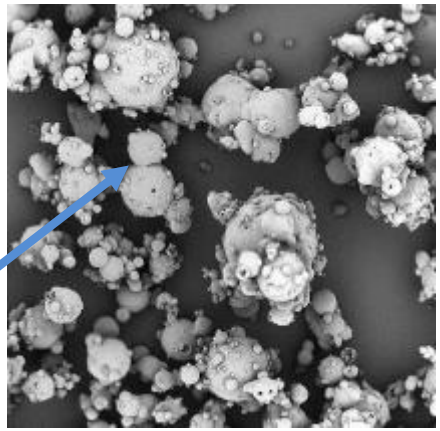
EPT milk powder non agglomerated

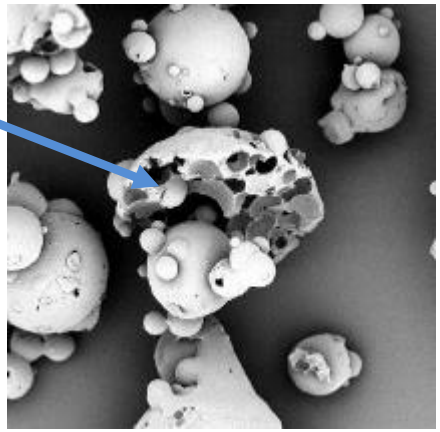




Structure: spherical shapes, smooth surface, highly porous texture with numerous capillaries. Nice agglomeration is observed.

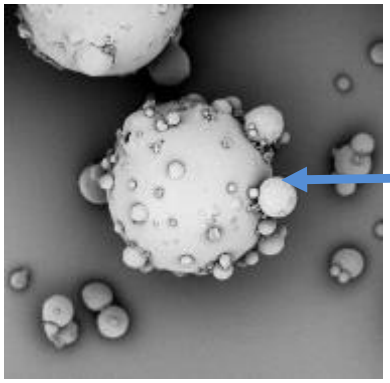
EPT milk powder agglomerated



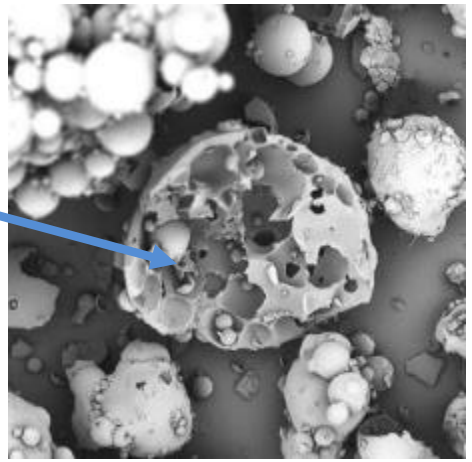


EPT™ powder structure

EPT MPC powder



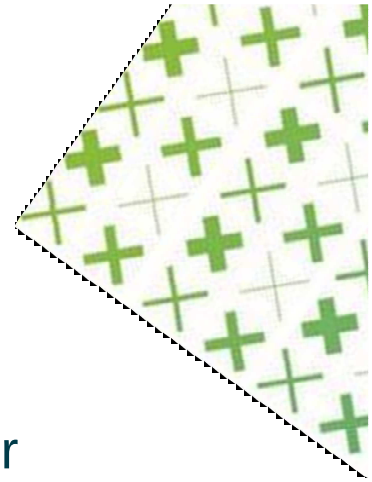
Structure:
spherical shapes, smooth surface, highly porous texture with numerous capillaries inside



Wettability: including for this kind of difficult product we observed an improved wettability of the particles

Dispersibility: with a gentle agitation, the dispersibility is possible in less than 1 minute.

Advantages of EPT™

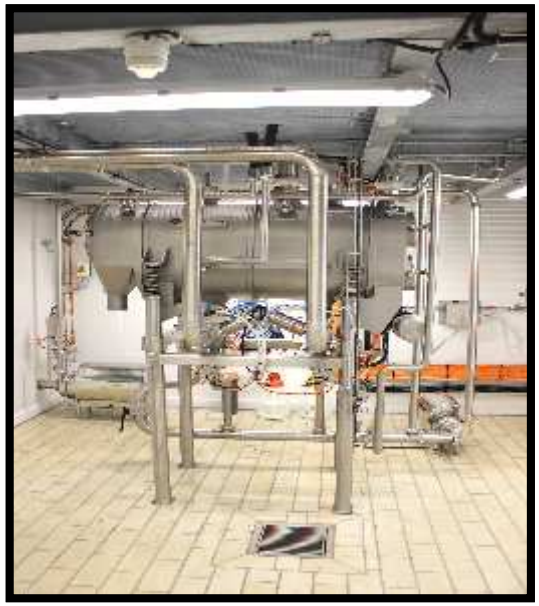


- Improved Functionalities: new powder shape with better disperbility & flowability
- New Products drying capabilities thanks to process high viscosity products
- Highly Flexible Platform
- Energy Savings
- Drying products at low temperature (preservation of assets)
- Compact System

Pilote EPT™ Europe

Extrusion unit

Mixing tank



External fluidized bed

Thank you

LIS France
LESAFFRE INGREDIENTS SERVICES