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Refrigerated Sea Water System

Bambang Triono[1], Mochamad Saleh[1], Revinsyah Nabil Kautsar Kabalmay[2]

[1]University of Sunan Giri, Surabaya
[2]Shipbuilding Institute of Polytechnic Surabaya

Email: moch.sholeh70@gmail.com

ABSTRACT – Almost all existing ships already have a cooling system. For fishing boats, a cooling system is needed to maintain the quality of fish in order to obtain high economic value. There are various types of refrigerants, one of which is the Refrigerated Sea Water (RSW) system. This paper describes the components and workings of the RSW system.

Keywords: RSW, ship cooler, fishing boat.

A. WORKING PRINCIPLE OF REFRIGERATOR

Refrigerator or cooling machine is a device used to transfer heat from indoors to outdoors to make the object/room temperature lower than the ambient temperature so as to produce a cold temperature. The working process of the refrigerator is always related to the process of heat flow and heat transfer. Refrigerant is a heat transfer medium in the refrigeration system, where the refrigerant absorbs heat at low pressure through the evaporator and releases heat at high pressure through the condenser. The evaporator absorbs heat from the conditioned room so that the room temperature becomes cold and the low-pressure refrigerant in the evaporator boils. The refrigerant vapor is then compressed by a high-pressure compressor so that the temperature of the refrigerant vapor also increases so that the heat of the refrigerant can be released into the environment through the condenser while the refrigerant undergoes condensation so that the refrigerant changes phase into a liquid at high pressure. The liquid refrigerant is then expanded to the evaporator pressure for the next cycle by the expansion device.

B. FISH STORAGE PRINCIPLES

In everyday life, refrigeration technology is better known in the form of its products in the form of ice, refrigerators (household refrigerators), ice factories and others. In the field of fisheries, an example of the use of cold storage is a building for fish storage (Clucas & Sutcliffe, 1981). Fish is classified as the food that decomposes the fastest due to the activity of the bacteria in it and refrigeration techniques have been proven to be able to preserve it (Dossat, 1997). Some methods or systems of cooling fish on board are:

a. Cooling Fish with ice (icing)
b. Chilling in cold air
c. Cooling fish with seawater ice
d. Cooling fish with chilled water
e. Cooling fish with dry ice
f. Fish cooler with refrigeration technology.

The temperature of seawater to cool fish has its own criteria, starting from 50C which is only enough to preserve fish for 4 days, and if it reaches -10C, the shelf life of fish can be extended to 15 or even 20 days.

C. HALK ROOM INSULATION

The hold room is a part of a ship that functions as a container for storing catches in the form of fish and is usually equipped with a hold space isolation system that functions as a heat barrier from outside to enter the hold space.

In general, the insulating material used must be clean, do not cause defects in the materials stored in it, be strong against shocks and impacts, do not contain toxins and do not cause odors, change the taste and colour of the preserved material.

Some of the most important characteristics of different insulating materials are:

a. Cellular glass, solid and used in floors where the weight factor is not a problem and the advantage is high compression strength.
b. Glass fiber, light weight but not able to withstand the weight and not resistant to moisture.
c. Polyurethane and polyisocyanurate are types of insulation that have the lowest thermal conductivity so they are very good at reducing heat.
d. Glass fiber and moulded polystyrene are the cheapest insulation, while the most expensive is cellular glass.

D. REFRIGERATION ON FISHING VESSELS

The process of fish refrigerant on fishing vessels usually uses raw materials in the form of ice blocks or ice with an even smaller structure. Generally, existing hatches require ice as a refrigerant medium which requires additional operational costs and has the potential to cause physical injury to the surface of the fish (Sainsbury, 1982). Here are some ways to cool fish in general.

a. Slurry Ice. Slurry ice consists of an aqueous solution that has ice crystals. Slurry ice is also defined as Fine crystalline Ice Slurry is slurry ice with ice particles that have an average diameter size equal to or less than 1 mm.

b. Ice Cube. Block ice is ice in the form of blocks measuring 12-60 kg/block. Before using the ice, cubes must be broken first to reduce the size. Block ice is the most common type of ice used in refrigeration of fish because it is cheap and easy to transport. Ice cubes are easier to transport because they melt less. However, it requires an ice crusher or mechanical crusher (ice crusher) so that the ice that comes out of the factory is ready to use with a size of 1 cm x 1 cm. Another advantage of using block ice is that it takes longer to melt and saves space in the hold, ice blocks are transported and stored in blocks and crushed when used.

c. Refrigerated Seawater. Water cooling media used with mechanical devices is also called Refrigerated sea water (RSW). The mechanical device used to cool the seawater is a refrigerator. The evaporator which is part of the refrigerator is stored on one wall of the tank. This evaporator functions to cool seawater by absorbing the heat released by fish and seawater. Cold water is circulated into the storage tank and then flowed back through the refrigerator with a pump (Wang & Wang, 2005). The water that has passed through the refrigerator will cool down and then be recirculated back to the storage tank. The use of fish using the RSW system is widely used by large fishing vessels. In general, these large vessels are fishing for months so that the refrigerant medium used must be able to maintain their catch until the ship is anchored.

d. Ice Curai. Curai ice is ice in the form of very fine grains with a diameter of 2 mm and a soft texture, generally a little runny. The machines used are small and the production is small, only for fish around the factory. This ice melts faster so that the refrigerant process occurs faster. However, on the other hand, there will be a large amount of ice lost so more ice is needed. The same thing happens with small ice. The smaller the size of the ice, the faster the fish will cool down.

E. LOAD CAPACITY OF REFRIGERANT

The parts of the hatch that have the greatest possibility of heat penetration are the main walls and roof of the ship (Widell & Eikevik, 2010). The hatch which is separated by longitudinal and transverse bulkheads has a relatively small temperature difference so that the heat flow rate is also small. Except for hatches 1 and 2 which are directly adjacent to the engine room. Thus, the hatch has heat flow from three sources, namely walls, roofs, and transverse bulkheads. The amount of heat receiving load through this section is also called the heat transfer rate which is expressed in kcal/hour units. Cooling load includes:

a. Heat flows into the cooling chamber from external conduction through insulated walls.

b. Heat enters the space directly by sunlight through glass or other transparent materials.

c. Heat flows into the cooling chamber by hot air entering through door openings or through cracks in windows or doors.

d. Heat from the product when the product temperature is lowered to the desired level.

e. Heat from people during activities in the cooling room.

f. Heat from equipment located within the product compartment, such as electric motors, lamps, electronic equipment, steam tables, material handling equipment.

F. REFRIGERATED SEA WATER SYSTEM

Refrigerated Sea Water (RSW) is a catch handling technology that is specially designed, installed as a place to accommodate fish/boat hatches so that the fish caught, especially certain types of fish, have economic value. RSW is a cooling system with a seawater circulation system that is cooled by a refrigerator. The main components of RSW consist of compressor, condenser, evaporator and refrigerant. The design of the RSW cooling system is carried out by considering the heat load from the fish load and the cooling load from the seawater itself. In general, the RSW design includes the following stages:

a. Calculating hatch heat load
b. System and refrigerant selection
c. Component design and selection
d. Draw a system key plan or flow chart
e. Designing RSW system layout.

RSW system in general is flowing refrigerant to cool seawater. The first work is done by the compressor to release high pressure hot air to the condenser (Zhao et al., 2016). After that the expansion valve is opened so that the refrigerant from the receiver is released to go to the evaporator so that the high-pressure liquid refrigerant turns into a low-pressure liquid refrigerant. After that, the liquid refrigerant enters the evaporator and takes heat from seawater or air so that the liquid refrigerant turns into low-pressure steam. The refrigerant in the form of low-pressure steam is then compressed by a compressor so that it turns into a high-pressure gas. Then the refrigerant in the form of a high-pressure gas then circulates in the condenser with water so that the refrigerant turns into a high-pressure liquid. After experiencing the cooling process in the condenser, the refrigerant is then flowed to the receiver. From the receiver the refrigerant passes through the expansion valve to the evaporator in the form of a liquid with a very low temperature. Furthermore, in the evaporator the refrigerant interacts with seawater so that the heat transfer process occurs. The initially low refrigerant temperature rose to approximately 5°C while the seawater temperature dropped from 28 °C to 5 °C. The refrigerant then flows back to the compressor in the form of low-pressure steam. The sea water that has been cooled in the hold by the refrigerant is then ready to cool the fish. The temperature in the hold can be maintained at the desired temperature because the seawater cooling process using refrigerant takes place continuously.

It is possible that the catch is not enough to fill one tank. In this condition, cooling is carried out by mixing ice or fresh water that has been previously cooled. The water system cannot be started until the tank is filled. The condition is that no seawater is added to prevent salt absorption.

The use of the RSW system on ships can reduce costs for ice and other possibilities such as injuring the skin of fish during storage. The RSW system can maintain fish conditions for a long time.

Storing fish catch in RSW is a very effective and economical choice of preservation method because it is cost-effective until it arrives on land or is further processed on board. The freshness of the fish can also be maintained and still have a good selling value.

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