DRYING TECHNOLOGIES

CLEXTRAL

Extrusion Expertise Excellence

CLEXTRAL A DIVISION OF GROUPE LEGRIS INDUSTRIES
INTRODUCTION TO THE TECHNOLOGY OF DRYERS

BELT

ROTARY

“JET ZONE”
FUNCTIONALITIES AND OBJECTIVES OF THE FOOD DRYING PROCESS

**FOOD** preservation / stabilisation unit operation

= decrease in product moisture

➤ **FOOD SAFETY**

Decrease in product moisture

= **ENERGY INPUT** ➔ water evaporation

Reach the product’s **QUALITY OBJECTIVES**

- Control and compliance with the H$_2$O objective
- Organoleptic quality (formulation, texturization)
- Absence of enzymatic and non-enzymatic reactions, and of the development of microorganisms
QUALITY CRITERIA

PRODUCT MOISTURE

- Formula: $H_2O = 100 \times (\text{water mass} / \text{wet product mass})$
- **RAPID measurement method:**
  - NIR = spectrophotometer close to infrared
  - Scales to measure moisture = Method utilised at the research centre (during tests)
- **STANDARD measurement method = DRY MATTER ANALYSIS**

WATER ACTIVITY (aw) = availability of water in the analysed food

- Measurement range between 0 and 1
- Widely studied parameters in the food industry, for example: pet food, co-extrusion, fruit cake, etc.
- Measurement with “aw meter - Water Activity Meter”
**Extruded Products Drying Theory**

**AIR NOTION**

Initial (Ta) = **DRY AIR TEMPERATURE**

(In this case gaz type = Air)

Subsequent (Th) = **MOIST AIR TEMPERATURE**

=> Temperature given by a probe wrapped inside a wet wick:

=> (Th) always < (Ta)

**RELATIVE HUMIDITY (RH):**

RH (%) = Actual Vapor Density / Saturated Vapor Density x 100%

Also known as the hygrometric degree

At saturation: RH = 100% (Dew Point)

**ABSOLUTE HUMIDITY (AH):**

= mass of water / mass of dry air
EXTRUDED PRODUCTS DRYING THEORY

PRINCIPLE OF CONVECTION DRYING

Energy transmission = CONVECTION
Drying mode = DRIVEN

HOT AND DRY AIR FLOW

ENERGY

INCREASED PRODUCT TEMPERATURE:
• T product surface < :
• T hot air
• T boiling of water in the product

WATER VAPOR

EVAPORATION OF THE PRODUCT’S WATER

SIMULTANEOUS TRANSMISSION HEAT / MATTER

MOIST AIR FLOW

COOLER

WET PRODUCT
**EXTRUDED PRODUCTS DRYING THEORY**

**EVAPORATION NOTION (FREE & BOUNDED)**

**Free water evaporation**
- Superficial water
- Lightly bound to the product

**Bound water evaporation**
- Water absorbed in the walls of structures
- Water more difficult to extract

\[ T_0 = 29^\circ C \]
\[ T_{max} = 65^\circ C \text{ at } t = 15 \text{ min} \]

The availability of water depends on the product and has different functions.
TYPICAL CURVE OF CONVECTION DRYING

Product MOISTURE

Product Temperature

Retention time

10 – 2 %

30 -15%

Initial sudden drop

Constant rise

Slow rise
**PHASE 1 – ADJUSTING TEMPERATURE**
- $T_p: \rightarrow$ product introduced cold or hot
- High Thermal Energy & Fast Drying speed
- Evaporation at the product’s surface

**PHASE 2 – CONSTANT DRYING SPEED**
- $T_p = T_h = \text{constant if constant air conditions stable}$
- Driven Drying:
  - High Air Temperature
  - High air speed
  - Dryer air

**PHASE 3 – DRYING DECREASE**
- Drying speed $\downarrow$
- Contributed energy:
  - $\rightarrow$ less water for evaporation
  - $\rightarrow$ less drying energy required
  - $\rightarrow$ $T_p \uparrow \text{ and Air Temperature } \uparrow \text{ and }$ $\rightarrow$ drying $\downarrow$
EXTRUDED PRODUCTS DRYING
BASIC FACTORES TO CONTROL DRYING

• TEMPERATURE
• AIR FLOW (VOLUME & SPEED)
• RELATIVE AIR MOISTURE
• RESIDENCE TIME
• PRODUCT VOLUME
• PRODUCT CHARACTERISTICS
EXTRUDED PRODUCTS DRYING
TEMPERATURE EFFECT

- Heated air at 90°C has 100X of water holding capacity than air at 20 °C
- With higher temperature the air can hold more water
➢ Heated air at 90°C has 100X of water holding capacity than air at 20 °C
➢ With higher temperature the air can hold more water
AIR FLOW EFFECT TO THE PRODUCT DRYING TIME

The higher the air velocity the higher the heat transfert and drying speed.
DISTRIBUTION OF HOT AIR INTO THE PRODUCT’S LAYERS

70 °C

80 °C

100 °C

120 °C

140 °C

150 °C

EXTRUDED PRODUCTS DRYING
PRODUCT LAYER EFFECT
SNACK line example
## CLEXTRAL EVOLUM DRYER

### Models:
- EV300
- EV600
- EV1200

### Products

<table>
<thead>
<tr>
<th>Products</th>
<th>EV 300 (kg/h at Dryer Outlet)</th>
<th>EV 600 (kg/h at Dryer Outlet)</th>
<th>EV 1200 (kg/h at Dryer Outlet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNACKS</td>
<td>250 / 300</td>
<td>500 / 600</td>
<td>1000 / 1200</td>
</tr>
</tbody>
</table>
Air heated with gas burner or electric resistance

AIR EXTRACTOR

Receiving hopper

Product input

Product Spreader

Air transmission limitation

Under the plenum

Conveyor belt

Plenum height

Product output

Zone 1

Zone 2

AIR CONDITIONS:
- Recirculation fan
- Air flow measurement in the dryer
- Recirculation of part of the air
- Controlled T
- Uncontrolled RH
DRYING TECHNOLOGY

ROTANTE Rotary dryer for small Ingredients

Example: Couscous line
## ROTANTE ROTARY DRYER

### Short Pasta Line
- 1800 kg/h
- 3000 kg/h

### Couscous Line
- 1200 kg/h
- 1800 kg/h
- 3600 kg/h

### Ingredients Line
- 200 – 300 kg/h
- 350 – 600 kg/h
- 700 – 1000 kg/h
ROTANTE ROTARY DRYER

INFERIOR BUILD

SUPERIOR BUILD
- Centrifugal fans
- Batteries (Exchangers)
- Air extraction fan
ROTANTE Rotary dryer - INFERIOR BUILD

Discharging Outlet

Rolling drum cage
- Rolling drum cage
- Product moves very slowly through the dryer
- Linear ascent on the Archimedes screws
- Rolling drum cage with Archimedes screws covered with steel sheeting

2 Archimedes screws to recover fine particles

Feeding inlet
COMPLEMENTARY FEATURES OF THE ROTARY DRYER

- **ABSENCE OF DEAD ZONES:**
  - Homogeneous drying
  - No contamination among different products
  ➔ **HYGIENE**

- **LINEAR PRODUCT FLOW:**
  - Drying control
  - Possibility of defining 2 independent zones
  ➔ **FLEXIBILITY, CONSTANT PRODUCT QUALITY - RELIABILITY**

Energy efficiency 90%
“JET ZONE” TYPE DRYER/TOASTER

Example: Extruded Flakes Line
Two zones, gas-activated direct air intrusion toaster-dryer
Two zones, gas-activated direct air intrusion toaster-dryer

**CRUNCHY TOASTED FLAKES**

**HOT AIR**

215-225°C  185-195°C

**CHREY FLAKES**

**INTRUSION TOASTER**

(FLUIDISED BED)
Drying Technology - Importance of the cooler

- Necessary operation for the preservation of food products
  = FOOD SAFETY

- Prevents condensation of the evaporating water during cooling after leaving the dryer
Thank you for your attention

www.clextral.com