Website : jurnal.umj.ac.id/index.php/icecream

ANALISYS PNEUMATIC CUTTING SYSTEM ON AUTOMATIC PRINTING & CUTTING LONG RICE CRACKERS MACHINE CAPACITY 7 KG / H

Gustav Permadi[1], Windarta[1]*, Fadwah Maghfurah[1], Ratna Dewi Nur'aini[2]

[1]Mechanical Engineering Department, Universitas Muhammadiyah Jakarta, Indonesia
[2]Archietecture Department, Universitas Muhammadiyah Jakarta, Indonesia
**Email address of corresponding author: windarta@umj.ac.id*

ABSTRACT

The cutting of lontongan (rice crackers) was done manually. It has disadvantages nonuniform in thickness and low productivity. The aim of this research is to plan a cracker molding and cutting machine with a capacity of 7 kg/hour and to analyze the pneumatic system used in cutting cracker cake dough. The design of cracker molds and cutting tools was carried out using computer-based design software. Calculations were carried out to obtain image dimensions, determine the materials and determine the existing components used in making molding machines and cracker cake cutters. The testing mechanism was to determine the test that will be carried out. Testing was carried out by means of experimental testing, then data collection was carried out. Data analysis was carried out by observing the data results that have been obtained from experimental testing which were then analyzed and conclusions were drawn. The results shows that using cracker molding and cutting equipment on a home scale can increase production yields by 7 kg / hour or about 48-53 pieces ricecake crackers per hour, compared to the home scale that makes manual long ricecake crackers can only be 3kg / hour or as many as 21-24 pieces ricecake crackers. Secondly, the air pressure required to mold cracker cakes is 7 bar with a diameter of 2 cm. and the third, The advantage of this cracker molding and cutting tool is that it can increase productivity, the disadvantage is that it requires a lot of electricity and costs a lot.

Keywords: cracker molding and cutting machine, Cutting system, pneumatic system, rice crackers

1. Introduction

The definition of Small and Medium Enterprise (SME) is productive businesses owned by individuals or business entities that meet the criteria for being a micro-enterprise. The SME produce culinary business, fashion business and agribusiness. Culinary business is one of the SME businesses that is most popular with even young people. The culinary business is a business that operates in the food sector, both in terms of making, serving, and selling certain products to customers. One of Indonesian people's favorite foods is crackers. Crackers can increase people's appetite (Batubara & Nasution, 2023).

The stages of making shrimp crackers are very simple, which includes preparing the ingredients, making dough porridge, making rice cake, steaming, slicing, and drying (Nur Afifah & Anjani, 2008). Based on observations at the Home Cracker Industry Center in the Patrol area, Indramayu, West Java, it turns out that the process of cutting lontongan is still done manually (using knife to cut), so it has disadvantages in the form of non-uniform thickness and very low production capacity, namely around 3 kg/hour. Another problem

faced was how the tool could cut the cracker cakes strongly and quickly.

Several studies have been carried out on cutting cracker cakes, including by Hiola et al. (2016) by using a string to cut cracker cakes. The advantage of this tool is that it produces cracker cuts of around 2mm, the lontong cutting speed is faster. Meanwhile, Putra and Haris (2017) used natural fibers to cut cracker cakes. This research seeks to speed up the process with thin cutting tools.

A different approach was taken by Sulharman et al. (2019) the design applies using stainless wire and mechanism of the suppressor for cutting. Meanwhile, Wijaya et al. (2019) uses the Theory of Inventive Problem Solving (TIPS) which means the theory of innovative problem solving. Altshuller found a way to solve complex inventive problems by identifying and categorizing each existing solution. The categorization of each solution has been formulated by Altshuller in the 40 TRIZ principles. There are three basic principles that are applied to get the best solution. Meanwhile, Hartadi et al. (2020) developed manual cutting system using motor to got 2 mm slice in depth.

Based on the reasons and findings above, the author intends to solve the problem to improve the cracker business by designing a cracker dough cutting machine using a cracker dough cutter using a pneumatic system that can increase the production capacity of crackers to 7kg/hour.

The aim of this research is to plan a cracker molding and cutting machine with a capacity of 7 kg/hour and to analyze the pneumatic system used in cutting cracker cake dough.

2. Material and Methods

Design of cracker molding and cutting tools as described in Figure 1.

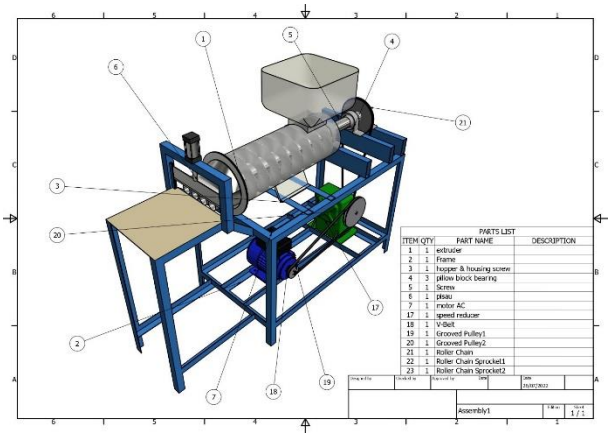

Figure 1. Design of cracker molding and cutting tools

The materials used in research on cracker molding and cutting tools include cracker dough (Figure 2). The cracker dough that will be analyzed uses pneumatics to be cut into cracker dough.

Figure 2. Cracker dough

Calculations were carried out to obtain image dimensions, determine the materials and determine the existing components used in making molding machines and cracker cake cutters. The testing mechanism was to determine the test that will be carried out. Testing was carried out by means of experimental testing, then data collection was carried out. Data analysis was carried out by observing the data results that have been obtained from experimental testing which were then analyzed and conclusions were drawn.

2.1. Tools knife and Pneumatic System Design

Lontongan cutting knife designs are presented in Table 1.

Table 1: Cutting knife design

Thickness (mm)	Length (mm)	Circumference (mm)
3	150	306

Based on Table 1, cutting area could be determined. If the dough thickness was 40 mm, then cutting area = 40 x 306 = 12240 mm^2;

The design of the lontong cracker dough maker was made in the form of 4 pipes with a diameter of 4 cm.

The amount of time that must be applied so that the timing for cutting the cracker shells matches the desired length of the cake shells is shown in Table 2.

Table 2: Lontongan Length produced versus Cutting time

Number	Knife Timer Adjusment	Knife Down Time	Length of long ricecake produced
1	T1 4s	0,62s	14 cm
2	T1 3s	0,62s	12 cm
3	T1 5s	0,62s	14,9 cm
4	T1 6s	0,62s	15,3 cm
5	T1 8s	0,62s	17,6 cm
Average	T1 5,2 s	0,62 s	14,76 cm

So the timer needed to be suitable for cutting the cracker for a length of 15cm, therefore the speed obtained from the trial can be found by using the distance of cutting the cracker cake with a knife and the time when the knife starts cutting the cracker cake.

$$V = \frac{s}{t}$$

The minimum force required by the pneumatic piston to cut the cracker ricecake is :

Known :

mass of knife weight =
Gravity force = 9,81 m/s^2

Minimum force could be determined using this formula

$$F = m.g$$

2.2. Pneumatic Device Design

To find the minimum pneumatic cylinder diameter required, Therefore, in the initial planning, a pressure of 100000 N/m^2 was taken, a pressure of 1 bar or 100000 N/m^2 was taken from the pressure value for a dough hardness level of 3187 grf) with a ratio of tapioca flour; milk (40gr; 60gr). and a minimum force of 7.9 N. This data is then used in the planning of pneumatic cylinders for cutting crackers rice cake.

The minimum diameter can be found with the equation:

$$\boldsymbol{F = A\ x\ p}$$

Or,

$$(F + R) = \left(\frac{\pi}{4} x\ D^2\right) x\ p$$

And for find grade R (Friction Force)

$$R = \pm 5\% \; x \; minimum \; F$$
$$R = \pm 5\% \; x \text{ minimum } F$$
$$R = 0{,}395 \; N$$

Then,

$$(Minimum \; F \; (N) + 0{,}395 \; N) = \left(\frac{3{,}14}{4} x \; D^2\right) x \; 100000 \frac{N}{m^2}$$

Then from the above equation, the minimum diameter of the piston can be calculated with the following data below:

F = 7,9 N

P = 1 bar = 100000 Pa = 100000 N/m^2

$$(7{,}9 \; N + 0{,}395 \; N) = \left(\frac{3{,}14}{4} x \; D^2\right) x \; 100000 \; N/m^2$$

8,295 N = $\left(\frac{3{,}14}{4} x \; D^2\right) x \; 100000 \; N/m^2$

8,295 N = $\left(\frac{3{,}14}{4} x \; D^2\right) x \; 100000 \; N/m^2$

$$D^2 = \frac{8{,}295 \text{ N}}{0{,}785 \; x \; 100000 \; N/m^2}$$

$D^2 = 0{,}00015067 \; m^2$

$D = \sqrt{0{,}00015067} \; m^2$

$D =$ m

$D = \leq 2\text{cm} \rightarrow 2cm$

(minimum size that available on market)

Known : for a piston diameter (D) of 2cm has a piston rod diameter (d) of 0.008 cm

From the above calculation, the minimum diameter of the pneumatic cylinder is 1.02 cm. Therefore, for this calculation, a double acting cylinder with a diameter of 2 cm is used, using double acting because it is necessary to have repeated cutting movements forward and backward at certain intervals.

Calculation formula of the effective force of the piston when advancing

$$F_a = A \; x \; p$$
$$F_a = \left(\frac{\pi}{4} \; x \; (D^2)\right) X \; 100000 \; N/m^2$$
$$F_a = 31{,}4 \; N$$

Calculation of piston effective force in reverse

$$F_b = A \; x \; p$$
$$F_b = (\frac{\pi}{4} \; x \; (D^2 - \; d^2) \; x \; 100000 \; N/m^2)$$
$$F_b = 33{,}6 \text{ N}$$

Calculation of forward piston air consumption

$$V_1 = p \; x \; A \; x \; h$$

Then,

$$V_1 = 1 \; x \; \left(\frac{\pi}{4} \; x \; (0{,}02)^2 m\right) x \; 0{,}15 \text{ m}$$
$$V_1 = 0{,}000471 \; liter$$

Calculation of piston air consumption in reverse

$$V_2 = \; p \; x \; A \; x \; h$$
$$V_2 = p \; x \; \frac{\pi}{4} \; x \; (D^2 - \; d^2) x \; h$$

Then,

$$V_2 = 1 \; x \; \frac{3{,}14}{4} \; x \; (0{,}02^2)m - (0{,}008^2)m) \; x \; 0{,}15 \; m$$
$$V_2 = 0{,}0003956 \; liter$$

Compressor discharge calculation

$$Q_s = A \; x \; v$$

Finding the piston speed can be found using the following formula :

$$v = \frac{s}{t}$$

$$v = \frac{0{,}15m}{0{,}62 \; s} = 0{,}241 \; m/s$$

Then,

$$Q_s = \; \frac{\pi}{4} \; x \; (D^2) \; x \; v$$
$$Q_s = 0{,}75 \; liter \text{ / s}$$

Compressor power calculation

$$N_s = \; Q_s \; x \; \eta_{tot}$$

With the note that the value of η is taken as 0.85

Then,

$$N_s = \; Q_s \; x \; \eta_{tot}$$

$$N_s = 0{,}75 \text{ x } 0{,}85$$
$$N_s = kw$$
$$N_s = watt$$
$$N_s = 0{,}802\ pk$$

2.3. Planning an automatic pneumatic circuit system using one double acting cylinder

An automation pneumatic circuit system using one double acting cylinder is shown in Figure

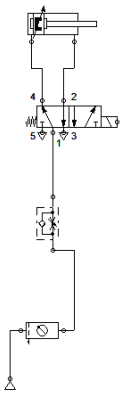

Figure 3 : pneumatic concept circuit

Figure 3. above shows a simulation when air enters from the compressor towards the air regulator, and towards the 5/2 valve terminal to channel air towards the first fitting of the pneumatic cylinder to push the cylinder. Figure 3. above shows that when the solenoid is active, the wind flow changes towards the two cylinder fittings to push the cylinder back to its original position.

3. Results and Discussions

Based on the calculation results, the results obtained are as shown in Table 3.

Table 3: Calculation results

No	Calculation	Results
1	minimum compressive force	7,9 N
2	Planning minimum cylinder diameter	1,02 cm ≈ 2cm
3	Effective force of the piston when advancing	31,4 N
4	Effective force of the piston in reverse	33,6 N
5	Air consumption when advancing	0,000471 liter
6	Air consumption in reverse	0,0003956 liter
7	Compressor discharge	0,75 liter/s
8	Compressor power	0,802 pk

The cracker molding and cutting machine is assembled based on the calculation results presented in Table 3. This assembled machine is used to make cracker cakes.

The ingredients for the cracker crust are then mixed. The process of mixing the ingredients for making cracker dough and after kneading it (Figure 4), it is then fed into the dough molding and cutting tool. Figure 5. is the result of molded cracker dough

Figure 4. cracker dough

Figure 5. the result of cracker bursting

Tests that have been carried out by the author have successfully lifted the load, namely the cutting knife to cut the long ricecake cracker by applying a compressive force from a pneumatic system that has a cylinder size of 1.02 cm ≈ 2cm with air pressure of 1 bar. In determining pneumatics to suit the needs of the required scheme, it is necessary to pay attention to an appropriate calculation.

4. Conclusion

Based on the experimental results, it was found that the use of cracker molding and cutting equipment on a home scale can increase production yields by 7 kg/hour or around 48-53 pieces of lontong crackers per hour, compared to a home scale where making long manual lontong crackers can only be 3kg/hour or as much as -a lot. as many as 21-24 pieces of lontong crackers. The air pressure in the pneumatic system required to print cracker cakes is 7 bar using an actuator with a diameter of 2 cm. The advantage of this cracker printing and cutting tool is that it can increase productivity, the disadvantage is that it requires a lot of electricity and costs a lot.

Acknowledgement

The Authors thanks to the Dean of Engineering, Universitas Muhammadiyah Jakarta for permitting this research.

References

[1] Batubara, I.W.S., Nasution, A.I.L., 2023. Strategi Pengembangan dalam Pemberdayaan Masyarakat Pesisir Tanjung Leidong Melalui Pengelolahan Udang Menjadi Kerupuk Udang, *Jurnal Informatika Ekonomi Bisnis*, Vol. 5 no.2, pp 537 - 542

[2] Nur Afifah, D. and Anjani, G., 2008. Sistem produksi dan pengawasan mutu kerupuk udang berkualitas ekspor. *Seminar Nasional PATPI*, 2008.

[3] Hiola, E., Antu, E. S., Djamalu, Y., 2017. RANCANG BANGUN ALAT PEMOTONG LONTONG KERUPUK MENGGUNAKAN TALI SENAR. *Jurnal Teknologi Pertanian Gorontalo (JTPG)*, Vol. 1 no. 1, pp 1 - 8

[4] Putra, I. E. and Haris, M., 2017. ANALISA SISTEM PNEUMATIK ALAT PEMOTONG SERAT ALAM, Jurnal Momentum, Vo. 19 no. 2, pp 50 – 56

[5] Sulharman, Sirait, J., Saptaningtyas, W.W.E., 2019. The Engineering of Non-Electrical Wheat, Cracker Dough Cutting Tool, IPTEK The Journal for Technology and Science, Vol. 29(3), pp 76 – 80

[6] Wijaya, C. A., Sianto, M. E., Santosa, H., 2019. Perancangan Ulang Alat Pemotong Kerupuk Dengan Menggunakan Metode Triz (Teorija Rezhenija Izobretatelskih Zadach), Scientific Widya Teknik Journal, Vol. 18 (2), pp 64 - 70

[7] Hartadi, B., Herlina, F., Royani, A., 2020. PERANCANGAN MESIN OTOMATIS PEMOTONG

KERUPUK IKAN HARUAN, Jurnal Teknik Mesin UNISKA, Vol. 5 no. 1, pp 18 – 21

[8] Martino,2013; [*Analisa Dan Perhitungan Pneumatik Sistem Pada Penggunaan Miniatur Furniture Multifungsi]*

[9] Febri Indriyanto,Rudy ; [*Rancang Bangun Sistem Pengepresan Dengan Penggerak Pneumatik Pada Mesin Press Dan potong Untuk Pembuatan Kantong Plastik Ukuran 400 x 550mm] ;*

[10] Jatira,2017; [*Perancangan Mesin Cutting Cheese Block Dengan Cutting Tools Kapasitas 20 kg]*

[11] Wiseno,Eibi,2018 ; [*Analisis Tekanan Pneumatik Pada Mesin Sablon Semi otomatis]*

[12] Arif,suharno muhammad,2018 ; [*Rancang Bangun Mesin Pemotong Pipa Dengan Sistem Pneumatik];*

[13] Rozano,Faiq,2018 ; *[Rancang Bangun Mesin Press Topi Dengan Sistem Pneumatik*];

[14] Prasetyo,Irwan,2012 ; *[Analisa Alat Pneumatik Mesin pemotong spon/ Gasket Dengan Tekanan 60 Psi];*

[15] Subagja,Fajar,2020 ; [*Dasar Sistem Kontrol Sistem Pneumatik];*