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Design and Construction of a Coffee Roasting Machine with a Horizontal Cylinder with a Capacity of 5 Kg

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ABSTRACT

Roasting is the process of heating coffee at a temperature of 200O-225OC, the aim of which is to get dark brown roasted coffee. Roasting greatly determines the color and taste of the coffee products consumed, the color changes in the beans can be used as the basis for a simple grading system. In this roast machine study, engineering research methods were used. The results of the main frame loading simulation calculations with a load of 617N show a minimum stress value of -2.58735 Mpa and a maximum of 9.07512 Mpa. The minimum displacement value is -0.0167252 mm and a maximum of 0.00221817 mm. initial long strain -0.000000649485 ul and final length 0.0000415432 ul. Minimum Safety Factor is 8.64 ul and maximum value is 15 ul. The test results for the 1st coffee roaster machine were obtained with the lowest capacity of 2 kg and took 26 minutes with a capacity of 4.28 kg. in the 2nd test it was obtained with the lowest capacity of 2 kg and required 26 minutes with a capacity of 4.28 kg/hour. in the 3rd test it was obtained with the lowest capacity of 2 kg and required 25 minutes with a capacity of 4.28 kg/hour.

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Keywords: Roasted, frame loading, design, coffee roast machine

1. Introduction

Coffee is a drink made from coffee beans that have been roasted and ground into powder. Coffee is a commodity in the world that is cultivated in more than 50 countries [1].

History records that the discovery of coffee as a nutritious and energy drink was first discovered by the Ethiopians on the African continent around 3000 years (1000 BC) ago. Coffee then continued to develop until now it has become one of the most popular drinks in the world consumed by various groups of people. Indonesia itself is able to produce more than 400 thousand tons of coffee per year. Apart from its attractive taste and aroma, coffee can also reduce the risk of cancer, diabetes, gallstones and various heart diseases [2].

The coffee processing process goes through a long process before it can be drunk, namely harvesting mature coffee beans either by machine or by hand, then processing the coffee beans and drying them before they become coffee beans. The next process is roasting at different levels. After roasting, the coffee beans are ground into coffee powder before the coffee can be drunk [3].

Roasting is the process of heating coffee at a temperature of 200- 225°C, the aim of which is to get dark brown roasted coffee. Roasting really determines the color and taste of the coffee product consumed, color changes in the beans can be used as the basis for a simple grading system [4].

As time goes by, the roasting process is becoming more modern than before. The roasting process is carried out traditionally using a clay pan and the stirring process during roasting is done manually. Meanwhile, the modern roasting process is carried out using an automatic coffee roaster that can stir the coffee itself [5].

The most important part of the roasting machine is the roasting cylinder which functions as a coffee holder during the roasting process. So that the roasting cylinder is safe to use, it is necessary to calculate the dimensions so that the volume or capacity of the roasting cylinder matches what we want [6]. The process of selecting the roasting cylinder material also influences the quality of the coffee being roasted. The material for making the roasting cylinder on this machine is a stainless steel plate. The material of this plate. chosen because it does not rust easily so it does not damage the quality of the roasted coffee. The roasting cylinder material used in this roasting machine has the characteristics of being resistant to corrosion and porous [7].

The other main part of this roasting machine is the frame. The frame functions as a tool holder. So that the frame is safe to use, it is necessary to calculate the load that will be imposed on the frame. The material selection process can determine the strength of the frame. The frame material used in this roasting machine is hollow iron [8].

The choice of hollow iron material has its own characteristics, firstly the price of this material is affordable so it can minimize manufacturing costs, this roasting machine can be easily moved, lastly this material is strong and easy to weld [9].

The advantages of hollow iron are as follows:

1. Resistant to various weather conditions, this hollow iron is suitable for use indoors and outdoors.
2. Long lasting, this type of material is a strong material and is not eaten by termites or other animals.
3. Easy application, the application of hollow iron can be said to be easy, one of which is by welding.
4. Does not easily conduct fire so it is safe from fire.

In the field of engineering and engineering, software tools are generally used which aim to facilitate the design and analysis stages of stresses and strains that occur in machine parts. One of the software tools usually used is Inventor.

Based on the results of the description above, the author wants to raise a research title “Design and Construction of a Coffee Roasting Machine with a Horizontal Cylinder with a Capacity of 5 Kg”. With this research the author aims to plan the manufacture of a coffee roasting machine with a rotating roasting cylinder.

2. Methodology of Research

This research is using experimental method. Data was taken through simulation results and design of a coffee roasting machine. The data obtained was analyzed using descriptive analysis. This research was carried out for three months starting from April, May and June 2023. This research was carried out at the Mechanical Engineering Production Laboratory, Universitas Yudharta, Pasuruan.

1. *Tools and materials*

   The following are the tools and materials used in this research.

   a. Roll meters
   b. Ruler
   c. Protractor
   d. Elbow ruler
   e. Grinding machine
   f. Electric welding (SMAW)
   g. Hammer
   h. Dropper
   i. Hand drill
   j. Air compressor
   k. Roll plate
   l. Hollow Iron
   m. Electric machine
   n. Bearings
   o. On/off switch
   p. Pulley
   q. V-belt
   r. Axis
   s. Stainless steel plate
   t. Gas stove
   u. Pillow blocks

2. *Concept of design*

a. Reference model

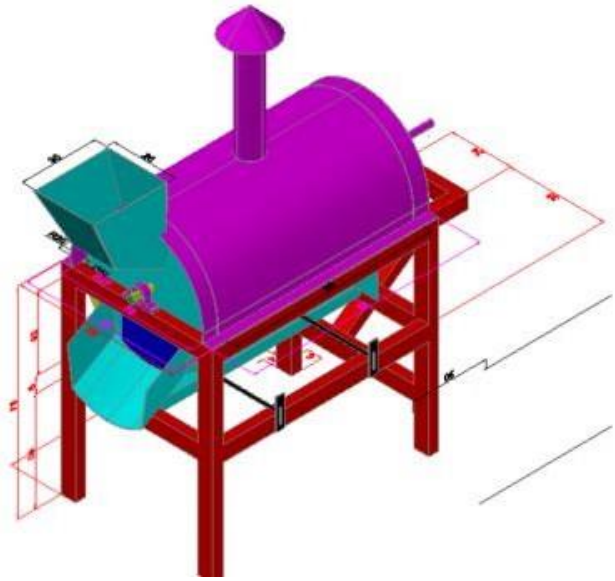

Figure 1. Coffee roasting machine with rotating stirrer

Specifications for coffee roasting machine cylinders. The specifications for coffee roasting machine cylinders are as follows:

Length	:	92 cm
Width	:	62 cm
Height	:	160 cm
Cylinder diameter	:	50 cm
Model	:	Rotating stirrer
Cylinder material	:	Stainless steel
Thickness	:	2.5 mm
Capacity	:	± 40 kg
Driving engine	:	Electric dynamo 1 hp

This coffee roasting machine with a rotating stirrer has several main parts consisting of:

1. Frame
2. Cylinder cover
3. Roasting cylinder
4. Mixer
5. Driving dynamo
6. Gearbox reducer
7. V-belt
8. Gas stove

b. Design used

The design used by the researcher is a design adapted from a reference as shown in Figure 1 with modifications made by the researcher. The following image is the final design used by researchers in designing a coffee roasting machine.

Figure 2. Coffee roasting machine with a horizontal cylinder with a capacity of 5 kg, side view

Figure 3. Coffee roasting machine with a horizontal cylinder with a capacity of 5 kg, front view

Figure 4. Coffee roasting machine with a horizontal cylinder with a capacity of 5 kg, top view

3. Work mechanism

The working mechanism of a coffee roasting machine with a horizontal cylinder model with a capacity of 5 kg is as follows [10]:

Position the engine in roasting mode, start the engine by pressing the on button (1) after that the driving dynamo will rotate (2) and transfer power using the vbelt and pulley to the cylinder shaft (3) and (4), when the engine has been started, then turn it on. gas stove (5) wait for the temperature in the cylinder to reach 100 C. When the temperature has reached 100 C, the coffee is put into the cylinder and roasted until the desired level of maturity (6), when the coffee is cooked, prepare a container in front of the roasting machine as a coffee container. is cooked, then pull the lock then move the position of the machine from roasting to coffee bean dispensing mode, wait until all the coffee beans in the cylinder come out then position the machine back to roasting mode (7), turn off the gas burner and press the off button to turn off the roasting machine [11].

Table 1. Coffee roasting machine components with a horizontal cylinder model with a capacity of 5kg

No	Component name	No	Component name
1.	Switch on/off	5.	Gas stive
2.	Driving engine	6.	Cylinder
3.	*Pulley*	7.	Locking lever
4.	*V-belt*		

3. Result and Discussion

The load is taken based on the weight of the swing arm frame and its components (dynamo, gearbox reducer, roasting cylinder, panel box and gas stove) by weighing them. The software used in the frame load analysis is Autodesk Inventor professional 2017 [12].

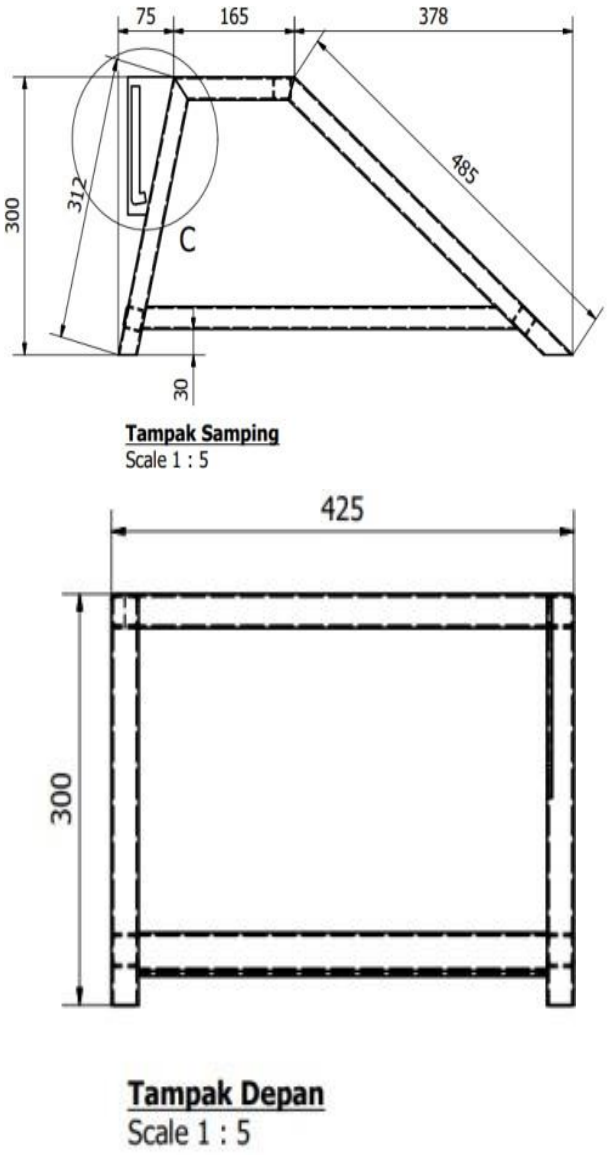

Figure 5. 2-dimensional main frame

Below is an explanation related to the skeletal analysis that has been produced by researchers.

1. Stress

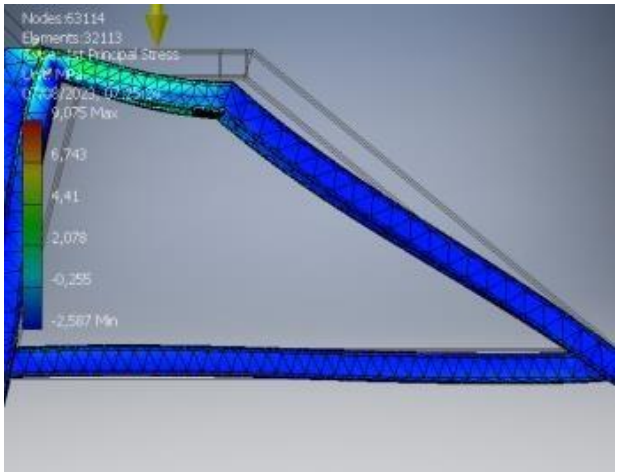

Figure 6. Stress test result

Based on the stress test results above, the minimum value obtained is -2.58735 MPa and the maximum value is 9.07512 MPa.

2. Displacement

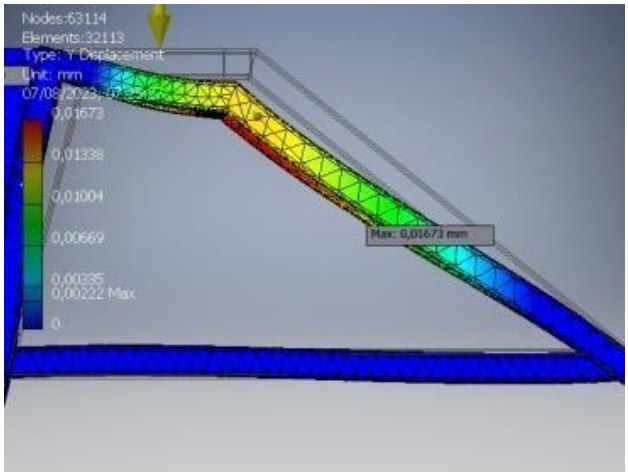

Figure 7. Displacement test result

The simulation calculation results show that displacement or deformation experiences changes in the shape of objects in the coffee roasting machine frame with a minimum value of -0.0167252 mm and a maximum value of 0.00221817 mm.

3. Strain

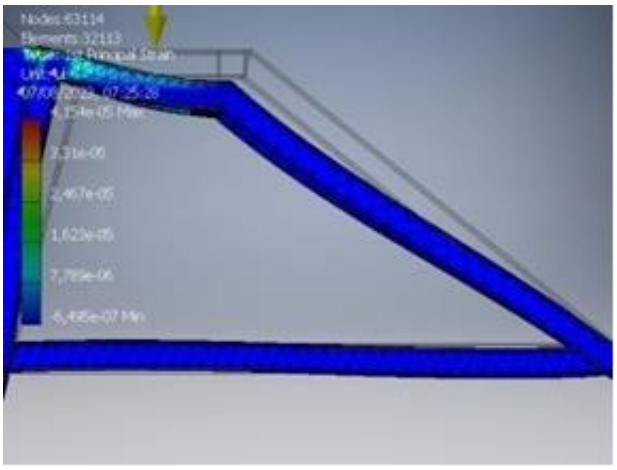

Figure 8. Strain test result

The results of the simulation calculations show that the strain has an initial length value of -0.000000649485 ul and when a force is applied the final length results show a maximum value of 0.0000415432 ul.

4. Safety factor

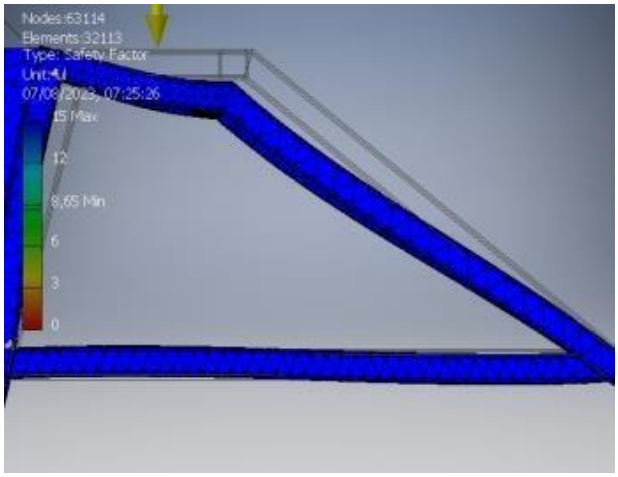

Figure 9. Safety factor test result

The simulation calculation results show that the safety factor gets a value of 8.64, so the frame is declared safe.

The data collection test was carried out 3 times, the test results are as follows:

Table 2. Data collection test results

Description	Test 1	Test 2	Test 3
Initial weight of coffee (kg)	2	2	2
Final weight of coffee (kg)	1.75	1.75	1.75
Initial temperature (°C)	100	102	104
Final temperature (°C)	123	126	124
Initial weight of gas (kg)	5.5	4.8	4.1
Final weight of gas (kg)	4.8	4.1	3.3
Rpm without load	23	23	23
Rpm with load	23	23	23
Duration of roasting (minutes)	26	26	26
Capacity (kg/hour)	4.28	4.28	4.28
Level of roasting	Medium	Medium	Medium

Before the coffee is put into the roasting machine, the temperature in the roasting cylinder must be 100-105°C, the aim of this is so that the coffee matures more quickly and does not destroy the characteristic taste of the coffee [13].

Figure 10. Level of cofee roasting

Based on the picture above, there are 5 levels of roasting, including: Light, Light Medium, Medium, Medium Dark, Dark. And the level of roasting used in testing the rotating cylinder coffee roaster with a capacity of 5 kg is the Medium level. A comparison of rotating cylinder roasting machines with rotating stir roasting machines is presented in the following table [14].

Tabel 3 Advantages and disadvantages of rotating cylinder coffee roasting machines

Advantages	Disadvantages
Manufacturing costs are minimal	Energy loss is too large
Suitable for use in small scale home industry	Not suitable for large-scale home industry use
The roasting results are even	The temperature sensor is less accurate
Doesn't require a big place	

Table 4. Advantages and disadvantages of rotary stirrer roasting machines

Advantages	Disadvantages
Suitable for large-scale home industry use	High manufacturing costs
The roasting results are even	Requires a fairly large place
Minimal energy loss	

4. Conclusion

Based on the results of this research analysis, the frame has a minimum analytical stress of -2.58735 MPa and a maximum of 9.07512 MPa. Displacement is a minimum value of 0 mm and a maximum value of 0.0203488 mm. The strain is the minimum value - 6.495e-07 and the maximum value is 4.154e-05. And the safety factor gets a value of 8.64. with a load of 617 N. Based on the comparative results of this research, coffee roasting machines with rotating cylinders and rotating stirrers get the same roasting results as evenly.

References

[1] W. Gunawan, D. Yunita, and B. Sekarningrum, “Pelatihan Pemasaran Kopi Ramah Lingkungan Secara Digital,” *Sawata J. Pengabdi. Masy. Pembang. Sos. Desa, dan Masy.*, vol. 3, pp. 34–40, 2021, [Online]. Available: https://www.intracen.org/.

[2] L. V. Wihartanti, F. Styaningrum, and G. C. Noegraha, “Pemberdayaan Masyarakat Melalui Pengembangan Produk Kopi Kare Dan Wisata Alam Berbasis Ekowisata Di Desa Kare Kecamatan Kare Kabupaten Madiun.,” *J. Terap. Abdimas*, vol. 5, no. 1, p. 57, 2020, doi: 10.25273/jta.v5i1.5226.

[3] N. Nahan, V. Kristinae, and A. Syamsudin, “Pendampingan Penerapan Strategi Bisnis pada Coffee ShopTradisional di Kalimantan Tengah,” *J. Pengabdi. Pancasila*, vol. 1, no. 1, 2022.

[4] H. A. Sanaky and F. Nashori, “Peningkatan Dan Pengembangan Produk Olahan Kopi Di Desa Brunosari,” *AJIE-Asian J. Innov. Entrep.*, vol. 03, no. 03, pp. 2477–3824, 2018.

[5] Noorjaya Nahan, V. Kristinae, and A. Syamsudin, “Pendampingan Penerapan Strategi Bisnis pada Coffee Shop Tradisional di Kalimantan Tengah,” *J. Pengabdi. Pancasila*, vol. 1, no. 1, pp. 31–38, 2022, doi: 10.55927/jpp.v1i1.1347.

[6] A. Lubis, S. Syafriandi, M. Idkham, and A. Maulana, “Design and construction of coffee roasting machine with rounding cylinder tube using electric heat source,” *Res. Agric. Eng.*, vol. 69, no. 3, pp. 118–123, 2023, doi: 10.17221/69/2022-RAE.

[7] D. D. Hidayat, A. Sudaryanto, Y. R. Kurniawan, A. Indriati, and D. Sagita, “Development and evaluation of drum coffee roasting machine for small-scale enterprises,” *INMATEH - Agric. Eng.*, vol. 60, no. 1, pp. 79–88, 2020, doi: 10.35633/INMATEH-60-09.

[8] A. A. Mita, A. Imron, and S. T. Sarena,

"Rancang Bangun Alat Penyangrai (Roaster) Kopi dan Penggiling (Grinder) Kopi Otomatis Berbasis Mikrokontroler," *Conf. Des. Manuf. Its Apl.*, vol. 1, no. 1, pp. 155–160, 2017.

[9] P. Prasetyo, T. Sholahudin, D. E. Septiani, I. Azmy, and M. Musyafak, "Rekayasa Ulang Mesin Sangrai Kopi Kapasitas 10 Kg Menggunakan Konveksi," *Pist. J. Tech. Eng.*, vol. 6, no. 2, pp. 14–20, 2023.

[10] G. N. Darmayasa, "Rancang Bangun Mesin Sangrai Kopi Horizontal Dengan Kapasitas 3Kg Rancang Bangun Mesin Sangrai Kopi," Politeknik Negeri Bali, 2023.

[11] I. Sofi', "Rancangbangun Mesin Penyangrai Kopi dengan Pengaduk Berputar Coffee's Roaster Design Machine with Rotating Mixer," *TekTan J. Ilm. Tek. Pertan.*, vol. 6, no. April, pp. 1–70, 2014.

[12] D. I. Tsamroh, "Comparison finite element analysis on duralium strength against multistage artificial aging process," *Arch. Mater. Sci. Eng.*, vol. 109, no. 1, pp. 29–34, 2021, doi: 10.5604/01.3001.0015.0512.

[13] A. Sulistyo and S. Suhono, "Implementasi Teknologi Mesin Sangrai Biji Kopi Semi Otomatis," *J. Teknol. Elektro*, vol. 14, no. 1, p. 8, 2023, doi: 10.22441/jte.2023.v14i1.002.

[14] A. Haslinah, D. Juma, M. S. Hidayat, and R. A., "Rancang Bangun Mesin Penyangrai Kopi Berbasis Mekanis," *ILTEK J. Teknol.*, vol. 18, no. 02, pp. 92–96, 2023, doi: 10.47398/iltek.v18i02.131.