

A GUIDE FOR A FACTORY FOR PREPARATION OF FISH AND FREEZING OF FILLETS

1 - PRESENTATION

1-1 Nature of the Activity

The freezing of eviscerated and filleted fish can result in :

- blocks of fillets weighing 7.5 kg (international standard : 485 mm x 255 mm x 63 mm) intended for further processing (breaded sticks, skewered fish, cooked dishes...),
- individual fillets.

All these operations may take place :

- either on board the fishing ship ("factory ship") : blocks of fish fillets or individual fillets with or without bones, are obtained ; called "frozen at sea", they are of excellent quality.
- or on land after the fish are unloaded : blocks as well as individual fillets are produced.

This second alternative is less valued by manufacturers using blocks due to the lower bacteriological quality.

1-2 Alternatives

* Species

Generally, all species of fish, from the ocean or from aquaculture, lend themselves to filleting or freezing. However, in industrialized countries, only a very small proportion of residual bones is tolerated (1 to 3 bones per kg of fillets) ; this excludes certain species whose bones grow in the flesh. The duration of preservation at -25°C varies according to the species due to the oxidation of fat that occurs after freezing.

* Finished Products :

- Standard blocks of 7.5 kg intended for processing.
- Individual fillets intended either for processing or to be sold as is.

* Technology

Preparation of the fish : the production line for fish can be entirely automatic (on land as on board ship). To reduce the level of bones per fillet, the J-cut or V-cut can be used (removal of the portion of fillet which may contain bones) ; 5 % to 20 % loss of flesh, but better valorization of the product (premium of "without bones" may increase by 30 %). The V-cut can be mechanized but must be verified manually afterwards.

Residual flesh adhering to the cartilagenous skeleton or to the V-cut may be removed with an extruder.

Deep freezing : two main techniques exist for deep freezing : cryogenic cold (spraying of liquid refrigerant) and mechanical cold (cold circuit with compression and expansion).

- The production of blocks of fillets always uses mechanical cold (in plate freezers with circulation of freon or ammonia).
- Deep freezing of individual fillets is done on conveyor belts either by cryogenic cold (smaller investment, better quality, but higher operating cost), or by mechanical cold, the most frequently used method.

When the blocks are placed in plate freezers, one can insert sheets of polyethylene or polypropylene in order to obtain an easily divisible package (shatter pack or interleaved).

1-3 Types of Possible Units

Three types of units are presented in this report.

Unit A : a filleting-freezing unit on a ship including three horizontal plate freezers with about 500 kg/h capacity or a total capacity of 1.5 t/h.

Unit B : a unit on land with the same type of equipment as unit A.

Unit C : a freezer unit on land with a deep freezing tunnel (mechanical cold : blown air and spiral conveyor) delivering individual fillets. The same capacity : 1.5 t/h.

2 - TECHNICAL AND ECONOMIC GUIDE

2 - 1 Description of Unit

2.1.1. Finished Products

Line	A filleting - freezing in blocks on board	B filleting - freezing in blocks on land	C filleting - individual freezing on land
Range of fish (examples)	Codfish, hake, pollak, etc...	Same as A	Same as A
Type of packaging	Block wrapped in waxed wrapping and packed in a cardboard carton	Same as A	Plastic sacks with cardboard carton for bulk packaging (10 to 20 kg cartons)
Size of packaging	7,5 Kg 485 x 255 x 63 mm	Same as A	Variable according to the need
Production - daily - annual	* < 5000 tons *	15 to 30 tons 4000 to 10 000 tons	15 to 30 tons 4000 to 10 000 tons

* Depends on the capacity of the catch : the ship freezes about 1,5 tons of fillets per hour and stocks up to 500 tons of frozen fillets. Annual production depends on the number of days spent fishing, the volume of the catches, organization aboard ship and the distance of the fishing site from the port of unloading. On the other hand, the factory on land can regulate its production by using several sources of supply.

2-1-2 Technological Choices

OPERATIONS	TECHNOLOGICAL OPTIONS	A on ship - in blocks	B On land - in blocks	C On land - in fillets
<p>Reception of fresh fish</p> <p>Calibration</p> <p>Washing - Scatting</p>	<p>- depending on the equipment, the order of the operations before freezing can vary</p> <p>- often integrated with the equipment downstream</p> <p>- A fish cleaner + rotating scaler inclined rotating drum under a jet of water</p>	<p>inclined rotating drum (VARLET type) Yield : 1200 kg/hr. Two machines used in parallel</p>		
<p>Removal of head + tail</p> <p>Evisceration</p> <p>Washing-bleeding</p>	<p>Existence of numerous kinds of equipment</p> <p>- conveyor belt with pockets : heads + tails which extend beyond the edge are cut off by circular saws. Viscera are removed with the head.</p> <p>- Turntable : circular knives cut the head, tail, ventral band and remove bones</p> <p>- Removal of the viscera by vacuum pump</p> <p>- etc...</p>	<p>Equipment of VARLET, VMK or BAADER type. Fish from 1 to 4 kg Yield : 800 kg finished product/hr 30-40 "white" fish/mm</p>	<p>Same as A</p>	<p>Same as A</p>
<p>Filleting</p>	<p>After ventral incision, separating of fillets from the backbone, then a dorsal incision</p>	<p>VARLET or BAADER equipment. Same yield as preceeding (+ skinning machine)</p>	<p>Same as A</p>	<p>Same as A</p>
<p>Removing skin</p>	<p>With specialized equipment (skinning machine)</p>		<p>Same as A</p>	<p>Same as A</p>
<p>Trimming</p>			<p>Manual with two levels of moving belts</p>	<p>Same as B</p>
<p>Freezing</p>	<p>- With plates : - vertical or horizontal - refrigerant liquid, ammonia or freon</p> <p>- Conveyor belt : mechanical cold - cyrogenic cold</p>	<p>Horizontal plate freezer (freon) Manual loading - unloading Waxed wrapping between plate and fish</p>	<p>Same as A, but use of freon or ammonia</p>	<p>Freezing tunnel with spiral conveyor belt Mechanical cold</p>
<p>Packaging</p>	<p>Plastic film with final packing in cardboard box</p>	<p>Block of 7,5 kg in waxed wrapping, in a cardboard box</p>	<p>Same as A</p>	<p>Individualized fillets in plastic bags inside cardboard box</p>
<p>Treatment of by-products</p> <p>Recovery of flesh</p>	<p>Possibility by extrusion (bonde separator), recuperation of fish stuffing frozen in blocks or 7.5 kg</p>	<p>no</p>	<p>no</p>	<p>no</p>
<p>Treatment of waste</p>	<p>Please see sector orientation report</p>	<p>Waste thrown into the sea (for large ships, flour production)</p>	<p>Waste sent to a treatment plant</p>	<p>Waste sent to a treatment plant</p>

2-2 Economic Analysis

2-2-1 Investments

Equipment	OPTION A : 1,5 t/h Freezing at sea	OPTION B : 1,5 t/h Freezing on land (blocks)	OPTION C : 1,5 t/h freezing on land (individual fillets)
	Price FOB US \$	Price FOB US \$	Price FOB US \$
Unit operations			
Washing - scaling	2 x \$ 12 000	same as A	same as A
Evisceration - Removal of head	\$ 60 000 to \$ 70 000	same as A	same as A
Filleting	\$ 300 000	same as A	same as A
Removal of skin	\$ 25 000	same as A	same as A
Packaging	\$ 80 000	\$ 80 000	\$ 30 000
Freezing			
- equipment	\$ 240 000	\$ 240 000	\$ 400 000
- cold production	\$ 500 000	\$ 500 000	\$ 500 000
Total equipment	\$ 1,2 millions	\$ 1,2 million	\$ 1,4 million
Buildings	150 m2 minimum for the factory (with only 150 m2 one cannot make fillets without bones)	Filleting unit (with cold room) : 1250 m2 Packaging-freezing unit : 600 m2 Cold room (for 500 t of stock) : 3000 m3 Machine room : 100 m2 Wharf : 400 m2 Office space : 200 m2	same as B
Other foreseeable investments		Generating set : \$ 130 000	same as B
Total investment	\$ 10 to \$ 15 million for a new ship-factory with 500 t storage capacity	\$ 4 to \$ 5 million	\$ 4 to \$ 5 million

2-2-2 Functioning

	UNIT A	UNIT B		UNIT C	
Labour		Filleting	Freezing + packaging	Filleting	Freezing + packaging
Personnel					
- unskilled *	13	20	5	20	5
- Skilled	12	2	1	2	1
* on factory-ships it is better to have semi-skilled and highly-skilled personnel					
Annual Consumption :					
- Fish	< 10 000 t	8 to 20 000 t		8 to 20 000 t	
- Energy		Filleting + freezing : 620 KWh		same as B	
- Packaging		Storage : 30 KWh/m3/yr		same as B	
- Water		60 liters/minute		same as B	

3 - KEY FACTORS TO THIS PROJECT'S SUCCESS

3-1 Supply

Unit A : the factory-ship fishes in a fleet so it can obtain information about fishing areas and assure a tonnage per day. The period of self-sufficiency varies from 30 to 60 days and depends on the capacity of the hold (fuel and resupplying). A 50 m ship is self-sufficient for 30 days maximum.

The landing must have refrigeration installations.

Units B and C : zones where fresh fish is unloaded (thus near fishing areas).

3-2 Technology and Equipment

Rigorous hygiene is fundamental in processing fish : continuous washing of equipment and installations with water.

Evisceration is the most delicate operation : if the viscera burst, there is a risk that the flesh will be contaminated.

Unit A : fish treated immediately. Ultra-fresh product.

Unit B and C : necessary to treat recently caught fish. Delay has an immediate impact on the finished product's quality. Rigorous control of supply is essential.

Regular maintenance of equipment.

3-3 Personnel

- On board, the employees are specialized : fishermen or factory workers.
 - On land, and even more on board ship, the regulation of the equipment for preparation necessitates the presence of a specialized technician.
- The refrigeration equipment demands the presence of a refrigerator specialist.

Before freezing, it is important to prevent pockets of air from forming between the fillets, which are placed manually between the plates in a criss-cross pattern.
Personnel must be trained.

3-4 Quality Control

- Freshness of raw material (in the case of land processing) can be measured by Total Basic Volatile Nitrogen, but the controls are essentially visual.
- Number of bones/kg.
- Size of plates.
- Size of the fillets (important for certain processing later).

3-5 Distribution and Commercialization

It is necessary to maintain the cold chain : plan for refrigeration installations of sufficient size for storage, as well as for trucks or refrigeration containers for transportation to the places of consumption.

Eventually, take precautions against power failures.

Frozen blocks are intended exclusively for the food industry : requires presence of a local industry for breaded fish, or possible means for export (blocks frozen on land are harder to export).

The demand from industrialized countries is basically for fillets without bones.

3-6 Other Specific Problems

The yield from filleting varies between 40 to 50 % -> large volume of waste. If there is a group of factories, it may be possible to render a waste treatment plant profitable -> animal feed.

Water consumption is important. Plan for the treatment of residue water.

4 - INDUCED ACTIVITIES

- Unit A : the activity of fishing is included in the project
- Unit B and C : turn-over of 8,000 to 20,000 tons of fish.

This can lead to :

- depending on the local market, the possibility of establishing one or more units for prepared dishes using on fish fillets (notably breaded fish from blocks and balls from flesh recovered from the bones),
- possibility of increasing the value of waste from factories B and C in the form of flour and oils intended for animal feed.