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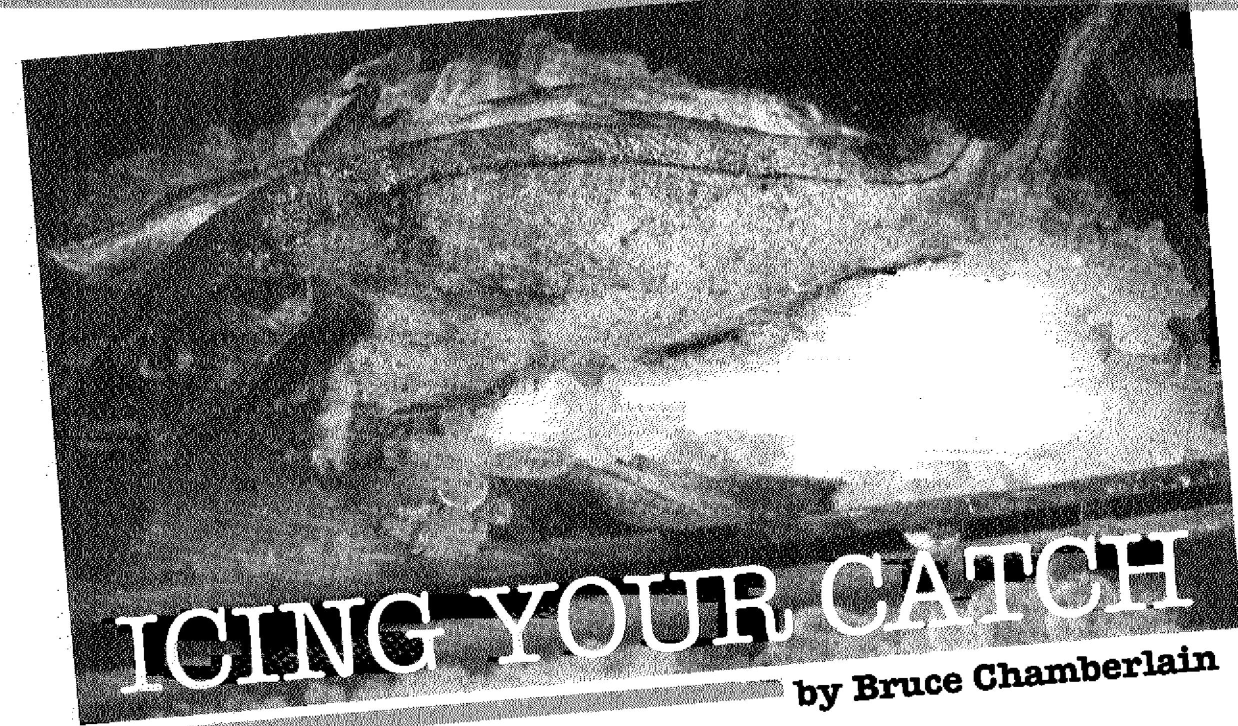
ICING YOUR CATCH



by Bruce Chamberlain

Increasing demand for quality in seafood products has resulted in a related increase in the use of ice on board Maine commercial fishing vessels. However, this preservation technique is effective only if the many types of ice available are handled properly in order to assure a quality product.

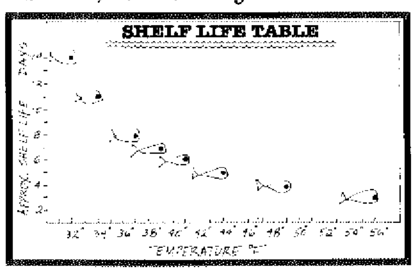
This guide provides vessel owners, shoreside businesses considering the purchase of their own ice plants, and others an introduction to the basic forms of ice, their principal characteristics, and proper handling methods.

Why Ice Your Catch?

The primary reason for icing your catch is to land fish with a longer shelf life. **Shelf life** is the time it takes before fish spoils and cannot be used by the consumer. A longer shelf life can mean a higher price for the fish. Temperature is the single most important factor controlling the speed at which fish spoils. Therefore, to maintain long shelf life, chilling must begin as soon as the fish is caught.

Fish spoilage is triggered by three major causes: 1) **enzymes** which remain active after the fish has died, causing flavor and texture changes; 2) **bacterial spoilage** caused by millions of bacteria which are present in the surface slime, on the gills and in the intestines of the living fish, which can cause spoilage after the fish has died; and 3) **chemical changes,** which are caused by the oxidation of the fat in the flesh of the fish, leading to a rancid odor and flavor.

Although spoiling is a natural process which occurs after the fish dies, it can be slowed by chilling the fish to 32°F. A freshly-caught cod fish, if packed in ice, will remain very fresh for seven days and maintains a usable shelf life of fourteen days. Other species have different shelf lives. For example, large, flat, lean fish have a longer shelf life than small, round fatty fish.



SOURCE: NATIONAL MARINE FISHERIES SERVICE
At freezing temperatures, bacterial growth is virtually stopped.

Maine Department of Marine Resources with the
Maine/New Hampshire Sea Grant College Program

Ice is the preferred method to chill fish for the following reasons:

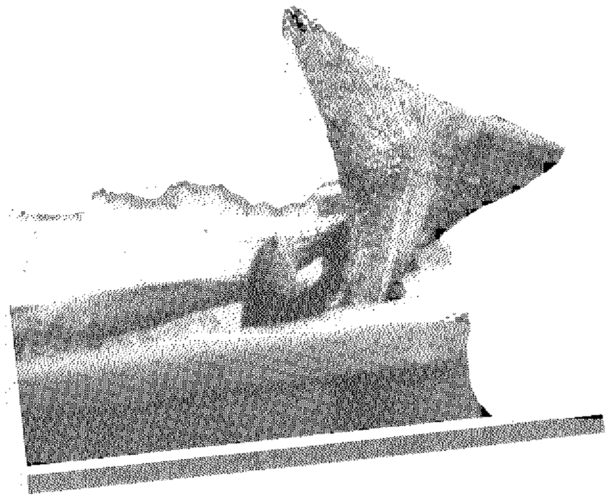
- Ice has a large cooling capacity per given weight.
- Ice is relatively inexpensive to use.
- Ice keeps fish moist and prevents weight loss.
- Ice cools quickly when fish and ice are in good contact.
- Ice has its own thermostat; the **temperature of ice melt is always 32°F.**

After a fish dies, it goes through **rigor mortis,** in which the muscle tissue becomes temporarily rigid. If the fish is allowed to warm up as it goes through rigor, the muscle tissue will tear. By chilling the fish, it goes through rigor more slowly, which puts less stress on the muscle tissue of the fish, minimizing the tearing. This, in turn, prevents poor quality in the fillets due to holes in the flesh.

Fish chills as the ice meltwater flows over the fish, removing heat from the fish. Heat flows from the area of the highest concentration (the fish) to that of the lowest concentration (the meltwater). In order for this heat transfer to take place, the fish and meltwater must have direct contact. The mixture of ice and meltwater will not rise above 32°F until all the ice has melted. If the meltwater is allowed to drain properly, it will also remove the blood, slime, and bacteria from the surface of the fish.

When fish is covered by the ice, the heat flows from the fish to the meltwater, bringing down the temperature of the fish. In a refrigerated fish hold where the temperature is 32°F or lower, ice will not melt. The only source of cooling will be the chilled air. This cold air cools the fish more slowly than the meltwater. Under laboratory conditions, it takes about three pounds of ice to lower the temperature of 25 pounds of fillets from 50°F to 32°F. This, of course, is not the case in the real world. The above example also does not take into consideration the amount of cooling that is lost to the surrounding environment.

In Maine, the rule of thumb for chilling fish has been one pound of ice to every two pounds of fish, in the summer; and one pound of ice for every three pounds of fish, in the winter. It is important to remember that the heat of the fillet in the middle of the box, or the fish in the middle of the pen in the fish hold, has to travel through the fish above and below it in order to reach the ice. The thicker the layer of fillets or fish, the longer it will take for the fillet or fish in the middle to cool down to 32°F. This should be heeded when icing fish in the hold; **every layer of fish should be iced.**



Forms of Ice

There are several kinds of ice-making plants, each producing a different form of ice. These include **block ice, slice ice, plate ice, tube ice,** and **flaked ice.** These can be further defined into **dry subcooled** or **wet ice.** Subcooled is usually made in machines with mechanical harvesters to remove the ice from the freezing surface; flaked ice is an example of this type. Wet ice is made in a machine that defrosts the freezing surface in order to harvest the ice, thus causing part of the ice to melt and fall off the freezing surface.

The capacity of an ice machine is usually measured in pounds or tons made during a 24-hour period. For example, when a brochure describes the machine as a 1000-pound machine, it's not referring to the actual weight of the machine but to the quantity of ice the machine will make in a 24-hour period. The output is affected by a number of variables including the air temperature and the temperature of the incoming water. By pre-chilling the water from 95° to 41°F, the output can be increased by 20%.

The cost of the machines is based on the size, in terms of the machine's capacity, and whether it's a fresh water or a saltwater machine. Factors that increase cost are larger size, saltwater operation, and on board usage.

Any water used for making ice which will be used on fish must be free from any bacteria, that is, fit to drink if it were fresh water.

Block Ice. This type of ice is made by freezing cans of water in a brine of sodium or calcium chloride. The size of the blocks are from 25 to 300 pounds and take between 8 and 24 hours to freeze. The blocks are then transferred to a crusher where they can be crushed to any fineness. The smaller the pieces, the better contact the ice will make with the fish, but the more quickly it will melt.

Rapid block ice is the common form of block made by ice machines today. The term block refers to the size, between 50 and 300 pounds, and not to the shape. The ice is formed by freezing water around tubes through which a refrigerant is circulated. The tubes then go through a defrost cycle and the blocks drop into a crusher. These plants are usually very large and expensive, and the output is measured in tens of tons per day. The block ice machine is the type found at a large fish plant or fish pier. A separate building is usually required to house the machine and provide storage space for the ice. The cost may range between $50,000 to $100,000 or more.

If the crushed ice is too large, it will make poor contact with the fish. If it is too small, it will melt too fast, requiring more ice. It is up to the user to decide what size ice chunk fits best into his application.

Flaked Ice. To produce this type of ice, a thin layer of ice ⅛ inch (2-3mm) is formed on the surface of a refrigerated cylinder. The ice is harvested by a mechanical scraper as dry subcooled ice flakes about .16-1.6 inches^2 (100-1000 sq.mm) in size. Because the cylinder is subcooled (-4° to -13°F), it can make ice quickly, thereby allowing the machine to be smaller in size, as these machines do not require a crusher.

The flake ice machines come in capacities from a few hundred pounds up to ten tons, and the costs are between $4000 to $6000 for the smaller machines (1000 pounds) to about $35,000 to $40,000 for a ten ton machine. They also come in both fresh water and saltwater models. Some are designed for use on board boats, which can be run electrically or hydraulically, and cost between $8,000 to $11,000 for a 2000 pound machine. One of the problems with flaked ice is that if it is allowed to melt and refreeze, the flakes tend to freeze together or bridge over, leaving air spaces between the fish and the ice, and thus resulting in poor contact with the fish.

Tube Ice. Tube ice is formed by freezing water on the inside of vertical tubes producing ice in the shape of hollow cylinders. During the hot gas defrost cycle, the cylinders of ice drop onto a cutter which cuts the ice into pieces about 2x2 inches (50x50 mm) with a wall thickness of about ½ inch (10-12 mm). Since the ice is still too large to use on fish, a crusher is needed. The costs are about the same as for flaked ice.

Plate Ice. This ice is formed on a vertical, refrigerated plate in layers of about ½ inch (10-12 mm), and it is harvested by a hot gas defrost. A crusher is needed to break the ice into usable size pieces. Again, the costs are based on size, saltwater or fresh water, and other considerations.

In terms of cooling capacity, different kinds of ice must be compared based on weight and not volume, because the different ices have different densities. For example, a ton of crushed ice will occupy 56 cubic feet; a ton of tube ice will take up 66 cubic feet; and a ton of flaked ice will fill 75 cubic feet of space. However, all three have the same cooling capacity.

Onboard Ice Systems

There are many advantages and disadvantages to using ice made from seawater. Only the ice user can decide if salt ice fits into his application.

Unlike fresh water ice, seawater ice is soft and flexible. It will not bruise the fish and can be packed in and around the fish for better contact.

Saltwater ice machines are very useful on large boats making long trips, where carrying enough ice is a problem. Saltwater machines are also useful in ports where there is a shortage of fresh water. However, the seawater used has to be clean, which rules out its use in many harbors.

Seawater freezes slowly and as it freezes, the fresh water crystals are separated from a very salty residual. This residual brine, if not allowed to drain away, may cause the fish to become salty.

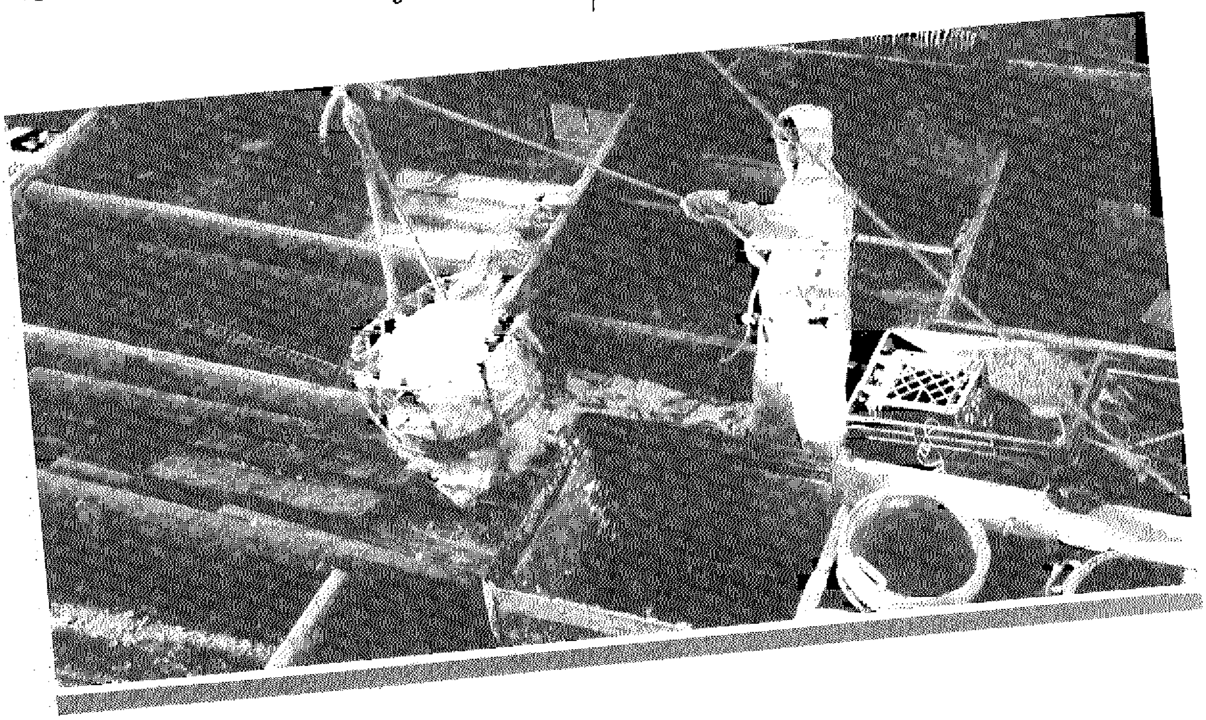
Saltwater requires more energy to convert it to ice than fresh water because it freezes at a lower temperature. However saltwater ice also melts at a lower temperature (about 28°F). This allows less ice to cool more fish. However, if the ice is not allowed to melt quickly enough, the 28°F temperature of the ice is cold enough to start to freeze the fish flesh itself.

An on board machine that would produce enough ice to match the peak catch rate would be very large and take up valuable space. Making ice on the trip out and storing that ice, however, would allow use of a smaller unit. This would also lower the power requirement. However, a three ton machine would need its own 20-25kw generator. To determine the economic feasibility of on board ice machines, initial cost, power cost, plus shoreside ice availability and cost must all be figured in.

Another method of chilling fish with ice is the chilled seawater system. There are two types: **slush ice** and the **champagne system.** Slush ice, which is a simple mixture of water and ice, has been successfully used for quite some time on the West coast by the salmon fleet. Adding water to the ice in watertight holds creates slush in which to put the fish. It chills the fish very quickly, because the cold mixture completely surrounds the fish.

The "champagne" system is a slush ice system incorporating a grid of pipes on the floor of the fish hold. Air bubbles up into the water/ice mixture through perforations in the pipes. The bubbles circulate the cold water through the load of fish, thus eliminating warm spots and formation of large ice chunks. The champagne system chills large quantities of fish faster than either slush or flake ice.[1]

One other system that is halfway between chilled seawater and ice is the refrigerated seawater system. In this method, the hold is filled with water which is refrigerated by mechanical means, instead of ice, as the boat steams to the fishing grounds. This may require a smaller cooling unit than an on board machine.



Keeping the Ice Clean

At the end of each trip of regular ice use, the old ice should be removed to prevent contamination of the spoilage bacteria from the fish of the last trip. The hold should be completely cleaned with soap and water, rinsed, and disinfected with a solution of water and chlorine bleach. As a result, the clean ice for the next trip will not become contaminated before it is used.

How the fish is handled after it is caught and before it is put in the hold is very important. Improper handling can completely undo all the benefits ice provides. Gutting and gilling the fish and then using a wash box to remove the slime and blood will reduce the amount of bacteria on the fish and will keep the ice from becoming contaminated. The water in the wash box can be chilled by either adding ice to the water or by chilling it with a small refrigeration unit. The water from the decks should not be allowed to enter the fish hold and contaminate the ice.

If you are **bulk loading,** the ice in the fish hold should be a foot deep on the floor and six inches on the sides. The hold is filled by layering the fish and ice so that all the fish are covered on both top and bottom by the ice. The problem with bulk loading, however, is that the fish in the bottom layers become crushed by the weight of fish and ice above. A better method similar to bulk loading is **short shelving.** This technique involves loading fish on shelves in the hold pens while keeping the depth of the layers to a minimum of thirty inches to prevent crushing of the fish.

Boxing at sea can produce better quality fish on landing than bulking, and boxing also helps to ensure the continued protection of the fish after landing by keeping the fish in the same box all the way to the cutting house.[2]

Design of the box is important. It must be large enough to hold the required weight of fish and sufficient ice to keep the fish chilled until landing. It should not be too large for one or two men to be able to lift it. In addition, drain holes should be arranged so that ice meltwater drains down the sides or ends of them both and not through the fish in the boxes below. The boxes should also be easy to clean and able to withstand rough handling.[3] For boxing to be effective, the fish must remain in the box until they are filleted. This requires close cooperation between the vessel and the fish buyer.

Stowage in the boxes should consist of a bottom layer of ice, about two inches thick, layers of fish sprinkled with ice, and a final top layer of ice about two inches thick.[4]

REFERENCES

[1] **Chilled Seawater Systems** by Chuck Crapo. University of Alaska Marine Advisory Program Bulletin 19, December 1985.

[2, 3, 4] **Ice in Fisheries.** FAO Fisheries Report No. 59, Rev. 1 RIIM/R 59 Rev. 1, Food and Agriculture Organization of the United Nations, Rome, January 1975.

RELATED PUBLICATIONS

Refrigeration Options for Small Boat Fishermen by Chuck Crapo. University of Alaska Marine Advisory Program Bulletin 21, July 1986.

Which Kind of Ice Is Best? by J. J. Waterman. Torry Research Station Advisory Note No. 21, Edinburgh, undated.

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by Bruce Chamberlain
Fisheries Technology Service
Maine Department of Marine Resources

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Edited by **Kathleen Lignell**
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