Preservation of Fish In Refrigerated Seawater

T. K. GOVINDAN, M. Sc., Dip. in Tech.
Junior Fishery Scientist,
Central Institute of Fisheries Technology,
Ernakulam, Cochin-11

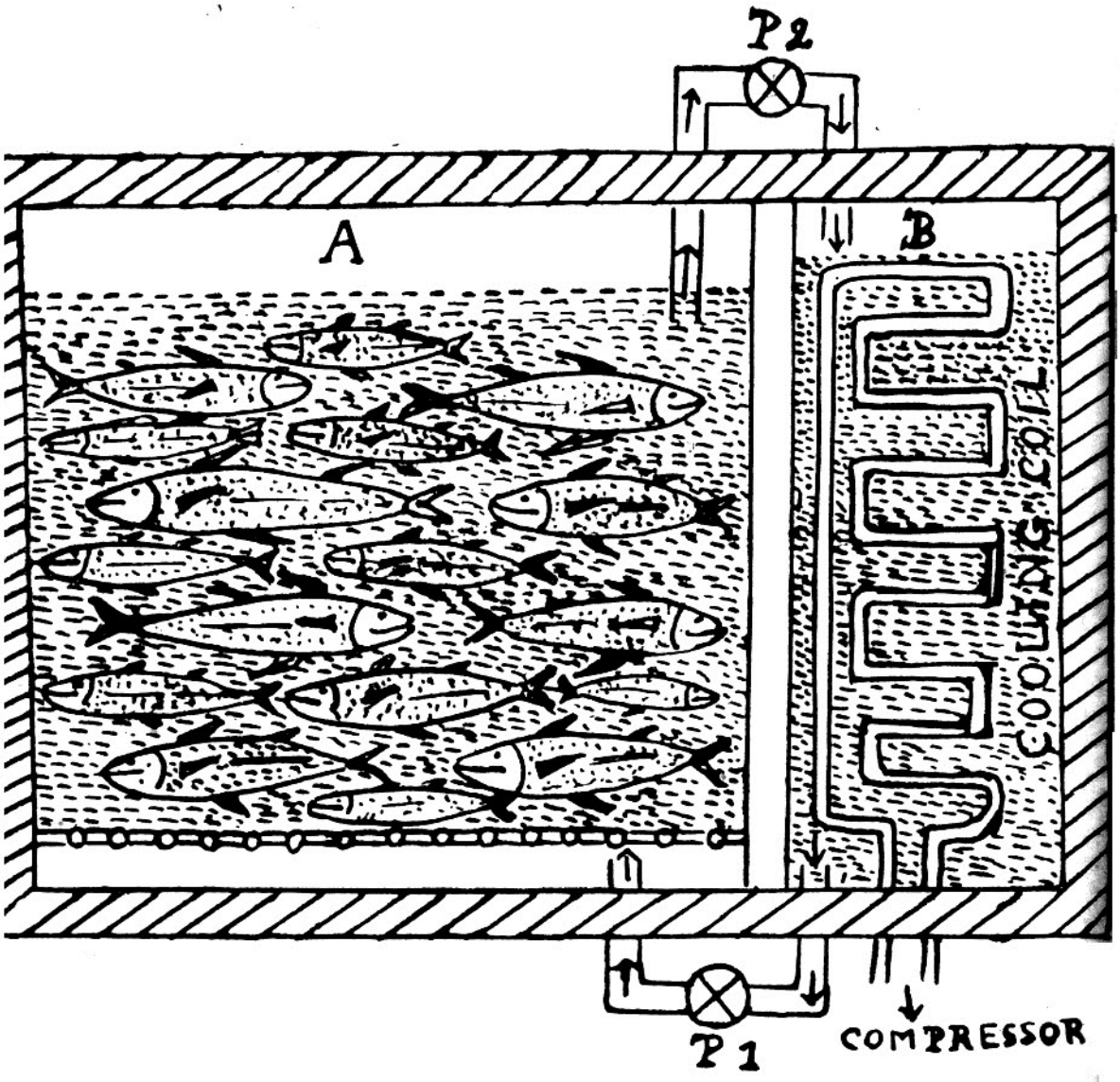
Introduction

Even though refrigerated seawater (RSW) has been widely employed for preservation of fish in many of the developed countries, the process is practically unknown in India. The principle involved in this method is to store the fish in natural or artificial seawater cooled to 30°F. It appears to be more suited for storing fish on board fishing vessels and the first ever reference available in literature to this method is regarding a French patent issued in 1920 in which fish were held in seawater cooled to minus 4°C. In the early stage of development of this process, cooling of the brine or seawater was effected by blocks of ice which however diluted the strength of the brine. Moreover, carrying the large quantities of ice required for a whole fishing trip posed problems of space, labour and economic implications which were successfully solved later on by employing mechanical refrigeration for cooling the brine instead of ice. This also prevented dilution of the brine which occurred when ice was employed for the purpose. One important precaution that has to be observed is to maintain the temperature slightly above the freezing point of the fish, which otherwise undergo a process of slow freezing with all accompanying difficulties like rapid denaturation of proteins etc.

Equipment

The following is a diagramatic representation of an RSW fish preservation unit.

It consists of an insulated tank seperated into two compartments, the larger one, A to hold the fish and the smaller one B for the cooling coils through which a refrigerant, usually Freon 12 is circulated at the required temperature by means of a compressor system. Cooled brine from the smaller tank is pumped to the bottom of the fish tank by pump P1 uniformly where it rises through



a perforated partition and is drawn out just below the top surface of the seawater into the cooling tank for further cooling by pump P2. Thus the same seawater is circulated through the fish with sufficient cooling to maintain the desired temperature in the fish.

Procedure

The fish has to be thoroughly cleaned before they are placed in the storage tanks. It is preferable to eviscerate larger fishes and clean them well prior to stowage in the seawater tanks. Care has to be taken that all the fish remain well under the surface of the seawater. Cooling of the brine prior to the introduction of the fish ensures quicker chilling. The temperature of the seawater is thermostatically controlled at 0 to minus 1°C.

RSW Vs ICE Storage

Both the storage systems viz., RSW and ice, possess their own merits and demerits which are briefly discussed below. There is much more efficient and rapid cooling in the case of RSW due to the thorough and intimate contact of the cooling medium with the fish while in the case of ice storage, the solid ice pieces do not make such a perfect contact. Another important advantage in using RSW storage is that fish held in this medium have buoyancies almost equal to their weights and hence, to whatever heights the tanks may be filled, the fish do not get pressed or crushed, whereas in ice storage if the depth of fish and ice stored in one container exceeds about half to one meter, the bottom layers of fish get crushed and more often pitted by the pieces of ice. There is better control of temperature in RSW storage which is maintained generally at minus 1°C whereas in ice storage, it is very difficult to bring the temperature even below plus 1.5 to 2°C and even there uniform temperature conditions throughout the material are seldom obtained. RSW storage eliminates the difficult task of icing and hence there is considerable saving of labour and ice storage space on board fishing vessels where this is employed. Moreover, there need not be any fear of the ice getting exhausted and hence the fishing trip can be prolonged to any length of time without the catch getting spoiled.

One of the disadvantages in RSW storage is that the medium accumulates heavy bacterial loads especially if the surfaces of the fish are not scrupulously cleaned before stowage in the tank. Of course this problem can be solved by frequent changes of the seawater. On the contrary, in ice storage, there is a continuous washing of the surfaces of the fish by the ice melt water and considerable amounts of the bacteria originally present on the fish surface are washed off, though a certain amount of loss of nutrients and flavour bearing compounds also occurs in the process. Due to the latter reason, fish held in RSW is organoleptically superior to those held in ice for equal durations. However, frequent changes of the seawater as mentioned above also bring about these changes. Since the fish is in contact with a limited volume of seawater which is recirculated in the RSW storage, the fish holding and cooling tanks get highly contaminated by bacteria due to the rapid and heavy build up of the organisms in the medium. This necessitates thorough cleaning of the tanks and connected equipments especially the cooling coils etc with which the seawater comes into contact, after each operation. This is accomplished by flushing them with clean water after unloading the fish and before they get dried up, scrubbing with a detergent solution to remove all slime and particles of muscle, spraying with or preferably keeping them immersed in a non-corrosive germicidal solution overnight and further flushing with clean water to remove the adhering germicide.

Changes in fish muscle due to RSW storage

Weight gain; Fish held in RSW generally gain in weight as a function of the holding time. Upto 15% increase in weight has been reported in the literature in the case of some lean fish held in this medium for 10 days, even though in the normal course the figures vary from 4 to 5%. The gain is more in eviscerated fish than in round. Likewise, lean fish gain comparatively more weight than fatty fish.

Gain in sodium and loss in potassium ions: Another important change taking place in fish stored in RSW is their gain in sodium chloride and loss in potassium ions. The former is more rapid than the latter. Hence the net result is generally an increase in the total salts in the muscle. Here also, the change is more prominent in lean and eviscerated fish than in fatty and round fish.

Leaching losses: Loss of nitrogenous constituents occurs from the muscle of fish stored in RSW. The substantial losses occuring in soluble nitrogenous material including proteins in prawns stored in ice in whole, headless as well as peeled and devined forms have been extensively studied by the author and reported elsewhere. Similar observations in the case of taleost fishes like cod, salmon, etc have been made and reported earlier by Dyer and others from Fisheries Research Board of Canada. Loss of nearly 1.3% of the total proteins of whole fish by storage in RSW for six days have been reported. The loss is three times when the fish is stored in eviscerated condition due to the cut surface exposed to the seawater.

Belly burn: In the case of some fish like tuna and salmon stored in RSW in the whole condition, softening followed by bursting of the belly walls occur after some days especially if the fish had been feeding heavily at the time of capture. This phenomenon termed "belly burn" has been attributed to autolysis i.e., decomposition caused by the enzymes present in the fish muscle and intestines. It is very commonly observed in the smaller size of our oil sardines when they are preserved in ice as well as after freezing and thawing. Incorporation of 1.5 ppm of Chlorotetracycline in the RSW used for storage delays the belly burn which fact goes to show that micro-organisms are also partially responsible for the phenomenon.

Rancidity: Fatty fish stored in RSW sometimes develop rancidity especially if they happen to come in contact with air by direct exposure or through air dissolved in the brine. The small amounts of salt absorbed into the fish muscle from the RSW accelerates the development of rancidity. This can be controlled to a great extent by preventing the fish from getting exposed to air and ensuring that no bubling of air or froathing of the sea-water takes place.

Bacterial spoilage: Fish stored in RSW are more prone to development of heavy bacterial loads and consequent spoilage than those held in crushed ice due to reasons already referred to earlier. Addition of 1 to 5 ppm of CTC to the RSW has been found to check the undue multiplication of micro-organisms in the medium.

Conclusion

Even though RSW storage has not yet been tried for the preservation of fish in our country, it appears to hold out promising prospects in India. As our deep sea trawling operations are expanded, which is a "must" for any further development of our fishing and fish processing industry, RSW storage is sure to find favour with them due to its convenience, easiness and better control over the temperature than storage in crushed ice. The method can be employed on land also i. e., at the fishing harbours when the catch cannot be transferred immediately to the processing factories as well as in the factories themselves instead of ordinary ice storage. It appears worth while trying this method for transportation of fresh fish also because of its more efficient control on the temperature of the fish than the existing methods of refrigeration. ●