

# The Manufacture of Cold Storage with 10 Kg Capacity

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## ARTICLE INFO

## ABSTRACT

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Indonesia is one of the maritime countries so that most of Indonesia's territory is the sea, which is rich in marine product; fish is one of the marine products. Fish is a commodity that is not durable and easily damaged if placed in open place. The main causes of fish damage include the activity of microorganisms and bacteria in the fish meat, where at room temperature bacteria and microorganisms can multiply rapidly. Therefore, the author makes a cold storage cooling system with a 10 kg capacity, which can be used to cool the fish caught by fishermen so that the quality and quality of the fish is still fresh to consumers or buyers so that can increase the selling price of fish caught by fishermen in South Aceh Regency. The cold storage manufacturing method is carried out with the initial process of measuring, cutting, welding, drilling, joining, vacuuming and electrical installation. The tools used in the process of making cold storage are welding machines, acetylene welders, cutting grinders, rubbing grinders, measuring elbows, meter tubing cutters, vacuum pumps, digital scales and clam meters. The materials used are angle iron, cold storage boxes, electrodes, relays, MCBs, elbows, and thermostat. The benefits generated in the manufacture of cold storage are to cool fish and increase knowledge of how the system works in cold storage for students of the South Aceh Polytechnic. The results of the cold storage trial for 30 minutes operate with an outside cold storage temperature of 27°C and a cold storage temperature of -20°C.

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## I. Introduction

Indonesia is one of the maritime countries so that most of Indonesia's territory is the sea, which is rich in marine product, Most of Indonesia's population lives as fishermen. Fish is a commodity that is not durable and easily damaged if placed in open place. The main causes of fish damage include the activity of microorganisms and bacteria in the fish meat, where at room temperature bacteria and microorganisms can multiply rapidly. Therefore, fishermen usually bring ice blocks which are used to cool the fish catch to keep it fresh, at least the fish caught are still good and fresh until they are sold at the fish selling place to consumers<sup>1</sup>.

Along with the development of the times, technological developments in the industrial sector are also experiencing rapid progress, one of which is the development of industrial technology in the field of refrigeration and air conditioning. The development of technology in the field of refrigeration or cooling provides many advantages for human needs, humans use refrigeration or

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<sup>1</sup> Afrianto, E. dan E. Liviawaty. "Pengawetan dan Pengolahan Ikan".



cooling systems for the industrial storage and distribution of fish ingredients, so that fish stored with the refrigeration system can maintain its quality and freshness for several weeks until when it is needed for distribution to consumers or buyers.

South Aceh district is known as one of the abundant sea fish-producing areas. Therefore, the author will make a Cold storage Cooling System with a capacity of 10 kg, which can be used to cool the fish, caught by fishermen so that quality of the fish is still fresh to consumers or buyers, so that it can increase the selling price of fish caught by fishermen in the area South Aceh District.

## II. Theoretical Background

### A. Cold Storage

Cold storage is a cooling machine that accommodates objects that will undergo a cooling process. Cold storage units not only cool fish but also are commonly used in everyday life to cool or preserve food such as meat, vegetables, and fruits as well as drinks. The use of cold storage in the industry can be used to cool raw materials or finished materials of a product. One of the purposes of cold storage is to keep the freshness of fish, drinks and food that we will cool<sup>2</sup>.

### B. Refrigerator

Refrigerator is a cooling device used to store products that require temperature conditions in accordance with the character of the product. Refrigerators are widely used for household and industrial purposes. Its use is to store food and beverage products. For the Refrigerator industry to store finished products, one of which is fish cooling products. The components used in the refrigerator as follows:

#### 1) Compressor

Compressor or suction pump, the compressor is a power unit for diverting refrigerant throughout the circulation of the cooling system. In accordance with changes in the volume of the cooling system by sucking in low-pressure refrigerant so that a pressure difference occurs which allows refrigerant to flow from the low-pressure side to the high-pressure side so that the compressor has three functions as suction, pressure and pumping.

#### 2) Condenser

The function of the condenser is to reduce the heat sucked from the evaporator and the heat obtained from the compressor and change from the gas phase to liquid. Condensers are also widely used for household appliances such as refrigerators.

#### 3) Evaporator

The evaporator in the cooling system functions as an absorber or heat exchanger and changes the liquid refrigerant from the condenser to liquid, and vaporizes the refrigerant before being sucked in by the compressor. The evaporator temperature, which is also affected, by the air temperature around the evaporator also drops. Low-temperature air is transferred to another place by being blown by a fan, which causes the exhalation of airflow. Heat transfer in the evaporator is heat transfer by forced convection that occurs inside and outside the tube and conduction occurs in the tube<sup>3</sup>.

#### 4) capillary pipe

The capillary pipe functions to reduce the pressure of the coolant before entering the evaporator. The refrigerant liquid enters the flowing capillary pipe so that the pressure will be reduced due to the friction and acceleration of the refrigerant. The capillary pipe also connects the high-pressure section to the low-pressure section and the construction of the capillary pipe is very simple, so interruptions rarely occur. Thus equalizing the pressure and facilitate the next start.<sup>4</sup>

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<sup>2</sup> Dirja, "Dasar-Dasar Mesin Pendingin"

<sup>3</sup> Holman, J.P. "Perpindahan kalor (di alih bahasakan oleh E. Jasifi)".

<sup>4</sup> Stoecker, W.F, Jones. J.W, Hara. S, "Refrigerasi Dan Pengkondisian Udara Edisi II".

- 5) Fan  
The fan is an electric motor that has one end of the shaft sticking out. Fan blades can be added to the shaft to circulate air or blow air to cool the condenser or something else.
- 6) Freon  
Freon is an artificial coolant or refrigerant, which is usually used as a fluid to absorb the cooling load of a room or place to be conditioned. Freon is widely used in air conditioning equipment (air conditioning machines) and refrigerators or refrigerators, there are many types of Freon, but what is generally used is the type R-12 CFC (chlorofluorocarbon), R-22 HCFC (Hydro chlorofluorocarbon) and R-134a HFC (Hydro fluorocarbons).<sup>5</sup>
- 7) Filter drier  
Filter drier is a liquid refrigerant storage tube, to filter foreign matter and water vapor from refrigerant circulation. The filter drier has three functions, namely storing the refrigerant, filtering foreign matter and water vapor so that it does not circulate in the refrigeration system, and separating the gas bubbles from the liquid refrigerant before being inserted into the high-pressure expansion valve from the condenser and channeled to the expansion valve (expansion valve). Refrigerant liquid flows into the pipe to be channeled to the expansion valve through the outlet pipe, which is placed at the bottom of the main body after being filtered out by the filter and desiccant moisture and foreign matter.

### C. Thermodynamics of Refrigeration Systems

#### Steam Compression Refrigeration Cycle

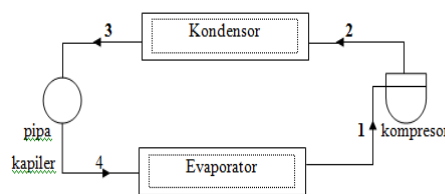


Fig. 1. Steam Compression Refrigeration Cycle

The steam compression cycle is the most widely used cooling machine in refrigeration. In this cycle, the steam is pressed and then condensed into a liquid and the pressure is lowered so that the liquid can evaporate again. Heat absorption in the steam compression cycle occurs in the evaporator with low pressure and temperature. Inside the evaporator, the refrigerant changes from the liquid phase to the gas phase, then enters the compressor. Due to the work of the compressor, the refrigerant becomes a gas at high pressure and temperature. To release the heat absorbed by the evaporator, the refrigerant is condensed again into the condenser so that the refrigerant turns into liquid. Before the refrigerant enters the evaporator, the refrigerant is expanded first by the expansion valve. In this tool the refrigerant pressure entering the evaporator is lowered<sup>6</sup>. This pressure drop is adjusted to the conditions so that the refrigerant can absorb heat from the evaporator. The main components of the vapor compression cycle are the evaporator, compressor, condenser and expansion valve. The refrigeration vapor compression cycle is shown in the Figure 1 above.

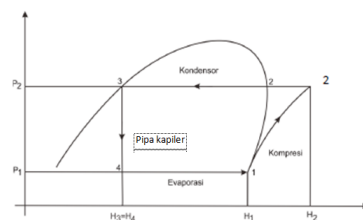


Fig. 2. Enthalpy pressure chart

<sup>5</sup> Vukovic Z., "Reducing the quantity of freon in cooling systems for supermarkets. Proceedings of the 43rd International Congress on Heating, Refrigerating and Air-Conditioning".

<sup>6</sup> Bernard D. Wood, Zulkifli Harapa . "Penerapan Termodinamika Edisi Kedua".

- a) process 1-2 Compression Process  
The compression process takes place at point 1 to point 2. In the cycle, it is assumed that the refrigerant does not change while flowing in the suction line. The compression process is isentropic so that on the pressure and enthalpy diagrams they are on a line with constant entropy, point 2 is in superheated condition. The compression process works from the outside and the enthalpy of steam increases from  $h_1$  to  $h_2$ .
- b) Process 2 - 3 : Condensation Process  
Process 2-3 is a condensation process that occurs in the condenser, hot steam from the compressor is cooled by water to the condensation temperature. At point 2, the refrigerant is in a saturated vapor condition at the condensing pressure and temperature. Then processes 2-3 occur at constant pressure, and the amount of heat transferred during this process is the enthalpy difference between points 2 and 3.
- c) Process 3 - 4: Expansion process on the capillary tube
- d) Expansion process at point 3 to point 4. In this process, there is a process of decreasing refrigerant pressure from point 3 condensing pressure to point four evaporation pressure. Refrigerant reduction and condenser temperature decrease to the evaporator in liquid conditions where it is expanded through a capillary pipe. Process 3-4 is an adiabatic expansion process where the fluid enthalpy does not change throughout the process. The condition of the refrigerant vapor mixture occurs at point 4 so that the  $h_3 - h_4$  values decrease in pressure with constant enthalpy.
- e) Process 4-1: Heat Absorption Process (Evaporation) in the Evaporator.  
Process 4- 1 is the evaporation process that occurs in the evaporator with constant pressure. At point 1, the refrigerant is in a saturated vapor condition 4-1 process 4-1 refrigerant enthalpy increases due to absorption of heat from refrigeration. The heat absorbed is at enthalpy point 1 and point 4, which is usually called the cooling effect.

### III. Method

The methods in the cold storage manufacturing process include the following:

1. Measurement  
Measurement is an activity to obtain quantitative data information. The results of measurements can be in the form of information or data expressed in the form of numbers or descriptions, which are very useful in making decisions, therefore measurement, is an activity of comparing a quantity measured with a measuring instrument used as a unit.
2. Cutting  
Cutting is the process of separating solid objects or other objects into two or more parts. The cutting work process is carried out by clamping the material in the vise of the grinding machine. Furthermore, a grinding wheel with high rotation is rubbed against the material, in the process of making cold storage; several parts are cut, such as cutting angle iron, which will be used as a framework for cold storage.
3. Welding  
Welding is an activity carried out to join materials by using an electric arc flame that is directed to the surface of the metal that we are going to connect. In the process we need to join the cold storage frame using a welding machine, the welding machine used in making this cold storage uses two welding methods, namely electric arc and acetylene welding.
4. Drilling  
Drilling is a cutting process using a drill bit (twist drill) to produce round holes in metal or non-metallic materials that are still solid or not yet formed. Drilling is carried out on the cold storage frame to be used as a cross section for the position of the compressor engine.
5. Vacuuming  
The purpose of vacuuming in the cold storage cooling system is to empty the cold storage refrigerant circulation from air and water steam, by reducing the pressure in the

system to below 1 atm. If the cold storage refrigerant circulation is not vacuumed, corrosion will occur in the cold storage circulation flow. Therefore vacuuming must be done before filling cold storage refrigerant.

6. Electrical installation

The electrical installation is an important part of a machine that functions to transmit electricity from the electrical installation to the load point. Installation is a support or conductor of electric current in some parts of the cold storage unit such as the compressor and thermometer in cold storage.

#### IV. Results and Discussion

1. The size of the cold storage box with a capacity of 10 Kg

The specifications for the size of the cold storage box as a whole can be seen in the table below:

Table 1. The size of the cold storage box

Box	Measurement (cm)
<i>cold storage length</i>	66 cm
Cold storage width	26 cm
Cold storage height	40 cm
cold storage thickness	3 cm

Table 2. The size of cover cold storage

Box	Measurement (cm)
<i>cold storage length</i>	66 cm
Cold storage width	26 cm
Cold storage height	5 cm
cold storage thickness	3 cm



Fig. 3. Appearance of cold storage

2. Trials of cold storage

The cooling machine that has been made needs to be tested to get information whether the cooling machine or cold storage can work properly or not. If the cooling machine or cold storage is in good condition, it means that the cold storage machine has no leaks or deadlocks. The cold storage tool trial was carried out using fish caught by fishermen as much as 10 kg, the cold storage trial was carried out for 30 minutes. The trial begins with measuring the initial temperature of the cold storage, namely the outside temperature of 29°C and the inside temperature of 29 °C before the cold storage machine is operated, then we put 10 kg of fresh fish caught by fishermen into the cold storage box, then turn on the

cold storage with an electric current of 2.28 A. We can see cold storage trials as shown in the table below:

Table 3. Cold storage trial for 30 minutes

No	Samples	Times	temperatures	Currents	Freon pressure enters the condenser	Freon pressure comes out of the condenser
1	10 kg of fish	initial temperature	29 <sup>0</sup> C	0.10 A	4 bars	4 bars
2		5 minutes	23 <sup>0</sup> C	2,14 A	13 bars	-0,5 bars
3		10 minutes	16 <sup>0</sup> C	2,11 A	19 bars	-0,4 bars
4		15 minutes	6 <sup>0</sup> C	2,20 A	20 bars	0,0 bar s
5		20 minutes	-3 <sup>0</sup> C	2,15 A	19 bars	0,1 bars
6		25 minutes	-12 <sup>0</sup> C	2,12 A	19 bars	0,1 bars
7		30 minutes	-20 <sup>0</sup> C	0,09 A	20 bars	0,1 bars

## V. Conclusion

Cold storage with a vapor compression refrigeration cycle system has been successfully made and can work well, cold storage temperatures can reach -20<sup>0</sup>C. The advantages of cold storage with a capacity of 10 kg that have been made includes easy to disassemble the assembly cold storage, not easy to corrode, light and non-flammable, the cooling process cools down faster, and easy to understand cold storage circulation system.

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## References

- [1] Afrianto, E. dan E. Liviawaty. 1992. *Pengawetan dan Pengolahan Ikan*. Bandung: Unpad.
- [2] Dirja, 2004 *Dasar-dasar Mesin Pendingin*. Yogyakarta: Andi Offset.
- [3] Holman, J.P 1986. *Perpindahan kalor* (di alih bahasakan oleh E. Jasifi) Jakarta: Erlangga.
- [4] Stoecker, W.F, Jones. J.W, Hara. S.1989. *Refrigerasi Dan Pengkondisian Udara* Edisi II. Jakarta: Erlangga.
- [5] Vukovic Z., (2012), *reducing the quantity of freon in cooling systems for supermarkets. Proceedings of the 43rd International Congress on Heating, Refrigerating and Air-Conditioning*, Belgrade.
- [6] Bernard D. Wood, Zulkifli Harapa 1988. *Penerapan Termodinamika Edisi Kedua*. Jakarta: Erlangga.