



# Manual on hygienic ice production for the small-scale fisheries in Timor-Leste

## Module 3

### Introduction to ice and its application in the Timor-Leste small scale fisheries sector

Regional Fisheries Livelihoods Programme for South  
and Southeast Asia (RFLP)

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## **Introduction**

Ice is made from either fresh water or sea water depending on the type of ice manufactured, whether at sea or on land. Ice is formed when heat is removed from water in its liquid state. When water reaches 0°C it begins to solidify when crystals form. During the crystallization process, the water expands approximately 10 % in volume and its molecular structure changes releasing heat energy.

The capacity of ice to absorb heat from warm catch is used during catch handling in small-scale fisheries to chill the catch from its ambient temperature to approximately 0°C. Ice absorbs heat from the catch while in contact with its relatively warm surfaces. As a result, the ice begins to melt and the melt water, which is in direct contact with the exterior surfaces of the catch, removes the latent heat from the catch. The cooling of the flesh causes bacteria and enzyme activity to almost completely cease.

1 kg of ice can chill 1 to 3 kg of catch depending on the catch temperature, the thermal insulation capacity of the catch storage area and the chilling method used.

## **Catch chilling methods**

### **Direct chilling**

Direct chilling is when there is direct physical contact between the applied ice and the catch. The contact between the warmer catch, causes the ice to melt. The melting water will be at +0°C, which will gradually lower the catch temperature. The smaller the ice pieces, the more contact points there are with the catch and the quicker the temperature lowers in the catch. The direct chilling method requires a drainage outlet from the compartment or the container, to allow warm melt water to be dispersed of. This method is predominantly used for larger catch specimens.

### **Indirect chilling**

Indirect chilling is best done using a **Chilled Sea Water (CSW)** system, which is essentially a mixture of ice and pure seawater. The principle that ice melts at 0°C is used in this method. The cleaned catch has a relatively large surface area, which when submerged into the ice/seawater mixture causes rapid heat exchange from the catch to the ice/water solution. This causes the ice to melt and a rapid drop in catch temperature. This chilling method has the added advantage that the submerged catch has no contact with free oxygen, which further inhibits bacteria and enzyme activity. This chilling method is frequently used to chill small pelagic fish, which are often caught in large volumes and where individual gutting and cleaning is impractical.

The fisher can use either system alone or both combined, for instance starting the chilling process of a large fish in a CSW compartment and once chilled, transferring the catch to a direct chilling compartment to save ice.

For either system to function effectively, it is important to regularly monitor the melt down process and replenish ice as required to maintain the cold chain integrity. Further details of the cold chain will be provided in another module.

## Types of ice

Ice for use in the fishing industry of several types, most is industrially manufactured.

Type	Form	Mass	Size in use	Use
<b>Block or plate ice</b>	Blocks, cubic or tapered	5 to 50 kg	Approximately 30 x 30 mm	Chunks for direct or indirect chilling
<b>Crushed or nugget ice</b>	Granulate	1 to 10 g	Approximately 5 to 10 mm nugget diameter	Direct chilling
<b>Tube or cube ice</b>	Cylindrical or cubic	10 to 30 g	25 to 40 mm nugget diameter or cubes of approximately 30 mm	Direct and indirect chilling
<b>Scale or flake ice</b>	Scales or flakes	1 to 10 g	Flakes of up to 3 mm thickness and 30 x 30 mm	Direct chilling
<b>Slush ice</b>	Liquid	Liquid	Liquid	Direct chilling
<b>Dry ice</b>	Solid, scales or flakes	Depending on use	Depending on use	Direct chilling

TABLE 01 Types of ice used in the small scale fishing industry

The ice type most frequently seen today in Timor-Leste small-scale fisheries sector is block ice made in plastic bags of different sizes. The ice is usually produced as a home industry, using domestic chest freezers. Ice of this type can sometimes be found on sale in shops and markets.

## Manufacture of ice

Ice has been used for well over 3,000 years to preserve food and ingredients intended for human consumption.

In its simplest form small batches of block ice can be made in small bags inside a domestic chest freezer as is common practice in Timor-Leste.

However, ice is generally commercially manufactured using specialized machines powered by electricity. Ice can also be manufactured using absorption refrigeration technology using either solar or fossil fuel heating sources in locations where electricity is unavailable.

Ice is normally manufactured in connection with cold/chill stores or dedicated fish processing plants and may be found aboard fishing vessels in the semi- and industrial size category.

In order to meet the sanitary requirements stipulated in international and national fisheries legislation and those of public health services, ice must be manufactured either from fresh water of drinking quality , i.e. potable water, or in the case of slush ice from unpolluted sea water. Ice intended for preservation of aquatic catch from the small- scale fisheries must be manufactured, handled, transported, stored and applied in the most hygienic manner possible in order not to expose the catch to any physical, chemical or biological hazards.

Manufacture of ice today is essentially an entirely automated process. However regardless of advanced technology there is still a need for the presence of skilled and trained technical staff.

An industrial sized unit will typically produce ice, irrespective of type, which is deposited directly into a refrigerated buffer store, from where it is distributed to users.

Industrially manufactured crushed, scale/flake and tube/cube ice is usually stored so it can be transported by a conveyor belt to a weighing station, while block ice is usually stored on pallets with dividers to avoid the individual blocks joining together where they touch.

Slush ice machines are invariably installed aboard fishing vessels and are demand operated for direct dosage onto cleaned catch or large volume small pelagic species stored in tubs or boxes.

Dry ice has no practical use in the small-scale industry.

The following table provides an overview of the capacities and cost of manufacture of each type of ice.

Type of ice	Manufacturing	Cost of manufacture	Application
<b>Block or plate ice</b>	Small to industrial size plants Absorption machines	Low to medium	Needs to be broken or crushed prior to use in sizes of approx. 30 mm max.
<b>Crushed or nugget ice</b>	From block ice or small machines up to 5 MT/24h	Medium	Can be used directly but is sensitive to external heat impact and has a tendency to form a crust
<b>Tube/cube ice</b>	From small to industrial size plants	Low to medium	Can be used directly but is sensitive to external heat impact and has a tendency to form a block
<b>Scale /flake ice</b>	Small to industrial size plants	Low to medium	Can be used directly but is sensitive to external heat impact and has a tendency to form a crust
<b>Slush ice</b>	Small to medium size machines	Medium to high	Direct application
<b>Dry ice</b>	Small to medium size machines	High	No practical utilization in today's fishing industry

## Use of ice in small-scale fisheries

The diagram below illustrates step-by-step the actions to be undertaken by fishers. The personal and production hygiene rules and actions detailed in modules 1 and 2 of this manual must also be followed.

### ICE STORAGE

The ice storage area is filled with the required quantity of ice. The chosen type of ice will depend on the chilling method preferred by the fisher and the local availability of ice.



### RINSING

Using a bucket, clean the catch with large amounts of clean sea water to remove excess slime and blood.



### STORAGE

Carefully place the catch in the clean, dedicated catch storage area, taking extreme care not to physically damage the catch.



### CHILLING

Chill the catch using ice as quickly as possible.

For direct chilling put approximately 30 mm of ice at the bottom and place the catch on top. Cover the catch with approximately 60 mm on top and 30 mm on the sides. Make sure the catch, in the case of fish, is stored in a straight position and is not bent.

If using the Chilled Sea Water (CSW) method, place the catch carefully into the solution of ice and seawater, ensuring complete submersion.

Check for ice melt regularly at intervals of 1 hour or less. Replenish ice as necessary to compensate for ice melt and drain melt water as and when required.



### TRANSPORT

When returning from the fishing grounds to the landing site, check for ice melt and keep the ice uniformly distributed over the catch. If weather conditions are rough, take measures to prevent the catch from moving inside the storage area, to avoid damage.



## HANDLING

Upon arrival at the landing site, the catch should be registered specifying the vessel name, the species, and the weight and temperature and thereafter graded.

Treat the fish with utmost respect and care to avoid physical damage to the flesh, as the fish may have turned rigid due to the rigor mortis effect.

It is recommended to use thermally insulated boxes e.g. Cool Man or similar or containers, which are fitted with lids to reduce the heat impact on the catch, as well as shielding the catch from contact with flies and other insects, rodents, other animals, dust and other potential hazards of contamination.

## Key elements in ice application

### Storage methods

It is important to arrange adequate storage space and conditions for the catch from harvest throughout every handling stage along the supply chain, (cold chain), until the catch reaches the consumer.

In most fishing boats, if not already fitted, it is possible to incorporate a suitable fish hold or cooler box for storage of ice and catch. It is possible, in most cases in vessels not having this feature to incorporate a suitably sized fish hold, using PU foam (polyurethane foam) or other insulation material, which then is covered by coats of polyester resin coating, GRP/fiber glass.

The catch storage area should be dimensioned to allow for unrestricted storage of the average length-, height-, width and volume of the expected catch, plus an additional 50% space for ice application.

Once the catch is properly stored it will not move significantly even under adverse weather conditions during the fishing trip, thus preventing any additional physical impact.

### Chilling

The chilling process should preferably be initiated moments after the catch has been harvested, gutted and cleaned.

It is important to slow down the growth rate of any spoilage bacteria and enzyme activity by rapidly cleaning and lowering the temperature of the catch, using ice.

Chilling is achieved either by direct icing or by use of Chilled **Sea Water** (CSW), which is a mixture of ice and pure sea water.

Direct icing is more convenient for larger catch specimens. Smaller sized, large volume catches of sardines, mackerel and scads are more conveniently stored using the CSW method because it is impractical to gut and clean each individual fish.

Depending on the size, thickness and fat content of the flesh, the temperature should drop rapidly from the prevailing sea water temperature to approximately 0 °C in a matter of minutes. The catch temperature should reach 0 °C within 30 minutes when using the CSW system, depending on the catch volume.

It is important to replenish ice to either chilling system as required to compensate for ice melt.



Photo series – direct ice storage method



A cooler box prepared for direct cooling.  
Note how the ice is distributed in an even layer in the bottom of the box.



The catch is being stored and arranged inside the cooler box storage container.  
Note how the ice is evenly distributed how and the fish is positioned to utilize the space with ice in between the individual fish.



Storing the rinsed, gutted catch using the direct icing method. Ensure that the fish body is not bent, but straight in the stored position. Note the stomach cavity is filled with ice before stowing the catch. Also ensure the sides of the fish are covered with 30 mm ice and a minimum of 60 mm on the top. If storing more layers apply the ice as described for each layer.

## CSW storage method



Preparing a solution of sea water and ice using a Cool Man. This method can be used to achieve a quick drop in temperature in large fish before storing them using the direct ice method, as well as on smaller species such as sardines and scads.



Properly CSW stored, rinsed, and gutted catch.

Typical local ice production in Timor-Leste



Typical ice production in Timor-Leste. Water stored in drums is used to fill plastic bags, which are closed off by tying a knot seal.



Filled plastic bags ready for freezing in a chest freezer.



Chest freezers used for ice production.

## Pilot RFLP hygienic ice production project



Automated small-scale cube ice machine, which RFLP is using to produce ice in Timor-Leste in a pilot project.



Cube ice storage bin in the RFLP automated small-scale cube ice production pilot project.



Storage boxes for the produced ice, while awaiting distribution to the pilot project sites. This photo was taken in the interior of the dedicated storage container.



The produced ice stored inside the storage boxes used for the pilot project sites. The photo was taken in the interior of the dedicated storage container.



The dedicated storage container in the background. In the foreground is the water pressure pump, which serves as the water supply line for the automated ice machine.