



## Analysis of The Design of Thickness Variations of Pressure Cooker Equipment Using A Strainer

Alfan Dabbar Muqaffi <sup>1</sup>, Prantasi Harmi Tjahjanti <sup>1\*</sup>, Edi Widodo <sup>1</sup>

<sup>1</sup> Muhammadiyah University Sidoarjo, East Java, Indonesia, E-mail: [alfandabbar@gmail.com](mailto:alfandabbar@gmail.com)

<sup>1</sup> Muhammadiyah University Sidoarjo, East Java, Indonesia, Email: [ediwidodo@umsida.ac.id](mailto:ediwidodo@umsida.ac.id)

\*Corresponding Author: [prantasiharmi@msida.ac.id](mailto:prantasiharmi@msida.ac.id)

### Abstract:

**Background.** In micro, small, and medium enterprises (MSMEs) that make pressure milkfish, the majority still use manual pressure cookers, with the pressure showing that the milkfish is cracked, making it less attractive in terms of performance and appearance.

**Aims.** Therefore, the purpose of this research is to design a presto milkfish pot equipped with a filter. The design uses AutoCAD for 2D drawings and SolidWorks software 2023 for 3D. The results obtained have been used to design pressure-cooker equipment with a filter.

**Methods.** The results of the design of pressure cooker equipment using filters with varying pan thicknesses are for Von Mises stress, displacement (shift)/elongation, strain/strain, and Safety Factor (SF).

**Result.** The analysis of all design results was obtained: (a). The results of the Von Mises stress simulation, with varying pressure cooker thickness, show that the wall thickness is directly proportional to the maximum Von Mises stress. So the wall of the pressure cooker with the greatest thickness (3mm) has the maximum voltage value of *Von Mises*, also the greatest (978.0 MPa), (b). The results of the pressure cooker elongation/*displacement* simulation with varying pressure cooker thickness showed that thickness variation was not significant for elongation/*displacement*. The average elongation/*displacement* is 0.008468 mm; the result is quite small, indicating that the thickness of the pan is not related to the elongation of the pressure cooker material at a break or a certain limit (c). The results of the *pressure* cooker strain simulation with the pressure cooker thickness variation, with a value of 0.004613, indicate that the pressure cooker thickness variation is not significant to *the pressure* cooker strain, because the strain obtained does not cause a change in the shape of the pressure cooker equipment, even though the pressure cooker wall has a different thickness

**Conclusion.** Safety Factor simulation results/ *Factor of Safety* (FS) pressure cookers with pressure cooker thickness variations it appears that for the pressure cooker thickness variation, all have an acceptable FS, because the value exceeds the value of 1.

**Keywords:** variations of the thickness of the walls of the presto pan; Von Mises stress; elongation/*displacement*; strain; simulation of Safety Factor



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## INTRODUCTION

Equipment (generally in the form of a pot), Presto is used to process food so that it has a nice, tender texture. This presto method will make food more tender and easy to eat, such as processed chicken and bones, which can then be eaten with the bones, because this presto cooking system will make all ingredients soft and soft-textured. With presto equipment, cooking is faster without taking a long time to become soft, and the food produced is more hygienic and maintains its nutritional content (Maksindo, nd).

Sidoarjo Regency is the second-largest milkfish-producing area in East Java. Sidoarjo milkfish production reaches 34,150 tons, valued at around 750 million rupiah per year. Because of this, milkfish has become a typical souvenir, already legendary. One of the most famous milkfish preparations in Sidoarjo Regency is presto milkfish. This processed milkfish food can be an alternative, especially if you are too lazy to get rid of the duriduri and milkfish bones. Milkfish that has been pressurized becomes softer, making its bones and spines easier to eat with chili sauce and hot rice (Go Food, nd).

This opportunity is widely used by micro, small, and medium enterprises (MSMEs) to create a presto milkfish business; however, the majority still use manual pressure cookers, which, of course, affects the processed food products. Especially for presto milkfish, the pressure results show that the milkfish is cracked (Figure 1a, b, black circle), so, in terms of performance/appearance, it is less attractive.



**Figure 1** Results of cracked presto milkfish (black circles)

The rupture of the presto milkfish is caused by the old model of the presto milkfish pot equipment (Figure 2). The standard model for cooking presto milkfish is to use presto milkfish pot equipment filled with water and spices, soaking the milkfish until the spices are absorbed and the water shrinks. Next, the process of removing the presto milkfish involves

waiting for it to cool (or no longer be hot). The main problem is that when the presto milkfish are removed one by one, the presto milkfish is damaged/broken on its body, so that when fried, it does not look attractive, as shown in Figure 1a, b earlier.



**Figure 2** Old model presto milkfish pot utensils, none Strainer Inside

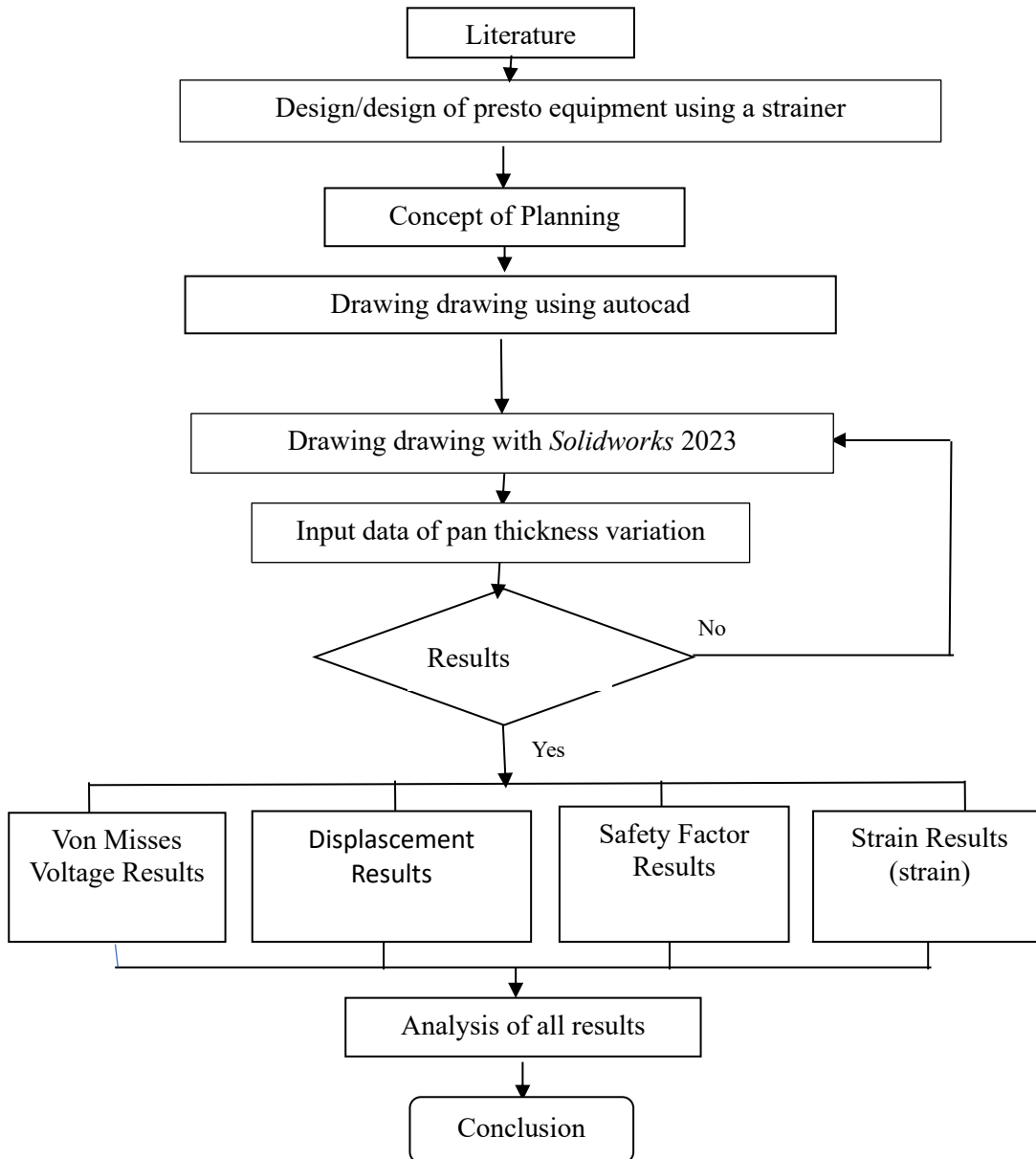
## LITERATURE REVIEW

This study aims to overcome the problem of presto milkfish breaking when lifted by designing a presto milkfish machine/pot equipped with a filter. The design uses AutoCAD for 2D drawing, and SolidWorks 2023 software for 3D (Strimpel, 1997; Beverige & Roseman, 1997). Research using Autodesk software, SolidWorks software, and Autodesk Inventor software includes Autodesk Inventor 2016 to design a tube for clean water from stainless steel 304 and 201 (Putra & Tjahjanti, 2021). In addition, using *Solid Work* 2016 software in simulating the prototype design of a liquid smoke machine from wood waste using a temperature of 400°C (Rivaldi et al., 2026), research on the design of a semi-automatic cup sealer machine for clean water packaging in Sumbergedang Village, Pasuruan (Hamzah et al., 2023), a research entitled *designing a stable and comfortable motorcycle for uneven roads: enhancing mobility for individuals with disabilities* (Tjahjanti, 2024). In addition, research on the design of a semi-automatic plastic cup lid sealing machine (Ivanda et al., 2022) and on the design analysis of folding trolleys (case studies of store and mall tadas) (Hadliri et al., 2023) also uses SolidWorks software.

The purpose of this study is to design pressure cooker equipment using a filter, find out the design results of pressure cooker equipment using a filter with variations in the thickness of the pan, and analyze all the design results obtained for Von Mises voltage, elongation/*displacement* (shift), safety factor, and *strain/strain*.

**METHOD**

The research flowchart is shown in **Figure 3**



**Figure 3** Research *Flow Chart*

The above Flow Diagram can be described as follows:

1. Personal Computer (PC)

The PC is used to design tools using *Autodesk AutoCAD* software and *SolidWorks 2023* as software, with the following specifications:

Computer name: B560M PRO

Operating System: Windows 11 Pro 64-bit

System Manufacturer: MSI

Processor : Intel® Core™ i5 CPU@ 2.90GHz

Memory: 8 GB RAM

2. Autocad Software

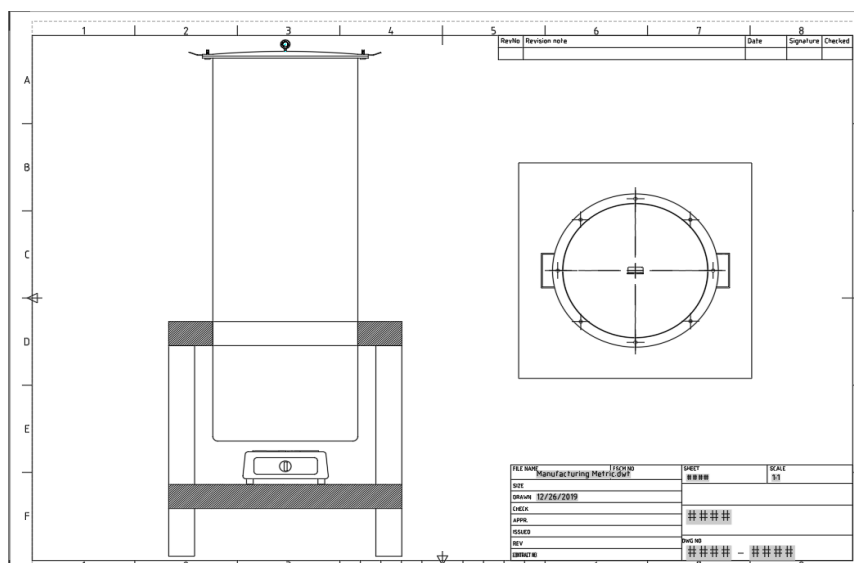
Autocad software is a *computer program that allows you to draw 2D pressure cookers/machines*. Minimum specifications for running the *Autocad* software:

- Operating System: Windows 10 or 11 64-bit operating system
- Processor: Speed 2.5-2.9 GHz
- Memory: 4 GB

3. SolidWorks Software 2023

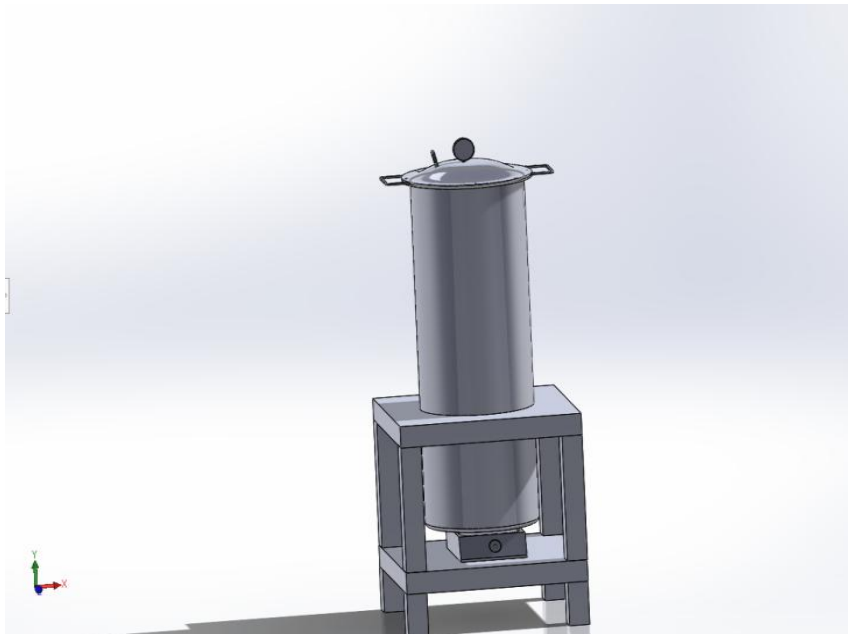
*SolidWorks is a computer software that helps design 3D machines/pressure cookers*. Minimum specifications to run the *SolidWorks* software 2023:

- Operating System: Windows 7,8,10, 11 64-bit operating system
- Processor: Speed 2.5-2.9 GHz
- Memory: 4 GB



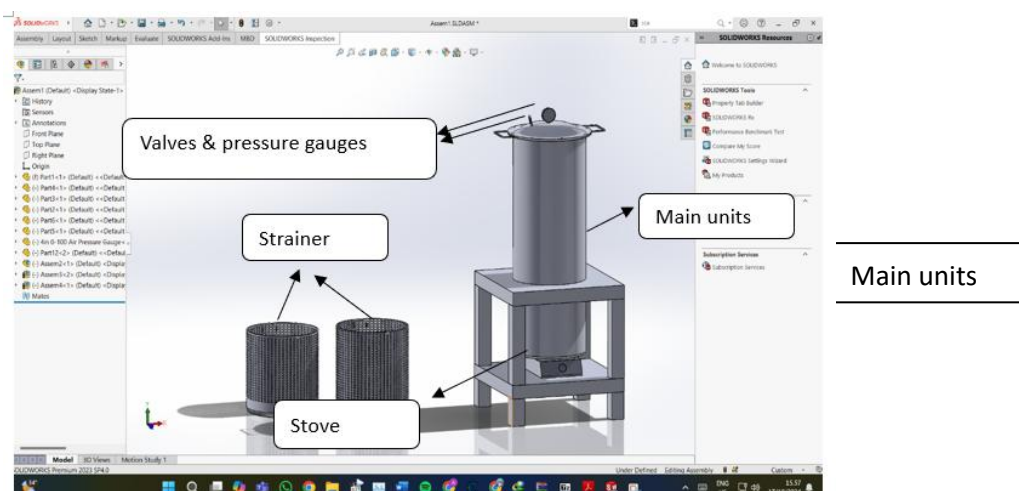
**Figure 4** Design using 2D AutoCAD Pressure Cooker Equipment Wear Strainer  
**Figure 5** Design/design using AutoCAD 2D equipment pressure cooker using a strainer

The provisional results obtained using AutoCAD are shown in Figure 4, while the design/design results using the 2023 SolidWorks file are shown in **Figure 5**. The engine/presto paci with a strainer has a machine height of 600 mm, a filter height of 300 mm (from the bottom of the pan), and a machine diameter of 280 mm.



**Figure 6** Design/design using SolidWorks 3D pot equipment Presto uses a strainer with its stove holder

The pressure cooker equipment has several main components, namely the main pressure unit, pressure gauge, pressure opening valve, filter, and stove. as shown in **Figure 6**



**Figure 7** Main components of pressure cooker equipment

**Von Misses voltage**

The Von Mises voltage is defined as the uniaxial tensile voltage that produces the same distrophic energy as a working combination of voltages. *Stress* is a collection of forces on the surface of an object. The narrower the surface area, the greater the stress when the force is fixed. The greatest voltage is indicated by the reddest color and the smallest voltage is indicated by the bluest color, while the medium area is indicated by light blue yellow-green (Tjahjanti et al., 2026). Mathematically, the definition can be written as:

$$\sigma = \frac{F}{A} \dots\dots\dots(2.1)$$

Description:

- σ : Voltage or force of the association area (N/m<sup>2</sup>)
- F : Style (N)
- A : Cross-sectional area (m<sup>2</sup>)

**Displacement/Elongation**

*Displacement/Elongation* is the percentage elongation of a material after it has been drawn to a specified break or limit, often used in tensile tests of materials such as plastics, metals, and threads to measure ductility. It is the result of static structure analysis using the 25-element method, namely *deformation* or *displacement* (Haryanti et al., 2021). *Displacement/Elongation* (%) is measured from the initial neutral surface to the neutral position after deformation and represents the total elongation of a material when it is pulled to break, indicating its ductility. So elongation is a measure of final ductility. shown in equation (2.2).

$$Displacement/Elongation (\%) = \frac{\Delta L}{L_0} \times 100\% \dots\dots\dots (2.2)$$

Description:

- ΔL = change in length (final length - initial length)
- L<sub>0</sub> = initial length.

**Safety Factor**

*Safety Factor* (SF) is a factor that shows the level of ability of an engineering material to accept external loads, namely compressive or tensile loads, which is the ratio between the maximum strength of the material and the working stress (actual load), Generally ductile materials (such as steel) use yield stress, while brittle materials (such as concrete) use ultimate strength. It shows how much overload the structure can withstand before it fails. SF equation based on material type

- Ductile Material (e.g. Steel):

$$Safety\ Factor\ (SF) = \dots\dots\dots(2.3) \frac{Kekuatan\ Luluh\ (Yield\ Strength)}{Tegangan\ Kerja\ (Working\ Stress)}$$

- *Brittle Material* (e.g. Concrete):

$$Safety\ Factor\ (SF) = \dots\dots\dots(2.4) \frac{Kekuatan\ Ultimit\ (Ultimate\ Strength)}{Tegangan\ Kerja\ (Working\ Stress)}$$

An SF value of > 1 means safe, and < 1 means it will be damaged

**Strain**

Strain is a geometric measure of the relative displacement of particles in a material. *Strain* is caused by external resistance or load, and is a measure of how far the stem changes shape [11]. *Strain* is a comparison of the increase in length when it is applied (deformation), and is a description of the deformation *when it occurs*. The greater the stretch, the easier it is to deform. Mathematically, stretches can be written with equations (2.5):

$$\epsilon = \dots\dots\dots(2.5) \frac{\Delta L}{L_0}$$

Description:

- ε : Stretch
- ΔL : Increase in length (mm)
- L : Initial length (mm)

**The difference between Elongation/Displacement and Strain** is shown in **Table 1**.

**Table 1.** The Difference Between Elongation/Displacement and Strain

	Measurement Time	Concept	Relationships
Elongation/ Displacement	The final value after the object breaks	Final ductility indicator	Calculated based on the change in cumulative length
Strain/Strain	Measured throughout the loading process	Deformation size	Measured in strain during tensile tests

**Material Properties of Stainless Steel**

The material for the pot device design is Stainless Steel 304, with its properties shown in **Table 2**.

**Table 2** Properties of Stainless Steel 304 material

No.	Properties	Stainless Steel 304
1.	Density (g/cm <sup>3</sup> )	8000
2.	Poisson's Ratio	0.29
3.	Modulus of Elasticity (GPa)	193
4.	Tensile Strength (MPa)	505
5.	Yield Strength (MPa)	205

## DISCUSSION

### Results of the Pressure Cooker Equipment Design

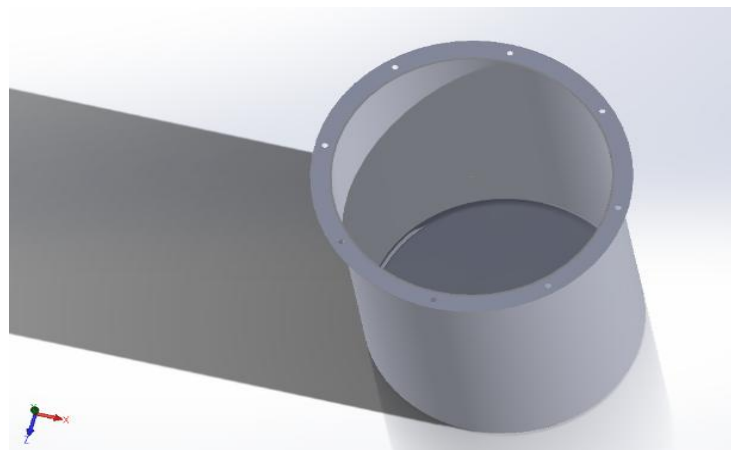
The design of pressure cooker equipment has several main components: the main unit, pressure gauges, pressure-opening and closing valves, and stoves. While the supporting components are: lower stand, upper stand, stand height, lower legs, lower legs, lower legs,

### Pressure Cooker Equipment Design

The design of pressure cooker equipment is made by:

- Make 2 circles with a diameter of 280mm and 320mm each, and make a line on 8 sides for the benchmark.
- Make *sketch circles* on the 8 sides that have been pegged earlier with a diameter of 6mm each.
- Select the *features* menu, then click *extrude boss* with a size of 5 mm
- Choose an *extrude boss* size of 800mm on a circle with a diameter of 280mm
- To smooth the edges at the bottom of the *extrude boss*, select *the fillet* and then type 10mm for the radius.
- Create a hole by clicking *features*, select *the shell*, and give it a thickness varying from 1 up to 3mm

The results of the pressure cooker equipment design are shown in **Figure 8**



**Figure 8:** Pressure cooker equipment design

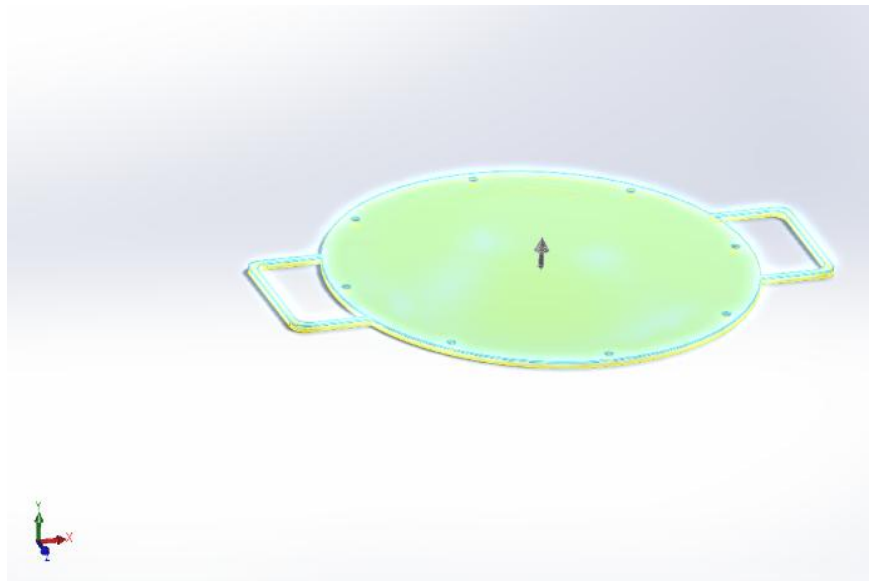
### Pressure Cooker Cap Equipment Design

The design of the pressure cooker cap equipment is made by:

- Select *the top plane*, click *sketch*, click circle with a diameter of 320mm, then select *the centerline* and make an 8-sided benchmark.
- Select a sketch and then make a circle with a diameter of 6mm on the 8 sides of the benchmark that has been made earlier.

- c. Select the sketch, then make 2 rectangles with lengths and widths of 52x100mm and 58x110mm, respectively, then select the fillet with a radius of 10mm to smooth the edges, do the same on the other side.
- d. Next, select *the extrude boss* with a size of 4mm.
- e. Then click features and then select *deform*, click *deform type point*, *deform point* with a height of 30mm, and deform region with a diameter of 280mm.

The results of the pressure cooker cap design are shown in **Figure 9**.



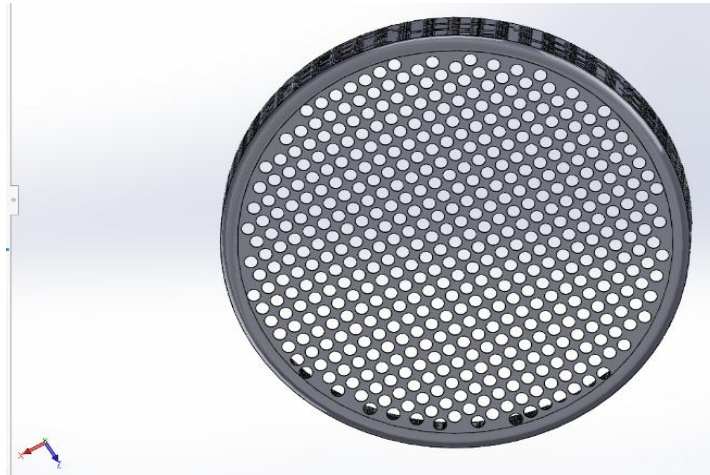
**Figure 9.** Results of the design of the pressure cooker equipment cap

### Bottom Screening Plan

- a. Select *the top plane*, click *sketch circle* with a diameter of 278 mm, then select the *features menu*, click *extrude boss*, size 300 mm.
- b. Select *the sketch* at the top of the workpiece, click circle diameter 278 mm, then select the features menu, click on *the shell* size 5 mm.
- c. Next, to smooth the edges of the lower workpiece, select *the features*, click the fillet, and then type 10mm for the radius.
- d. Select *the front plane*, click *sketch circle* 8 mm diameter, then select the *features menu*, click *wrap*, select *wrap type*, *deboss*, *wrap method*, *analytical*, and *depth* 5mm
- e. Select *the features* menu, click *the circular pattern*, select *the 3600* spacing, *60 instances*, and *features and faces wrap*.
- f. Select the *features menu*, click *linear pattern*, select *10 mm* spacing, *instances 29*, and *features and faces circular pattern*.

- g. Select *the sketch* at the bottom of the workpiece, click *sketch circle* 8 mm diameter, select the *features menu*, click *linear pattern*, select *spacing 10 mm*, *instances 530*, and *entities to pattern arc1*, then *cut extrude 5 mm*.

The results of the bottom strainer design for the pressure cooker equipment are shown in **Figure 10**.

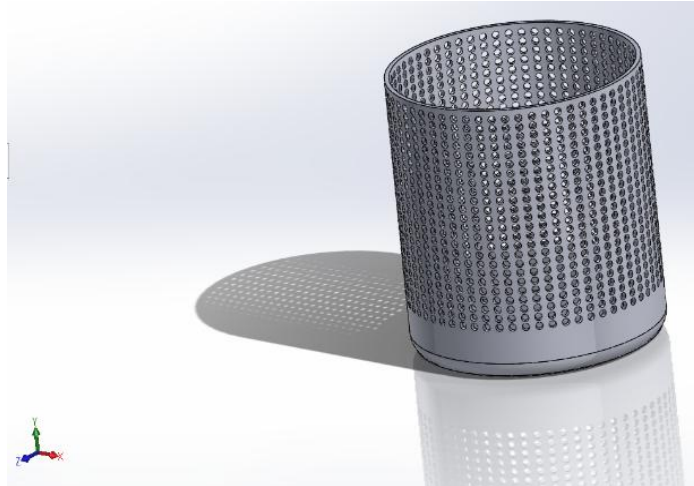


**Figure 10:** Results of the design of the pressure cooker equipment under the strainer (seen from above)

#### **Strainer Skin/Wall Plans (Strainer Strainer)**

- a. Select *the top plane*, click *sketch circle* with a diameter of 276 mm, then select the *features menu*, click *extrude boss*, size 300 mm.
- b. Select *the sketch* at the top of the workpiece, click the circle diameter 276 mm, then select the *features menu*, click *the 5 mm shell*.
- c. Next to smooth the edges of the lower workpiece, select *the features*, click *the fillet*, and then type 10mm for the radius
- d. Select *the front plane*, click *sketch centerline* height 10mm, then *circle* diameter 8 mm, then select the *features menu*, click *wrap*, select *wrap type, deboss, wrap method, analytical, and depth 5mm*
- e. Select the *features menu*, click *the circular pattern*, select *the 3600 spacing, 60 instances, and features and faces wrap*.
- f. Select the *features menu*, click *linear pattern*, select *10 mm spacing, 24 instances, and features and faces circular pattern*.

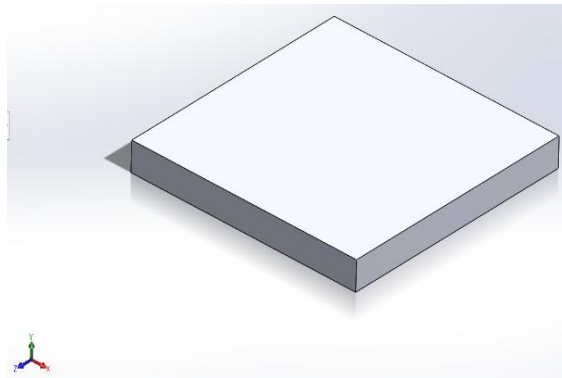
The results of the filter design of the pressure cooker equipment are shown in **Figure 11**



**Figure 11.** Result of the skin/wall design of the filter (around the filter) pressure cooker equipment (viewed from the side)

### Bottom Stand Design

The first step is to select *the top plane* and then select *the sketch*. Next, a square is made by clicking a line with a length and width of 450mm. After that, make the height of the mount by choosing *a boss extrude* with a size of 50mm. The results of the lower stand design are shown in **Figure 12**.

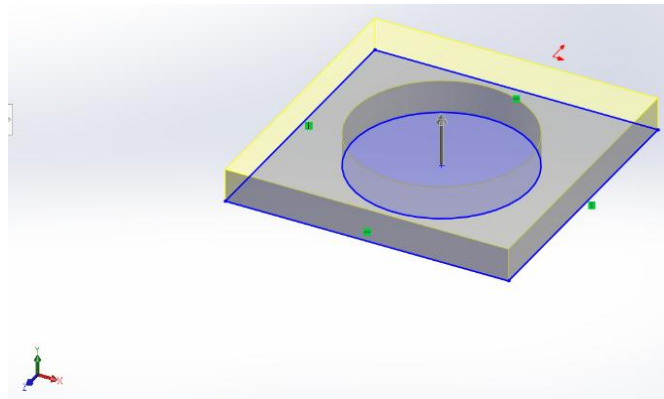


**Figure 12** Results Bottom mount design results

### Top Stand Plan

- a. Select the top plane, then draw a square by clicking on a line with a length and width of 450mm. Next, draw a circle with a diameter of 280mm.
- b. Next, make the height of the mount by choosing a boss extrude with a size of 50mm.

The results of the upper stand design are shown in **Figure 13**

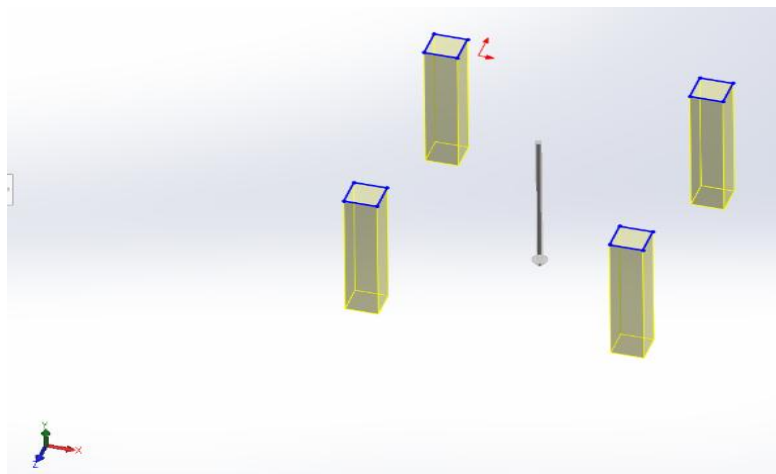


**Figure 13**Top-mount design results

### Upper leg plan

- a. Select the top plane Then draw a square as a benchmark by clicking on *the centerline* with a length and width of 350mm
- b. Next, make a square in the four corners with a size of 50x50mm
- c. Select *the extrude boss features* with a size of 290 mm.

The results of the upper legs are shown in **Figure 14**.

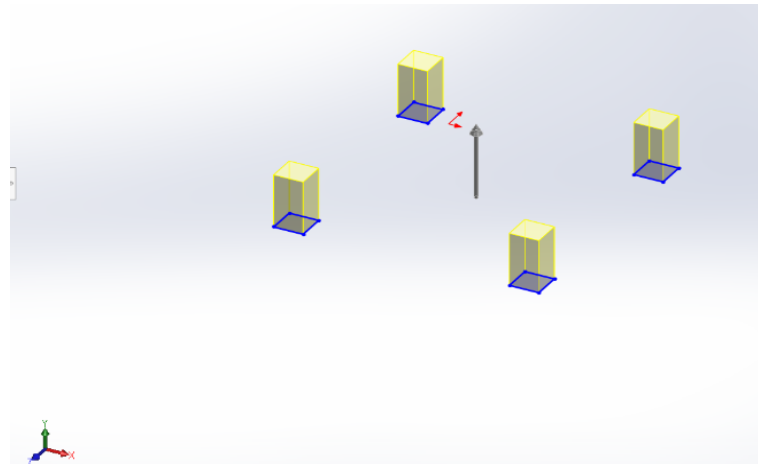


**Figure 14** Results of the upper legs plan

### Lower Leg Plan

- a. Select *the top plane* then the square image as a benchmark by clicking.
- b. Made square at all four corners with a size of 50x50mm
- c. Next, select *the extrude boss features* with a size of 100 mm.

The results of the lower legs are shown in **Figure 15**.



**Figure 15** Results of the lower legs

### **Simulation of Design Results**

The design simulation carried out in this study is when pressure cooker equipment is applied. In the process of simulating the load conditions provided by the pressure cooker in a static state. The simulation process carried out on pressure cookers uses the pressure type in *the Solidworks software*. The simulation process carried out in the analysis of this pressure cooker uses static loads obtained from the pressure required during the pressure process, static simulation analysis is used to determine *Von Misses stress, strain, displacement and safety factors*.

### ***Von Misses Stress Simulation Results***

**Figure 16** shows the results of *the Von Misses stress* simulation with a pressure of 1.5 Barr on the variation of the pressure pan wall thickness. The *maximum Von Mises stress* value for a 1mm pan thickness is 133.8 MPa, a 2mm pan thickness is 928.5MPa (**Figure 17**), and a 3mm pan thickness is obtained as 978.0 MPa (**Figure 18**).

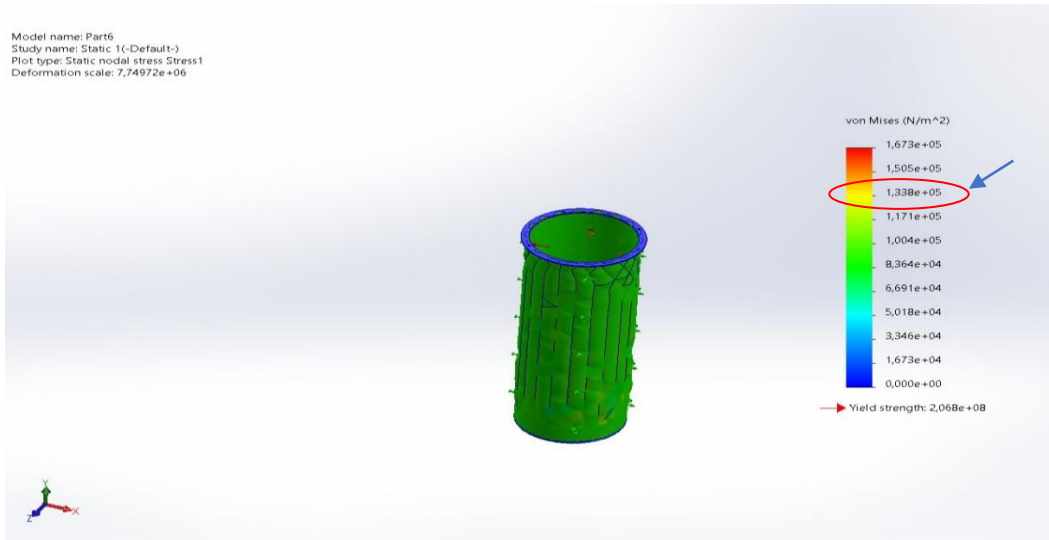


Figure 16 Simulation results of Von Misses stress for 1mm thick pressure cooker

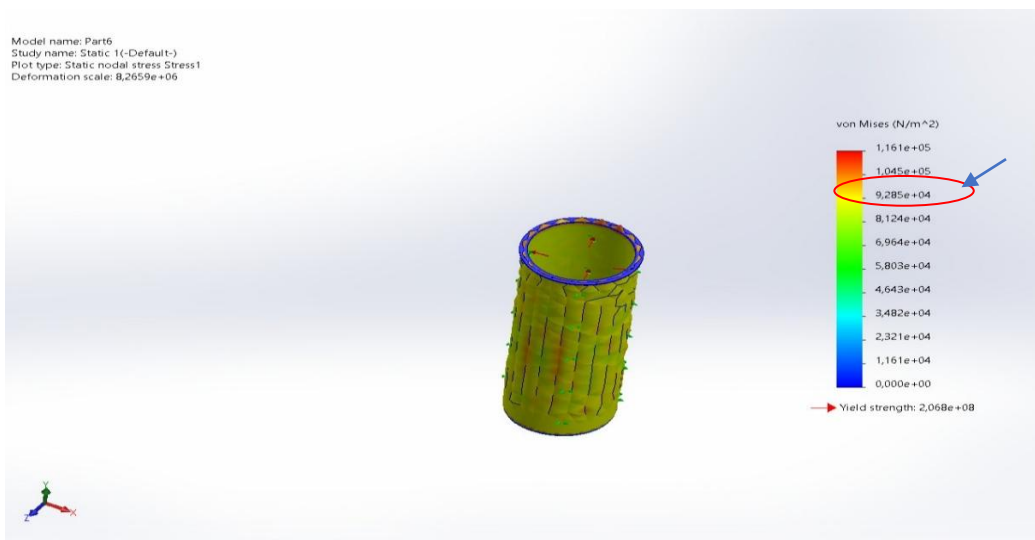


Figure 17 Von Misses stress simulation results for 2mm thick pressure cooker



Figure 18 Simulation results of Von Misses stress for 3mm thick pressure cooker

The complete results of *the Von Misses stress* simulation with pressure plate thickness variations are shown in **Table 3** From Table 3.1 it appears that the wall thickness of the pressure cooker is directly proportional to the maximum voltage *of the Von Misses*. So the wall of the pressure cooker with the largest thickness (3mm) has the maximum voltage value *of Von Misses* as well as the largest (978.0 MPa).

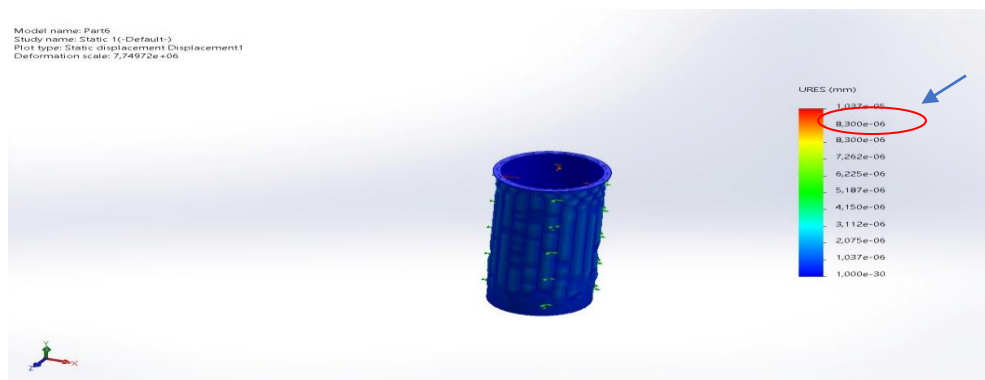
**Table 3** Simulation results of *Von Misses stress* with pressure of 1.5 Barr to variations in the thickness of the pot.

Ye s	Pressure Pan Wall Thickness Variations	Results of <i>the Von Misses stress</i> (MPa) simulation test
1	1 mm	133,8
2	2 mm	928,5
3	3 mm	978,0

**Displacement Simulation Results**

**Figure 19** shows the results of the simulation of pressure cooker elongation/*displacement* with a pressure of 1.5 Barr on the variation of the pressure cooker wall thickness. The maximum *displacement* value for a 1mm pan thickness is 0.008300, a 2mm pan thickness is 0.008350 mm (**Figure 20**), and a 3mm pan thickness is obtained as 0.008754 mm (**Figure 21**).

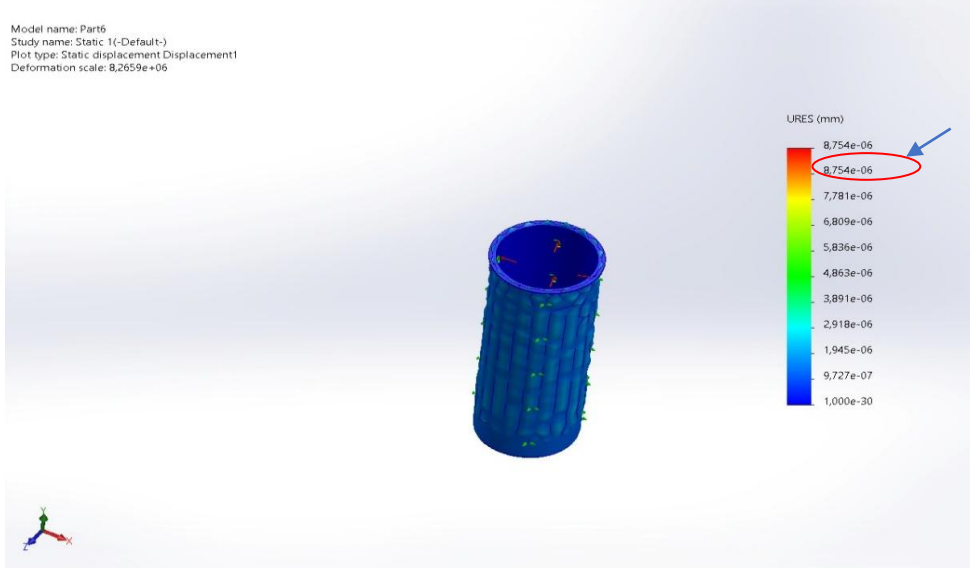
The complete results of the pressure cooker elongation/*displacement* simulation with variations in pressure cooker thickness are shown in **Table 4**. From Table 4, it appears that the variation in pressure cooker thickness is not too significant for elongation/*displacement*.



**Figure 19** Displacement simulation results for 1mm thick pressure cooker



**Figure 20** Displacement simulation results for 2 mm thick pressure cookers



**Figure 21** Elongation/*displacement simulation* results for 3 mm thick pressure cooker

The *displacement* of the pressure cooker, with an average of 0.008468 mm, because thickness is not related to the elongation of the pressure cooker material/material after being pulled to a break or a certain limit.

**Table 4** Results of simulation of elongation/*displacement* of pan thickness variation.

Ye s	Pressure Pan Wall Thickness Variations	Elongation/ <i>displacement</i> <i>simulation results</i> (mm)
1	1 mm	0,008300
2	2 mm	0,008350
3	3 mm	0,008754
Average		0,008468

### Strain/Strain Simulation Results

Figure 22 shows a simulation of pressure cooker strains with a pressure of 1.5 Barr on the variation in the thickness of the pan. The maximum strain value for a 1mm pan thickness is 0.005157, a 2mm pan thickness is 0.004668 mm (Figure 23), and a 3mm pan thickness is obtained as 0.004214 mm (Figure 24).

The complete results of the pressure plate strain simulation with pressure plate thickness variations are shown in Table 5 From Table 5 it appears that the variation in pressure cooker thickness is not significant to the strain of the pressure cooker, because the strain obtained does not cause a change in the shape of the pressure cooker's equipment, even though the pressure cooker's wall has a different thickness.

Table 5 Strain/strain simulation results on pan thickness variations.

Ye s	Pressure Pan Wall Thickness Variations	Strain/Strain simulation results (mm)
1	1 mm	0,005157
2	2 mm	0,004668
3	3 mm	0,004214
Average		0,004613

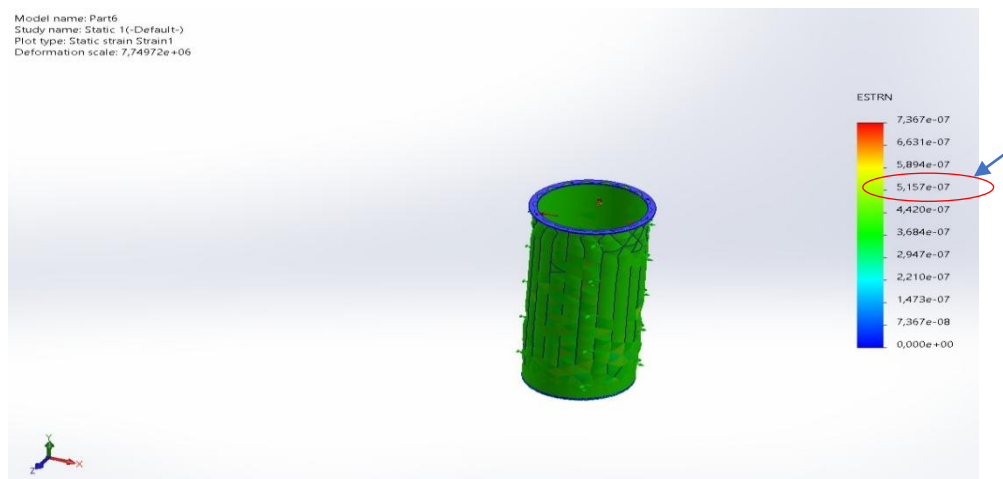
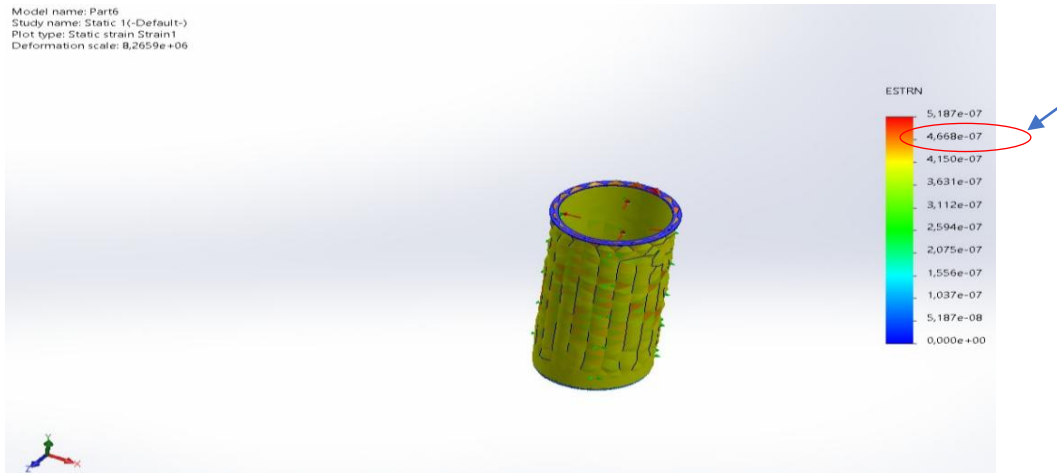
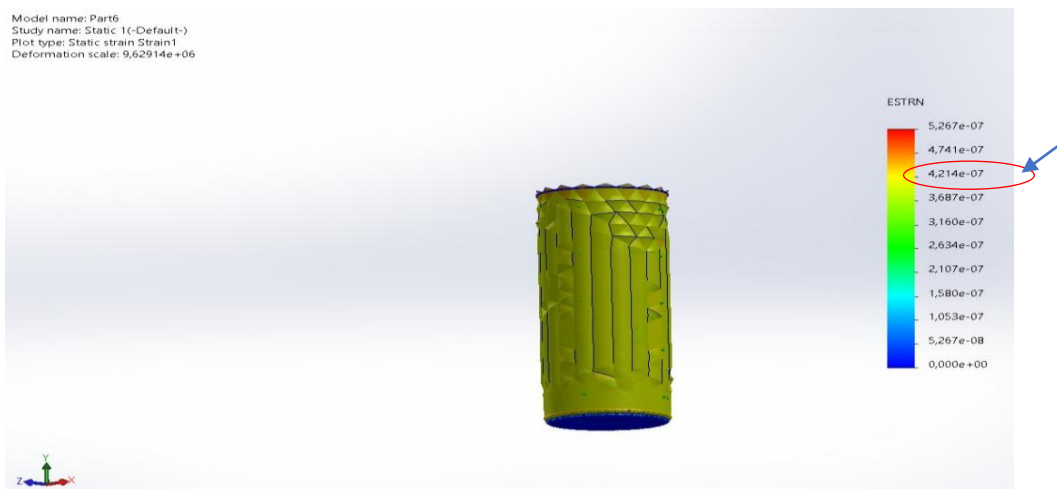


Figure 22 Strain/strain simulation results for 1mm thick pressure cooker



**Figure 23** Strain/strain *simulation results* for 2mm thick pressure cooker



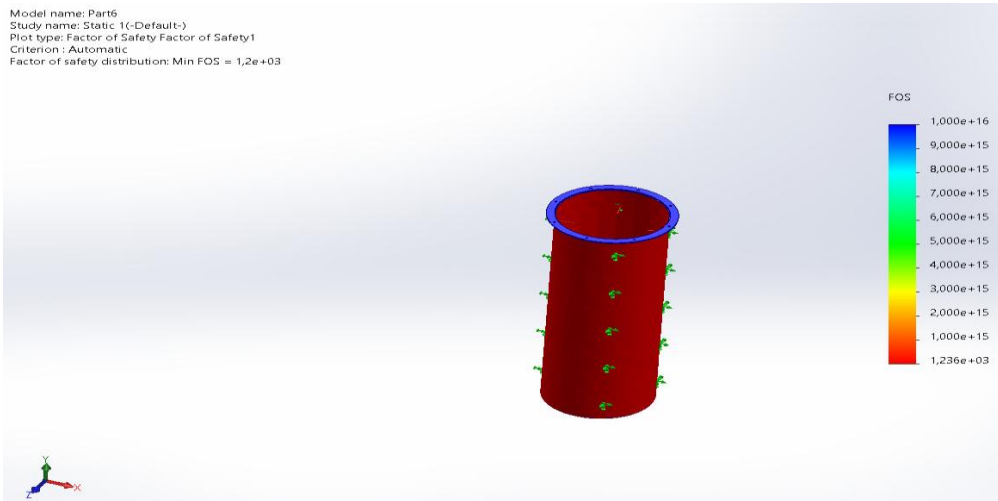
**Figure 24** Strain/strain *simulation results* for 3 mm thick pressure cooker

### **Factor of Safety Simulation Results**

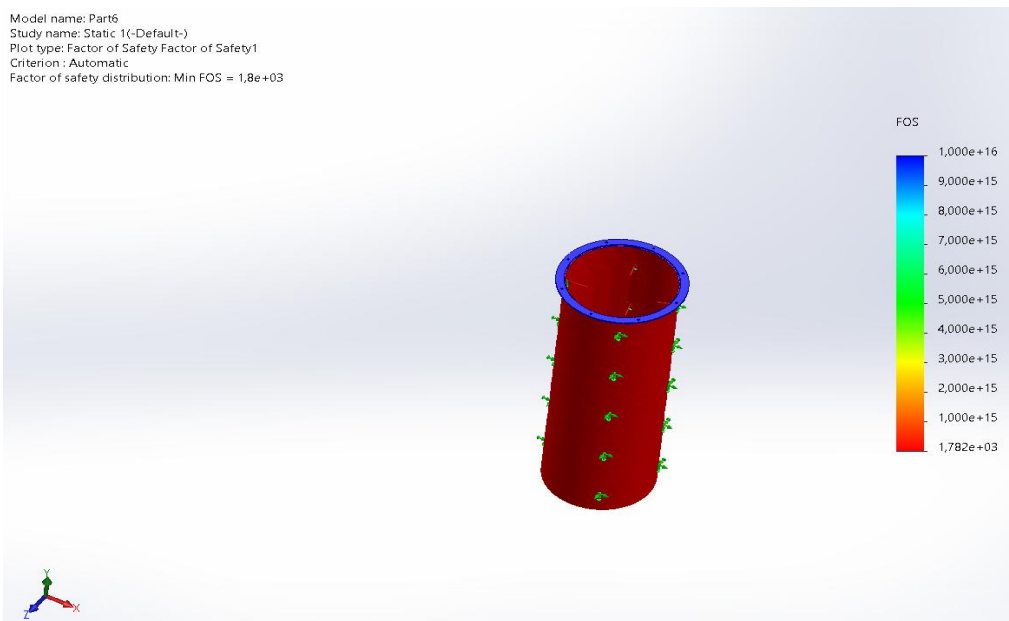
**Figure 25** shows the results of the simulation of the Factor of Safety (FS) of pressure cookers with a pressure of 1.5 Barr on the variation in the thickness of the pan. It was obtained that the FS with a thickness of 1 mm had a value of 1,236,000, for a thickness of 2 mm, it had an FS of 1,782,000 (**Figure 26**) and a thickness of 3 mm had an FS result of 1,692,000 (**Figure 27**). The complete results of the simulation of the Factor of Safety (FS) pressure cooker with variations in pressure cooker thickness are shown in **Table 6**. From Table 6 it appears that for the above variations in pressure cooker thickness, all have an acceptable FS, because the value exceeds the value of 1 (one).

**Table 6** Strain/strain *simulation results* on pan thickness variations.

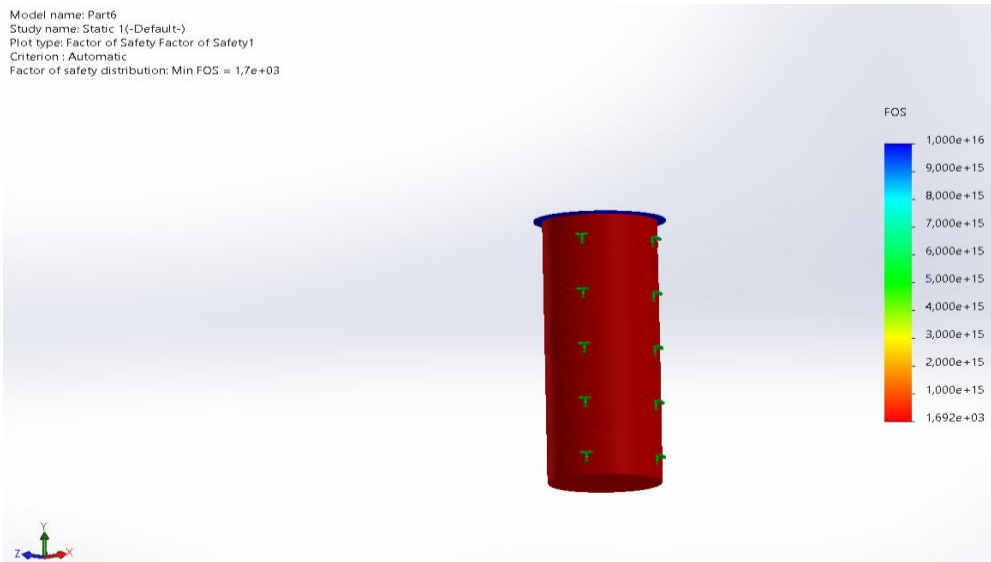
Yes	Pressure Pan Wall Thickness Variations	Strain/ <i>Strain</i> simulation results (mm)
1	1 mm	1.236.000
2	2 mm	1.782.000
3	3 mm	1.692.000



**Figure 25** Factor of Safety *simulation results* for 1 mm thick pressure cooker



**Figure 26** Factor of Safety *simulation results* for 2 mm thick pressure cookers



**Figure 27** Factor of Safety *simulation results* for 3 mm thick pressure cookers

## CONCLUSION

The conclusions of the study are:

1. The design/design of pressure cooker equipment has been carried out using a filter.
2. The results of the design of pressure cooker equipment using filters with variations in the thickness of the pan are for Von Misses tension, *displacemement* (shift)/elongation, *strain/strain*, and *Safety Factor/SF* (Safety Factor),
3. An analysis of the entire results of the planning was obtained:
  - a. The results of *the Von Misses stress simulation* with the variation in pressure cooker thickness show that the thickness of the pressure cooker wall is directly proportional to the maximum voltage *of the Von Misses*. So the wall of the pressure cooker with the largest thickness (3mm) has the maximum voltage value *of Von Misses* as well as the largest (978.0 MPa).
  - b. The results of the pressure cooker elongation/*displacement simulation* with the pressure cooker thickness variation showed that the pressure cooker thickness variation was not too significant to the pressure cooker's elongation/*displacement*. The average value of elongation/*displacement* is 0.008468 mm, the result is quite small, meaning that the thickness of the pan is not related to the elongation of the pressure cooker material/material after being pulled to a break or a certain limit.
  - c. The results of the pressure cooker strain simulation with the variation in pressure cooker thickness with a value of 0.004613, it appears that the variation in pressure cooker thickness is not significant to *the strain* of the pressure cooker, because the

strain obtained does not cause a change in the shape of the pressure cooker equipment, even though the pressure cooker wall has a different thickness.

- d. The results of the simulation of the Factor of Safety (FS) of pressure cookers with variations in pressure cooker thickness show that for the variety of pressure cooker thickness, all have acceptable FS, because the value exceeds the value of 1 (one).

The suggestions in this study are:

1. The design/design of pressure cooker equipment using a more complete filter is made with pressure variations, not only 1.5 Barr.
2. Temperature variations are also carried out in cooking milkfish in pressure cooker equipment using a strainer

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