3. Planning considerations for ice plants

3.1 PLANNING THE REQUIREMENTS

This section outlines some of the points to be considered when planning for the installation of an ice-making facility. Further information can be found in specialized publications available from many different sources, including FAO papers and publications. Some of these are listed in the bibliography.

Prior to actually purchasing any ice-making equipment, it is necessary to assess the actual requirements. This will help prevent the costly mistake of purchasing an inappropriately sized unit. Purchase and installation of an undersized unit may necessitate purchase of more equipment or replacement to upgrade the system in the future. Undersized units may also require more maintenance and repairs, because the system has to operate more or less continuously. An oversized system, while initially costing more to purchase, is probably the better option in the long run. However, if a system is too oversized, it could cost more to operate than is economically feasible.

There are a number of basic facts and considerations to be kept in mind when planning for the installation of ice-making facilities. Some of these are listed below:

- the probable demand for ice (consumers);
- the ability of consumers to pay a fair price for ice;
- the availability of a clean uncontaminated water supply;
- air and feed water temperatures;
- the reliability of the electrical power supply;
- a convenient site for the installation of the plant;
- qualified personnel to maintain and operate the equipment;
- spare parts and service availability in the country;
- willing investor(s) to finance the costs of purchase and maintenance of the plant.

Initially, a thorough study of likely demand will need to be made, not only from the fishery itself, but also for possible domestic use for chilling other foods and drinks, for instance. It has been the authors' experience that when an ice plant is opened, where previously none existed, there is an immediate increase in demand for domestic use and from shoreside businesses. This can sometimes lead to shortages for fishermen, post-harvest marketing facilities and traders who are dependent on steady supplies of ice for their operations. Also, in many situations, an allowance will be necessary for passing trade from fishermen from outside the immediate area who, when they find ice available, will take the opportunity to buy.

TABLE 3.1
Ice plant output relative to feed water input temperatures

Feed water temperature (°C)	Ice plant capacity (tonne/24 h)	Relative output capacity (%)
0	43.0	100
5	41.8	97
10	40.4	94
15	39.2	91
20	38.0	88
25	36.8	85
30	35.7	83
35	34.5	80

Source: FAO Fisheries Technical Paper. No. 331. Rome. 1992

Calculation of ice requirements for the local fleet can be relatively simple. The number of boats in the fleet will generally be known more or less accurately and the hold capacity and amount of fish landed by the larger vessels can be estimated. The ice requirements of smaller boats using insulated boxes can also be calculated in a similar manner.

The figure obtained for the fleet will then need adjustment to allow for melt losses on board the boats, and variations in output due to variations in input water temperature and local ambient temperatures. For example, a small ice plant rated for an output of 5 tonnes in a 24-hour period under temperate conditions will not produce as much if operated at tropical ambient temperatures and humidity. Table 3.1 gives information on variations in ice production at different water temperatures. This is only one factor to be considered in ice plant efficiency; other factors such as refrigerant temperatures and the difference between condensing and evaporating temperatures also affect output capacity. When these factors combine, the efficiency and output of the plant can drop by more than 50 percent. The details of ice plant design and operation are covered in more detail in other FAO publications dealing specifically with the subject of ice plants (see Bibliography).

Estimating local, non-fishery shoreside ice consumption is perhaps a little more difficult. This will depend on the size of the community and its infrastructure, such as markets, shops, restaurants and bars. However, with careful research in the community and surrounding areas it is possible to make some fairly accurate estimates for non-fishery consumption. It may be that sales from the ice plant will be restricted to fishery needs only, so that domestic demand does not need to be considered. However, commercially run ice plants would not normally ignore commercial opportunities, and sales to domestic users may be made to subsidize them.

In addition to calculating the maximum production and storage capacity of the ice-making plant, the seasonal variations in demand need to be considered. There may be species that are abundant for only one or two months per year, placing high pressure on ice needs for a short period only. One way of addressing this problem is by the use of multiple or modular ice-making machines. For normal operations, one machine is used to supply ice for normal demands. During peak periods, a second or third machine would be brought on line. Installing multiple ice-making machines also provides a backup system in case of breakdown or servicing requirements of the operating units. Figure 3.1 shows a fairly typical modular flake ice plant with ice machines, ice rake, storage bin and delivery system.

Having established that there is a demand/need for an ice plant or ice provision at a particular location, it is then necessary to establish the availability of some basic technical requirements. These include:

- **An adequate supply of clean water.** If water of adequate quality is not immediately available, then the costs of filtration and treatment will need to be taken into account when assessing the economic feasibility of the operation. If ice is to be made from seawater rather than freshwater, the potential markets for the ice will be much more limited. Ice made from seawater will not be suitable for hotel, domestic or catering use, for instance.
- **A reliable source of power for the refrigeration equipment.** In many situations this will be electrical power. Direct-drive diesel units have been produced, but these tend to be more expensive than purchasing power directly from a supplier. Despite this, it may still be advisable where the local electricity supply is unreliable, to install a stand-by or emergency diesel electric generator set.

For installation in remote regions where electricity supply is either non-existent or unreliable and constant hours of strong sunlight are normal, solar-powered absorption refrigeration systems may be suitable. These systems are usually for production of block ice and a standard unit can produce 200 kg of blocks in 24 hours. Blocks weigh approximately 20 kg each. For larger production volumes, extra units are added as required.

The exact location of the ice-making facility can often be crucial to the success and viability of the operation. The needs of the end users of the ice should be carefully considered in final site selection. Installations are often built in locations that were considered best from an engineering standpoint, or because the site was cheap or land was deemed suitable by planners with little local knowledge of the site. Many such sites, whilst they may be only a short distance from the central fish harbour, can go virtually unused by fishermen because it is not convenient for them or within their normal patterns of operation to visit the location. End users must be consulted in site selection.

Competent trained personnel will be needed to maintain and repair the plant, along with a reliable source of spare parts for the equipment installed. Even the best equipment available will break down eventually. Where spares are not readily available, there is always a risk of considerable down time whilst waiting for simple spare parts. In many countries spare parts have to be imported, signifying a requirement for foreign exchange, which may or may not be easily found. These are all matters to be considered when investment in ice-making machinery is being considered.

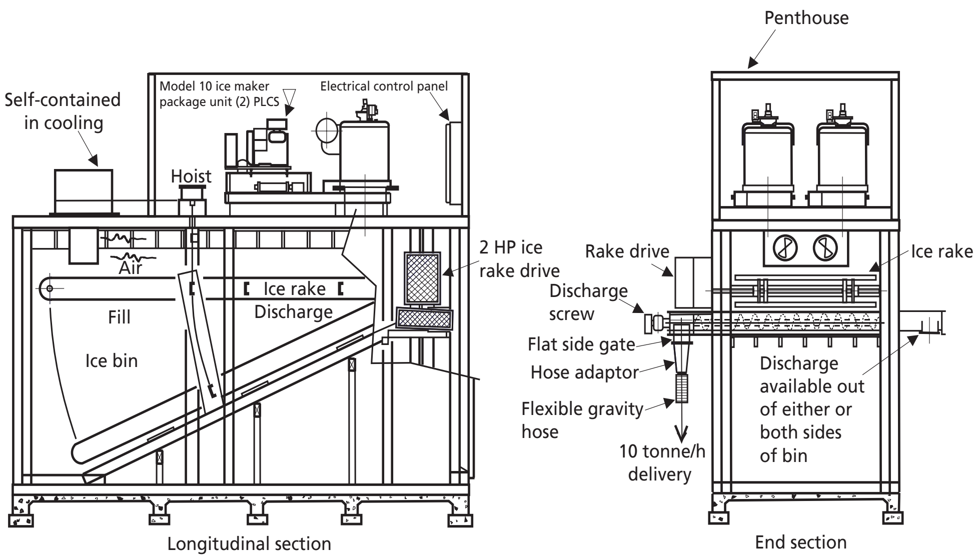
Because of the relatively high investment costs of ice plants, it is not unusual for these to be borne by more than one person, or by an organization such as a fishermen's cooperative. Either way, the economics of the investment must be sound so that potential investors are not exposed to unnecessary financial loss due to poor planning; otherwise it can be extremely difficult to finance plant costs without willing investors.

In some instances, ice plant purchase and installation costs are paid for by international technical assistance projects, and then donated to local organizations when the project ends. Considerable numbers of these plants fail within short periods due to lack of sufficient funds for maintenance and repairs, and a lack of adequate training of local personnel, who are ultimately left to try and maintain the equipment. The root cause was probably an incomplete analysis of the requirements in the beginning, and the assumption that if an ice plant were available, even if poorly located, it would attract customers. Initial cost–benefit and capacity analysis of the potential market is therefore extremely important, along with an assessment of the availability of parts and technical expertise on site for ongoing maintenance and repair.

3.2 STORAGE OF ICE ON SHORE

It is usually impossible for ice to be produced only when needed, and some sort of storage facility is required within the ice-manufacturing plant. Many commercial ice-plant installations are actually supplied with insulated storage capacity as part of the package, such as that shown in Figure 3.1.

FIGURE 3.1
Commercial ice plant with storage facility



Source: North Star Ice Equipment Corp., Seattle, WA, USA.

FIGURE 3.2
Storage space requirements for various types of ice used in fisheries

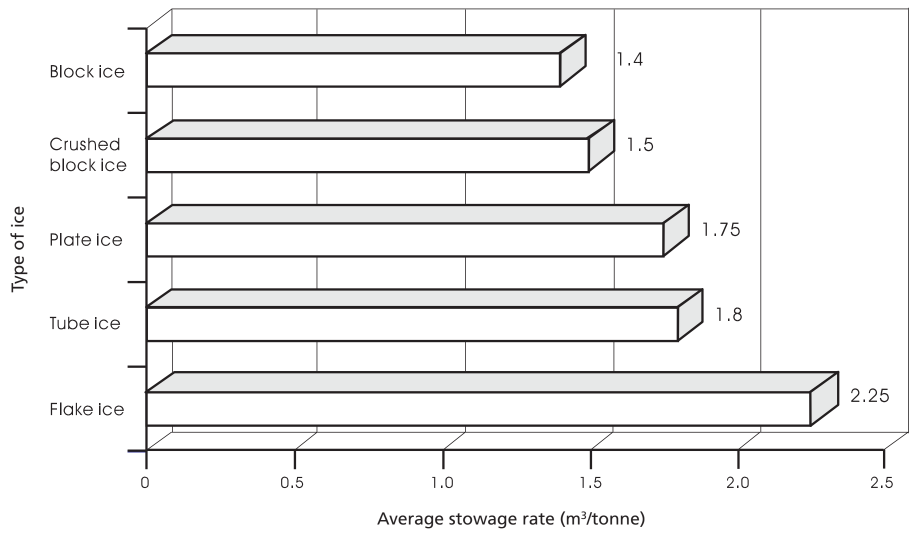


Figure 3.2 shows the storage space requirements for different types of commercially available ice, which vary according to their bulk density. In general, the storage space requirements for block ice are less than for any other type of ice. However, flake ice, despite its greater storage space requirements, can be stored to a greater depth in a silo. Therefore, in practice, flake ice floor space requirements would be much the same as for other types of ice.

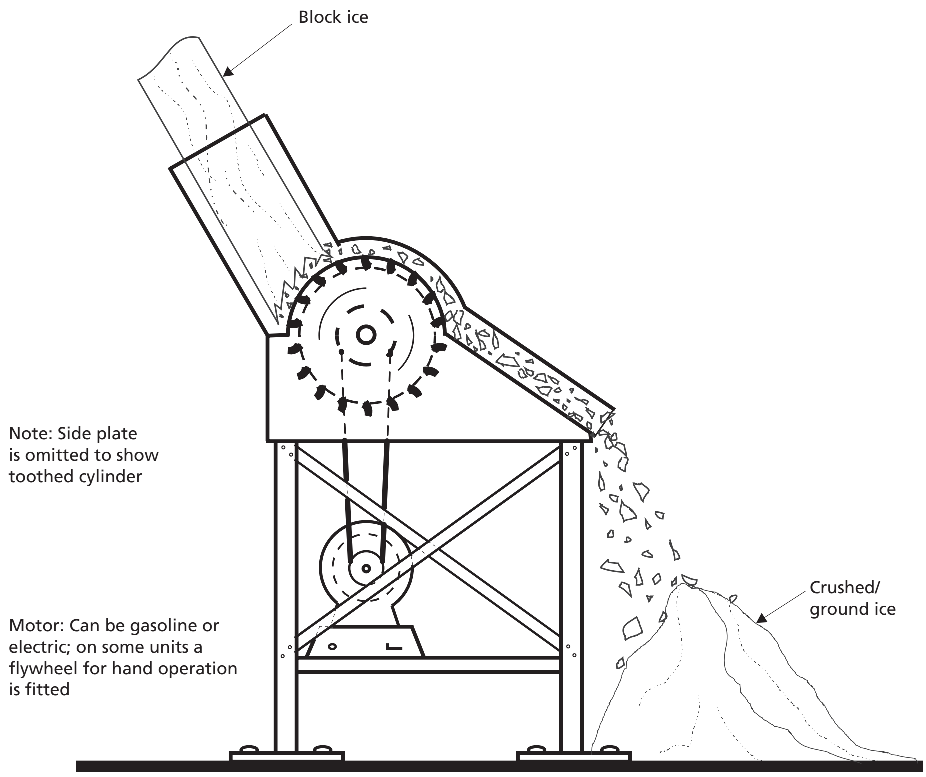
3.3 HANDLING OF ICE

Methods of handling vary considerably between different types of ice.

Block ice, for instance, requires special handling equipment in the plant, especially for larger-sized blocks. Some form of mechanical hoist is normally used to lift blocks from their containers prior to shipment. Blocks can also be moved from place to place by sliding them along shoots or over the ground. Individual blocks can be carried manually from place to place without any special containers or facilities. One advantage of block ice is its comparative longevity in storage compared with other forms of ice. This factor makes it a favourite of many fishermen. Blocks must be crushed before use and on some fishing boats a mechanical block-grinding device is carried. This machine can be powered by electrical, hydraulic or small gasoline motors and in some cases it is manually operated by addition of a flywheel. A typical unit is shown in Figure 3.3.

A simple block-ice grinder of this type can be adapted from an animal feed mincer. The teeth should be made of hardened steel, welded onto the cylinder and kept sharp. The unit can be fabricated from steel plate and angle iron by most

FIGURE 3.3
Block-ice grinder



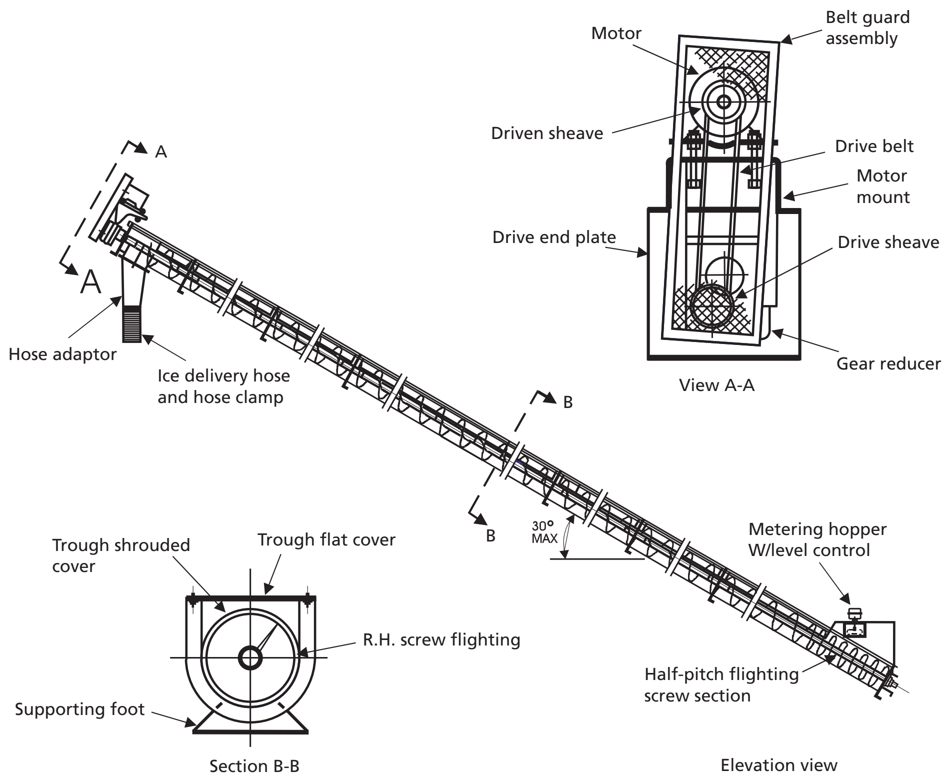
local metal shops with welding equipment. The unit should be dimensioned to accommodate the biggest ice blocks supplied by the ice plant.

Flake ice can be transported using screw conveyors, gravity feed or pneumatic systems. The ice can be discharged directly into the fish hold or into insulated containers, which are then shipped to the boat. Where manpower is available or only small quantities are required, the ice can be shovelled into containers. Flake ice tends to pack in containers or the fish hold and become difficult to work over a period of several days. This can be somewhat alleviated if the ice is worked occasionally with shovels.

In large installations, flake ice is taken from the storage bin by a screw conveyor incorporated in the storage area, as can be seen in Figure 3.1. Sometimes it is necessary to transfer the ice over slightly longer distances, for example across a wharf apron or quayside that is also used as a roadway. In this case, an auxiliary screw-type conveyor unit can be used as shown in Figure 3.4.

Flake ice can also be loaded and transferred using pneumatic powered systems. An example of one such system is shown in Figure 3.5 using two methods of discharge for loading the ice, one by gravity feed via a cyclone hopper, the other

FIGURE 3.4
Screw-type ice conveyor

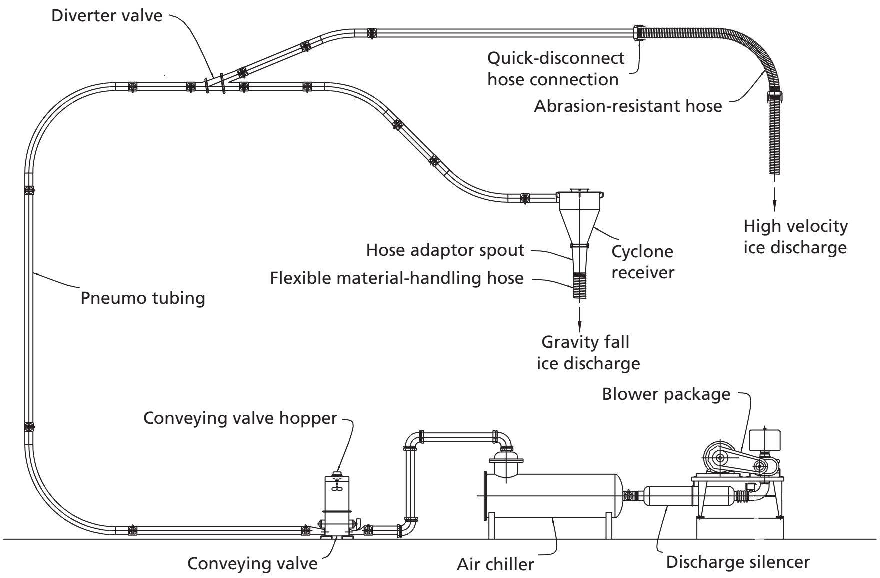


Source: North Star Ice Equipment Corp., Seattle, WA, USA.

by direct high-velocity discharge. Both methods require an operator to be on hand to manage loading. The system cannot be left running without ice being drawn off as the delivery pipes and cyclone unit may clog and become inoperable. Ice is fed to the air pressurized pipes by means of a “conveying valve”, and held in a hopper prior to being fed into the system. This valve is designed to feed ice to the pressurized side of the system without allowing air out through a one-way valve arrangement.

The problem of subcooled ice such as flake ice becoming difficult to work or solidified after a period of storage is addressed in various ways. Larger plants will have rake systems, which are belt mounted to keep the ice continuously and evenly distributed in the store. The rake also feeds ice to the delivery system. Other systems, such as round “hopper-style” storage bins, use rotating paddles or chains to keep the ice from freezing into a solid mass in the storage and delivery hopper.

FIGURE 3.5
Pneumatic ice delivery system



Source: North Star Ice Equipment Corp., Seattle, WA, USA.