Journal of Applied Science and Advanced Technology
Journal Homepage : https://jurnal.umj.ac.id/index.php/JASAT

Calculation of Freezing Heat Load of Catches on Refrigeration Machines of KM. Sumber Natuna in Natuna Waters Province of Kep. Riau

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ARTICLE INFO

JASAT use only:
Received date : 27 January 2019
Revised date : 24 February 2019
Accepted date : 26 March 2019

Keywords:
Refrigration
refrigerant
evaporator
heat load

ABSTRACT

Refrigeration is the process of absorption of heat from the room with high temperature and transfer the heat to a certain medium. Application of refrigeration is used to maintain the quality of a product, foodstuff, medicine, air conditioning and others. In the world of refrigeration fisheries are used to maintain the quality of the catch so that its economic value and nutritional value is maintained up to the hands of consumers. In general, the main component of refrigeration is divided into five namely compressor, condenser, receiver, expansion valve, evaporator. One of the components that has a role in heat absorption is the evaporator. Evaporator function for evaporation process of refrigeration material. The low-pressure refrigeration vapor is sucked from the evaporator into high-pressure, high-temperature refrigeration vapor. Then through the condenser the steam is condensed (heat exchange) so that the refrigerant vapor becomes high-pressure and normal temperature refrigerant liquids. Heat exchange can be through three ways: by air, water or air + air. After that the liquid refrigerant dropped the pressure on the expansion valve so that the high-pressure refrigerant liquid becomes low. Then on the evaporator component refrigerant material evaporated, in this process the absorption of heat in the product occurs so that the product can be cool temperatures even frozen. The larger the heat is absorbed in the evaporator, then the work on the refrigeration machine is also getting bigger. Based on research in one trip, the heat load at KM. Natuna source reached 147,716.9 kJ / hour. Associated with the fuel consumption of the generator drive motor in a single trip KM. Sumber Natuna reached 2.14 tons.

INTRODUCTION*

The potential of fisheries found in the Batam area is quite large, especially capture fisheries. Because indeed the city of Batam is mostly waters. The potential of the fisheries sector is large, but unfortunately the area is not matched by commensurate fishing vessels. So from that with abundant potential, fishing gear and supporting technologies are needed so that the utilization of fisheries resource management activities in Batam can be maximally utilized. The utilization of the fisheries sector is certainly influenced by several factors. One of the factors that influence is handling the results of capture and storage. For storage activities in fishing vessels require refrigeration machines to maintain the quality of the catch.

Refrigeration is the process of heat absorption from a high-temperature room and moving the heat to a certain medium which has a lower temperature and maintaining that condition as needed. In general, this refrigeration effect is used to condition the air condition of a room. The existing conditions are used to support the comfort of workers in an

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DOI: https://dx.doi.org/10.24853/JASAT.1.3.99-104

office and industrial space or to be used to support and maintain the quality of production. (Badaraus S. 2012)

According to (Metty Trisna Negara et al. 2010) The vapor compression refrigeration cycle is the type of cooling machine that is most often used today. This cooling machine consists of four main components namely a compressor, condenser, expansion valve and evaporator. In this cycle, low-pressure refrigerant vapor will be pressed by the compressor so that it becomes high-pressure refrigerant vapor, and then high-pressure refrigerant vapor is condensed into high-pressure refrigerant liquid in the condenser. Then the high pressure refrigerant liquid is lowered by the expansion valve so that the low pressure refrigerant liquid can evaporate back into the evaporator into low pressure refrigerant vapor. The arrangement of the four components can be shown schematically in Figure 1 and the sketch of the standard vapor compression cycle in the P-h diagram is shown in Fig. 1.

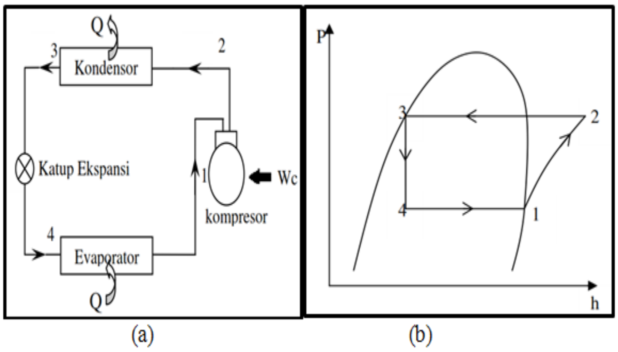

Fig. 1. a. Schematic Cooling System for Standard Steam Compression Cycles b. P-H Standard Steam Compression Cycle Diagram

1. Process 1-2
   Adiabatic reversible compression is dry compression (steam under superheated conditions) that takes place inside the compressor, from the pressure of the evaporator to compressor pressure. The refrigerant is sucked by the compressor and leaves the evaporator in the form of saturated vapor under conditions of low temperature and pressure, then the steam compressor increases its pressure to steam with a higher pressure (condenser pressure). Compression is needed to increase the temperature of the refrigerant, so that the temperature of the refrigerant in the condenser is higher than the ambient temperature. Then the transfer of heat from refrigerant to the environment can occur. Process 1-2 is isentropic compression along a constant entropy line, from saturated steam to condensation pressure.
2. Process 2-3
   After experiencing the compression process, the refrigerant is in a further heat phase with high pressure and temperature. To change its form into liquid, the heat must be released from the environment. This process occurs in a heat exchanger called a condenser. Refrigerant flows through the condenser and on the other hand cooled fluid (water or air) with a temperature lower than the refrigerant temperature. Heat will move from refrigerant to cooling fluid and as a result the refrigerant will experience a decrease in temperature from further heat vapor conditions to saturated steam conditions. Next condenses into a liquid phase and comes out of a saturated liquid phase condenser. This condensation process is a reversible isobaric heat discharging process in the condenser. The 2-3 process is a further heat reduction and condensation with a fixed pressure, which is a horizontal straight line in the enthalpy pressure diagram.
3. Process 3-4
   Refrigerants in saturated liquid form flow through expansion devices. Refrigerant undergoes an expansion process at constant enthalpy occurring in the expansion valve and takes place in a non-reversible manner. Furthermore, the refrigerant comes out of the expansion device in the form of a steam-liquid mixture at a pressure and temperature equal to the pressure of the evavorator. Process 3-4 takes place on fixed enthalpy, because it is perpendicular to the chart.
4. Process 4-1
   Refrigerant in the vapor-liquid mixture phase, flows through a heat exchanger called the evaporator. At evaporator pressure, the boiling point of the refrigerant must be lower than the ambient temperature (working media or cooled media), so that heat transfer occurs from the working medium into the refrigerant. Then the liquid liquid refrigerant evaporates inside the evaporator and then

the refrigerant leaves the evaporator in the saturated vapor phase. This evaporation process is a reversible isobaric process of entering heat in the evaporator which causes the refrigerant to evaporate into saturated steam. Process 4-1 is a horizontal straight line because the flow of refrigerant through the evaporator is fixed pressure.

Refrigerant

According to (Karyanto E et al 2004) Refrigerant is a heat transfer medium that absorbs heat or heat by evaporation (evaporator) at low temperatures and provides heat with condensation (condenser) at high temperatures and pressures. Refrigerants circulate in a cooling machine where the phase can be changed from steam to liquid or vice versa. For vapor compression refrigeration systems, refrigerants absorb heat in the evaporator at low temperatures and pressures and release heat to the condenser at high pressure and temperature.

Load on Freezing Evaporator

According to (Djoko et al., 2010) When the products (fish, meat, fruit, etc.) are stored at a higher temperature in the cold storage room then this product will provide heat to the room until the product has the same temperature as room temperature. The heat produced by this product can be sensible heat and / or latent heat depending on whether the storage temperature is lower than the product freezing temperature or higher. Where the value of freezing temperature of various kinds of products If the product storage temperature is lower than the temperature of the freezing point, then the type of heat released by the product consists of three types :

1. Sensible heat before freezing, which is released by the product decreases the temperature of the product to the temperature limit of its freezing point (Q1).

$$Q_1 = m \times Cp_{fresh} \times (T_1 - T_b)$$

Q_1 = Heat amount (kJ)
m = Product mass (kg)
Cp_{fresh} = specific heat (kJ/kg°C)
T_1 = Initial temperature (°C)
T_b = Freezing point (°C)

2. The latent heat of freezing, which is the heat released when a product changes from liquid to solid (frozen). (Q2)

$$Q_2 = m \times LH$$

Q_2 = Heat amount (kJ)
m = Product mass (kg)
LH = Freezing latent heat (kJ/kg)

3. Sensible heat after freezing, is the heat released by the product due to a decrease in temperature from the freezing temperature to a lower temperature (minus). (Q3)

$$Q_3 = m \times Cp_{frozen} \times (T_b - T_2)$$

Q_1 = Heat amount (kJ)
m = Product mass (kg)
Cp_{fresh} = specific heat (kJ/kg°C)
T_2 = Final temperature (°C)
T_b = Freezing point (°C)

To calculate the magnitude of Qtotal = Q1 + Q2 + Q3.

EXPERIMENTAL METHOD

Research methods are performed as in Fig. 2.

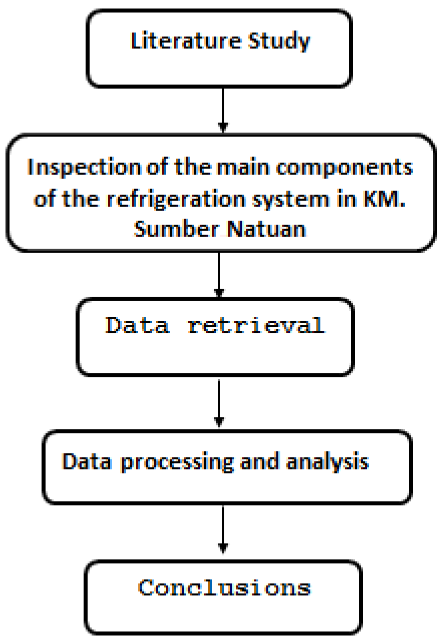

Fig. 2. Flow chart this research

RESULTS AND DISCUSSION

Calculation of Freezing Heat Load of Catches in KM. Sumber Natuna

In calculating the heat load of the catch, it is classified into 10 types of fish samples. Fish catches include small flyovers, medium flyovers, large flyovers, Kembung, Cumi, Mata Besar, Tunul, Tongkol, Tengiri, Jahan. To calculate the period of fish caught, the writer uses a measurement of the number of trays containing fish before being frozen into the freezer. These results are obtained from the measurement results of wet fish when on land. One tray containing fish is an average of 10 kg. So that the catch can be obtained by counting the trays before the fish is put into the freezer. The following is a picture when recording fish period based on 10 fish samples.

In this study data obtained on the percentage of catches in KM. Natuna source in one trip. The percentage can be seen in the following figure.

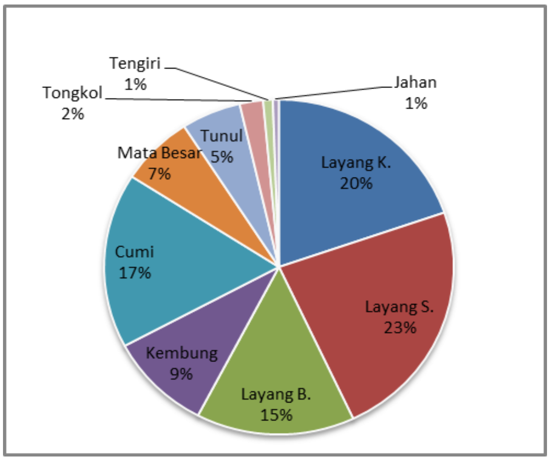

Fig. 3. Percentage Catch of KM.Sumber Natuna

Calculation of data taken in one day as a result of arrest with freezing time of 10 hours.

Table 1. Calculation of Freezing Heat Load

Fish species (In Indonesia)	Massa (kg)	Temperature 1	Temperature 2	Q1 (kJ)	Q2 (kJ)	Q3 (kJ)	Q total (kJ)
Layang K.	860	29,4	-8,8	86.419,68	203.071,8	9705,96	299.197,44
Layang S.	640	30,3	-11,2	66144	151.123,2	9849,6	227.116,8
Layang B.	420	29,1	-8,1	41.804,28	99.174,6	4237,38	145.216,26
Cumi	840	28,4	-11,7	81.738,72	198.349,2	13.645,8	293.733,72
Kembung	480	27,7	-14,1	45.639,36	113.342,4	9767,52	168.749,28
Total	3240			321.746	765.061,2	47.206,26	1.134013,5

Table 2. Specific Heat and Latent Heat

Cp fresh (kJ/kg°C)	Panas Laten	Cp frozen (kJ/kg°C)
3,18	236,13	1,71
3,18	236,13	1,71
3,18	236,13	1,71
3,18	236,13	1,71
3,18	236,13	1,71

From the calculation of heat load above, it is known in one day the refrigeration machine in KM. Sumber Natuna accommodates heat loads reaching 1,134,013.5 kJ. In the field observations the amount of freezing heat load always fluctuates. This is because the amount of freezing heat load is influenced by the amount of catch that will be frozen. The more catches will be, the greater the heat load that must be met and vice versa, if the catch is low, the heat load will be low.

In this case the freezing time is also influenced by the amount of frozen catch. To see the complete calculation can be observed in the attachment. In the above calculation example in freezing the heat load the refrigeration machine in KM. Sumber Natuna takes 10 hours. So at each hour the refrigeration machine absorbs heat of 113,401.35 kJ / hour.

CONCLUSION

The amount of freezing heat is influenced by the number of catches. The bigger the catch, the higher the freezing heat load. Based on research in one trip, heat load in KM. Sumber Natuna reaches 113,401,35 kJ / hour.

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