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# 「우리나라 제빙 냉동업의 기술적 리뷰」

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## Technological Review of Icing & Frozen Industry in Korea

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### 1. Brief history

Most of the freezing plants installed before 1965 were equipped with low-medium speed reciprocating type compressors and local temperature control systems. Further, the insulation walls were made of cork of less than 150mm of width. Thus, freezing of such fish like shrimp incurred the significant loss of heat.

After 1965, however, high-speed reciprocating compressors with styropol insulation wall of about 200mm were imported with the claim fund from Japan. These plants had central control systems. Thus, the heat-radiation could be controlled. But these plants were used mainly for ice-making and cold storages. Without being used efficiently for freezing.

Since the latter part of 1970, the compressors are increasingly replaced by those of screw type, which can be installed in a smaller space and do not need its parts to be replaced or repaired, thus more efficient than the old ones. Yet ammonia were used as catalyst in all cases. Recently, freon refrigerants are used in several plants only.

### 2. Selection of facilities in the future

Generally, selection of a type of freezing and cold storage facilities and efficiencies of those facilities largely depend the purpose of utilization. However, in freezing marine products such as fish is required rapid freezing in order to keep ice crystal from increasing and to maintain frozen fish fresh quite similar to raw fish.

Thus, in selection of the facilities, first rapidity of freezing, second economic efficiency should be taken into account. Accordingly, screw type compressors are being employed increasingly for this type is favorable in terms of the criteria mentioned above. There are, also, contact freezer or screw tunnel freezers in use for freezing the shell fish or crust fish. Such as oyster and shrimp. Further, the materials of insulation wall are changing from cork to styropol and from styropol to polyurethan gradually.

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In general, the usage of ice largely determine the selection of freezer type. In Korea, however, the technique of plate ice manufacturing has been widely adopted that is, other type of techniques or facilities are limitedly used due to the higher cost. Recently, variety of ice-making technologies are developed in the advanced countries, thereby various type of ices such as "flake ice," "pack ice," "tube ice," and "rapid ice" etc. Thus, relevant facilities seem to be imported to Korea to produce flake ice and tube ice at least in consideration of the rising demands for those ices.

As discussed above, ice-making technologies have been developed elsewhere, so that the local manufacturers would import them easily if demand for them rose in Korea. Further, technologies of ice-making on fishing vessels are developing, so that these technologies may be imported.

### 3. Feasibility of chill storage of fish

#### 3. a. Cold storage vs chill storage

In definition, cold storage and chill storage are not clearly distinguished, so that both terms are generally regarded identical. But in cold storage products are frozen and stored under freezing point of temperature, while in chill storage products are stored at temperature (either over 0°C or over freezing point) lower than the temperature of the products thereby to maintain the original quality of the products during the storage periods. The method of storage within the zone of maximum ice crystal formation(-1°C~-5°C) is sometimes defined as cold storage. Those various methods of storage are based on the theory that microorganisms can be kept from multiplying if products (or materials) are stored in temperature lower than that of the product, even over freezing point. On the basis of time period, cold storage may be long-term storage method, while chill storage is a short term one.

Fish is stored in a cold storage after freezing for certain period of time. In some cases fresh which will be marketed red fish are also often stored in cold storages without freezing.

In cold storage of fish, the quality of the products can easily be diminished particularly in long term storage. That is, fish is dried due to the evaporation of the ice on the surface of the fish, thereby to result protein dehydration, fat oxidation and discoloration, and disorganization due to the increment of ice crystal formation.

On the other hand, physical or chemical changes occur in lesser degree in chill storage than in cold storage. However, chill storage is not appropriate for fish storage, for fish are in most cases stored for a long period of time. Further, it has been asserted by storage storage specialists that fish should be stored at a temperature far below the zone of maximum ice crystal zone.

#### 3. b. Feasibility of chill storage of fish

According to the theory of food freezing technologies, "freezing storage" technique is

**Table 1. Status of water in fish by temperature**

Temperature (C)	Water in Fish	
	Frozen (%)	Unfrozen (%)
-1	0	100
-1.1	32	68
-2.2	61	39
-3.3	76	24
-4.4	83	17
-5.6	86	14
-7.8	89	11

used for storing fish, which is somewhat distinguished from "chill storage" technique in that an optimum temperature is not defined so that the lower the temperature the better. For in lower temperature, the microorganisms such as lipase can be kept from multiplying in extremely low temperature. When the storage temperature is lowering, the number of bacteria or enzymes is decreased to 1/3~1/4, so that the quality of the stored food is not much degraded during the storage period. Therefore, the lower temperature is desired to a possible extent.

In chill storage, products are stored on short term basis, and stored in various ways depending on the type of the products, length of storage period, and variety or kind of fishes.

About 80% of the free water in the muscle of fish is frozen in the zone of maximum ice crystal formation ( $-1^{\circ}\text{C}\sim-5^{\circ}\text{C}$ ). So the fish to be consumed within a week after unloading can be stored by chill storage technique only in consideration of the hygienic state. The ideal state of hygienic conditions largely depends on the degree of cleanness of the market site, treatment in transit, and the quality and capacity of chill storages of the transportation facilities and of the retailers. That is, cold-chain systems should be established for a hygienic chill storages.

#### 4. The industry for manufacturing freezing facilities

The industry, manufacturing the freezing and cold storage facilities, has only 4-5 years of history. Yet, the firms in the industry are so small in size that some parts of the facilities are still imported.

However, the freezing and cold storage facility has been expanded steadily every year. As a result, the total icemaking capacity reached to 5,283 T/D, ice storage capacity to 97,128%, freezing capacity to 3,659 T/D, cold storage capacity to 181,123% as of the end of 1978. Further, about 80% of the total distant water fishing vessels had cold storage facilities on the vessels. The local manufacturing industry, however, is hardly meeting the fast increasing demand for the facility. Consequently, invaluable amount of foreign exchanges was paid to import the facility itself and its parts.

From the beginning of 1970's, the government of Korea has extended administrative as well as financial supports to the manufacturing industry. As a consequence, the number

### Major type of the freezing facility

Before 1965	1965~'70	1970~'75	After 1975
low-medium speed reciprocating compressors	high-speed reciprocating compressors	high-speed reciprocating compressors	in transition to screw-type compressors

of companies manufacturing the freezing and cold storage facilities is increased to four as of now (see table2). Two of these companies have been designated as specialized firms to produce the facilities exclusively.

Three of the four companies have bilateral agreements for technical cooperation with the Japanese counterparts, and assemble the facilities with parts imported from Japan. Yet, the locally manufactured facilities can hardly compete with the imported ones.

Further, the demand for the parts of the facilities is hardly met by the local industry due mainly to the below-capacity operations of the companies. That is, the companies supply the parts contract base because of the lack of operational fund. In a word, the locally-manufactured facilities should be further improved in quality to compete with the foreign brands. But liberalization of imports of the facilities is likely to have negative impacts in the development of the local industry. In the table below are shown the major type of facilities manufactured in each period of time.

Before the local firms were incorporated in Korea, foreign companies supplied the freezing and cold storage facilities under the turn-key base contracts. Consequently, local people could hardly have opportunities to learn the technologies, however, the demand for locally manufactured facilities is seems to be increasing steadily due to the good performance of reliable after-service. Accordingly, if the local manufacturer try to upgrade the quality of local-made equipment by engaging actively in research and development activities, they would be capable of satisfying the future demands for the freezing equipment. Also the government has set a plant to realize 100% local production of the facilities by 1981.

**Table 2. Present Status of Domestic Suppliers of Freezing and Cold Storage Facilities**

(As the end of 1978.12.31)

Name of Company	Type of Compressor	Size of Compressor	Evaporation	Catalyst	Portion of Local Production	Capacity (Annual)	License Agreement with:
Samhwa Machine Co., Ltd.	Multi-piston (high-speed)	6.9km ~84.1km	0°C~ -4°C	NH <sub>3</sub> R-12 R-22	70	200	Japanese Company
Uhong Machine Co., Ltd.	"	22km ~110km	"	NH <sub>3</sub> R-2	65	200	Japanese Company
Micom Plant Co., Ltd.	Screw	30km ~330km	"	NH <sub>3</sub> R-12 R-22	39	100	Japanese Company
Chosun Cold Storage system Co., Ltd.	Piston (low-speed)	11km ~37km	"	NH <sub>3</sub>	100	50	

Source:Korea Association of Freezing Facility Manufacturers

In summary, the freezing facility manufacturing industry has a bright prospects for further development. So followings are recommended:

- 1) The import restriction policy should be continued to expand the demand for the locally manufactured facilities,
- 2) Training of local people and import of advanced technologies should be encouraged
- 3) The capacities of the local manufacturing industry should be expanded to meet the increasing demand for the facilities,
- 4) Further incentives should be offered to the freezing & cold storage sector for the replacement of the worn-out facilities
- 5) The marketing channel of marine products should be reorganized into "cold-chain system" by providing a legislative supports.      —End—

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