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Effect of Dry Ice Application in Fish Hold of Fishing Boat on the Fish Quality and Fisherman Income

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Abstract: Problem statement: This study presents the effect of dry ice application in the fish hold of fishing boat on the fish quality and fisherman income. Dry ice is made with compressed CO_2 gas to produce hot, high-pressure gas. Hot gas then cooled to condense into liquid CO_2, which is still high pressure. Dry ice can be used to cool a room and can reach temperatures under 0°C. **Approach:** Objectives of this study are to know the effect of the use of cooling applications by using dry ice as a cooling fish on the fish quality. **Results:** The experimental investigation has been done in dry ice variations weigh, variations cooling load (fish) and variations fan speed. **Conclusion:** The results of these experiments have been shown in this study that the dry ice has been reducing the weight of refrigerant weigh to cooling of fish in the fishing boat.

Key words: Ice cubes, temperature, fan rotation, bacterial growth

INTRODUCTION

One effort to help the fisherman to increase the income is using dry ice for the fish cooling and storage in the fishing boat. Dry ice is a solid form of CO_2 and the using of dry can be prevented the putrid bacteria growth in the fish. The higher concentration of CO_2 it is more effective for the anti putrid bacteria in the fish. Dry ice have advantages, but dry ice have lower temperature up to -78°C, high quality with 99,98% is pure of dry ice, not odorless, no alcohol and just have low in the reducing of volume.

Dry ice has a surface temperature of -78°C and can be used in the process of cooling products (packaging pointers). Because the gas is made of compacted, then in the process of dry ice will change phase from solid to gas form without leaving the rest, so it can be said that the dry ice has a cooling effect that is greater than ice cubes made from water (Semin *et al*., 2008). According to, from one kilogram of solid carbon dioxide sublimes at atmospheric pressure obtained by refrigerating effect 70% larger than the one kilogram of ice blocks. Thus, dry ice is much greater cooling capacity than the ice blocks with the same ice size. If the ice cubes capable of absorbing 80 kcal kg^{-1}, the dry ice can absorb 136.6 kcal kg^{-1}. Carbon Dioxide (CO_2) has long been used for air regulation on meat cold storage; its main function is to prevent bacterial growth (Abbas *et al*., 2004; 2008). Now, this has to be proved that the beef did not change color when stored in a room with a dosage of carbon dioxide in the absence of oxygen.

Dry ice is made with compressed CO_2 gas to produce hot, high-pressure gas. Hot gas then cooled to condense into liquid CO_2, which is still high pressure. The liquid is then reduced to 1 atmospheric pressure through spray equipment to produce snow compressed into dry ice crystals are ready for use. The largest manufacturer of dry ice in Indonesia being PT. Petrokimia Gresik Indonesia with a capacity of 24 tons per day with a reliable continuity.

In the research that has been done about the application of dry ice for air conditioning has succeeded in proving that dry ice can be used to cool a room and can reach temperatures under 0°C. In this study this was conducted using two boxes lined with foam therein. The first box as a place of dry ice with the length x width x height is 520×360×330 mm. On the inside of the box have trey as the laying of dry ice, was at the bottom of the fan or blower mounted an adjustable speed, so that air flow can vary. In the second box as a space to be cooled made larger by length x width x height is 1400×1000×1000 mm. In this second box no load is cooled due to be cooled is his office. The purpose of this study was to determine if dry ice is able to be applied as an air conditioner in lieu of the cooling system Air Conditioned (AC), from the results of the experiment were able to cool the room. But the constraint is less

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practical when compared with air-conditioning system (Kim and Yoon, 2009).

In the year of 2000 and 2001 PT. Petrokimia Gresik Indonesia in cooperation with PT. Kelola Mina Laut Gresik to disseminate application of dry ice in Muncar Banyuwangi with the results of exposure, a brief explanation of benefits and a demo application using dry ice to fish collectors, fishermen, employees of the Pelabuhan Samudera Besar and vendors of ice cubes. Dry ice application procedure is to perform cooling experiment on 100 kg of fish are placed in a plastic box covered with a layer between the coated side down foam and equipped with sewer water. Dry ice application is done by reducing the amount of ice blocks; ice block that is equal to 28 kg (40%) is replaced with 9 kg of dry ice (3: 1). Reducing the ice cubes is to increase the content of fish in storage box from the original 100-120 kg per box coolers. After 9.5 h the results of this experiment is the quality of fish is very good views of the scales, gills, fins, tails, eyes and body (violence and lenders). Physically preservation with a combination of block ice and dry ice more fish harder, more rigid, colder room remaining ice cube that is 90% more dry ice and the remaining 15-20%. Obstacles faced the pickling with a mixture of ice and dry ice is at the time of demolition, where the rest are still quite a lot of ice cubes and blend with the fish, so that when the demolition takes much longer when compared with the ice blocks alone.

Until now the process of cooling fish performed traditional fishermen generally use block ice or wet ice (Kim and Yoon, 2009). This method has the disadvantage of which properties are easy to melt the ice blocks so that the storage temperature rises rapidly and easily damaged fish (Mokhtar *et al*., 2004; 2005). Another weakness of using block ice is heavy and the volume is large enough where it will reduce the amount of cargo of fish hold. This research is done to make the fish cooler with dry ice as alternative refrigerants and fish preservation. This research was done to investigate the performance of the use of dry ice as a fluid preservative against the income of fishermen fish by doing experiments. The issue to be discussed is the relationship between the use of a cooler with dry ice as the coolant and fish preservation. Is the use of dry ice can be applied on a fishing boat? Is the use of dry ice can increase the amount of cargo transported fish? Is the use of dry ice does not damage the quality of fish?

Objectives of this study are to know the effect of the use of cooling applications by using dry ice as a cooling fish on the income of fishermen.

MATERIALS AND METHODS

The experiment was conducted to examine the extent to which joint cool box ability when given the cooling load (fish). Experiments carried out by placing the fish on the inside cool box made of aluminum and given a block of ice cooling, aluminum is placed outside the box of dry ice used to restrain the rate of heat coming from the outside as shown in Fig. 1. Then noted the change in temperature every hour and to change the quality of fish was observed every open cover cool box. Diagramed temperature observation data and created graphs that were analyzed. While the score sheet data were statistically analyzed fish.

Design of cooling with dry ice vapor consists of two boxes as shown in Fig. 2. The first box as a means of cooling, in the first box have Trey laying place under dry ice dry ice is equipped with an adjustable fan spins. The second box to function as a box or a cooling load of fish to be cooled, equipped with a thermometer and anemometer. Both boxes foam coated and coated the inside of the box with aluminum foil. Both boxes are connected with two pipes. The first pipe located above the cooling load as a function drain pipe cooling steam dry ice (carbon dioxide) from the first box (cooler) to the second box (cooling load). The second pipe line under the cooling load as circulation which in the box cooling loads into the cooler. Under the given cooling load box drain the goal is to remove dirt from the cooled fish.

Implementation of experiments performed by varying the amount of dry ice on the dry ice box, the variation of cooling load (fish) in the cooler and fan rotation variation. In this experiment recorded temperature changes until the dry ice out.

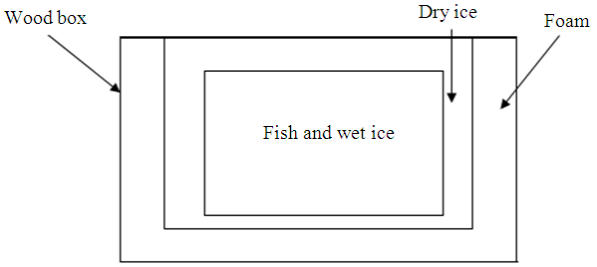

Fig. 1: Schematic of fish cooling using combination of dry ice and wet ice

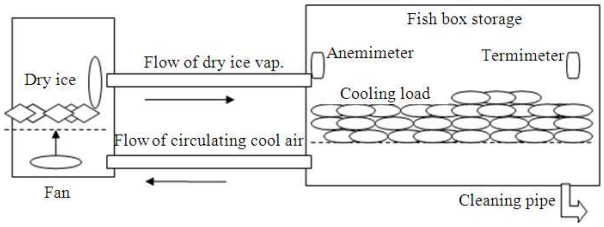

Fig. 2: Schematic of fish cooling room using dry ice

The variation of experiments conducted is as follows. Firstly, the variation of the amount of dry ice in this experiment performed 2 kinds of variations of dry ice with a weight of 4 and 7 kg, while the total cooling load and fan rotation is made constant.

Cooling load is set on the amount of 15 kg with a temperature of 30°C, while the lap belt is set in round 1 and round 2 for each variation. Secondly, variation of cooling load in this experiment carried out three kinds of variation in the amount of cooling load, the product load 10, 15 and 20 kg (each conditioned at a temperature of 30°C). Fan rotation is set in round 2, while the amount of dry ice used in each of these variations is 7 kg. Thirdly, variations fan rotation. In this experiment performed 2 kinds of variations of the spinning fan, which is the cycle 1 (the average flow velocity is 2.1 m sec^{-1}) and round 2 (the average flow velocity is 4.5 m sec^{-1}).

RESULTS

Experiments carried out by varying the amount of dry ice on the dry ice box, the variations of the cooling load on the cooler and fan rotation variation. Were observed and recorded in this experiment is the large flow rate of carbon dioxide and temperature changes that occur in the cooler at a time, starting from the beginning of the cooling system is run and ended up out of dry ice. The results are shown in Fig. 3-7.

DISCUSSION

Experiments on dry ice variation weigh: In this experiment performed 2 kinds of variations, namely dry ice weighing 4 kg and 7 kg, while the total cost of the cooling load and fan rotation is made constant. Cooling load is set on the amount of 15 kg with a temperature of 30°C, while the lap belt is set in round 1 and round 2 for each variation. The results are shown in Fig. 3 and 4.

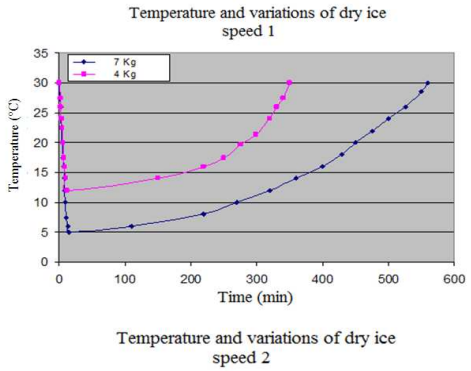

Fig. 3: Temperature of dry ice 4 and 7 kg in speed 1

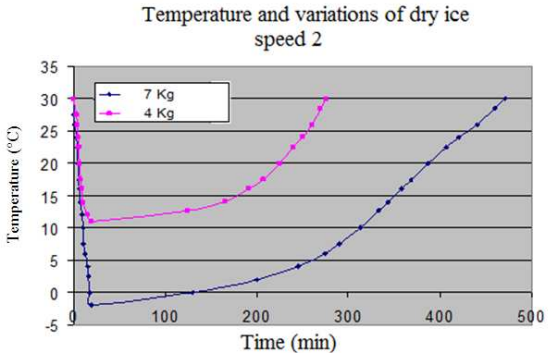

Fig. 4: Temperature of dry ice 4 and 7 kg in speed 2

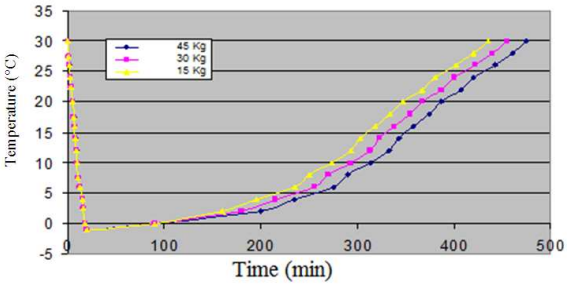

Fig. 5: Temperature in variations cooling load (fish)

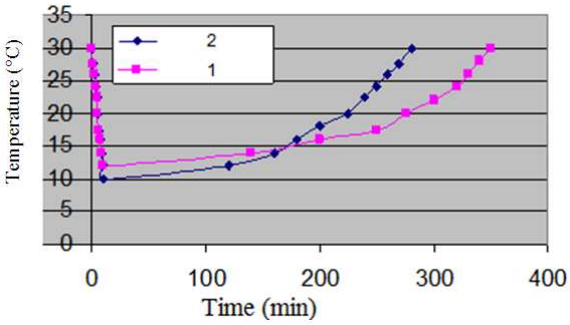

Fig. 6: Temperature in variations of fan speed with 4kg of dry ice

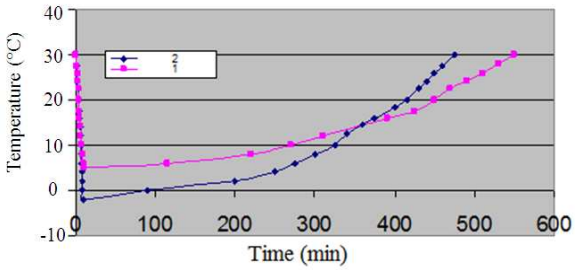

Fig. 7: Temperature in variations of fan speed with 7 kg of dry ice

From the results in Fig. 3 and 4 are shows that: 1. In the fan rotation 1 (flow velocity 2.1 m sec^{-1}) with 4 kg of dry ice, the lowest temperature achieved by the system is 12°C, with a range of cooling time (at the required temperature product, 15°C) reached 167 min (2 h and 47 min). While the system with the amount of dry ice 7 kg, the lowest temperature reached 5°C, cooling time range 376 min (6 h and 16 min).

In the fan rotation speed 2 (flow velocity 4.5 m sec^{-1}) with 4 kg of dry ice, which reached the lowest temperature is 10°C, with a range of cooling time reaches 163 min (2 h and 43 min). While the system with the amount of dry ice 7 kg, the lowest temperature reached -1°C, with a range of cooling time for 359 min (5 h and 59 min).

On systems with a number of dry ice 7 kg, the time required to reach the lowest temperature is faster when compared with the amount of dry ice 4 kg. At 7 kg of dry ice, the time required was 11.5 min in round 1 and 7.5 min on lap 2. At 4 kg of dry ice, the time required is 15 min in round 1 and 14 min in speed 2.

Experiments on variations cooling load: In this experiment carried out three kinds of variation in the amount of cooling load, the product load 15, 30 and 45 kg (each conditioned at a temperature of 30°C). Fan rotation is set in speed 2, while the amount of dry ice used in each of these variations is 7 kg.

From the experimental result in Fig. 5 shows that: Large cooling load is inversely proportional to the range of cooling time. The greater the cooling load on the system, the cooling time range will be more briefs. In the 15 kg load, cooling time reaches 359 min (5 h, 59 min), while the load of 30 kg and 40 kg, cooling time was reduced to 324 min (5 h, 24 min) and 304 min (5 h, 4 min).

Large cooling load is directly proportional to the achievement of the lowest temperature. The larger cooling load on the system, the time needed to reach the lowest temperature in the system will be even larger. On load of 15 kg, it took 7.5 min to reach the lowest temperature, while the load 30 and 45 kg, the time required increases to 8.5 and 9.5 min.

Experiments on variation fan speed: In this experiment performed 2 kinds of variations of the fan speed, which is the speed 1 (speed average flow is 2.1 m sec^{-1}) and speed 2 (speed average flow velocity is 4.5 m sec^{-1}).

From the experiment results in Fig. 6 and 7, shows that:

- Higher fan rotation linear inversely with cooling time. The higher fan rotation, the cooling time will be briefer. In speed 1, the range of cooling time reaches 167 min (2 h, 47 min) and 376 min (6 h, 16 min) for amount of dry ice 4 and 7 kg, while in round 2 cooling time reaches only 163 min (2 h, 43 min) and 359 min (6 h, 59 min)
- The higher fan rotation, temperature achieved in the system will be lower and faster. In speed 1, the lowest temperature reached was 12 and 5°C for 15 and 11.5 min. While in speed 2, the lowest temperature reached 10°C and -1°C with 14 and 7.5 min

From the aspect of the above data and from the fisherman field data has been obtained:

- With a ratio of 1:1 between the load of fish and the amount of dry ice, the amount of dry ice needed to fish hold cooling is relatively large. For example, 2 among 3 held a cargo ship will be filled with ice blocks at the time the ship set off to sail. This is certainly detrimental to the operational ship itself. In addition to more power is needed to transport the ice to the ship, the load of ice also affects the fuel consumption of ships
- Capacity of existing fish in the cooler can be said a little. This was due to the ratio between the number of fish and ice that reached 1:1, so the amount of ice that brought a relatively large
- The durability of the existing cooling in the cooler is not good, where the system can't maintain the temperature in the cooler as expected, which is about 0°C. Because the insulation material used is not quite right, then the heat from outside to enter to the cooler, so that the cooling load to increase and result in rising temperatures

From the dry ice cooling system has been obtained:

- The amount of dry ice needed far less than the needs of ice in coolers used. With a ratio of 1:0, 3 fishermen do not have to transport the dry ice with such a large burden on the perceiver with ice beam. Reduced burden of this ship can save fuel consumption. Another advantage is the time of use, which the dry ice into use when the fish have been obtained and coolers filled with fish. This is certainly different from the perceiver with ice beam system, where the ice has begun to be used when the ship set off the screen
- Fishing capacity of the cooling system is greater than the ice cooling system. This is due to the amount of dry ice needed to cool the fish is not as much on the use of ice cubes
- The durability of the system to maintain the temperature inside the room is well, but the insulation needs to be made more tightly. This needs to be done because the cooling media used in

the form of gas, so leaks can easily occur and is difficult to know its location. In other words, the impermeability is a major factor to maintain the cooling temperature

CONCLUSSION

Based on the design of refrigeration system models of traditional fishing vessels, dry ice can be applied as a cooling medium. The use of dry ice is intermittent in combination cool box can keep room temperature at about 0°C, could save that use the dry ice and can also be used in accordance with the needs of the time sailing of fishing boat.

On the wet ice cooling using wet ice to fish ratio is 1: 1, whereas if the ratio of dry ice fish with dry ice is 1: 0.3. So take load the ship, reducing fuel consumption and improve the ability to load more fish of the fishermen. According to the results of experiments using a combination cool box to raise the quality of fish, the conditioned storage space at lower temperatures bacterial growth can be inhibited so that the rate of decomposition of fish flesh can be postponed. With the application of this research can be increase the fish quality and fishermen income.

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