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Performance Test on Modified Block Ice Crusher Using Double Crusher System in Sorong West Papua

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***Keywords*— Modification, Ice Crushing Machine, Effectiveness.**

***Abstract*—** *The modification of the ice block machine using a double crusher system in this study has dimensions of 100 cm long, 80 cm wide and 115 cm high. Some of the machine components are made using stainless steel and steel. The propulsion engine uses a 7 HP gasoline engine. The working system of this machine is to use two ice block counters that rotate in opposite directions so that it will speed up the process of chopping ice blocks. The number of blades in each chopper is 36 and 42 blades. The engine production capacity at 800rpm shaft rotation produces 117,47 kg/minute or 7.048,2 kg/hour. The results of the chopped size varied from 2 to 7 mm. This machine is very effective with a target output of 3000kg production capacity while the actual output is 7048.2 kg/hour.*

I. INTRODUCTION

Fish is one of the food products with a soft meat structure and has a high water content of about 60 to 70%, so that fish will experience a very fast decay process. So good handling is needed on the ship so that the quality of fish remains good to consumers. One of the handling of fish on the ship is using ice blocks. The method of crushing ice blocks carried out by fishermen is still done conventionally, which is only using wooden blocks as a bat to crush them. This method requires quite a long time and tiring effort. This method produces chunks of ice that are still large, sharp and non-uniform. The chopped results are less effective when used to cool fish because it can injure the physical condition of the fish and the large size of crushed ice cannot directly enter the fish crevices so that the quality of the fish decreases. In previous studies, various designs of block ice crusher machines have been carried out but still use a single crusher system. The disadvantage of this machine is that it still takes quite a long time in the process of chopping ice cubes. The development of fishery equipment technology is still being carried out in order to to increase the productivity of fishermen.

The ice block chopper machine using a double counter (*Azis, 2006*) has provided fairly even chopping results because the counters work separately and each has a filter at the bottom of the counter. The disadvantage of this ice crusher is that it is too heavy and difficult to move. In addition, caution is required when moving the pulley transmission system and gears when changing the ice chopper drum to be used. The ice block machine in this research is to modify the machine using a double crusher system. This chopper uses a gasoline engine driving engine with a power of 7 HP.

The working system of this machine is that one driving machine moves two crushers that rotate simultaneously in opposite directions, so that the ice cubes will be crushed through the two sides of the surface. This system will speed up the ice cube counting process. This machine is very applicable, can be used on ships or in general because it has dimensions of 100 cm long, 80 cm wide and 115 cm high and weighs ± 62 kg. How to operate this machine is very easy and can be operated by one operator.

II. RESEARCH METHODS

The method used in this research is the experimental method and then trial and learn is carried out, so that in the research the design and manufacture of the tool will be carried out, experiment and direct testing of the tool, then evaluate and repair the machine whether it is in accordance with the objectives to be achieved. This research was conducted in the machinery laboratory of the Sorong State Middle School of Fisheries, West Papua.

2.1 tools and materials

The tools that will be used in this research are tools that are in the workshop such as grinding machines, welding machines, drilling machines, lathes, vise, screwdrivers, ring wrenches and fittings, pliers, caliper, roll meter, elbow ruler, scraper, tachometer. While the materials needed in this study were a 7 HP drive motor, 22 cm diameter gears, 5 cm angle iron, 1,2 mm stainless steel plates, stainless steel shafts, pulleys, v belt transmissions, bolts and nuts and bearings.

2.2 design

Modifications are changes made to an objects from its original form,either adding or subtracting components without reducing the function of the tool. While the design is the drawing, planning, and sketching or arrangement of several separate elements into a unified and functioning unit *(Pressman 2002).*

Design Results in 3D Drawings Using the Google Sketch up Pro 8 Application

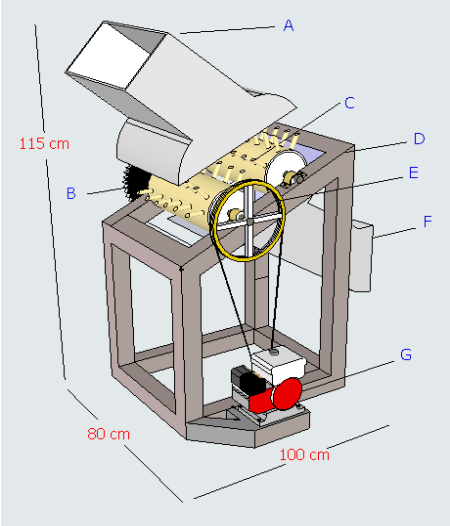

Fig.1: Design sketch of block ice crusher machine using double crusher

Information:

A. Inlet

B. Gears

C. Crusher

D. Frame

E. Pulley

F. Outlet

G. Drive engine

III. RESULTS AND DISCUSSION

The design of the modified block ice crusher machine using the double crusher system in this study is the result of collecting data and information about the advantages and disadvantages of the block ice crusher machine that has been designed and made in previous studies. So that the manufacture of components and the addition of several components of the block ice crusher is designed according to the calculations in previous studies.

3.1 welding joint strength

In this design, the most critical part is the ice counter. The type of welding electrode used is type E 6013 with a maximum tensile strength of 60,000 psi, of which 414 N/mm2. As for the machine parts made of stainless steel using welding electrodes Jnis E 308 S 1.6 mm.

Shear stress (tg)

t_(g= F/(0.707.t.L.N))

Where:

tg = Shear stress (N/mm2)

T = Welding thickness

F = Load received

N = Safety factor

3.2 drive engine power

The amount of engine power can be calculated using the equation:

P = Ftot . Vc

Where:

P = motor power (w)

Ftot = Total force (N)

Vc = Linear speed of shaft (m/s)

Ftot = Mtot . g

Mtot = Total mass (Kg)

G = Gravity

Mtot = Mass of shaft + mass of cylinder + mass of pulley (weighed)

3.3 pulley calculation

In the design of the pulleys used are V-groove pulleys, 2 pulleys are used, namely: the driving pulley on the motor

shaft with a diameter of 3 inches (dp) and a driven pulley with a diameter of 12 inches (Dp). The rotation of the driving motor is a maximum of 3600 rpm (n1). So that the final round (n2) can be determined as follows:

$$\frac{n\,1}{n_2} = \frac{D_p}{dp}$$

3.4 gear calculation

The gears used are straight gears.

To determine the number of teeth using the equation: N = P.d

Where N = number of teeth

P = Circular pitch in in (the distance measured on the puncture circle between two equal points on two adjacent teeth.

d = diameter of the puncture in

Meanwhile, to determine the radius of the base circle of the gear can be calculated using the equation: r b = r cos Φ

3.5 number of blades

The number of blades is 36 and 42 in each chopper. The blade length is 50mm and the diameter is 10mm. Installation of the blades with a distance of 40 mm so that if the two crushers rotate and the blades meet each other it will be 15 mm apart. This distance is to avoid collisions between the blades due to the bending stress on the blades due to the impact load. The shape of the blade really determines the result of chopped ice cubes. The tip of the blade is cut at a 45^{o} angle to create a sharp angle and prevent detarmination

The results of the design of the tool can be seen in the image 02 below

Fig.2: The result of the design of a block ice crusher using a double crusher system

3.6 performance test

The performance testing of the block ice crusher machine in this study focused on the turnaround time, so that the machine performance testing was carried out in three treatments. The time required can be set by varying the rotation of the shaft. In the first treatment using an output of 600 rpm, the second treatment with 700 rpm and in the third treatment using 800 rpm. Each treatment was carried out five (5) times. Machine performance testing is done by crushing 1 ice block in each treatment. The crushed ice blocks measure 18x18x100 cm and weigh approximately 30kg.

The time required to complete the tool testing for each treatment and repetition can be seen in the table 01 below

Table.1: Tool Testing Time

Repeat	**Treatment**		
	600 rpm	**700 rpm**	**800 rpm**
I	21,63 s	18,56 s	16,16 s
II	22,49 s	16,05 s	15,43 s
III	21,95 s	16,79 s	14,14 s
IV	22,03 s	17,63 s	15,45 s
V	22,31 s	18,29 s	15,58 s
Average	22,082 s	17,464 s	15,352 s

From the table above, it can be seen that the completion time of each replication in each test did not occur such a significant time difference, which in the 600 rpm test the test could be completed with an average time of 22,082 seconds, then at 700 rpm can be completed with an average time of 17,464, while at 800 rpm it can be completed with an average time of 15.352 seconds. When compared to a single crusher machine that has been made previously, the test results of the machine are much better than the results of previous studies, where the results of the best research conducted by Syharuddin Rasyid 2017 with a test result of 191 seconds on ice blocks measuring 20 x 20 x 120 cm.

For the production capacity of crushed ice blocks based on rpm and speed of completion of the test can be seen in the table below.

Table.2: Machine Production Capacity

Repeat	**Results of the count (weight kg / min)**		
	600 rpm	**700rpm**	**800rpm**
I	83,21 kg	96,98 kg	111,38 kg
II	80,03 kg	119,60 kg	116,65 kg

III	82,04 kg	107,20 kg	127,29 kg
IV	81,70 kg	102,09 kg	116,50 kg
V	80,68 kg	98,41 kg	115,53 kg
Average	81.52 kg/minute	104.85 kg/minute	117.47 kg/minute

From the table it can be seen that the production capacity is different for each rpm difference where at 600rpm it can produce an average of 81,52 kg/minute or 4.891.2 kg/hour of crushed ice, then at 700rpm it can produce an average of 104,85kg/minute or 6.291 kg/hour and at 800rpm it produces 117,47 kg/minute or 7.048.2 kg/hour. With this production capacity, this block ice crusher machine will be very effective when used by fishermen because it will greatly save time at work.

Then for the results of the size of the count on the engine performance test, it can be seen in the table below

Table.3: Size of Crushed Ice Cubes

Repeat	**Size of crushed ice cubes**		
	600 rpm	**700rpm**	**800rpm**
I	3 – 7 mm	3 – 6 mm	2 – 6 mm
II	3 – 7 mm	3 – 6 mm	2 – 6 mm
III	3 – 7 mm	3 – 6 mm	2 – 6 mm
IV	3 – 7 mm	3 – 6 mm	2 – 6 mm
V	3 – 7 mm	3 – 6 mm	2 – 6 mm

From the table above, the size of the count is quite uniform in each repetition of the test. At 600rpm rotation, the size of the pieces is 3-7mm, at 700rpm it is obtained with a size of 3-6mm and at 800rpm with a size of 2-6mm.

The recommended size of ice grains is 1-2 cm *(Suhana: 2010).* Ice chunks that are still large are less effective, because they do not quickly cool the temperature of the fish. However, if the size is too small (in the form of shavings) it will be better because it can cool the temperature of the fish quickly but melts faster. This can be overcome by improving the fish storage container with a better one, so that even though the size of the fish flakes is smaller, it is not easy to melt and will speed up the cooling process of the fish. By using this machine, the results of breaking ice blocks are more evenly distributed, which is about 2-7mm and the breaking process is faster than the machines in previous studies.

3.7 effectiveness level

Effectiveness is usually carried out together with efficiency, although they look the same, they actually have different meanings. Effectiveness emphasizes more on the results achieved, while efficiency looks more at the process to achieve these results well. So to achieve an effectiveness, the following effectiveness formula can be used:

Effectiveness = (Actual Output / Target Output) ≥ 1

If you compare it with the results in the research of *T. Azwar and Pribadyo in 2015*, the calculation of the production capacity is 33,411 kg/minute or 2004,66kg/hour, so in this study the target to be achieved is 50 kg/minute or 3000kg/hour with a chopped size which is desired. So that the level of effectiveness in this study are:

Effectiveness (Actual output / Target output) ≥1

= 7048.2/ 3000 = 2.3494

= 2.3494 > 1 then the level of effectiveness is achieved or the actual output is 234.94% greater than the target output.

IV. CONCLUSION

By using this double chopper, the time required in the process of chopping ice blocks will be faster than using the previous chopper machine. With relatively small dimensions, this machine is very applicable, can be used on ships or in places in general. In each process, the ice block measuring 30 kg can be completed in 15,352 seconds. With a high production capacity and desired chopping results, this chopper machine is very effective when applied by fishermen. Using stainless steel material, the machine meets food safety standards and does not contaminate fish products.

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