

A GUIDE TO A FRUIT AND VEGETABLE FREEZING UNIT

1 - PRESENTATION

1-1 Nature of the Activity

Freezing is one method to preserve fruit + vegetables.

As with appertization or dehydration, one obtains a finished product with a long shelf life (12 to 30 months). Freezing presents the advantage of not submitting fruit or vegetables to heat processing, or great destructureation which modifies their organoleptic characteristics.

Frozen fruit + vegetables are intended for household, restaurant or commercial consumption or for second transformation industries.

In the first transformation, the products are semi-raw (washed, pared, blanched) or purées.

1-2 Alternatives

* Raw Materials :

Vegetables are well-suited for freezing (whith a few exceptions such as endive, whose texture is greatly modified after freezing).

Fruit is more fragile and cannot generally be consumed in its natural form after freezing (it is intended for further transformation at the industrial, artisanal or domestic level).

* Finished Products :

Blocks of frozen fruit or vegetables in mass.

Fruit + vegetables frozen individually: for the large-sized varieties (pineapple for example), a prior cut-up is necessary before freezing).

This choice depends on the final destination and type of product.

The blocks are primarily intended for secondary transformation (except for chopped spinach, for example).

* Technology:

Preparation of fruit and vegetables :

The paring, tailing and coring equipment are specific to each fruit or each vegetable.

It is thus important to provide automatic lines with specific equipment adapted to the principally processed products (sometimes with links between the lines for multi-purpose equipment).

For multi-purpose equipment, the main alternatives are :

- stone removal (pitting) : drum with (extensograph alveoles) or vibrating belt,
- cleaning : in (tub) by pressurized jet or rotating drum.
- blanching : with water or vapour

Freezing:

There are three major freezing techniques :

- by convection (circulation of cold air) :
 - . in tunnels : the products are introduced in carts, scales, etc.
 - . on fluidized beds : the products must be presented in the form of 25 to 30 mm particles (max.). They are "fluidized" by a current of vertical cold air from top to bottom. The products advance by "overflow" or on a conveyor belt.
- by conduction (direct contact between the product and a platform cooled by a refrigerant).
- by immersion or spraying (in general one uses liquid nitrogen which allows rapid freezing). It is a costly method which should only be used for products of great value.

Freezing on fluidized beds or by spraying allows one to obtain individual products ; by conduction and freezing tunnels one obtains blocks.

* Packaging :

The products frozen individually are generally stored before packaging which allows a spacing of the packaging activity throughout the whole year.

- Transitional packaging : bags of 25 kg or on pallets (1 t)
- final packaging :
 - . second transformation industries : 5 kg
 - . households
 - . plastic bags : 1 kg
 - . cases : 500 g
 - . collectives : plastic bags : 2 kg

1-3 Types of Possible Units

We will discuss two possible units :

Unit A : freezing unit for blocks of fruit and vegetables comprising a horizontal plate freezer and a vertical plate freezer (for vegetable purées and fruit pulp) with a 500 kg/hr capacity each in terms of spinach.

Final products : blocks of fruit + vegetables, whole or in pieces and purées, destined for second transformation industries (babyfood, jam, fruit in sugar, prepared dishes...).

Unit B : a unit for individual freezing of fruit and vegetables comprising a fluidized bed freezer with a 3.5 t/hr capacity in terms of peas.

Final products : fruit + vegetables frozen individually whole or in pieces, essentially intended for household, pastry-maker and restaurant consumption. One can foresee the addition of a compartment for tray carts to increase the use of the tunnel (freezing, non-simultaneous of product blocks).

The freezing capacity of fluidized beds is always expressed in terms of peas.

To evaluate the capacity for different fruit and vegetables, one must use coefficients supplied by the builders.

(A machine that processes 1 t/hr of peas, only processes 0.7 t/hr of green beans).

The freezing capacity of plate freezers is expressed in terms of spinach.

2 - TECHNICAL AND ECONOMIC GUIDE

2-1 Description of Unit

2-1-1 Finished Products

| LINE | A | B |
|--|---|---|
| Range | Blocks of fruit + vegetables whole, or in pieces, blocks of puree | Production essentially designed for vegetables : - two principal vegetables : peas, green beans - vegetables to complement the range - whole fruit, or in pieces |
| Type of packaging | Bags | Bags, cases |
| Size of packaging | 5 kg | 5 kg, 2,5 kg, 1 kg, 500 g (case) |
| Daily production (16 hr/day in peak periods) annual production | 16 tons about 1 000 tons | 56 tons peas : 1 800 tons max. green beans : 1 300 tons max.* |

(*) Based on the following hypotheses :

- 2 harvests per year of peas + green beans,
- 90% of tonnage processed each harvest in 20 days,
- harvest of peas and green beans superpose one another during 10 days.

2-1-2 Technological Choices

| OPERATIONS | TECHNOLOGICAL OPTIONS | SOLUTIONS | | | |
|-----------------------------------|---------------------------------|--|---------------------------|--|-------------------------|
| | | UNIT A | | UNIT B | |
| Preparation of fruit + vegetables | | 1 multi-purpose line | | 2 preparation lines : green beans and peas | |
| Reception | | Reception basin | | Green beans reception pneumatic separator | Peas reception |
| Washing | Vat, spraying in vibrating drum | Washer | | Washer | Washer |
| Sorting | Manual or mechanized | Manual sorting table | | Cluster separator vibrating distributor sorter | Sieve |
| Paring | Manual or mechanized | 2 manual paring tables (with specific equipment if necessary for certain products) | | End remover | |
| Blanching | Water or vapour | Water blanching machine | | Water blanching machine | Water blanching machine |
| | | | Pre-grinder grinder | | |
| Cooling | Soaking in cold water | Cooling machine | Cooling machine | Water cooling machine | Water cooling machine |
| Cutting | | Multi-purpose cutter | Buffer solution tank | Draining | Draining |
| | | Packaging machine | | | |
| Freezing | | Freezer (horizontal plates) | Freezer (vertical plates) | Fluidized bed freezer | Fluidized bed freezer |
| | | | | Packaging | Packaging |

2-2 Economic Analysis

2-2-1 Investments

| Equipment | OPTION A | | OPTION B | |
|-------------------------|---|------------------------|--|---------------------|
| | Description | FOB price in US \$ | Description | FOB price in US \$ |
| Pretreatment | Multi-purpose cutter | \$ 30 000 | 2 complete lines | env. \$ 1,3 M |
| | Pregrinder grinder | \$ 12 000 \$ 40 000 | | |
| Blanching machine | | \$ 30 000 | | |
| Cooler | | \$ 25 000 | | |
| Freezer | Horizontal plate freezer | \$ 30 000 | 1 fluidized bed freezer | \$ 500 000 |
| | Vertical plate freezer | \$ 30 000 | | |
| Packager | Buffer solution tank | \$ 25 000 | 1 bagging line | |
| | Packager | \$ 250 000 | | \$ 320 000 |
| Cold production | Cold room | \$ 180 000 | Cold room | \$ 560 000 |
| | Freezing | \$ 150 000 | Freezing | \$ 350 000 |
| Total Equipment | | \$ 800 000 | | \$ 3 000 000 |
| Building | Preparation unit : 100 m x 20 m : 2000 m2 Freezing unit : (packaging + freezing) 500 m2 | | Preparation unit : 100 m x 30 m : 3000 m2 Freezing unit : (packaging + freezing) 600 m2 (height : 6 m) | |
| Description | Cold room : 6000 m3 1000 tons Machine shop : 400 m2 Docks (pier) : 200 m2 Offices + social area 200 m2 Road network 2500 m2 | | cold room : pre-packaging (1 500 tons) : 9000 m3 Post-packaging : (stock for 20 days) : 3000 m3 500 tons Machine shop : 400 m2 Docks (pier) 200 m2 Offices + social area : 200 m2 Road Network 2500 m2 | |
| Other investments | Water purification : \$ 160 000 Maintenance : \$ 160 000 \$ Generating set : \$ 80 000 | | Water purification : \$160 000 Maintenance \$ 160 000 Generating set : \$ 160 000 | |
| Total Investment | \$ 3,5 million | | \$ 3 million (excluding buildings + cold rooms) --> \$ 8 million for complete installation | |

Option B : the packaging can also take place outside the production unit.
One can create a packaging unit which performs these duties for several freezing factories, especially if the unit is strategically placed.

2-2-2 Functioning

| | UNIT A | UNIT B |
|----------------------|----------------------|--------------|
| Personnel : | | |
| production | by team | by team |
| - skilled | 2 | 3 |
| - unskilled | 12 | 10 |
| Offices | 2 | 4 |
| Consumption : | | |
| - water | 10 m3/t | 12 m3/t |
| - energy | | |
| production | 320 kwh/t | 350 kwh/t |
| storage | 30 kwh/m3/yr | 30 kwh/m3/yr |
| Packaging | 200 sacks of 5 kg/hr | |

3 - KEY FACTORS TO THIS PROJECT'S SUCCESS

3-1 Supply

To obtain high quality products, the transformation should take place about 6 hours after the harvest. The factory should thus be located near the production site and the management of supply should be rigorous.

Organize an adequate system for the transportation of raw materials to the factory.

It is essential to foresee a supply for as long a period as possible to make investments profitable.

3-2 Technology and Equipment

The key points are the reliability of the equipment and the processing lines (one must look for multi-purpose tools). The raw materials cannot be stored, a power failure would result in considerable losses.

Take into consideration the hygienic problems in the planning of equipment from blanching to freezing.

3-3 Personnel

This is a seasonal activity which demands few permanent employees, but the employment of seasonal personnel in peak production period.

3-4 Distribution and Commercialization

The key point of distribution is the presence of equipment to generate sub-zero cold until the products reach the consumer, if one targets the interior market.

For fruits intended for second transformation, it is necessary to adapt production to the demands of industrial clients.

3-5 Other Specific Problems

Pollution : one must have filters to eliminate suspended particles in residual waters.

Valorization of waste : animal feed (rich in fibre).

4 - INDUCED ACTIVITIES

Fruit + vegetable production adapted to the industrial demand.

Possible development of industry for second transformation which requires a frozen supply for at least one part of its production.