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Prototype for Automatic Ice Block Crusher Machine

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Abstract – *As the heat intensifies during the summer season, anything cold is the first thing people want. Ice-cold refreshments are the primary defense of people during this season. These drinks can be achieved through refrigeration or by adding ice to the said drinks. However, some drinks do not just use the usual ice cubes for drinks; a new refreshment called slushy uses a smaller and more refined ice called slush ice. These types of ice are achieved using an ice crusher or ice shaver. The current ice crusher machine in the industry needs to be redesigned to provide more than one type of ice and ensure the user's safety. The prototype for the automatic ice block crusher machine was a success as it provides slush ice for ice-cold refreshments and crushed ice for food preservation, depending on the user's choice. The said prototype can also crush an ice block of approximately 15 kgs with a specific dimension of 25x25x50 cm. It is best for business purposes as it lessens the amount of wasted ice in a 15 kg block which in both crushed and slush ice, the percentage of ice crushed was 99.33% and 98.66%, respectively. Lastly, it increases the speed of the crushing process, where it takes 19 seconds to achieve the user's choice of crushed ice in one operation.*

Keywords – *automatic, ice block crusher, prototype*

INTRODUCTION

In tropical countries such as the Philippines, it is naturally hot and humid. Due to climate change, during the summer season, these countries' weather intensifies. To beat the heat, people travel to colder places or drink ice-cold refreshments.

Ice-cold refreshments are usually found in restaurants, cafés, bars, food and drink stalls, and even at home [1]. To have a cold drink, it can be refrigerated or by adding ice. There are 4 categories of ice – ice tube, ice cube, ice flake, and ice block [2].

Companies use ice tube or tube ice for processing seafood, chicken meat, even those dyes, and intermediates manufacturers [3]. The usual ice used for home drinks is ice cubes. In the food processing industry, such as meat and bakery applications, ice flakes are used [4]. Ice blocks, on the other hand, are used for large consumption.

However, aside from these categories, a new type of ice is used for drink refreshments. These are more refined and smaller than ice flakes. This type of ice is called slush ice, explicitly used for a slushy or frozen drink. Slush ice is created from a bigger form of ice such as tubes or ice blocks through an ice crusher machine [2].

Ice crusher machines are typically used to have a smaller output of ice. There are two types of ice crusher machines – ice tubes crusher machine and ice block crusher machine. The former types of machines are used typically for mobile businesses; the latter is used for more extensive and permanent businesses. In terms of sizes, ice block crusher machines are heavier and bulkier, while ice tube crusher machines take up less space and lighter.

Different designs for the ice crusher machines appear in the market. Most machines are usually designed to ease the process, which can be operated manually or motorized. One machine can only produce one type of ice.

The refinement of the ice using this automatic ice crusher machine gives the consumer satisfaction of their needs. This machine gives the best output of ice, depending on the ice needed. Thus, the seller or company has big profit than before because of good service and expecting more consumers or clients to come and the sellers of perishable goods, mainly fish and meat, to preserve the freshness of the goods.

The project's main scope is to build a prototype machine that could crush a block of ice depending on the type chosen by the user. The process involved three basic steps. First, insert the block of ice into the inlet.

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Then, the user will push the button of their desired crushed ice size. The machine will automatically crush the block of ice according to the selected setting, and after waiting, get the produced ice in the outlet. For industry-standard, there will also be an emergency stop button.

Some other delimitations of the project are as follows:

Block of ice. The automatic ice crusher machine can crush an ice block of approximately 15 kg of ice with a specific dimension of 25x25x50 cm.

Output. The machine can provide 2 different types of crushed ice – slush ice and crushed ice.

OBJECTIVES OF THE STUDY

This study intended to design and evaluate an automatic ice block crusher machine that could produce different types of crushed ice and provide user safety.

Specifically, it aimed to:

1. Crush an ice block approximately 15 kilograms with a specific dimension (25x25x50 cm);
2. Provide different types of crushed ice depending on the user's choice; and
3. Lessen the amount of wasted ice and increase the speed of the crushing process

MATERIALS AND METHODS

Design

This study adopted G.E Diether's overall steps in Design Process, as seen in Figure 1. This is used to analyze the innovation of the automatic ice crusher machine thoroughly.

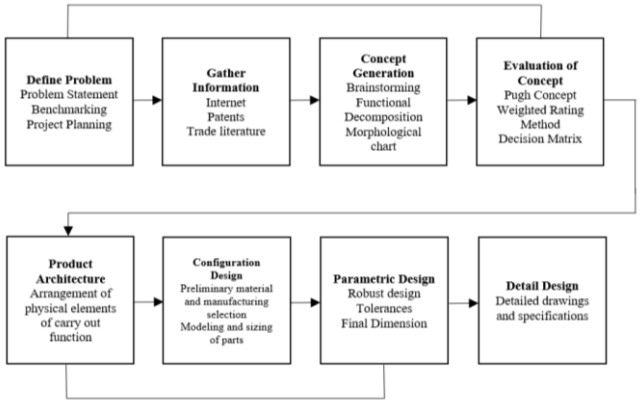

Figure 1. Overall Steps in Design Process

Since the study is experimental-developmental research, in Figure 2, C.P. Huber Model conceptual framework was also used in this study.

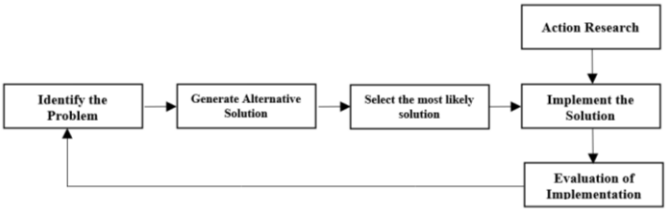

Figure 2. Conceptual Framework

Procedure

The following procedures/processes were involved in the conduct of the study:

1. Fabrication and welding of the frame.
2. Fabrication and assembly of the roller.
3. Fabricating and assembly of the shaver.
4. Assembly of the pulley system.
5. Installation of the pulley system and motors to frame.
6. Installation of the shaver to the electric motor.
7. Installation of the roller to frame.
8. Connection of the wirings and installation of motors to controller.
9. Installation of the controller to frame and troubleshooting the controller.
10. Configuring manually and tuning of the pulley to electric motor and roller.
11. Covering up the roller and shaver with ice inlet and outlet.
12. Testing and calibration.

Sampling Procedures

The sampling procedures are taken by crushing ten 15kg blocks of ice, timing the whole process, then calculating the mean average of the ten testings. The researchers used the data gathered to set the time of the off feature of the controller. No sensors are used to start and stop the machine to lessen the cost of the whole project.

The crushed ice is gathered and transferred to the shaving chamber. The researchers conducted 10 batches of experiments. Each batch is timed from the beginning of the shaving until all the crushed ice on the chamber is shaved. The researchers then calculated the mean time

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average of the 10 batches and used it to off the controller under slush mode.

RESULTS AND DISCUSSION

Design of the Machine

The machine's dimensions are based on the standard size of a 15kg block of ice, 25x25x50 cm. The machine's ice inlet dimension is adjusted to accommodate 15kg of ice with dimensions other than stated above. The roller and shaver's cylindrical height follows the length of the ice inlet to have uniformity in the design. Ice shaver is on the same rod of the driver pulley to take advantage of the fast rotation of the electric motor.

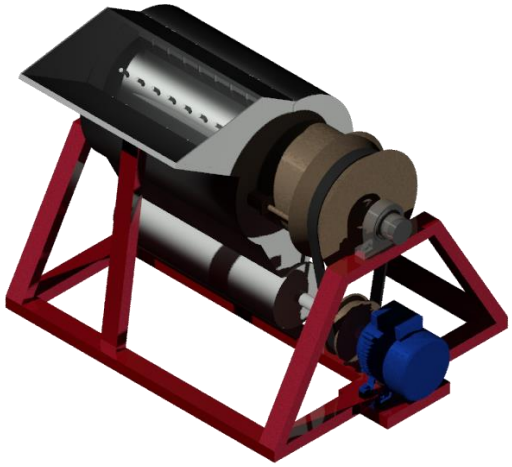

Figure 3. The Prototype Design

Main parts

The machine can be divided into four major parts: support frame, roller, electric motor, and pulley system.

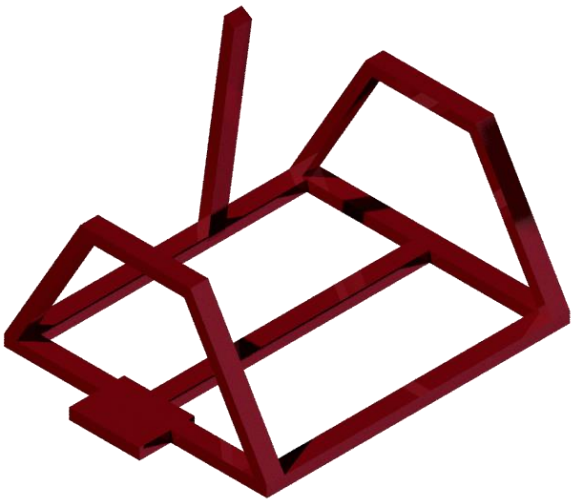

Figure 4. Support Frame

The frame holds and supports the other main parts. The support frame is responsible for the durability of the machine. It also absorbs vibrations caused by the electric motor and the crushing of ice.

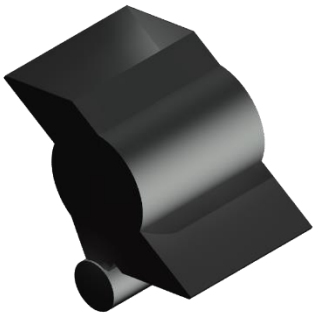

Figure 5. Inlet or Ice Feeder

The block of ice is inserted in the inlet or ice feeder of the machine. Inside the inlet or the ice feeder is the roller used to crush the block of ice.

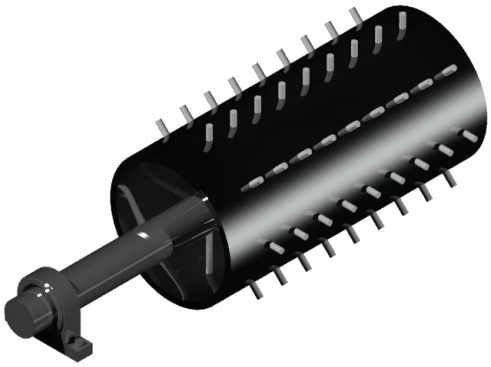

Figure 6. Roller

The roller is a cylinder with metal rods attached perpendicularly to its lateral area. The roller spins and crushes the ice. The speed of the roller is relative to the pulley system's driven size.

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Figure 7. Pulley System

A belt is used on the ice crusher's pulley system for safety reasons, and it requires no maintenance to operate. The pulley system showcases a diameter-changing driven wheel. This is used to apply appropriate tension on the belt and to make maintenance easier. The mechanism is made possible by 2 stepper motors that guide the other half of the driven wheel.

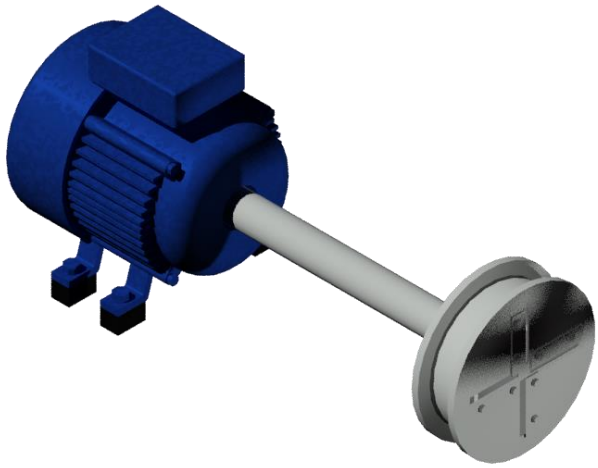

Figure 8. Electric Motor with Ice Shaver

Ice shaver is installed on the end of the electric motor rod. The rotation of the electric motor is directly translated to the ice shaver. The shaver is installed to lessen the cost of materials and maximize the angular speed of the electric motor.

Figure 9. Controller

The controller has 3 color-coded buttons. The green button is for crushed ice and white for slush, and red for emergency stop. The machine starts whenever one of the two buttons is pressed. The wirings on the whole machine are tucked on the frame for a cleaner look. Wirings are insulated for safety reasons.

Operation Procedure

The operation procedure is the same as the conventional way of using an ice crusher machine, except for choosing a mode at the beginning after inserting the block of ice.

The operator may now insert the ice block on the inlet or the ice feeder. After selecting a mode, the electric motor will start and operate until the process is finished, or approximately 19 seconds. At the same time, the roller will crush the ice, and depending on the mode, the ice will either go to the ice shaver chamber or out of the machine. On the shaver chamber, the electric the motor will spin again for another 6 seconds to shave the crushed ice.

RESULTS AND DISCUSSION

Table 1 shows the 3 trials conducted for each mode of the machine. In each trial, different weight of ice block – 5 kgs, 10 kgs, 15kgs – was used to produce the type of ice chosen by the user.

For both modes of operation, as the weight of the ice block varies, its average weight of ice crushed stays the same. In terms of speed, the process duration was also timed, and in every additional 5 kgs of ice block, it increases by 6 seconds to crush the ice. It can also be seen in the table that the bigger or heavier the ice block is, the higher its percentage of ice crushed.

Table 1. Trials and Results

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Type of Ice	Trial	Weight of Ice Block (Kilograms)	Average Weight of Ice Crushed (Grams)	Weight of Ice Crushed (Kilograms)	Time of Ice Crushed (Seconds)	Percentage of Ice Crushed
Crushed Ice	1	5 kgs	22 g	4.9 kgs	6 s	98%
	2	10 kgs	22 g	9.9 kgs	12 s	99%
	3	15 kgs	22 g	14.9 kgs	19 s	99.33%
Slush Ice	1	5 kgs	11 g	4.9 kgs	6 s	98%
	2	10 kgs	11 g	9.8 kgs	12 s	98%
	3	15 kgs	11 g	14.8 kgs	19 s	98.66%

CONCLUSION AND RECOMMENDATION

The study has shown the performance of the automatic ice block crusher machine. The machine attained a better and easier way to crush the ice than the manually chopping of ice. Based on the results of the study, the machine achieved its objectives: it can crush an ice block approximately 15 kgs with a specific dimension of 25x25x50 cm; it can provide 2 outputs of ice depending on the user's choice, may it be slush ice or crushed ice; it lessens the amount of wasted ice in a 15 kg block which in both crushed and slush ice, the percentage of ice crushed was 99.33% and 98.66%, respectively; and lastly it increases the speed of crushing process where it takes 19 seconds to achieve the user's choice of crushed ice in one operation.

The prototype for an automatic ice block crusher machine is recommended for business purposes, especially to the ice sellers and food processing market. It provides quality crushed ice, lessens the time of crushing ice, and is easily operated. For an additional innovation of the design, the following are recommended:

1. Add another cutting function of the machine so that instead of immediately crushing the ice block, it will be cut first; and
2. Redesign the inlet or ice feeder that can hold more than 15 kgs of an ice block with an additional dimension.

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