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Proper icing and freezing practices will help maintain quality in the hold

by Duncan Amos

Everybody knows that cooling the catch as quickly as possible is crucial to quality control. And although sophisticated refrigeration systems are highly efficient at that task, ice is still the most common method of lowering the temperature of the fish.

We all learned at school that when fresh water is cooled down to 32°F, it changes from a liquid to a solid – ice. The reverse is true when ice is allowed to warm: It melts, and the water reverts back to its original liquid form.

As the water is taken below its freezing point, a great deal of energy is used to change the liquid to a solid block of ice. This latent energy is locked into the ice and provides a very efficient "coldness reservoir." In turn, this ice will require a large input of energy (or warmth) to melt the ice back into water.

To the fishermen, ice acts as a heat sponge, initially soaking up warm air in the empty fish hold. But when applied to the recently caught fish, it will begin to absorb heat from the flesh, in turn cooling down the catch.

Ice conducts heat away from a source – be it air in the fish hold or fish flesh – 3½ times faster than water. Consequently, as it begins to melt, the water running off the surface of the ice actually insulates the remaining ice, thereby slowing down the melt rate. Obviously, the ambient air temperature still influences this melt rate. However, if the fish hold air temperature can be maintained near 32°F by good insulation and some mechanical means (say, by deck head cooling grids, which will be discussed later), the ice with its light coating of melt water will last longer.

Regardless of the type of ice used – whether it is flake, tube or crushed block – weight for weight, it all melts at the same temperature and has the same cooling capacity. Crushed block or **flake ice is preferred because of its increased contact area with the fish.** Also, the outer layers of this ice melt first and then refreeze as the melt water hits the lower layers of ice, thereby forming an ice skin and helping to slow the melt rate when the fish hold temperature is high.

Ideally, of course, we need melt water to run over the fish to remove the heat from the fish. Unfortunately, too high a melt rate would result in the rapid loss of ice and a subsequent spoilage of the fish. Consequently, fish room insulation is extremely important for preventing heat from entering through the engine room bulkhead or from the surrounding sea water and sun on deck. Opening the fish room hatches only when necessary will also reduce the ingress of heat, particularly when the vessel is underway.

Under ideal conditions of insulation and low ambient temperatures in the fish hold, it would only take 2 lbs. of ice to cool 14 lbs. of fish to 32°F. In the real world, however, with heat leaking in from various sources, at least 2 lbs. of ice should be used for every 4 lbs. of fish. In the summertime, with even higher temperatures around the vessel, that same 2 lbs. of ice should be allocated to 2 lbs. of fish, regardless of the method of stowage being used.

Seawater Ice

Ice can be made on board from sea water, but it behaves differently from that made from fresh water. As seawater ice melts, the fresh water in the ice runs first at about 32°F, followed by a brine solution as the rest of the ice melts at about 28°F. This super cool water may, in turn, partially freeze the surface layers of the fish, which can lead to a slight deterioration in the quality of a processed product in fillet form.

Some people feel that this super chilling is not detrimental. In some instances, it is even preferred, especially in the refrigerated sea water (RSW) tanks used to hold oily fish. Saltwater ice can also melt as much as three times faster than freshwater ice so that greater quantities may be needed on longer voyages.

Deck Head Refrigeration

If a fisherman experiences excessive ice loss on short voyages or wants to stay out a little longer on the grounds, the use of refrigerated deck head cooling coils might be worth considering. Their sole purpose is to assist in preserving the ice, rather than cooling the catch directly.

The deck head coils are used to lower the air temperature in the fish hold, and a good system can be very effective. There are only two basic rules to their use. The coils should be on while the vessel is in port or steaming to the grounds; they should be off during fishing and operations in the fish room. On the way to the grounds, the air temperature in the fish hold can be brought down to near 32°F to slow the melt rate.

During fishing, when the hatches are open and work is going on in the hold, the coils can be turned off the initiate the ice melt. That running melt water is the secret of fish preservation because it conducts heat from the fish flesh and washes away bacteria. Once fishing is completed and the fish hold secured for the run back to port, the deck head coolers can be turned back on, pulling the fish hold air temperature down again. Although this will slow the important melt rate of the ice, the fish has already been chilled fairly well if stowed properly.

Prior to securing the hold, a relatively thick layer of ice should be spread on top of the fish (4" to 6"), to prevent dehydration of the top layers by the cooling coils. On the homeward run, the fish hold temperature should be maintained at 34°F to allow for ice melt water to continue to do its job.

To assist in keeping the fish hold cool, layer the floor with ice up to 12" thick. Ample drainage should be provided, and shelves should be placed at least 6" above this layer. This ice will become contaminated with melt water, so fish should not come in contact with it. Remember, cool air flows downward, so the thicker the layer of cold air we provide, the better.

Freezing at Sea

Most U.S. vessels set up for freezing use horizontal plate freezers to protect their product. On the East Coast, the primary species to be frozen are squid and butterfish, while the West Coast fleet is filleting round fish prior to freezing.

In addition to all the other quality procedures involved when freezing product at sea, fishermen must be careful in the handling of fish in "rigor mortis." When a fish dies, the chemical energy reserves stored in the tissues gradually leak away, allowing proteins in the flesh to combine. This in turn causes the tissues to stiffen, and the fish becomes rigid.

Exactly when a fish passes into "rigor" varies according to its state of exhaustion, its size and, more importantly, the temperature at which the fish is being held. The higher the temperature, the quicker the fish will go into rigor. The temperature also influences the speed at which rigor sets in. Rigor starts at the tail and progresses toward the head. The length of time in this state before the fish becomes pliable again can be as long as 60 hours for a large cod held at 32°F, but as little as two hours for the same fish if it is allowed to warm up to 87°F.

What has all this to do with quality? As a fish begins to stiffen, the muscle tissue is put under considerable stress. If the process is accelerated because the fish is allowed to warm up then the muscles can literally tear themselves apart. Now if the fish is cut or filleted, the flesh will gape open and appear ragged with excessive drip loss.

Fish that are chilled promptly will not pass into rigor too quickly. Consequently, the onset of rigor will be gradual, thus reducing the chances of internal damage. If a fish is bent and rigid, it should never be straightened out until rigor has passed and it is once again pliable.

Whole fish in rigor have the benefit of a supporting skeleton that helps to hold the fish together. Once a fish is filleted, there is no support for the flesh and if the temperature of the fillet is allowed to rise then rigor can begin. This in turn can cause the fillet to shrink and the texture to toughen.

So, regardless of how fish are to be frozen at sea, they must still be kept cool at all times until they are packed into the plate freezers.

In summary then, rigor influences quality in three ways. It causes:

- toughness and high drip loss in frozen whole fish or fillets;
- gaping in fillets from frozen whole fish; and
- shrinkage and distortion in frozen fillets.

These can be reduced by:

- keeping the fish cool at all times;
- handling fish carefully that are already in rigor; and
- freezing fillets immediately after they are cut from the pre-rigor fish.

Using the Freezer

Careful packing of the product onto the plates is extremely important to ensure that the refrigerant can do its job. Air spaces between the plates caused by any means will reduce the effectiveness of the refrigerant passing through the plates.

It is crucial to make sure that the entire pack has been frozen properly before storing it in the refrigerated hold, which is designed to maintain temperature, not lower it. Improper handling could overload this system. In extreme cases a poorly frozen batch of fish could cause the fish hold temperature to rise and allow the product already stowed to begin spoiling.

This problem can also come about if the freezing cycle is shortened because of heavy fishing pressure. Product must never be removed before the manufacturer's recommended cycle time.