

Refrigeration for Small-fisheries

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ABSTRACT

The merits of fresh water ice, salt water ice and chilled water systems for fish preservation are compared and discussed. Descriptions are given of the different types of ice available (crushed, flakes, cubes, blocks) together with their advantages and disadvantages. Several chilled water systems are also described with emphasis on the spray and immersion methods. A comparison is made of the quality of the product protected by each method.

This paper discusses and compares two simple methods of fish preservation. The first and probably the most common is ice. The second, less known but very interesting, is chilled water systems.

Ice can be made with either fresh or salt water, though salt or sea water ice is softer than fresh water ice and diminishes the risks of bruising the catch. Its lower temperature gives it a longer conservation potential. Seawater ice also has the advantage of keeping the fish in their natural environment. Flake ice seems to be the ideal solution for almost any kind of seafood because it is softer than crushed ice and there is thus less chance of damaging the product.

When using ice the choice has to be made between buying it or making it on board. In many places ice, when available, can be quite expensive. In isolated regions ice production can be halted for weeks at a time due to the lack of a qualified repairman or the absence of necessary spare parts. There also may be shortages due to inadequate equipment and this can delay a fishing fleet for days and cause loss of revenue to the fishermen.

Now let us assume that the boat is loaded with ice and sets out for the fishing grounds. The extra weight of the ice slows the vessel down and increases the fuel consumption. If fishing is initially poor time is still passing and the ice is melting. Even if fishing improves after a few days, the boat may be out of ice and will have to return to port.

When making ice on board there is the option of making fresh water ice using a desalinator, sometimes called a "water maker" though this is too complicated and expensive for small or medium size vessels. The other choice is to use a salt water ice maker. These machines make ice directly from the sea water thus suffering from that highly corrosive environment. Even though the quality of this type of equipment has been improved in recent years they still remain a very delicate piece of

machinery and a qualified technician is necessary for maintenance. Spare parts are often hard to come by and a generator has to be kept running most of the time. There are some hydraulically driven units on the market but they have not been thoroughly proven as yet.

The obvious advantage in making one's own ice instead of buying it lies in the greater freedom of movement than allowed the vessel. The machinery is lighter than a full load of ice and does not need to be used if you are not fishing. The vessel can stay out until the fish hold is full without having to sail back to port for new supplies of ice.

On one of our customers' boat fishing off the coast of West Africa the daily catch can be up to 11 metric tons (25000 pounds). Just to cover the heat gain from the fish it was necessary to install an ice maker with a nominal capacity of 5 metric tons (10000 pounds). This ice maker requires a 20 to 25 kilowatts generator running almost constantly.

One interesting way of saving ice is by using an ice maintenance system. A refrigeration system driven from the main engine will help keep the fish hold cold. Ice then will only be used to pack the product and avoid hot spots or dehydration.

There are primarily two types of evaporators to choose from: cooling or holding plates and tube coil. The difference between cooling plates and holding plates is that the former cool only when the refrigeration system is running. Holding plates, however, make it possible to keep the hold at proper refrigeration temperatures for up to 8 hours when the boat is not fishing and the system is turned off. Holding plates though are bulkier and heavier than the cooling ones. We try to avoid the use of standard refrigeration evaporators with blowers because they tend to dehydrate the fish which results in a loss of weight and poor appearance of the product. With maintenance systems less ice is needed at the beginning of the trip and it can be made to last much longer by maintaining close to freezing temperature in the hold. The system is simple and inexpensive and will pay for itself in a few months.

The second refrigeration method I want to describe is refrigerated sea water which has been used with great success for quite some time. There are two different types of cooling processes in use: the flooded tank and the spray. The flooded tank system is best for small delicate species where crushing can be a problem or for inexpensive species which may be directly unloaded on shore by a pump. Cooling when done by liquid is very efficient and preservation extremely good. Shrimps for example can be kept up to 16 days and stay very fresh: this is not possible with ice.

It is very important not to overload the tanks so as to allow good water circulation and avoid hot spots. The fish hold is usually divided in several compartments filled with water. The first one is cooled before fishing begins while cooling of the second one starts upon the beginning of loading number 1. One tank is always kept ahead of the other and the last one is never filled with fish but used to chill the replacement water of the other tanks.

A major inconvenience of this system is the extra weight of the water and the related higher fuel consumption. Some boats cannot be modified to accommodate these tanks and it is recommended to consult a naval architect before attempting such an installation. It is also important to consider the amount of time required to chill such quantities of water.

The spray system keeps the fish chilled by spraying with cooled seawater. This system can be added to a fishing vessel at any time without any structural alterations. It is, however, extremely important to have a completely watertight liner in order to avoid destruction of insulation or even sinking. In this case the "pull-down" or initial cooling period of water will be much shorter than for the flooded system because of the small amount of water needed and the fact that it needs to be started only a few hours before fishing begins.

The spray system is an extremely good method for large fish such as grouper, red snapper, shark, swordfish or tuna. It is not recommended for flat species which may be packed too tight to allow good water circulation and suffer spoilage due to hot spots. With a water temperature of -1.6 degree centigrade (28 d.f.) it is common to have holding periods of 10 to 13 days with a very high quality product at the end of the trip.

The spraying is done with chilled water. The water is pumped from the sump of the fish hold and goes over a bank of tubes called the evaporator or chiller thus getting cooled. It then goes to overhead PVC pipes in which holes have been drilled to spray the fish. This water then returns to the sump and is pumped back through the system.

The evaporator or chiller can be of two types:

(i) The open types are made of coils of pipe directly installed down a sump or on the shallow spots on both sides of the shaft alley. They must be covered by water and protected by wire mesh or perforated metal. This is a set up which will not get clogged and is very easy to clean. It cannot be damaged by freeze-up. The inconvenience is that the system is not a one piece package and that a refrigeration technician will be needed for the installation. The longer length of exposed tubing also makes it more subject to refrigerant leaks.

(ii) The closed types are made of a coil of tube enclosed in a box or cylinder through which the water goes in order to get chilled before spraying the catch. Their main advantage is that it is a package system which can be installed by the boat builder without the help of a professional refrigeration man. The only installation required is that of the water lines and the power supply for the condensing unit, or fuel lines if an engine driven system is used. There will be no refrigerant lines running to the fish hold or across the engine room and this greatly diminishes the chance of freon leaks. On the other hand some of these systems are almost impossible to clean and have more risk of freezing up. One way to prevent this is by using a polyurethane-sleeve which is easy and inexpensive to replace should a freeze-up occur. The refrigerant runs inside the coil and would not be damaged in case of freeze-up. A plug

is installed at the end of the sleeve and is easily removed for inspection or cleaning. The system is controlled by two thermostats. One for adjusting the temperature, the other for safety purposes.

For long life a cupro-nickel water condenser is used. A MOP expansion valve, and a suction accumulator with heat exchanger ensure better efficiency and protect the compressor.

The spray system is built using only standard refrigeration parts available at good supply stores in any country. This is another advantage over ice makers which often have parts available only from their specific manufacturer.

The system driven by a small diesel engine is also very efficient using direct power from the main engine and is less costly than using a generator. It also eliminates all the usual generator problems such as wiring, controls and electric motor. Several different brands of engine can be used according to the customer's preference and also the availability of parts and service in the region where the fishing will be done. Again the system is kept as simple as possible. There are few filters or strainers on the suction line, The spray pump is all thermoplastic and 316 stainless steel. At the end of the spray line a valve is fitted to allow purging of any accumulation of debris.

For a vessel that make longer trips it is possible to add salt to the water so that the water can be brought to a lower temperature. This is called brine spray and can even be used for freezing with a -12 degrees centigrade (10°F) brine. On certain types of fish where salt penetration can be a problem the use of spray brine is not recommended.

Studies are now being conducted on some additives that would limit foaming and slow down the development of bacteria. Carbon dioxide seems to be efficient in this regard.

Cleanliness is very important and a make up of 10% fresh water per hour is also suggested. This extra water from the fish hold can be used on deck for cleaning fish.

Flooded tank and spray systems are compact and very efficient compared with air type evaporators.