

It is very difficult to model the processes involved in freeze-drying, because the transport of heat energy and mass involve very complex phenomena.

Algae

Procedure (Overview)

Freezing	Solidification range, Solidification point	Container for FD	Process A / B / C *	Vacuum primary drying
-35°C, freezing in LN ₂ is convenient	-15 to -25°C	wide-necked flasks, dishes	A and C	$T_{ICE} = T_{EP} - 10^\circ\text{C}$ $p_{HT} = f(T_{ICE})$ → ice pressure curve = 0.630–0.220 mbar

Temp. of the shelves during primary drying (T _{sf} /t)	Duration of primary drying	Vacuum for secondary drying
-10°C/4h, 0°C/4h, +10°C/4h, +20°C/12–24h	6–24h	not necessary

Special features

- watery material (not de-watered or pre-treated), straggly consistency
- very hygroscopic
- fresh water and sea-water species have different freezing points

Short description of market

Uses of the freeze-dried products/

Typical users

- Food industry (inclusion as flavour carrier, protein-rich)
- Cosmetics

* Comments	
Process A ("inside")	(Freezing and) drying in the ice condenser chamber
Process B ("outside")	Freezing separate (e.g. refrigerator), drying outside the ice condenser, e.g. with plexiglass hood
Process C	Freezing (on liquid-cooled shelves) and drying outside the ice condensers, e.g. with plexiglass hood or steel chamber (like EPSILON-systems)
EPSILON	system with rectangular product chamber, front loader