LOGIC
Journal of Engineering Design and Technology
Vol. 25 No.1 March 2025 ; p. 13 - 18

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs2.pnb.ac.id/index.php/LOGIC

THE EFFECT OF INJECTION PRESSURE AND INJECTION TEMPERATURE IN THE COMPRESSION MOULDING PROCESS ON FLASHING DEFECTS OF SHOULDER PRODUCTS

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Abstract. Plastic objects are everywhere: toys, household utensils, playthings, and cosmetic containers. One of the processes used was the plastic production process in the compression molding process to make a cover (shoulder) on the tube. Flashing defects are one of the biggest defects that can cause a product to fail in the assembly of shoulder extrusion tube products in PT. XYZ. This research was to determine the effect of injection pressure and injection temperature parameters on flashing defects in shoulder extrusion tube products. This research uses quantitative research and experimental research methods to collect data. Varying parameter settings carry out this method with an injection pressure of 4 bar, 5 bar, and 6 bar as well as injection temperatures of 250°C, 260°C, and 270°C. The results of the study show that both parameters have significant effects on the flashing defects in shoulder extrusion tube products. The combination of injection pressure of 4 bar and injection temperature of 250°C resulting in flashing defects of 0 mm or no defects.

Keywords : compression moulding, flashing defects, injection pressure, injection temperature, shoulder.

1. INTRODUCTION

Plastic objects are almost everywhere from food wrappers, to household utensils, toys, and cosmetic containers. Plastic is a material that is easy to shape, light, anti-corrosive, and cheap [1]. Plastic products can be produced through certain processes according to their needs. Based on the properties of plastic, the plastic product can gradually replace other materials. Therefore, improving the quality of plastic products is an important factor in getting good quality plastic products. The plastic molding process can be broadly classified as injection, extrusion, blow molding, calendering, and compression. The molding process is an effective and efficient forming process in the industry [2].

The shoulder manufacturing process uses a compression molding process. The compression molding process is where the plastic pellets are heated so that the phase changes from solid to melt and passes into the mold (matrix). The mandrel (punch) with the sleeve (extrusion process) applied pressure to the matrix, allowing it to freeze and cool for a while, where a shoulder will form and connect to the tube.

Machine parameters, material properties, mold shape, and machine capacity used during the production process influence the plastic molding process [3]. Parameters that influence the compression molding process which contributes to product defects include injection time, injection pressure, holding pressure, and injection temperature. These defects can be eliminated or reduced by designing process parameters appropriately and correctly [4]. Many things must be considered in the product production process so that the product has a quality that meets the specified standards. Injection pressure and injection temperature are important parameters that must be considered in the production process for shoulder extrusion tube products.

The production process of making shoulder extrusion tubes cannot be separated from product defects. One of the product defects that often occurs is unmolded shoulders, folded shoulders, and flashing. The flashing defect is one of the most common defects in the shoulder tube manufacturing process. To eliminate flashing on the product, a finishing process is needed on the product. Flashing is a defect where there is excessive material on the product [5]. Flashing defects can cause the product to fail to be assembled, so this causes big losses for the company because a lot of material is wasted and customers experience delays in product delivery.

2. METHODS

The type of research used is quantitative with experimental methods. This method is used to find out what factors can affect the result of the research. Data analysis was carried out to test the research hypothesis with the ANOVA method. The tools used in this research include compression molding machines with screw diameters of 34 mm and can produce tubes with diameters ranging from 13.5 to 63.5 mm. The material used in making shoulder extrusion tubes is a mixture of HD 80% + LD 20% (PE). The injection time is 0.25 s with a holding pressure of 2.5 bar. The height gauge used measures the flashing defect deviation of the shoulder extrusion tube.

3. RESULTS AND DISCUSSION

3.1 Result

The result of product identification and height measurement obtained from the data collection process was 90 shoulder extrusion tube products. Products with flashing defect height of more than 13.6 ± 0.1 mm, as shown in Table 1.

Table 1. Measurement flashing defect

Injection Pressure (bar)	Injection Temperature (°C)	Flashing Defect (mm)										Average (mm)
		1	2	3	4	5	6	7	8	9	10	
4 bar	250°C	0	0	0	0	0	0	0	0	0	0	0.00
	260°C	0.05	0.07	0.08	0.07	0.06	0.07	0.09	0.07	0.11	0.12	0.08
	270°C	0.09	0.1	0.16	0.24	0.22	0.1	0.1	0.15	0.23	0.23	0.16
5 bar	250°C	0	0	0	0	0.04	0.05	0.06	0.11	0.07	0.06	0.04
	260°C	0.14	0.07	0.06	0.15	0.07	0.09	0.21	0.07	0.14	0.15	0.12
	270°C	0.56	0.57	0.55	0.53	0.58	0.59	0.58	0.52	0.51	0.5	0.55
6 bar	250°C	0	0	0.11	0.06	0.09	0.12	0.07	0.14	0.12	0.08	0.08
	260°C	0.08	0.15	0.18	0.2	0.22	0.2	0.15	0.09	0.1	0.22	0.16
	270°C	0.95	0.98	0.92	0.95	1,02	1	0.99	0.98	0.99	1,01	0.98

The data collection that has been carried out, then processing is then continued using statistical software. Figure 1 shows the results of the analysis that has been carried out.

The normal probability plot graph shows that the residual points are formed close to the red straight line. A significant value is indicated (P-Value > 0.05). If the significant value is > 0.05 the data is normally distributed. The result of the residual normality test can be said to mean that the data follows a normal distribution. It is assumed that the regression model that has been created can be used.

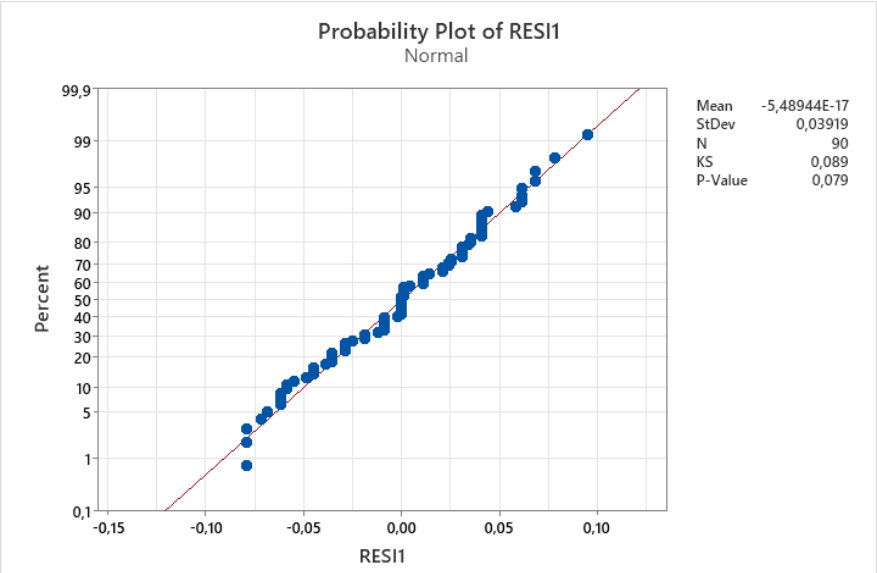

Figure 1. Graphic normal probability plot

Table 3. Analysis of Variance

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	8,2093	1,02616	608,04	0.000
Linear	4	6,3949	1,59872	947,30	0.000
Inject Pressure (bar)	2	1,5895	0.79475	470.92	0.000
Inject Temperature (°C)	2	4,8054	2,40269	1423,68	0.000
2-Way Interactions	4	1,8144	0.45361	268,78	0.000
Inject Pressure (bar)*Inject Temperature (°C)	4	1,8144	0.45361	268,78	0.000
Error	81	0.1367	0.00169		
Total	89	8,3460			

The ANOVA shows that injection pressure and injection temperature have a p-value of 0.000 so based on the hypothesis in this study the decision is to reject the initial hypothesis because the p-value is less than the alpha (α) tolerance level of 5% or 0.05 which is has been determined (p-value < alpha (α)). So the null hypothesis is rejected and the alternative hypothesis is accepted and the conclusion is that injection pressure and injection temperature have a significant effect on flashing defects in shoulder extrusion tube products.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0,0410811	98,36%	98,20%	97,98%

Figure 3. Model Summary

The coefficient of determination (R-square) value aims to predict or see how much influence the independent variable contributes to the dependent variable. Based on the model summary above, it is known that the coefficient of determination value is 98,36%, this figure shows that the injection pressure and injection temperature for flashing defects in shoulder extrusion tube products is 98,36% and the remaining 1,64% is an error caused by other variables not studied.

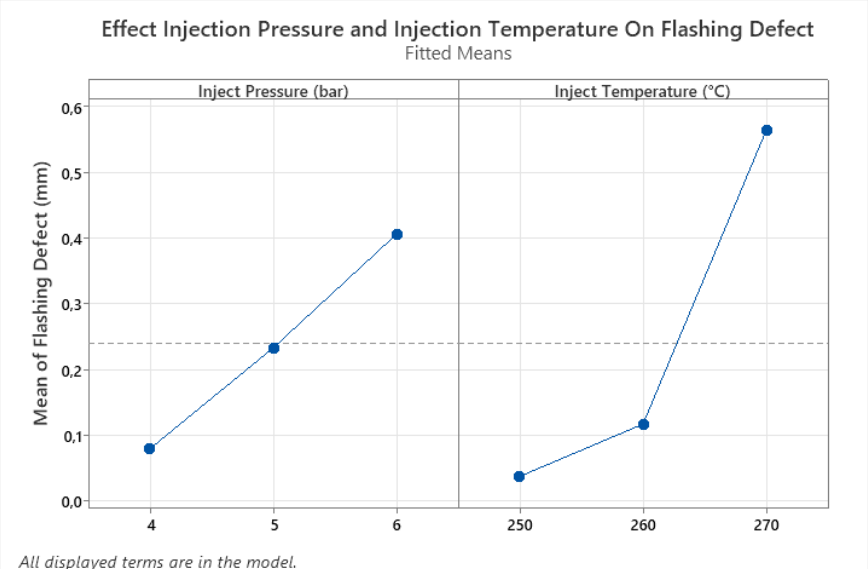

Figure 4. Effect of Injection Pressure and Injection Temperature on Flashing Defects

The main effect plot above is that the higher the level of injection pressure and injection temperature caused the flashing defects in the product to become larger, this is because increasing injection pressure facilitated the flow of plastic melt into the mold causing excess material so that flashing defect in the products increase. Meanwhile, higher injection temperature decreases the viscosity of the plastic material and makes it easier for the material to flow into the mold so that flashing defects in the product increase.

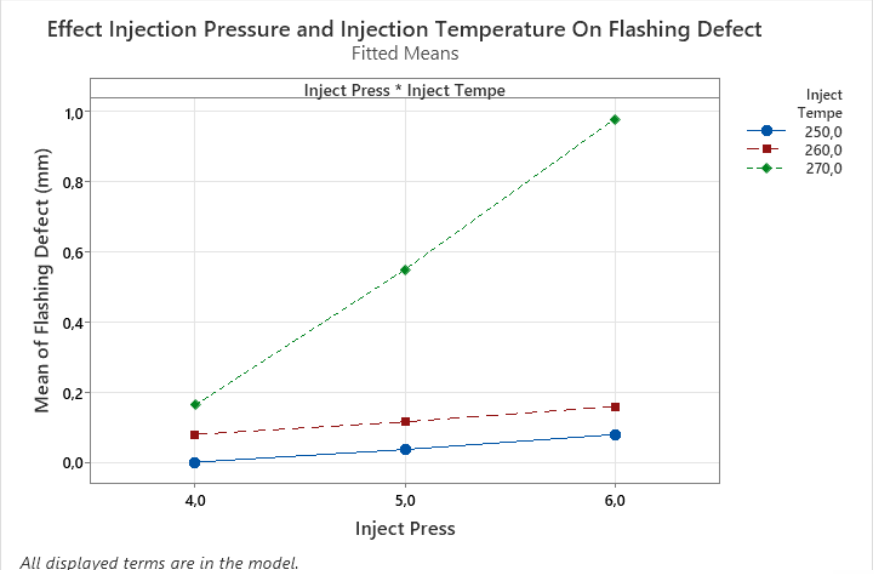

Figure 5. Effect of Injection Pressure and Injection Temperature on Flashing Defects

In figure 5 shows the interaction between injection pressure and injection temperature, there are different colored lines representing the independent variable injection temperature, namely blue, red, and green. The green line shows the injection temperature level of 270°C. The red line shows the injection temperature level of 260°C and the blue line shows the injection temperature level of 250°C. The horizontal line shows the level of the independent variable injection pressure which has levels of 4 bar, 5 bar, and 6 bar. The vertical line shows the dependent variable, the namely flashing defect. The interaction graph shows the result on the blue line for an injection temperature of 250°C with an injection pressure of 4 bar the possible defect value is 0. which means there are no flashing defects, and injection pressure of 5 bar the possible value of flashing defect value is 0.036 mm and injection pressure 6 bar, the possible value of flashing defect value is 0.079 mm. In the red line for an injection temperature of 260°C with an injection pressure of 4 bar, the possible flashing defect value is 0.079 mm. and the flashing defect value continues to increase injection pressure of 5 bar and injection pressure of 6 bar, amounting to 0.115 mm and 0.159 mm. In the green line for injection temperature of 270°C with injection pressure of 4 bar,

the possible flashing defect value is 0.162 mm, and the flashing defect value continues to increase at injection pressure 5 bar and injection pressure 6 bar, amounting to 0.549 mm and 0.979 mm.

3.2 Discussion

Effect of Injection Pressure on Flashing Defect

The use of injection pressure parameters in this research shows that the greater injection pressure will produce large product flashing defects, while the smaller injection pressure parameter will produce small product flashing defects. This is because the greater the injection pressure, the easier it is for the melted plastic to flow into the mold, causing excess material. Using injection pressure will cause the material to have difficulty flowing when filling the liquid plastic into the mold cavity. This is by previous research entitled "The Effect of Inject Pressure and Clamping Force on Flashing Defects in the Pot Cover Injection Molding Process" This research explains that the injection pressure parameter influences flashing defects. The higher the injection pressure, the greater the possibility of flashing defects occurring [6].

Effect of Injection Temperature on Flashing Defect

The use of the injection temperature parameter in this research shows that the greater injection temperature will produce large product flashing defects, while the smaller injection temperature parameter will produce flashing defects. This is because the higher the material temperature, the smaller the viscosity of the plastic material fluid so that the easier it is for the material to flow onto the mold, the fluid temperature is inversely proportional to the viscosity value. Using a low temperature will cause the material not to melt completely so that the material cannot directly enter the mold. This is by previous research entitled "Analysis of the Effect of Injection Molding Temperature and Pressure on Product Defects" The higher the injection pressure and injection temperature will cause too much material supply and too runny material to the mold cavity [7].

Interaction between Injection Pressure and Injection Temperatur on Flashing Defect

The interaction of the two independent variables, namely injection pressure and injection temperature on flashing defect in shoulder extrusion tube product, can be concluded that if the injection pressure and injection temperature are high, the resulting flashing defect will be larger. However, if the injection pressure is low and the injection temperature is low, it will produce a small product flashing defect. Based on this research and the two previous studies, the results were the same, namely producing products with small flashing defect values, which were achieved by using injection pressure and injection temperature parameters with the lowest values for each level.

4. CONCLUSION

The research effect injection pressure and injection temperature in the compression molding process on flashing defect of shoulder extrusion tube product, then the conclusions obtained are:

1. The influence of injection pressure on flashing defect of shoulder extrusion tube product. It can concluded that the influence of injection pressure has a significant effect on the flashing defect in the product. The research average flashing defect was 0.080 mm at an injection pressure level of 4 bar. The injection pressure increased and the highest average flashing defect was obtained at an injection pressure level of 6 bar with an average flashing defect of 0.405 mm.
2. The influence of injection temperature on flashing defect of shoulder extrusion tube product. It can concluded that the influence of injection temperature has a significant effect on the flashing defect in the product. The research average flashing defect was 0.038 mm at an injection pressure level of 250°C. The injection temperature increased and the highest average flashing defect was obtained at an injection temperature level of 6 bar with an average of flashing defect of 0.563 mm.
3. The result to determine the interaction of the two independent variables, namely injection pressure and injection temperature on flashing defect of shoulder extrusion tube product, can be concluded that the optimal combination of the two parameters for shoulder extrusion tube product is obtained at a combination of injection pressure of 4 bar and injection temperature of 250°C with a flashing defect value of 0 mm or no defect.

5. REFERENCES

[1] B. Pradika, S. Supriyadi, and A. Burhanudin, "Analysis of the Effect of Temperature on Result of Micro Injection Molding Product in Making Sauce Cups Made from Polypropylene (PP)" SENS vol 5 772-780. 2020.
[2] M. Hartono, "Improving the Quality of Plastic Product Using the Taguchi Method" Jurnal Industrial Engineering, vol 13, No.1, 93-100
[3] P. T. Devalia and T.M. Arief, "Analysis and Optimization of Multi Cavity Plastic Injection Process Parameters to Minimize Short Mold Defect" Ind. Res. Work National. Seminar., vol. 10. No.1, pp.553-560. 2019.

[4] E. Sunarto, and E. Prayogi, “Effect of the Cooling Process on Shrinkage and Dimensions of TS Plug Made from PVC in Injection Molding” Aplikasi Teknologi Industri 235-241, 2018.
[5] H. Permana, Topan, and S. Anwar, ”Production Process of Flip Flop Plastic Components Using a Hydraulic Type Injection Molding Machine” J. Baut and Manufactur, vol. 03, no. 02, pp. 2686-5351, 2021.
[6] S. Qomariah and A. Dani, “The Effect Inject Pressure and Clamping Force on Flashing Defects in the Pot Cover Injection Molding Process” JETM, 2023
[7] H. Yanto, I. Saputra and S. Wiratno, “Analysis of the Effect of Injection Molding Temperature and Pressure on Product Deffects” Jurnal Integrasi (Vol.10. Issue 1), 2018