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• LIS – France

• INTRODUCTION TO
• FOOD POWDERS
Introduction to food powders
Production and characterization methods
Introduction to food powders

Contents

• LIS France is part of Lesaffre Group
• Drying: a way to preserve food
• How to transform liquid in powder
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Lesaffre Group

A key global player

- A family-owned corporation founded in northern France
- Today we are a multinational, multicultural group
- Our development has been driven by innovation since 1853

A few key facts:
- €1.8 billion
- More than 160 years of experience and know-how
- 1/3 of the world's bread is made with Lesaffre yeast
- Every day, more than one billion people around the world consume food made with our products
Lesaffre Group

Our business

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.
Lesaffre Group

2 plants in Europe

- LIS France (1936)
  - 220 employees

- LIS POLSKA (2000)
  - 50 employees
Lesaffre Group

Products

50 years experience on thousands of 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.
Lesaffre Group

Pilot EPT Europe

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
- Dehydration (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, pasteurization is defined, for example 63°C 30min or 73°C during 16sec.

**1865-1913**
- 1865, Charle Tellier invents refrigeration with amoniac
- 1876, Carl Von Linde invents the first domestic fridge
- 1913, commercialization of the first domestic fridge

**Since 1960**
- Nowadays, tens of industrial processes exist for food preservation:
  - Lyophilization
  - Micro-wave
  - Modified atmosphere
  - UHT
  - Spray drying

**Innovation Summit 2016**

**LESARRE INGREDIENTS SERVICES**
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)

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

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

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

Air N₂ & or N₂
Food preservation: 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.

Water content

<table>
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<th>95% water</th>
<th>95% water</th>
<th>95% water</th>
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<tbody>
<tr>
<td>94% water</td>
<td>92% water</td>
<td>90% water</td>
<td>89% water</td>
<td>89% water</td>
</tr>
</tbody>
</table>

Water activity

\[
a_w = \frac{P}{P_0}
\]

- \( P = \) vapor pressure in food
- \( P_0 = \) vapor pressure of pure water
Food preservation: Water activity

Reducing the water activity is also a way to avoid microorganism activity 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
- Wet Air
- Powder

- Liquid

Conduction

- Liquid
- Powder
- Heat
- Vacuuum + water vapour
Spray Drying: A long story and evolution

1865: Charles La Mont / Egg

1872: Samuel R. Percy

1914

1935

1960
Different current spray dryers

One stage drier

Spray the liquid in small droplet

Hot air

Separate air and powder

Multi stage drier
Spray Drying

Spray the liquid in small droplet

Why?

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

The surface is 0.05 m²

Spraying this liter in droplet with a diameter 50 µm (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.

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 Bed drier

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
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 measure it is possible to use analyses like Angle Response or 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....
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**

**EPT milk powder agglomerated**

**Structure:**
spherical shapes, smooth surface, highly porous texture with numerous capillaries. Nice agglomeration is observed.
EPT™ powder structure

Structure:
spherical shapes, smooth surface, highly porous texture with numerous capillaries inside.
EPT™ powder structure

**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
LIS laboratory in Rennes

• We can help you to characterize the powder obtained with our lab in Rennes:

• Physical properties: granulometry, hygroscopicity, % of critical humidity before caking of the powder, porosity (picnometer)...

• Observation: optical microscope, binocular loupe and SEM (with metal coating)

• Rheology: Freeman FT4 rheometer.
Thank you