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ANALYSIS OF INJECTOR LOCATION AND DEFECTS OF PRODUCTS RESULTING IN THE MANUFACTURING OF CAR BUMPERS USING MOLDFLOW SOFTWARE

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ABSTRACT

Competition between industries is increasing. Every company is required to develop its products so that it has the ability to compete. PT XYZ is a company engaged in the automotive industry, one of its products is car bumpers. The problem faced by PT XYZ is the high number of product defects that are produced. This study aims to reduce product defects produced at PT XYZ. The research method is using injection molding simulation with moldflow software so that the best injector location is known and is expected to reduce production defects. The simulation results show that the best injector location is at the coordinates (752, 391, 239). The simulation results also show that there is no potential for water trap, weld line, and sinkmark defects that occur. However, the potential for warpage defects still exists. Three potential warpage defects that may occur are high warpage of 29%, medium warpage of 16.6% and low warpage of 5.4%.

INTRODUCTION

Competition between industries is currently getting tougher. Every company is required to improve product quality and productivity. PT XYZ is a company that produces automotive components. One of the components produced by PT. XYZ are bumpers. Bumpers are produced by using an injection molding machine where the raw material is fed into an injection machine, then molded. The problem faced by PT XYZ is the high production defects of the bumpers that are produced (Purbaningrum, Anggono, & Supriyono, 2017).

Simulation is a method to try or demonstrate something in an artificial form that is similar to the real situation. At this time simulation is often used as a solution to overcome a problem in the company. Usually before conducting a trial, the company will

conduct a simulation first so that the results of the simulation can be identified. If the simulation results are good, the trial will continue using the same parameters as those used in the simulation. Meanwhile, if the results are not satisfactory, then the parameters are changed and the simulation is carried out again using the new parameters (Chandrashekhar & Shinde, 2019).

This research was conducted to determine the location of the best gate injector and to analyze product defects that occur in the injection molding process. The simulation was carried out using injection molding software and then analyzed the simulation results. From the analysis of the results, it is expected to reduce the defects of the bumper products produced by PT XYZ (Rudiyadi, 2016).

In 2021, Suhaeri, et al conducted a study using Autodesk Moldflow Adviser software to determine the effect of mold temperature on product defects (Erdem, 2017). The results show that there is a potential sinmark defect of 0.1084 mm at a mold temperature of 30°, 0.1124 mm at a mold temperature of 40, and 0.1169 mm at a temperature of 50. Meanwhile, warpage defects have the potential of 1.418 mm at a temperature of 30, 1.521 mm at a temperature of 30. temperature of 40, and 1.6382 mm at temperature of 50. This means that the greater the mold temperature, the greater the defects of the sinkage and warpage products produced. The most effective and efficient setting parameter is obtained at a temperature of 50 (Sugiyarto, Wardhani, & Djuhana, 2021).

Research to analyze and optimize short mold defects in the injection molding process of under case products that are printed with multi-cavity molds has been carried out. The analysis was carried out using moldflow software to simulate the injection molding process. The product model is made first with the software inventor so that a 3D form model is produced. The material used in the analysis is polypropylene (PP). There are 2 types of PP used, namely recycled PP and Homopolymer PP. The input process parameter values in the simulation are adjusted to the parameters on the injection machine used. Short mold defects occur in the injection process using PP Homopolymer material as shown from the simulation results. The results of the analysis state that the two materials have different characteristics. The difference in material properties causes the optimal value of the melting temperature of the two materials to be different. The optimization process is carried out by changing the material's melting temperature variable. The limit value of the melting temperature of the analyzed material is 180-280ºC. From the data processing optimization results, the optimal value for the melting temperature of PP Homopolymer material is 225ºC and recycled PP is 200ºC. From the optimal value obtained, a trial was carried out on the software simulation. The test results show that short mold defects do not occur and the time needed to fill the mold is faster than (Devalia & Arief, 2019).

Correct estimation of filling time can prevent mold defects such as sink marks, weld and meld lines, short shots, jetting, surface delamination, melt flow lines, warping and flash. The research was conducted by modeling the flow of polymeric materials as non-Newtonian, incompressible and stable. The Cross-WLF viscosity model was used as a constitutive model for viscosity. The analysis is used to predict mold filling time, the areas that are prone to cracking in mold parts produced during cavity filling. The obtained simulations get significant results. As an example of a simple rectangular mold section, it was found that the applied visualization technique allows us to observe the filling process in the mold cavity in good agreement with the experimental and simulation results (Manjunath, Vasudeva Karanth, & Yagnesh Sharma, 2019)

Injection molded components are consistently designed to minimize the design and creation of information content of enterprise systems. However, the resulting designs are very complex and often exhibit relationships between various quality attributes. The mold flow software was used to analyze the flow status of the plastic during the formation of the plastic plate trapezoid. Comparisons and analyzes were made for different melting temperatures by MPI software. It fully reveals the outstanding effect of MPI software in injection system and injection mold development (Ali et al., 2021).

METHOD

The method used in this research is as follows:

1. Literature Study Literature
   study was carried out by collecting literature or references related to defects in injection molding and simulations were carried out to analyze product defects in the injection molding process. Literature studies are carried out by looking for previous research journals or by looking for reference books that provide information about injection molding theory.
2. Field
   Observations Field observations were carried out at PT XYZ. In field observations, observations of the injection molding process in the manufacture of bumpers were made and observations of the parameters of the injection engine used. These parameters will later be used as parameters when performing simulations using moldflow software.
3. Product Design Product
   design is done using CAD software. The bumper product design is made in 3D which will later be used during the simulation. The size of the product is obtained from field observations so that the actual size is obtained. The bumper used in this study is the rear bumper of the Rajawali R2 SUV.
4. Injection Molding
   Simulation Injection molding simulation was carried out using Autodesk Moldflow

Adviser 2016 software. The first step in this simulation was to import product drawings made from CAD software into moldflow. The next step is to choose the type of mold used. In this study, the type of mold used is part only, which means only the parts are analyzed.

The next step is to fill in the boundary conditions. This condition is obtained from the results of field observations that have been carried out at PT XYZ. Boundary conditions used include the type of material, mold temperature, melting temperature, injector location, maximum engine pressure, minimum engine pressure, injection time, injection speed, cooling time and the length of time the engine is open.

In this study, the selected to be analyzed are the location of the injector, filling, cooling quality and the possibility of defects.

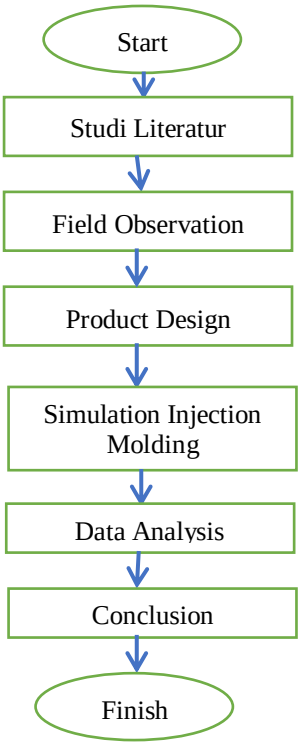
5. Analysis of Results

   After the simulation, the simulation results were obtained which were then analyzed. The analysis carried out includes the analysis of the best gate injector location so as to minimize the occurrence of product defects and the filling time is also faster. The results analyzed next are the potential for defects in the injection molding process where defects that may occur include: air trapped in water (air trap), cold encounter (weld line), bend (sinkmark) and warpage (Zhu & Wang, 2010).

6. Conclusions and Suggestions

   The last step in this research is to draw conclusions from the results of the analysis that has been done. Suggestions are given for the development of research or further research that will be carried out.

In general, the research method can be seen from the following flow chart :



RESULT AND DISCUSSION

1. Determining the Location

Before determining the best injector location, it must be known about the fluid flow and the obstacles that may occur in the fluid flow. The resistance and fluid flow can be seen from the figure below.

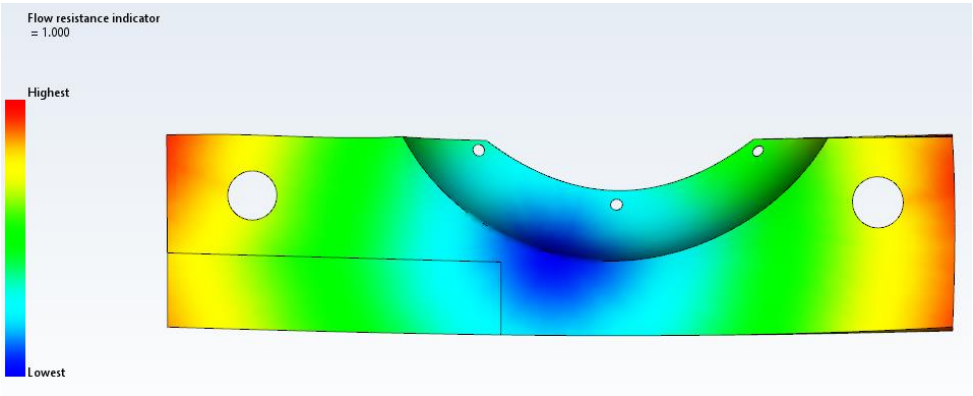


Figure 2. Flow resistance on the bumper

From Figure 2 it can be seen that the highest resistance will be red, the lower it is, the lower the resistance. The lowest resistance is marked in dark blue.

Figure 2 also shows that where the lowest resistance is in the middle of the bumper. Meanwhile, the closer to the edge, the higher the resistance. Injectors are best placed in areas with the lowest resistance. However, in this product, it is impossible to place the injector in the blue area because of what era in the middle of the product. Placement of the injector in the middle will reduce the aesthetic value in cutting the product. The second possibility is that the injector is placed in a turquoise colored area around the blue color. It is also impossible to place the injector in the turquoise curved part because it will make it difficult to cut the product so that the possibility of placing the injector is at the bottom of the turquoise color.

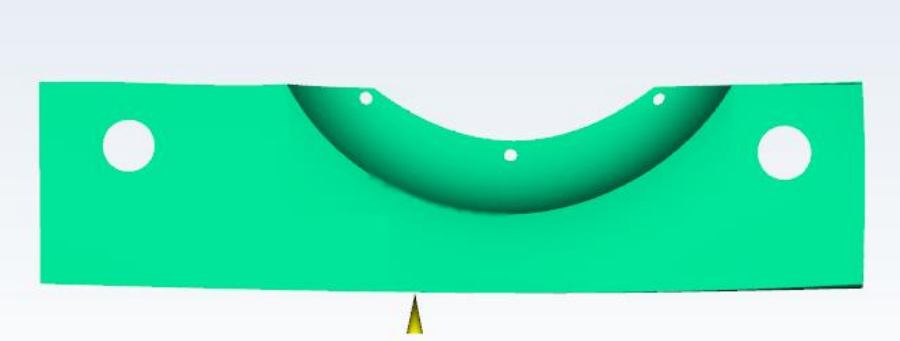


Figure 3. Location of the injector at the coordinates (752, 391, 239)

In the simulation that has been done, the best injector location is at the coordinates (752, 391, 239). This selection is based on the smallest flow resistance, ease of gate placement, ease of cutting the product and the aesthetic value of the product.

2. Potential for Product Defects

Potential for defects during filling include cold encounters (weld line), air traps (air traps), sink marks, and warpage defects

1. Air trapped (air trap)

Air trap is a product defect where there is air trapped in the mold so that part of the mold is not fully filled with material.
Potential water traps that may occur can be seen in the image below .

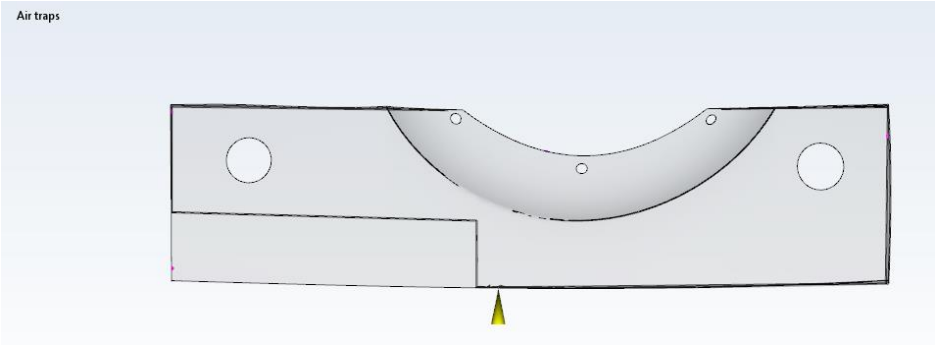


Figure 4. Air Trap

From the picture above, it can be seen that all parts are completely filled with material so that there is no air trap defect in the resulting product.

2. Pertemuan dingin (weld line)

Weld line is a product defect that occurs because the flow of material enters in two directions and meets in the middle of the product. The potential for weld line defects that occur can be seen in the following figure.

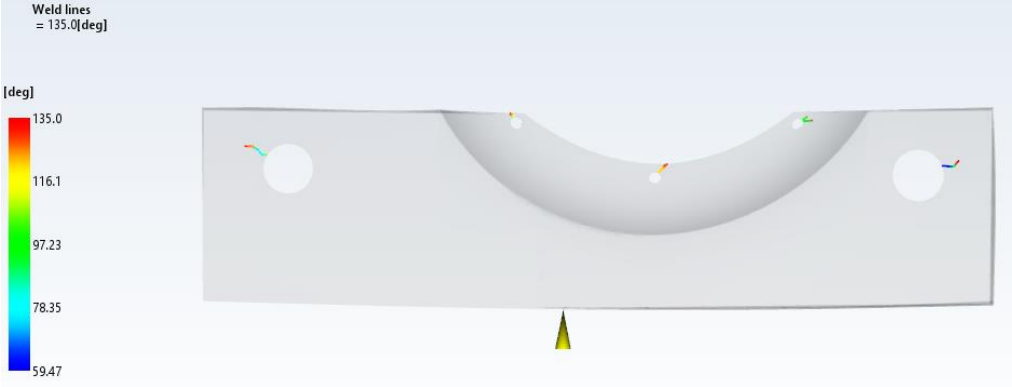


Figure 5. Weld line

From the picture above, it can be seen that there are several parts that have the potential for a weld line to occur. The part that has the potential for a weld line is near the hole, both the lamp hole and the bolt hole on the rear bumper.

3. The sink mark
   is a product defect in the form of a depression or curvature on the surface of the product. The potential for sink marks on the rear bumper can be seen in the following image.

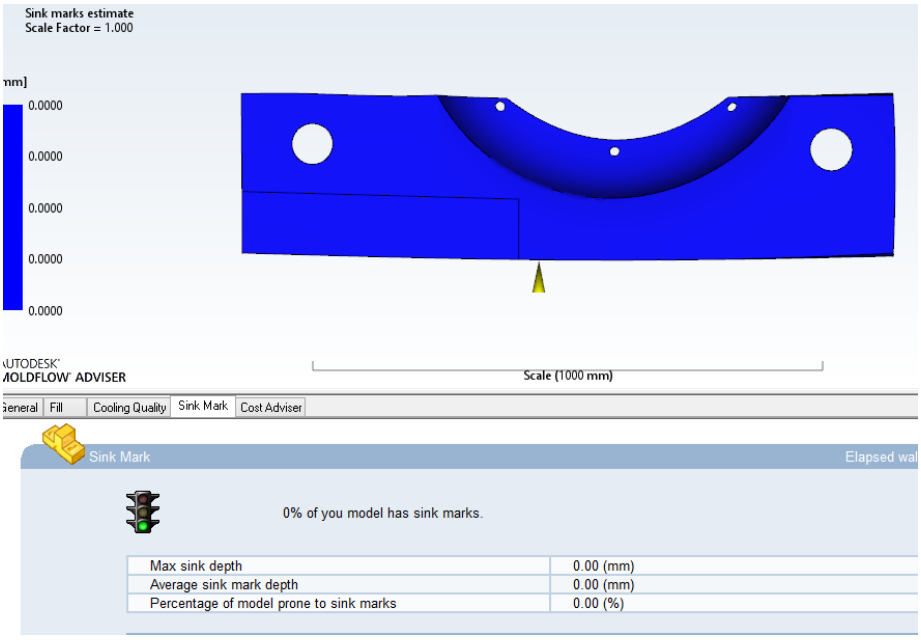


Figure 6. Sink Mark

From the picture above, it can be seen that the potential for sink marks is 0%, which means that there is no potential for sink marks to occur.

4. Warpage

is a defect that forms warpage or twists in the product. The potential for warpage in the manufacture of the rear bumper can be seen in the following image

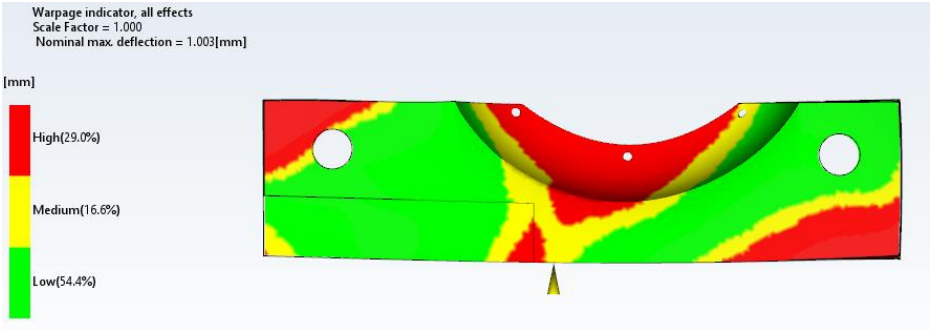


Figure 7. Warpage

From the image above, it can be seen that there are 3 potential warpages that may occur. The first is an area with a high warpage potential of 29% which is marked with a red area. The second is the area with moderate warpage potential, which is 16.6% which is marked with the yellow part. The third is the area with low warpage potential, which is 5.4% which is marked with the green part.

CONCLUSION

Dari hasil pembahasan data yang dilakukan, dapat diambil kesimpulan sebagai berikut :
1. Letak injektor dari hasil simulasi yang telah dialkukan berada pada koordinat (752, 391, 239)
2. Pada koordinat (752, 391, 239) tidak terdapat adanya potensi cacat air trap, weld line dan sinkmark.
3. Potensi cacat warpage yang mungkinterjadi ada 3 macam, yaitu warpage tinggi sebesar 29%, warpage sedang sebesar 16,6% dan warpage rendah sebesar 5,4%

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