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Effect of Pressure and Time of Blow Pin on Thickness of Abfal Mouth of 125 ml EL Bottle Extrusion Blow Molding Process

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ABSTRACT

PT X produces bottles using extrusion blow molding machines that produce EL 125-ml bottles of polypropylene borealis material. In the production process, there is a process of cutting the remaining material at the mouth of the bottle, called abfal. The separation of the abfal from the bottle mouth is still done manually by the operator before the product enters the quality control camera area. This research is experimental, comparing the pressure parameters and blow pin time with the thickness of the abfal mouth using an optical profile projector measuring instrument. In the variation of pressure parameters to the thickness of the abfal mouth, the thinnest occurred in the variation of blow pin pressure fast 80 kg/cm² and blow pin pressure slow 70 kg/cm² by 0.085 mm, and the size of the thickest abfal mouth occurred in the variation of blow pin pressure fast 60 kg/cm² and blow pin pressure slow 50 kg/cm² by 0.195 mm. In the variation of time parameters to the thickness of the abfal mouth, the thinnest occurred at a blow pin time of 1.4s by 0.085 mm, and the size of the thickest abfal mouth occurred at a blow pin time of 1.2s amounting to 0.195 mm. The results showed that the thickness of the abfal mouth is thinner if the pressure and time of the blow pin are given greater, and vice versa, if the pressure and time of the blow pin are given smaller, then the size of the abfal mouth is thicker.

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1. Introduction

PT X Company is a company that produces packaging bottles. One of the production processes is using extrusion blow molding machines. This year, PT X Company is focusing on improving production efficiency and starting towards Industry 5.0, which refers to the continued development of technology-driven industrial evolution. It is the next step after Industry 4.0, which focuses on automation, connectivity, and the use of data in the production process. The use of robots or automation can improve production efficiency. Robots can work non-stop with high consistency, reducing production time and increasing overall output.

In the 125-ml EL bottle extrusion blow molding process, there is a trimming process to cut off the remaining material at the mouth of the bottle, which we usually call abfal. For now, the separation of abfal from the mouth of the bottle and the first quality control of the product are still done manually by the operator; therefore, the company is innovating for the process to be carried out by the product quality control camera. Before the product enters the camera area for product quality control, Abfal on EL125-ml bottle products must be separated from the bottle mouth.

In the bottle extrusion process, the influence of blow pin pressure and time on the extrusion process can be a key factor affecting the thickness of the abfal. Therefore, it is necessary to conduct research to explain how variations in blow pin pressure and time can affect the thickness of the abfal. The object of study is the pressure and time parameters of the blow pin on a Parker PK 50 CD machine that produces bottles using polypropylene (PP) borealis plastic material. Nowadays, the use of plastic is increasingly popular because it is strong and not easily damaged by weathering. The need for plastic consumption in

Indonesia is quite large; the Indonesian Olefin Aromatic and Plastic Industry Association (Inaplas) states that plastic consumption in 2020 will reach 6.2 million tons. Almost all human activities use plastic, whether for daily equipment such as household appliances, product packaging, beverage bottles, or cosmetic equipment. The need, interest, and purchasing power of the community's plastic consumption are quite large, making companies in the field of plastic packaging innovate their products [1].

One of the most commonly used plastic processing methods is blow molding. Blow molding is the process of making a plastic-based product that is heated and produces a parison, then clamped by a tool in the form of a mold with a certain shape and type and developed in a mold using air pressure. Blow molding is widely chosen as a method of plastic processing because it has several advantages, including a higher production capacity that can make a lot of stock in a short time, lower costs and minimal use of labor, and little residual use of plastic base material. The blow molding process is influenced by the relationship between material properties, mold shape, machine capacity, cutting process, and process parameters. Process parameters and tools on the blow molding machine affect the tooling lifetime of the machine. In the blow molding process, parameters such as heater barrel zone temperature setting, cutting delay, cutting time, bottom deflasing delay, bottom deflasing time, blow pin preassure, blow pin speed, blow pin post it, blow pin time, mold preassure, mold speed, mold post it, and mold delay [2].

2. Method

This research is experimental type which is used to find out the difference between one different treatment on the same object with 2 different parameter setting sources. Where a parameter setting of pressure and blow pin time on a parker type extrusion blow molding machine, will be compared with the abfal mouth through measurement using a measuring instrument in the form of an optical profile projector. This experimental research method is carried out to obtain data results that will refer to the results of the best parameter settings of the pressure and time of the blow pin on the thickness of the abfal mouth.

2.1. Material

EL 125-ml bottle products using polypropylene material have a fairly high melting point (190–200 °C), while the crystallization point is between 130 and 135 °C. Polypropylene has high chemical resistance, but its impact strength is low [3].

2.2. Blow Molding Process

This process is aimed at making hollow products. The process is carried out by molding the workpiece (hollow product). The steps taken are to blow air with a certain pressure into the material. After that, the material will come out or go down, and then the two hemispheres of the mold will clamp the material. In order for the material to expand at the bottom, there is a blower that functions to inject air into plastic material that has not yet hardened [4].

2.3. Blow Molding Machine Parts

According to [5], the main stages of the blow molding process can be briefly explained as follows:

a. Thermoplastic material is heated until its melting state is reached.
b. Then the melt is extruded through the die head to form a hollow tube commonly known as a parison.
c. Parison is then dropped between two circular mold parts, which are then inflated with a driving fluid.
d. The thermoplastic melt will then undergo hardening due to the cooling process provided by the mold.
e. After reaching the optimum cooling time, the mold will open and the final product will fall due to the force of gravity or other automatic drives.

3. Results and Discussion

This research was conducted in January–April 2024 and was conducted at PT X Surabaya. The extrusion blow molding machine used is the Parker type, and the material used is polyprophylene borealis. From this research data, two variables were taken from the extrusion blow molding machine, namely blow pin down pressure and blow pin down time.

3.1. Layout of Abfal Mouth Thickness Data Results

The following is a table of abfal mouth thickness data results obtained from each parameter setting change.

Table 1. Abfal Mouth Thickness Data Results

No	BLOW PIN TIME (Secound	BLOW PIN DOWN PRESSURE		ABFAL MOUTH THICKNESS SAMPLE						Total (pcs)
		Fast (kg/cm^2)	Slow (kg/cm^2)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	5 (mm)	6 (mm)	
1		80	70	0.100	0.105	0.095	0.110	0.115	0.085	6
2	1.4	70	60	0.135	0.140	0.145	0.130	0.125	0.140	6
3		60	50	0.155	0.170	0.160	0.165	0.170	0.165	6
4		80	70	0.125	0.135	0.125	0.140	0.120	0.145	6
5	1.3	70	60	0.155	0.175	0.160	0.165	0.160	0.175	6
6		60	50	0.175	0.170	0.170	0.175	0.165	0.175	6
7		80	70	0.140	0.145	0.155	0.160	0.145	0.155	6
8	1.2	70	60	0.165	0.175	0.165	0.180	0.155	0.175	6
9		60	50	0.185	0.180	0.175	0.195	0.175	0.185	6

From the data of the abfal mouth thickness results, the maximum, minimum, difference, and average thickness of each parameter setting change are obtained.

Table 2. Max, min, difference, and average thickness data of the abfal mouth

No	Thickness			
	Maximum (mm)	**Minimum (mm)**	**Difference (mm)**	**Average (mm)**
1	0.155	0.085	0.030	0.102
2	0.145	0.125	0.020	0.136
3	0.170	0.155	0.015	0.165
4	0.145	0.120	0.025	0.132
5	0.175	0.155	0.020	0.165
6	0.175	0.165	0.010	0.172
7	0.160	0.140	0.020	0.150
8	0.180	0.155	0.025	0.169
9	0.195	0.175	0.020	0.183

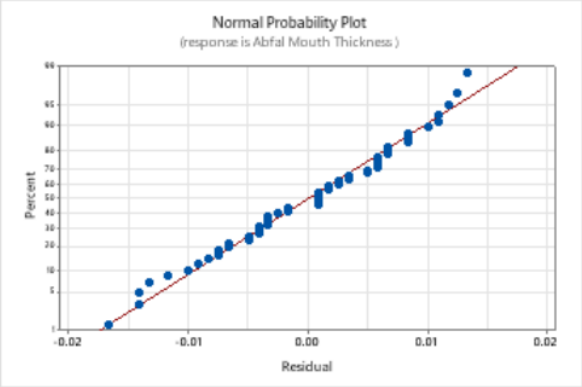
In the table above, there are blow pin down fast pressure parameters between 80 kg/cm^2 and 60 kg/cm^2 and blow pin down slow pressure parameters between 70 kg/cm^2 and 50 kg/cm^2. The selection of blow pin pressure variations is appropriate because if the press parameter is below 50 kg/cm^2, then the pressure has no impact on the product and does not work. If the press parameter is above 80 kg/cm^2, the energy consumption required tends to be too large. For a blow pin time length below 1.2s, if given a blow pin pressure above 80 kg/cm^2, there is a risk of the cutting sleeve part on the blow pin colliding with the striker plate part on the mold. Both parts are used to cut the abfal located at the mouth of the bottle.

From the data table above for each treatment, the parameter setting changes of blow pin down pressure and blow pin down time in printing EL 125 ml products 3 times, resulting in 9 products, and each product is measured for the thickness of the abfal mouth 6 times so that the abfal mouth thickness

size is obtained as much as 54 data points, after which each measured maximum, minimum, and average thickness data point is taken, which will be used to calculate size deviations. From the table of abfal mouth thickness data results, the smallest average obtained is 0.080 mm, which is produced by blow pin down pressure fast 80 kg/cm², blow pin down pressure slow 70 kg/cm², and blow pin press time 1.4 s. The data obtained will be processed using the same method. The data obtained will be processed using software, and the results of the analysis will be shown in Figure 1, a normal probability plot.

3.2. Data Analysis of Abfal Mouth Thickness

Data analysis of the results of the effect of pressure and time on the thickness of the abfal mouth using the DOE Taguci method is as follows:



Figur 1. Normal Probabylity Plot

Normality detection is done by looking at Figure 1. The normal probability plot graph shows that the data used is normally distributed. To test whether the data distribution is normal or not, which compares the cumulative distribution of the actual data with the cumulative distribution of the normal distribution If the data spreads around the line and follows the direction of the diagonal line, the regression model fulfills the assumption of normality. Therefore, it can be said that this research meets the statistical requirements where the data must be normally distributed. Thus, it can be said that the main requirements in this study have been met and can be processed by quantitative statistical analysis.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	0.030837	0.003855	58.80	0.000
Linear	4	0.029085	0.007271	110.92	0.000
WAKTU	2	0.010370	0.005185	79.10	0.000
TEKANAN	2	0.018715	0.009357	142.74	0.000
2-Way Interactions	4	0.001752	0.000438	6.68	0.000
WAKTU*TEKANAN	4	0.001752	0.000438	6.68	0.000
Error	45	0.002950	0.000066		
Total	53	0.033787			

Figur 2. Analysis of variance

Analysis of Variance shown in Figure 2: Analysis of Variance In this study, we used an alpha value of 5%, or 0.05. The alpha value referred to here is the maximum amount of error that can be accepted. From the results of this study, the p-value of blow pin down pressure and blow pin down time is less than the predetermined alpha of 0.05 for blow pin down time p-value of 0.000 and blow pin down pressure p-value of 0.000, then the interaction between time and blow pin down pressure p-value 0.000.

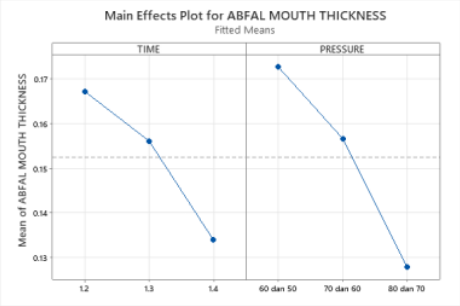
A p-value is a statistical measurement to validate the hypothesis in accordance with the observed test. A p-value is expressed in decimal form.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0080966	91.27%	89.72%	87.43%

Figur 3. Model Summary

The coefficient of determination, or R-sq, is a percentage to determine how influential the independent variables used are. The largest scale of R-sq is 100%; the greater the percentage of R-sq, the greater the influence caused by the independent variable on the dependent variable. The R-sq value obtained from the research results is 91.27%. So the two independent variables affect the dependent variable, abfal oral thickness, by 91.27%, and the remaining 8.73% is influenced by errors caused by variables that are not involved and other factors that occur during the data collection process. The following is a graph of data analysis using statistical software with factorial data analysis methods.

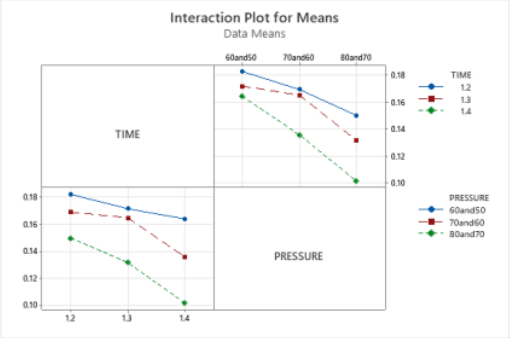


Figur 4. Main Effects Plot

Based on Figure 4 on the blow pin down time graph, it can be seen that the longer the blow pin down time used, the smaller the deviation in the size of the resulting abfal mouth thickness, it can be seen that for a blow pin down time of 1.2s produces an average deviation in the size of the thickest abfal mouth thickness of 0.167 mm then for a blow pin down time of 1.3s produces an average deviation in the size of the abfal mouth thickness of 0.156 mm while for a blow pin down time of 1.4s produces the smallest abfal mouth thickness deviation of 0.134 mm. In the pressure graph, the greater the blow pin down pressure used, the smaller the thickness of the resulting abfal mouth size, it can be seen that for a fast blow pin down pressure of 60 kg/cm^2, a slow blow pin down pressure of 50 kg/cm^2 produces an average deviation in the thickness of the thickest abfal mouth size of 0, 173 mm then for blow pin down pressure fast 70 kg/cm^2 blow pin down pressure slow 60 kg/cm^2 produces an average deviation in the size of the thickness of the abfal mouth of 0.156 mm while for blow pin down pressure fast 80 kg/cm^2 blow pin down pressure slow 70 kg/cm^2 produces the smallest average deviation in the size of the abfal mouth thickness of 0.128 mm.

Here, what is meant by the deviation of the average size of the thickness of the abfal mouth, which produces the smallest thickness, is the size closest to the size being sought, and the deviation of the average size, which produces the largest thickness, is the size away from the size being sought. The deviation affects the thickness of the product; the smaller the deviation, the thinner the abfal mouth

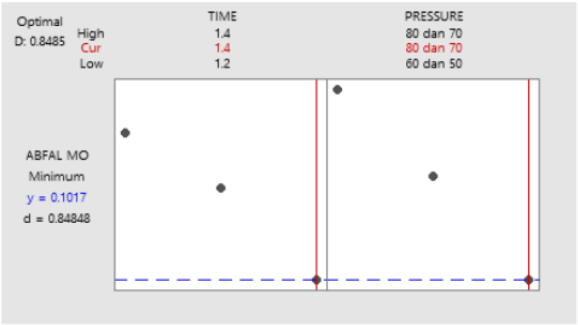
produced, and vice versa, the greater the size of the deviation, the thicker the thickness of the abfal mouth produced.



Figur 5. Interaction Plot

The factorial interaction plot graph shows the effect of each independent variable on the dependent variable, as shown in Figure 5 The interaction plot between the variables blow pin down time and blow pin down pressure. There are 3 lines of blow pin down pressure with different colors according to the many levels of blow pin down pressure, namely blue, red, and green.

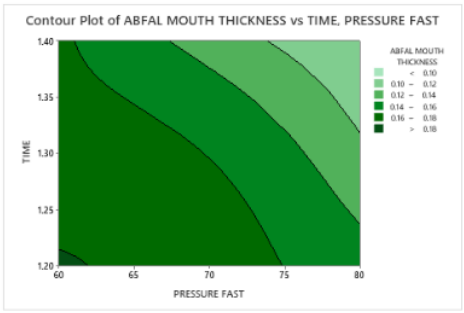
The results of this study are found in the blue graph, which shows that the large blow pin down pressure fast 60 kg/cm² and the blow pin down pressure slow 50 kg/cm² produce the largest average deviation of the size of the thickness of the mouth of the abfal by 0.183 mm, and the increased blow pin down pressure fast 80 kg/cm² and the blow pin down pressure slow 70 kg/cm² produce the smallest average deviation of the size of the thickness of the abfal mouth by 0.132 mm. It can be seen from all blow pin down times of 1.2, 1.3, and 1.4 seconds that the greater the blow pin down pressure applied, the thinner the abfal mouth thickness of the EL 125 ml bottle product obtained.



Figur 6. Minimum Response Optimization

Response optimization is done by looking at Figure 6 The minimum response optimization of this process is influenced by two variables, namely blow pin down time and blow pin down pressure. This is done with the aim of optimizing the results of the cut on the abfal mouth by using these two variables. Based on Figure 6 the variation of blow pin down time of 1.4 seconds with a blow pin down pressure of 80 kg/cm² and a blow pin down pressure of 70 kg/cm² has the thinnest abfal mouth cut. So it can be concluded that the variation of blow pin down time of 1.4 Secound with blow pin down pressure fast 80 kg/cm² and blow pin down pressure slow 70 kg/cm² is a parameter setting that produces the

thinnest abfal mouth pieces and is still within the tolerance limits recommended by the company, as can be seen from the minimum thickness that occurs.



Figur 7. Grafik Contour Plot Abfal Mouth Thickness vs Time, Pressure Fast

Figur 7. Grafik Contour Plot Abfal Mouth Thickness vs Time, Pressure Slow

Figures 7 and 8 are contour plot graphs of the results of research analyzing the time and pressure of blow pin down on the thickness of the abfal mouth in the 125 ml EL bottle extrusion blow molding process. The contour plot graph is used to determine the optimum composition area of each response studied. The graph shows that the area that produces the thickness of the abfal mouth results from the parameters of time and blow-pin pressure. The dark green area is the area that produces pieces of the thickest abfal mouth or are away from the expected target size of > 0.180 mm, which is in the blow pin down time area of 1.2s–1.25s, with a blow pin fast pressure of 60 kg/cm²–65 kg/cm² and a blow pin slow pressure of 50 kg/cm²–55 kg/cm². The light green area is the area that produces pieces from the mouth of the abfal slightly away from the expected target size of 0.120 mm to 0.140 mm, which is in the blow pin down time area of 1.4s with a blow pin fast pressure of 65 kg/cm² to 75 kg/cm² and a blow pin slow pressure of 50 kg/cm² to 60 kg/cm². While the brightest green-colored area is the blow pin down time of 1.4s, the blow pin fast 80 kg/cm² and the blow pin slow pressure of 70 kg/cm² indicate the area that produces pieces of the thinnest abfal mouth, which is <0.10 mm. If the thickness of the mouth of the abfal gets thicker, it moves away from the expected size target, and vice versa, if the thickness of the mouth of the abfal gets thinner, it is still within the target size.

4. Conclusion

The following is a conclusion that can be obtained from research on the effect of pressure and blow pin time on the thickness of the mouth of the 125-ml EL bottle extrusion process.

1. Based on the results of the study of the effect of blow pin down pressure on the thickness of the mouth of the 125-ml EL bottle extrusion process, the greater the blow pin down pressure given, the smaller the size deviation produced, or the thickness of the mouth of the resulting abfal is thinner,

and vice versa. If the blow pin down pressure given is smaller, the size deviation produced is greater, or the thickness of the mouth of the abfal produced is thicker. In the variation of time parameters, the thickness of the thinnest abfal mouth occurs in the variation of blow pin down pressure fast 80 kg/cm², blow pin down pressure slow 70 kg/cm², and the thickness of the thickest abfal mouth occurs in the variation of blow pin down pressure fast 60 kg/cm², blow pin down pressure slow 50 kg/cm², and 0.195 mm. To produce a thickness in accordance with the minimum response optimization of <0.1017 mm, we must use a variation of blow pin down time of 1.4 Secound with a variation of blow pin down pressure fast 80 kg/cm², blow pin down pressure slow 70 kg/cm².

2. Based on the results of the study of the effect of blow pin down time on the thickness of the mouth of the 125-ml EL bottle extrusion process, the longer the blow pin down time given, the smaller the deviation in size produced, or the thickness of the mouth of the resulting abfal is thinner, and vice versa. If the blow-pin-down time given is less, the deviation in size produced is greater, or the thickness of the mouth of the abfal produced is thicker. In the variation of time parameters, the thickness of the thinest abfal mouth occurs at a blow pin down time of 1.4s of 0.085 mm and the thickness of the thickest abfal mouth occurs at a blow pin down time of 1.2s of 0.195 mm. To produce a thickness in accordance with the minimum response optimization of <0.1017 mm, one must use a blow pin down time variation of 1.4 Secound with a variation of blow pin down pressure fast 80 kg/cm² and blow pin down pressure slow 70 kg/cm².
3. The results of the research using DOE Taguci analysis of the interaction between time and blow pin down pressure on the thickness of the abfal mouth have an influence because the p-value < alpha (0.05/5%) in the interaction of both the thickest size occurs at a blow pin down time of 1.2s and variations of blow pin down pressure fast 60 kg/cm², blow pin down pressure slow 50 kg/cm², and 0.195 mm, while the thinnest thickness occurs at a blow pin down time variation of 1.4 Secound with variations of blow pin down pressure fast 80 kg/cm², blow pin down pressure slow 70 kg /cm².

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References

[1] Sabila, F. T., Setyaningsih, W., Hardati, P., & Nugraha, S. B. (2023). Literasi Lingkungan Dan Pengelolaan Sampah Plastik Di Kelurahan Karangjati Kecamatan Blora Kabupaten Blora. Edu Geography, 11.

[2] Wu, H., Zhao, G., Wang, J., Wang, G., & Zhang, W. (2019). Effects of process parameters on core-back foam injection molding process. Express Polymer Letters, 13(4). https://doi.org/10.3144/expresspolymlett.2019.32

[3] Mujiarto, I. (2005). Sifat dan Karakteristik Material Plastik dan Bahan Aditif. Traksi, 3(2).

[4] Amirullah, M. B., & Yudistiro, D. (2019). Pengaruh Parameter Barrel Temperature, Blowing Time Dan Blowing Pressure Terhadap Volume Produk Botol. Elemen: Jurnal Teknik Mesin, 6(2), 77–86.

[5] Waskito, N. W. (2019). Optimasi Produksi Botol 400 ml pada proses extrusion blow moulding. Skripsi, 74.

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