

Design and Simulation for the Improvement of Cookies Packaging Process

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DOI: <https://doi.org/10.30880/mari.2021.02.01.022>

Received 11 November 2020; Accepted 01 January 2021; Available online 03 February
2021

Abstract: This project aims to reduce packaging time in small scale industries which are usually home-based industries. In small scale food industries, food items need to be handled with care to ensure the quality of the food is not disturbed. This project look towards a local food industry which is Pid's Cookies based in Ampang, Selangor. The idea developed can produce a packaging system which is better and faster than the current system that they apply and our goal is to reduce the amount of workers needed and to further enhance the packaging system of these cookies hence increasing the overall efficiency of the small scale industry. The fabrication of a cookies packaging prototype requires metal that is safe for food items which is stainless steel and the fabrication process requires metal working processes such as cutting, joining, welding and bending. Solidworks 2019 software was used to create the final outcome of our product and we also collect the data by using Solidworks simulation analysis as we can testify the strength of our product and do some analysis such as the strength of the support when some force exerted upon it. From the results, it clearly see that how the construction of the model helps to understand each function of the parts. In conclusion, this product can be used by the small scale industry that lack of resources to afford expensive packaging lines. By producing this packaging system, it can help the small local food industries to increase their productivity while still maintaining the quality of the food.

Keywords: Cookies Packaging, Small Scale Industry, Low Cost

1. Introduction

Machines in food industry play major part in producing high return of investment without compromising quality in food [1]. This project is focusing on small scale industries and the aims of this project is to design and simulate an industrial biscuit packaging system which is affordable for small scale industries. Currently, the industry using manual process of packaging which is take longer time and lower their productivity. Therefore the main objective of this project was to produce a simple biscuit packaging system that is low-cost, low-manpower and efficient in reducing time of packaging operation. This would benefit the company as it will increase the efficiency and improve the productivity of the packaging process.

2. Materials and Methods

Materials chosen for the products are very important in the food packaging to keep the quality of the food. To maintain the quality of the food, the good materials are chosen in fabricating the product.

2.1 Material of Products

There are different types of steels used to fabricate this product. Table 2.1 shown a differences between type of steels and their properties.

Table 1: Differences Between Types of Steels [2]

Properties	Carbon Steels	Alloy Steels	Stainless Steels
Density (1000kg/m ³)	7.85	7.85	7.75-7.81
Elastic Modulus	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3
Tensile Strength (MPa)	276-1882	758-1882	515-827
Yield Strength (MPa)	186-758	366-1793	207-552
Percent Elongation (%)	10-32	4-31	12-40
Hardness (Brinell 3000kg)	86-388	149-627	137-595

Based on Table 1, stainless steel has the highest density among the three steels that is 7.81. In food industry, the material used for the products are very important as to take care the quality control of the food. The higher temperature of the food, the higher density of the steels used. Therefore, stainless steel has been chosen as the hopper so there is not any food poisoning occur and the quality of the food maintain in a good condition.

2.2 Methods

2.2.1 Component Design

The following components were designed for their designated tasks.

i. Cookies Container

Figure 1 shows the cookies container design. The function of this component is to hold the cookies before they exit into the next stage.

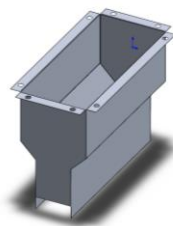


Figure 1: Cookies Container Design

ii. Dropper

Figure 2 shows that dropper design. The purpose of this component is to guide the cookies down into the package.

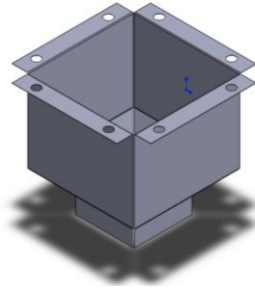
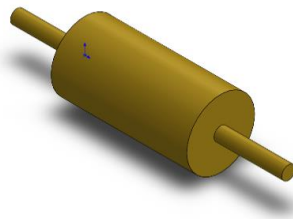


Figure 2: Dropper Design

iii. Roller

Figure 3 shows the roller design. The function of this component is to move the belt by using 12V DC motor. This component must rotate to move the cookies to the next stage. The acceleration of this roller must constant to keep the quality of the cookies.

Figure.3: Roller Design



iv. 12V DC Motor

A 12V DC Motor was used to actuate linear motion. A connector is used to connect the linear motor to the roller. Table 2 shows the motor specifications for this project.

Table 2: Motor Specifications.

Specification	Details
Material	Metal
Voltage	12-24 V
Input	12V DC
Weight	115g
Shaft Diameter	5mm
Shaft Length	16mm
Rated Power	130W

v. Support

Figure 4 shows the support structure design for this proposed packaging machine. This component supports the entire system on four legs and on a 465mm x 170mm base. The material of this support is using carbon steels type. The material used for this support is Carbon steels because it is tough and high stiffness. This steel has the ability to become harder and stronger through heat treating; however, it

becomes less ductile. Regardless of the heat treatment, a higher carbon content reduces weld ability. In carbon steels, the higher carbon content lowers the melting point [3].

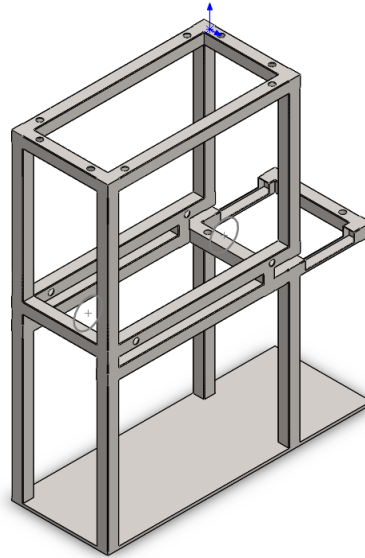


Figure 4: Support structure base design

2.2.2 Fabrication process

Mechanical joining process was used to perform the joining process of the sheet metals. Mechanical Joining is a process for joining parts through mechanical methods, which often involve threaded holes for example using screws or nuts and bolts [4]. Mechanical joining is low-cost and it is more safe than the welding. This is because, when using the welding itself, it can be harmful during the process of the welding. Harmful gases that may be present in the fume include nitrous oxide (N_2O), Carbon Dioxide (CO_2), carbon monoxide (CO), Argon (Ar), Helium (He) and Ozone (O_3) [5].

3. Results and Discussion

3.1 Current packaging

The main objective of this project is to study and improve the current packaging system used which is manually hand packing cookies packages. The actual shape of the cookies is round, which the diameter of the cookies is 4 cm as shown in Figure 5 below. The packaging of the *Pid's Cookies* using the ziplock bag where it is suitable for our packaging machine. The picture below shows an actual size of the cookies and ziplock bag used for the packaging.



Figure 5: Size of Cookies and Ziplock Bag

The size of the ziplock bag is 9cm x 14cm and the weight of the cookies packaging approximately 135g that used by company as shown in Figure 6. The current method of this cookies packaging is using manual packing where the cookies have to put inside the packaging manually one by one as shown in Figure 7 below.



Figure 6: Ziplock Bag used by company.



Figure 7: Manual hand packing

3.2 Design and Simulation

After a few conceptual design developed, the final design was simulate using Solidwork 2019 software to know whether the product is fully functional or not. This design also was analyzed using the simulation analysis in the software. The final design of proposed packaging machine as shown in Figure 8 below.

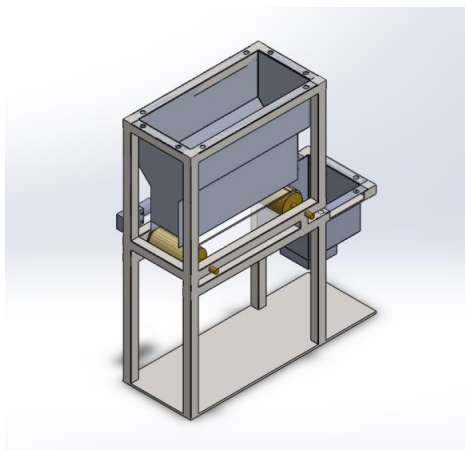


Figure 8: The final design of propose packaging machine

The results of simulation analysis shown in Figure 9. Alloy Steels was chosen as the support because it is tougher than Carbon Steel. The force has been applied above the structure with the certain force values to see the strength of the support structures.

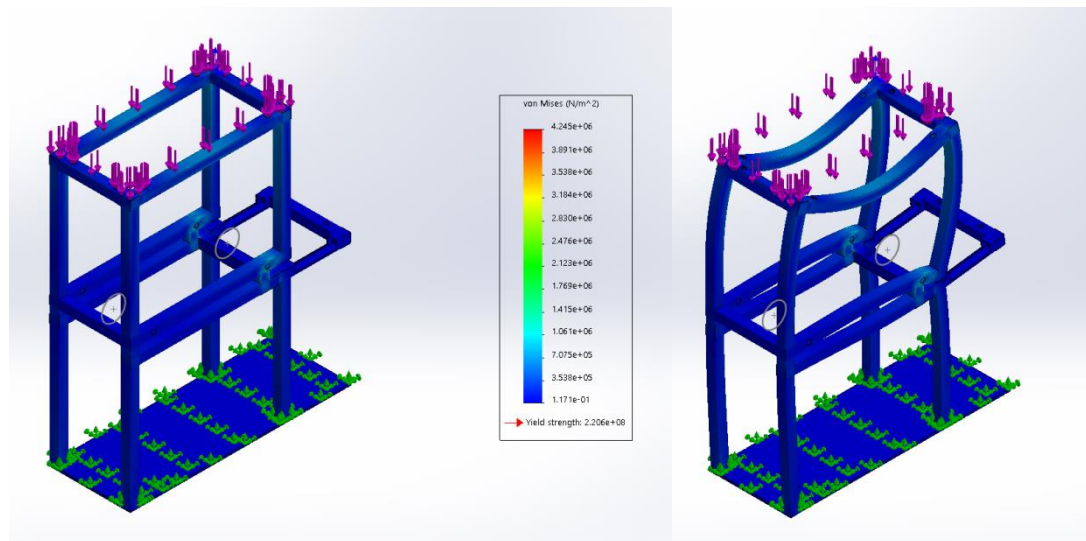


Figure 9: Result deformed and un-deformed stress on support

Based on above Figure, the maximum strength is equal to $1.06e+06$. It shows that this product can bear the load up to 5 kilograms. This is because, the mass of others part is only 3.9 kilograms and the mass of this support is equal to 7212.67grams or 7.2 kilograms. When the cookies fill up the container, the mass become ± 4.2 kilograms and the support still can bear the load.

3.3 Productivity improvement

The formula for calculating productivity is the ratio of outputs produced to the inputs used in production. The productivity formula was used to analyze the project's result.

$$Productivity = \frac{Packages\ Packed}{Work\ hours} \quad Eq. 1$$

Based on the observation at the selected industry, the current productivity of packaging was 80 packets/hour. Therefore, after doing some estimation of production using the proposed packaging machine design, the estimation of new productivity of packaging process was increase up to 200 packets/hour. The result is then compared to the current productivity of *Pid's Cookies*. Almost 150% of productivity improvement had been achieved and its objective of being efficient and faster than the current method of packaging also successfully achieved.

4. Conclusion

From the results and analysis, our main objective in this project has been achieved which is to design and fabricate the packaging product that is affordable for small scale industries. This can shown from the analysis on method and the results. Although this packaging machine already exists in the market sells, the price is too high for the small scale industries. This improvement on packaging cookies helps the small scale industries by making the packaging process more efficient and less manpower. Thus, this product only cost less than RM1,000.00 and it is affordable than other packaging machines. There are also some suggestion for improvement can be made on this product such as put a timer and a weigher on the machine so that the mass of each packaging product can be more accurate and also to install the wheels at the bottom of the machine for easier movement.

Acknowledgement

The authors express gratitude to Centre for Diploma Studies (CeDS), Universiti Tun Hussein Onn Malaysia (UTHM) for giving support for this project.

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