

A comparison of Vacuum Drying Processes of Food Products

VII CTC Symposium
Murcia – 14th May 2015

Pierre LANTHEAUME

Oerlikon Leybold Vacuum

Global Market Segment Manager - Food and Packaging

pierre.lantheaume@oerlikon.com



Vacuum Drying Processes of Food Products

- Fresh food products rapidly deteriorates unless some way can be found to preserve them.
- Bacteria, yeasts and molds need the water to grow, and drying prevents them from surviving in the food.
- Open air drying using sun and wind has been practiced since ancient times
- **Vacuum freeze drying (FD) and Vacuum microwave drying (VMD)** are two modern methods of food preservation that remove water to inhibits the growth of microorganisms.



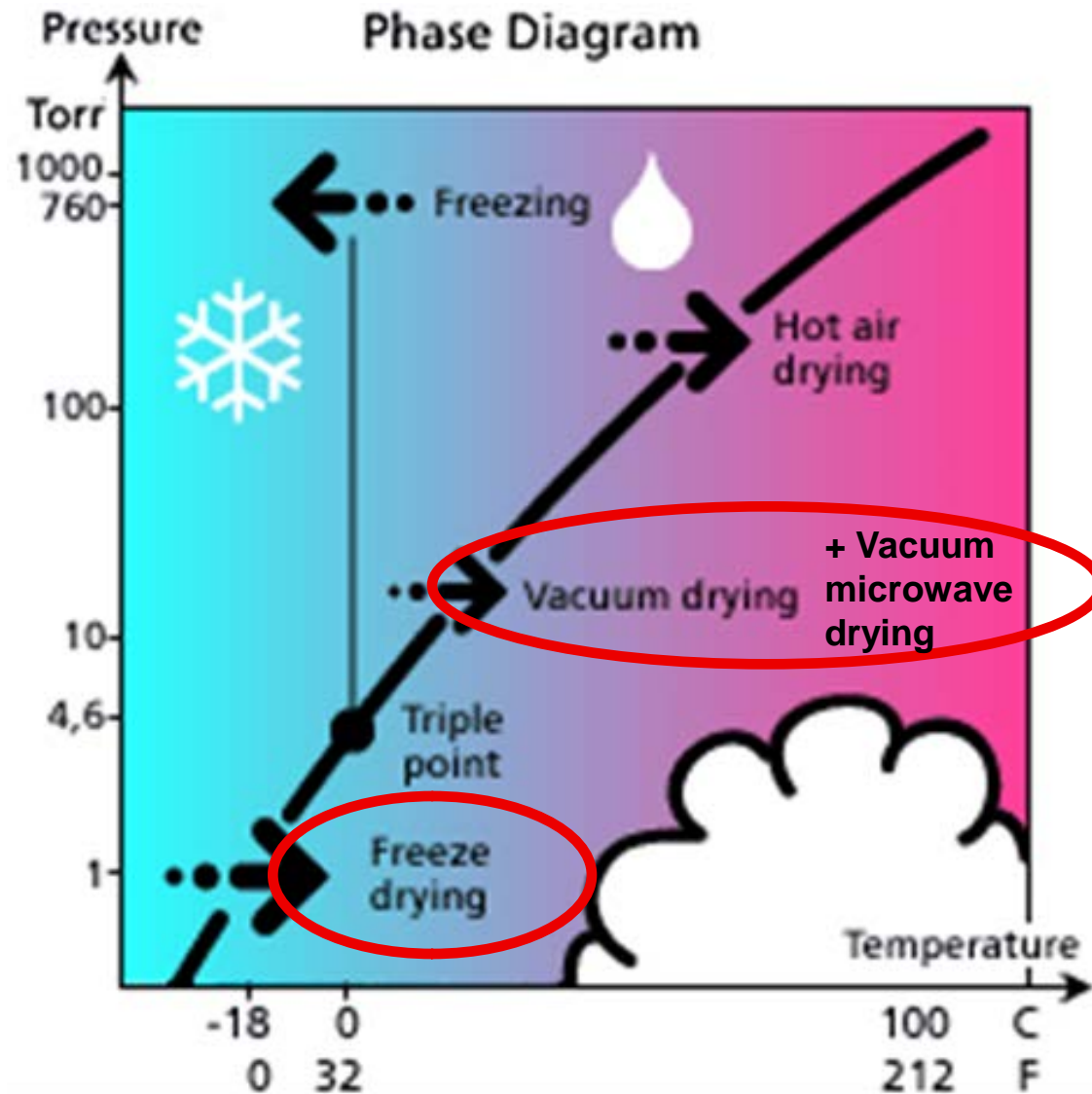
Vacuum microwave drying

Vacuum freeze drying

Two different
methods with
same goals

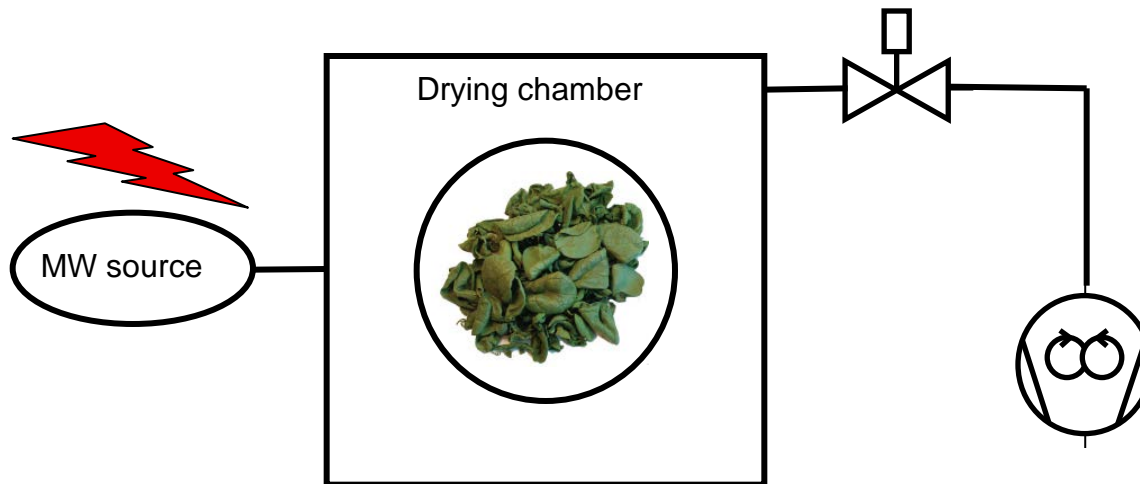
1. Food preservation at ambient temperature
2. Shelf life increase
3. Minimal products damages
4. Shapes, color and flavor conservation

Vacuum Drying Processes of Food Products



1) Vacuum Microwave Drying (VMD) - Principle

- Vacuum drying principle : by placing food product in a vacuum chamber and reducing pressure, water is naturally evaporated. Process is similar to natural drying with sun or wind, just speed up by the use of vacuum.
- Vacuum Microwave Drying process combines two different technologies to create specific conditions :
 - While Microwaves (2450 MHz) delivers gentle and uniform heat to the product,
 - Vacuum atmosphere allows using a lower drying temperature.



Typical layout of vacuum microwave dryer (using dry pump)

1) Vacuum Microwave Drying (VMD) Example of industrial microwave vacuum dryer



Leyvac LVO140 on VMD

1) Vacuum Microwave Drying (VMD) Example of industrial microwave vacuum dryer



Leyvac LVO140 on VMD

1) Vacuum Microwave Drying (VMD) Process and cycle description

Example of fish drying system :

(Conditions very depend on the products)

1. Chamber size : approx. 4.5 m³/h
2. Drying time : approx. 2h (for anchovy)
3. Working pressure : 10 torr
4. Water content of products : 65kg
5. 24 trays in a chamber.
6. Water / oil / vapors are stopped by a cold trap.



Typical vacuum solutions:

- **Single stage oil sealed rotary vane pumps**
- **Or dry screw pumps**
- **In the first case the use of a cold trap / condenser is mandatory to protect the vacuum pump !**

Application challenges from vacuum pumps in term of	
Pump temperature	Medium
Heavy duty operation (cycles)	Medium
Dust / Powder / Particules	Depends on product
Moisture	High

1) Vacuum Microwave Drying (VMD) Example of vacuum microwave food products

Fruits / Herbs / Sea fruits / Seeds / Leaves



2) Vacuum Freeze Drying (FD) - Principle

- Freeze-drying (also known as lyophilisation), works by freezing the material and then applying deep vacuum to allow the frozen water to sublime directly from solid phase to gas phase.
- Extremely wide range of food product can be processed such as fruit and vegetables, meat, fish, meat, coffee beans, spices, proteins...
- Freeze drying main advantages :
 1. Freeze dried products can be stored at ambient temperature (same as VMD)
 2. Does not usually cause shrinkage of the material being dried (no volume reduction)
 3. Freeze drying, as processing frozen product can be carried out all along the year (no seasonal effect)
 4. Longer shelf life than standard vacuum drying (or VMD) due to lower water residual content rates achieved



Freeze dried coffee
and red fruits



2) Vacuum Freeze Drying (FD) Process and cycle description

Cycle description :(mains steps)

1. Product freezing between -20 and -80°C (includ. pharma)
2. Primary drying (sublimation) at pressure range between 5 and 1.10⁻¹ mbar (80 to 90% of the water is removed). Water is condensed by -55 to -110°C cold trap
3. It is important to note that, in this range of pressure, the heat is brought mainly by conduction or radiation; the convection effect is negligible, due to the low air density.
4. Secondary drying in the 10⁻² – 10⁻³ mbar range. Residual water content after that step is 2 to 8%



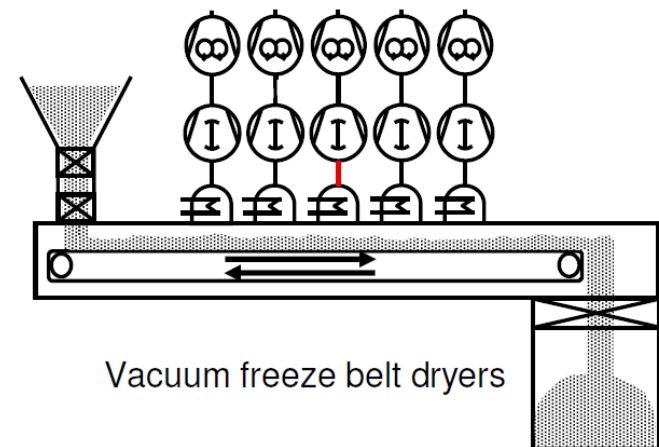
Challenges for the vacuum pumps:

1. Big amounts of water vapor enters the pumps!
2. Vapor includes organic oils and organic acids!
3. Particles (i.e. coffee powder) enters vacuum system and might build layers!

Typical vacuum solutions:

- **Dry screw pumps, with no or only one stage of Roots blowers**
- **Or single stage oil sealed RVPs with one or two stages of Roots blowers (alternate and cost effective solution)**

Freeze drying tunnel and vacuum system diagram



2) Vacuum Freeze Drying (FD)

Example of vacuum system for industrial coffee FD



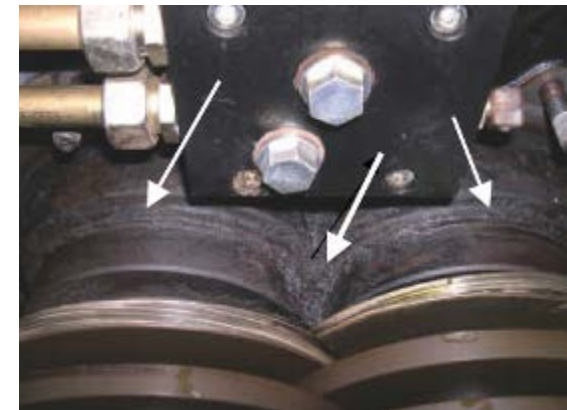
- 5x [Roots blowers WS2001+dry screw pump Screwline SP630]
- Production 2.000 tons of coffee per year
- FD tunnel ~ 2m diam. x 20m
- 0,35 mbar operat. press.

2) Vacuum Freeze Drying (FD)

Example of vacuum system for industrial coffee FD

ScrewLine Experience:

- Piston-ring shaft-seals are protected from potential blockage by sticky coffee powder thanks to purge-gas!
- SP630 operates trouble-free since several years!
- Some build-up of layers visible (coffee-powder)
- No pump corrosion!
- Only annual, manual cleaning by user necessary!
- No risk of oil-backstreaming!
- Customers are very satisfied!



Vacuum microwave drying

Freeze drying

Operating comparisons

(*data for berries based on study from Enwave® Corp.)

- Initial drying temp. : 30 to 50°C
- Final drying temp. : 45 to 60°C
- Drying time : 0,2 to 2 hours
- Energy cost : 0,23 \$/kg of dried product
- Capital cost : 0,13 \$/kg of dried product

- Initial drying temp. : -50 to -20 °C
- Final drying temp. : 30 to 50°C
- Drying time : 24 to 36 hours
- Energy cost : 0,66 \$/kg of dried product
- Capital cost : 1,19 \$/kg of dried product

Advantages in terms of process and costs

- Minimal products damages thanks to little temp. variation (few color / shape change, no volume reduction)
- Faster process
- Lower investment and operating costs




- Longer shelf life thanks to lower residual water content than VMD
- No seasonal effect, process is possible all along the year (as previously frozen)
- Requires freezing system (additional cost)
- Proven solution for serial production

Vacuum system

- Oil sealed vanes rotary or dry screw pumps (only one stage)
- Cold trap or condenser mandatory in case of oil pumps

- Vacuum systems requires at least 2 stages (pressure to achieve is lower than VMD): oil sealed or dry pump + Roots blower

OLV products for VMD and FD of food products

Rotary vane pumps	Dry screw pumps	Roots blowers
SOGEVAC B / FP	LEYVAC / DRYVAC / SCREWLINE	WA(U) / WH
From 10 to 1200 m ³ /h	From 80 to 1200 m ³ /h	From 250 to 7000 m ³ /h
		

....and systems combining all the aboves !

Thanks for you attention !

Any question please ask.

Visit our dedicated website : <http://www.leybold-foodandpack.com/>

