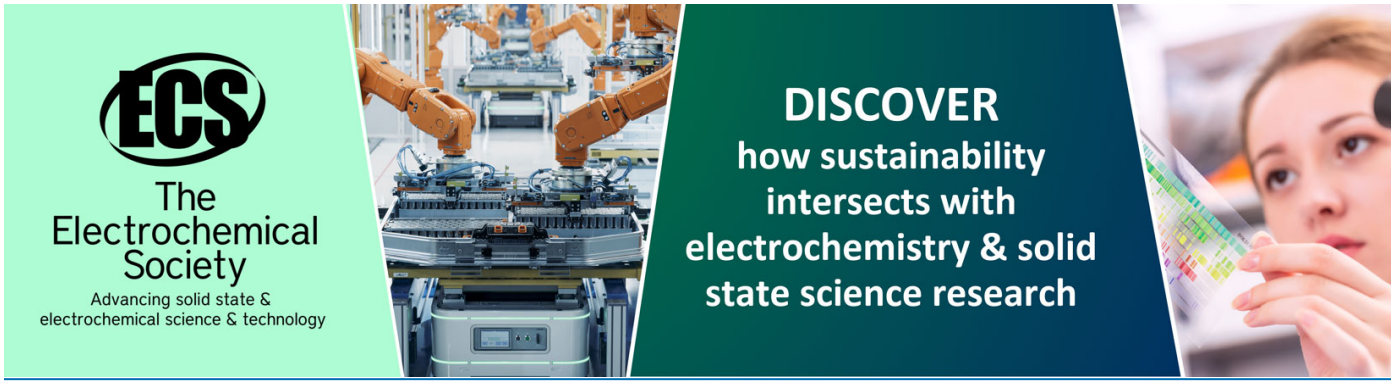
# Effect Of Injection Temperature On Defect Plastic Products





IOP Conf. Series: Materials Science and Engineering **536** (2019) 012102 doi:10.1088/1757-899X/536/1/012102

# Effect Of Injection Temperature On Defect Plastic Products

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**Abstract.** The process of plastic injection is one of the plastics forming processes is mostly done. Problems are often experienced in the injection process is the occurrence of product defects in the finished goods so that they can slow down the production process. This study aims to analyze the effect of injection temperature on product defects that occurred. Product as the object of the research is a standing hanger for wardrobe. Products are printed by using polypropylene material. Injection process uses injection molding manual toggle system. Injection temperature varied based on the melting temperature, namely 155, 160, 165, and 170$^0$C. The results showed the low injection temperature of 155$^O$C, defective products occur more dominant than the injection temperature of 160$^O$C and 165$^O$C and mold filled at an injection temperature of 170$^O$C. Injection temperature under the melting temperature will result in a more dominant defect occurs. By raising the temperature above the melting temperature injection can reduce the occurrence of product defects. The defects that occur in the process of injection plastic products buffer hanger hangers for cabinets are short shot, jetting, flashing, sink marks and shrinkage.

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## 1. Introduction

In Plastic materials gradually began to replace glass, wood and metal industry. Increased utilization of plastic products by the industry because has several advantages. Plastic is easily molded, lightweight, non-corrosive, and can be recycled. Plastic Malleable has a resilient nature, melted and the low melting temperature.

Generally, Technologies Process Plastics involve the same operation as the metal production process. Plastics can be molded, cast, and formed and processed machining (machining) and spliced (joining). Plastic products can be produced through certain processes in accordance with their needs.

The injection process is a process that is most widely used in producing plastic products. The injection process is done by inserting a raw material such as plastic granules through the hopper and plastic are cooked in the barrel. After the plastic melt to a certain temperature, the plastic is pushed out of the tube through a nozzle to be injected into the mold (mold). Furthermore, molded bodies were kept frozen and cooled while in the mold before the mold is released and opened to remove the molded bodies and then injected into the mold or mold.

The products produced by the process of plastic injection cannot be separated from the problem of product defects, such as; the shape is not perfect, shrinkage, dimensional products outside the specified tolerances, cracks, and so forth. A Product with precise dimension and perfect shape is not easily

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available, because there are several factors that influence: print, process temperature, the amount of pressure and cooling time.

In the process of molding plastic is worth noting some of the parameters of temperature, pressure, speed injection and cooling time. If one parameter is ignored, then the results of plastic injection will give poor results such as; the shape is not perfect, shrinkage, dimensional products outside the specified tolerances, cracks, etc. on the body mold. This resulted in many materials are wasted so that the cost of production becomes inefficient. An occurrence of defects in plastic products can be caused by several parameters, but the parameters of the dominant are due to the injection temperature. Temperatures are critical variables needed for melting plastic and can fill the mold.

In the plastic injection process are many factors that affect the results of the product, as follows: print, process temperature, the amount of pressure and cooling time. To limit the scope, so in this article only discussed one of the main causes of disability products are injection temperature. The products were produced in the study is a buffer hanger for wardrobe. Material products are made of a thermoplastic type of polypropylene. Injection process is carried out using manual injection machine with a toggle system.

The study was conducted with temperatures vary the injection based on the melting temperature of polypropylene (PP). This study aimed to analyze the effect of injection temperature on product defects that occur in the process of plastic injection using injection engine manual toggle system.

Plastic injection technology is so advanced; various shapes can be made well. But behind it, all turns out there is a very complicated issue related to mold making and the results of the desired product. Several studies have been conducted and generally discuss shrinkage defects. Firdaus [1] has conducted an experimental study of the manufacture of products pneumatics holder by varying several process parameters on the existing injection molding machine. The process parameters include the melting temperature (melting point), air pressure (water pressure), holding time (holding time), and time pressure (pressure duration). The study shows that the selection of the proper parameters greatly affects the results of the desired print objects, so necessary to find the best parameters for each print object based on the type of plastic raw material is there. In addition, the melting temperature parameter is very significant influence on shrinkage defects. Injection machines with lever mechanisms can operate well in plastic plastering and injection processes [2].

Some of the factors that caused the product defect is wrong placement of the injection point, the product thickness variations and irregular shrinkage during cooling [3]. Warpage is a common problem associated with the injection molding process and is often the main target by mold designers to eliminate. The existence of warpage deemed defective and would be minimized. Shaifull [4] examined the effects of the temperature difference between the core and cavity injection temperatures and reduce warpage using the Taguchi method. Differences in temperature at the core and cavity injection temperatures in simulations and experiments show that the difference in mold temperature helps to minimize warpage value.

Sugondo [5] investigated the defective mobile phone casing products using simulation models to see the effects of pressure on product quality. The study begins by determining the process parameters that mold temperature, the melting temperature of the plastic and injection pressure. Plastic melting temperature varied 2 levels while the injection pressure of 5 levels. Then do the simulation to obtain the confidence of filling and quality prediction. From the research, it was found that the maximum injection pressure only affects the temperature

In low melting plastic, lack of injection pressure could cause short shots and crack. In addition to the added pressure of the injection, the defect can be reduced by increasing the melting temperature of the plastic. At high melting temperatures, the increase in injection pressure becomes meaningless. Injection temperatures below the melting temperature will cause more dominant defects to occur [6]. The type and area of disability do not decrease when the injection pressure is increased.

Anggono [7] studied predicting shrinkage in the plastic products that use polypropylene material with a standard calculation method. Making the modeling in 3D (three-dimensional) injection molding by using CATIA, then analyzed with software MoldFlow. The results showed differences in the dimensions

of the real thing with dimensional objects simulation results, a maximum of 0.85 mm and a minimum value of 0.02 mm.

Cahyadi [8] analyzing the operating parameters in the plastic injection molding process for controlling a product defect. Analysis of the defective products is done by developing an empirical simulation model that describes the relationship between process parameters with product defects that occur, by using Autodesk MoldFlow Adviser software for products with variations in the value of injection pressure, injection temperature and cooling time. Fabrication and assembly of injection and clamping units using machine tools and performance tests are carried out to analyze the success rate of the machine [9]. From the research found that the injection pressure, injection temperature and a cooling effect on the occurrence of product defects. TB 650 for stationery products, obtain optimum setting is as follows; injection pressure ($P_{Inj}$) = 8,578 MPa, temperature injection ($T_{Melt}$) = 240 °C, and the cooling time ($t_{Col}$) = 20s.

## 2. Experimental

Plastic injection is one of the manufacturing processes to make products with plastic base material by injection. In this study, the object of the research is a stand hanger product hanger for wardrobe. Product support hanger made of thermoplastic material is polypropylene (PP). Product dimensions buffer for wardrobe hanger shown in figure 1.

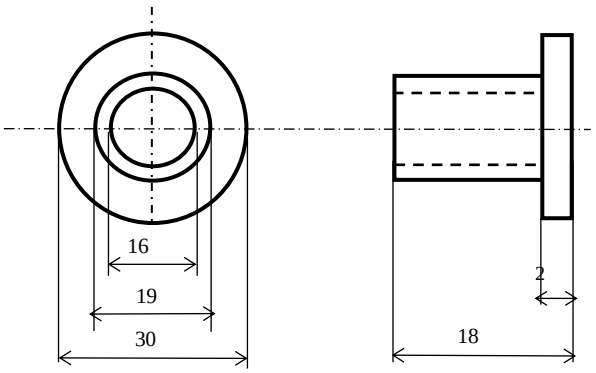


**Figure 1.** The dimensions of the product

Manufacture of buffer conducted on the material testing laboratory of mechanical engineering majors Lhokseumawe State Polytechnic. The injection process is carried out using manual injection molding with a toggle system. Construction products mold buffer hanger designed hanger for wardrobe consists of several components. Moulds had two cavity or two products produced in one injection. Figure 2 shows the construction of the mold buffer hanger for wardrobe.

**Figure 2.** Construction of molds and cavityy buffer hanger for wardrobe

Injection process carried out at the pressure, mold temperature and injection speed are held constant, whereas the injection temperatures varied at temperatures 155, 160, 165, and $170^0$C. The final stage of the study is the examination of a product defect. Examination of product defects in the product buffer hanger on wardrobe done visually.

## 2. Results and Discussion

Injection temperature is critical variables needed for the plastic melt can fill the mold cavity. In this test, the determination of the injection temperature variation was based on the melting temperature (melting temperature). The melting temperature is the temperature at which a material begins to experience a change from solid to molten form. Basically, the higher melting temperature increases the process temperature. In the plastics industry applications, the melting temperature is used as the identity of a plastic material. The melting temperature of the plastic material PP ranges 155-165$^O$C.

Results injection plastic products buffer hanger for wardrobe with temperature variation injection of 155, 160, 165, and 170$^O$C are shown in Figure 3 to 6. At a temperature of 155$^O$C injection products are not perfect or mold is not fully charged (Figure 3).

**Figure 3**. The resulting product at a temperature of 155$^O$C injection

Products that are not completely formed can occur due to a temperature less injection. Fewer temperatures can cause no fluid flow in the mold, so as to result in a short shot defect in the workpiece. In addition to short shot defect, the workpiece also occurs striped shape on the surface of the product known as a jetting defect. Less plastic material that will melt quickly thickens due to contact with the mold. The thickened plastic continues to be injected into the mold, so leave marks on the surface of the product stream. This process condition causes defective jetting.

Parameter melting temperature also affects the occurrence of shrinkage defects (shrinkage) in the product. Product support hanger injected at a temperature of 155$^O$C, disability shrinkage of 2.6%. Shrinkage defects can occur as a result of the difference between the temperatures of the liquid plastic with mold temperature.

Injection at a temperature of 160$^O$C, it still looks the same product defect injection temperature of 160$^O$C, the short shot and jetting. At a temperature of 160$^O$C injections, liquid plastic mold or cavity began to meet, so it looks more product form filled than the temperature of 155$^O$C. In addition, there is a short shot and jetting defect, the product also looks sink mark defect characterized by the basin on infernal surface objects product (Figure 4). The products were injected at a temperature of 160$^O$C occurs shrinkage of 2.1%.

**Figure 4**. The resulting product at a temperature of 160$^{O}$C

Figure 5 shows the products that are injected at a temperature of 165$^{O}$C. The Product began to take shape in full although it is still not good (perfect). Being filled due to lack of temperature injection molding is still not high enough so there is still the short shot on the product. At this temperature condition, disability jetting starts disappearing. It is not independent of the temperature rise in the injection is given. At a temperature of 165$^{O}$C occurs shrinkage of 1.6%.

Figure 5. The resulting product at a temperature of 165 $^{O}$C

The resulting product at a temperature of 170$^{O}$C injections has good print quality. Mold is fully charged so that the product completely formed (Figure 6). Temperature high injection may help lower the plastic viscosity, which can facilitate the flow so that the filling process will be easier.

**Figure 6.** The resulting product at a temperature of 170$^{O}$C

In this condition, the short shot defect does not happen again, but sink marks and jetting defects still occur in a small area. Although very small, at this temperature begin flashing defects. Flashing itself means that there is more material that comes frozen at the edges of the product. Causes flashing one of which can be caused by a lack of mold clamping pressure. At a temperature of 170$^{O}$C, shrinkage defects occur together with the injection temperature of 165$^{O}$C, which amounted to 1.6%.

By raising the temperature of injection, can minimize defects and reduce the area of the defect. However, there is still a significant effort to eliminate that occurs without being followed by the setting of other variables such as pressure, speed injection and cooling time.

## 3. Conclusions

Based on the research results, it can be concluded as follows: The injection temperature affects the melting temperature of the plastic, the lower temperature of injection against. The melting temperature of the tendency of defects occurs the greater. Defects that occur in the process of injection plastic products buffer hanger hangers for cabinets are short shot, jetting, flashing, sink marks and shrinkage. At a temperature of 155 $^{O}$C injections, product defects occur more dominant than the injection temperature of 160 and 165 $^{O}$C. Product perfectly formed at a temperature of 170 $^{O}$C injections.

## References

[1] F. Firdaus and S. Tjitro, "Studi eksperimental pengaruh paramater proses pencetakan bahan plastik terhadap cacat penyusutan (Shrinkage) pada benda cetak pneumatics holder," *J. Tek. Mesin*, vol. 4, no. 2, pp. 75–80, 2004.

[2] I. Mawardi, Z. Zuhaimi, and H. Hanif, "PENGEMBANGAN MESIN INJEKSI PLASTIK SKALA INDUSTRI KECIL," *Pros. SNaPP Sains, Teknol.*, vol. 4, no. 1, pp. 291–298, 2014.

[3] H. U. Akay, "Prediction of Shrinkage in Plastic Injected Parts Due to Cooling," *Comput. Eng. Anal.*, 2003.

[4] Z. Shayfull, M. F. Ghazali, M. Azaman, S. M. Nasir, and N. A. Faris, "Effect of differences core and cavity temperature on injection molded part and reducing the warpage by Taguchi method," *Int. J. Eng. Technol.*, vol. 10, pp. 133–140, 2010.

[5] A. Sugondo, A. Willyanto, and H. S. Ian, "Minimalisasi Cacat dengan Pengaturan Tekanan Terhadap Kualitas Produk pada Proses Injection Molding dengan Menggunakan Simulasi," *J. Tekno Sim*, pp. 34–40, 2007.

[6] I. Mawardi, H. Hasrin, and H. Hanif, "Analisis Kualitas Produk dengan Pengaturan Parameter Temperatur Injeksi Material Plastik Polypropylene (PP) Pada Proses Injection Molding," *Ind. Eng. J.*, vol. 4, no. 2, 2015.

[7] A. D. Anggono, "Prediksi Shrinkage Untuk Menghindari Cacat Produk Pada Plastic Injection," 2005.

[8] D. Cahyadi, "Analisis Parameter Operasi pada Proses Plastik Injection Moolding untuk Pengendalian Cacat Produk," *J. MESIN Teknol.*, vol. 8, no. 2, 2014.

[9] I. Mawardi, Z. Zuhaimi, and H. Hanif, "Desain dan Manufaktur Mesin Injeksi Plastik Menggunakan Mekanisme Toggle untuk Industri Kecil," *IEJ*, vol. 3, no. 2, 2014.