DESIGN AND ANALYSIS OF GATING IN PLASTIC PAPER CLIP MOLD

This report submitted in accordance with requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

SAHRUL BAKYAH BINTI YAHYA

B051310189

940227-01-5638

FACULTY OF MANUFACTURING ENGINEERING

2017

DECLARATION

I hereby, declared this report entitled "Design and Analysis of Gating in Plastic Paper Clip Mold" is the result of my own research except as cited in references.

Signature	:	……
Author's Name	:	Sahrul Bakyah binti Yahya
Date	:	22 June 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory committee is follow:

……

(Official Stamp of Supervisor)

ABSTRAK

Projek tahun akhir ini adalah mengenai "Rekabentuk dan Analisis Get dalam Acuan Klip Kertas plastik". Projek ini memberi tumpuan kepada reka bentuk klip kertas plastik dan mengoptimumkan ukuran saiz get dan suntikan lokasi menggunakan dua bahan yang sesuai iaitu Polietilena Ketumpatan Tinggi dan polipropilena. Reka bentuk klip kertas plastik telah dilukis menggunakan perisian CATIA V5R16. Kemudian, perisian "Autodesk Simulasi Moldflow Penasihat" (SMA) yang digunakan untuk menganalisis saiz optimum pintu dan suntikan optimum untuk klip kertas plastik. Permulaan projek adalah mereka bentuk yang mencadangkan reka bentuk baru klip kertas plastik dan kemudian menganalisis enam saiz get yang berbeza iaitu 1mm x 1mm x 0.5mm, 1mm x 2 mm x 0.5 mm dan 1mm x 3mm x 0.5mm bagi fasa 1, dan 1mm x 1mm x 1mm, 1mm x 2mm x 1mm dan 1mm x 3mm x 1mm untuk fasa 2 dan mencadangkan dua lokasi suntikan dimana lokasi depan dan lokasi belakang produk dengan menggunakan perisian SMA. Hasil untuk reka bentuk yang sedia ada adalah meningkat dimana mempunyai tiga jari dan benjolan kecil di kedua-dua belah klip kertas plastik sampingan. Reka bentuk ini lebih cengkaman untuk memegang sehelai kertas. Dalam usaha untuk mencari saiz get optimum, analisis Simulasi Moldflow Penasihat untuk pelbagai saiz pintu telah disimulasikan untuk mencapai matlamat itu. Data yang diperolehi daripada hasil analisis pengisian kedudukan dan pemeriksaan untuk menghapuskan produk yang mempunyai kecacatan. Selepas kedudukan, saiz get optimum dalam acuan klip kertas plastik adalah 1mm x 3mm x 1mm untuk kedua-dua bahan. Lokasi suntikan terbaik mengikut saiz pintu yang dipilih untuk kedua-dua bahan adalah dari lokasi belakang berdasarkan parameter yang diberikan.

ABSTRACT

This final year project is about "Design and Analysis of Gating in Plastic Paper Clips Mold". This project is focused on the design of the plastic paper clip and optimize size of gate and injection location using two suitable material which is High-Density Polyethylene and Polypropylene. The design of plastic paper clips have been drawn using the CATIA V5R16 software. Then, the software "Autodesk Simulation Moldflow Adviser" (SMA) is used to analyze the optimum size of gate and injection optimal for plastic paper clips. The project start by design a new propose design of plastic paper clip and then analyzing six different gate size which are 1mm x 1mm x 0.5mm, 1mm x 2mm x 0.5mm and 1mm x 3mm x 0.5mm for phase 1, and 1mm x 1mm x 1mm, 1mm x 2mm x 1mm and 1mm x 3mm x 1mm for phase 2 and two propose injection location which are front location and back location of product by using SMA software. The result for existing design was improve that there have three fingers and small bump at both side plastic paperclip. This design more grip to hold a sheet of paper. In order to find the optimum gate size, the analysis of Simulation Moldflow Adviser for the various gate size has been simulate to achieve the objective. The data derived from the result of the filling analysis is being ranking and screening in order to eliminate the product that has defect. After being ranking, the optimum gate size in plastic paper clip mold are 1mm x 3mm x 1mm for both material. The best injection location according to the selected gate size for both material is from back location based on the given parameters.

DEDICATION

Special thanks to my supervisor and my friends,

And all the hard work is only for my love:

Yahya bin Pakeh

Salbiah binti Abu Samah

ACKNOWLEDGEMENT

Alhamdulilah, all praises to Allah for the strengths and His blessing in completing this final year project. First and foremost, I would like to thank to take this opportunity to express my utmost gratitude to the people who have directly or indirectly involved in my study.

I wish to extend my sincere thanks to Dr Rosidah binti Jaafar as my main supervisor for always helping and guiding me without fail in the development of this research.

Also not forget to the Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka for allowing me to be part of the network and thus giving useful knowledge and experiences.

Lastly, my special thanks to my parents, and my siblings who always gives her love, support, encouragement and understanding during my studies.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABS	-	Acrylonitrite Butadiene Styrene
HDPE	-	High-density Polyethylene
PA	-	Polyamide
PAS	-	Polyether sulfone
PBT	-	Polybutylene Terephthalate
PC	-	Polycarbonate
PE	-	Polyethylene
PEEK	-	Polyetheretherketone
PET	-	Polyetherimide
PET	-	Polyethylene Terephthalate
PMMA	-	Polymethylmethacrylate or Acrylic
PP	-	Polypropylene
PPS	-	Polyoxymethylene Sulfide
PS	-	Polystyrene
PSU	-	Polysulfone
PVC	-	Polyvinylchloride
SMA	-	Simulation Moldflow Adviser

CHAPTER 1
INTRODUCTION

This chapter will discuss about the background of study, problem statement, objective of study, scope of project in order to complete this study. The problem statement will be determined and objective of the project constructed based on background of the study. This chapter is important to explain about the whole project.

1.1 Background of Study

Paper clip is commonly used by student and also officer to hold sheets of paper together. There are various type of paper clip which is different in material, size and shape. This project is about studying the design and analysis of gating in plastic paper clip mold which to get optimum gate size and injection location for plastic paper clip.

Injection molding is a cyclic process for producing identical articles from a mold, the most commonly used manufacturing process for the manufacture of plastic parts and plastic paper clip is one of product that used this process. The main purpose of injection molding process is to reproduce the desired geometry of the final plastic part by transforming molten plastic into its final shape and dimensional details. Plastic paper clip is the one of product that produce from injection molding process.

Setting parameter such as pressure, temperature and speed are very important for the cycle time in injection molding. The product can be affected even if there is slight difference of those parameters.

Furthermore, gate is also included in factor of the most important parameter in injection molding. Without proper selection of gate design, it really can influenced the manners of the

plastic flow in injection molding. The selection of gate size become most vitals variable to improve the part quality to reduce the rejection and also elimination in trial and error method.

1.2 Problem Statements

Firstly, observation from an existing plastic paper clip find the problem when they are not tightly grip to hold the sheet of paper. When have propose plastic paper clip design, so a new mold is needed.

Injection molding has a parameter or condition required to produce the product that need to follow. Problems can arise when there are no parameters or specific guidance to make the product and if the fill pattern cannot be balanced by changing the position of the gate, flow deflectors or leaders can be used to balance the flow (Shoemaker, 2006), hence it can cause defect towards the products.

This problem will lead to loss of money and time. Thus, this is important that the gate location be correctly position in the mold. To reduce form of disability, the optimum injection molding control is a crucial area for the study of accuracy mold design (Kim et al., 2014).

1.3 Objective of Study

The main objective in this project are:

a) To propose a new design for plastic paper clip.
b) To identify the optimum gate size in plastic paper clip mold using polypropylene and high density polyethylene.
c) To identify the optimum injection location in plastic paper clip mold using polypropylene and high density polyethylene.

1.4 Scope of Studies

The scope for this project will cover on redesign plastic paper clip using Catia software and analysis of the optimum gating size for plastic paper clip with two material which are Polypropylene (PP) and High-Density Polypropylene (HDPP). The validation process for the best gate size and location will be determined by using analysis of Simulation Moldflow Adviser software.

CHAPTER 2
LITERATURE REVIEW

This chapter will discuss about the previous research on related topics used in this study. This research finding helps a lot to gain information and works as a guidance throughout the entire project.

2.1 Introduction to Injection Molding

Tool and die fabrication in plastic injection technology nowadays has turn out to be one of the quickest developing venture in the world and injection molding is an inclusive in manufacturing an assortment of plastic parts for smallest component to whole plastic item. Plastic has been widely used in almost every application from household articles to space travel, from transportation to packing, from medical field of consumer products, from bridge building to recreation. There are numerous injection molded parts can be found in day by day life. This procedure is utilized to created thin walled plastic part for wide assortment of uses, one of the most common being plastic housing (Jagannatha, 2013).

For the most part, injection molding is a procedure that structures the plastic material into required shape under an appropriate pressure by melting the plastic material (Vinod et al., 2010) and forcing that achieved by cooling in thermoplastic or by chemical reaction for thermosetting (George D., 2007). This process is a very complicated system to consist of many components that commanded many cycle of temperature and pressure (Chen et al., 1999) the injection molding process technology represents the most critical process, interesting, engaging and effective foe the manufacture of plastic parts. By and large, the packaging operation is not

necessary. It makes injection molding, suitable for mass produced article (Gerd and Walter, 2008). Figure 2.1 show the example of injection molding machine.

Figure 2.1: Injection molding machine

Source http://www.kishoreandcompany.com/plastic-id-33.htm

2.2 Injection Molding Process

The injection molding machine under through some steps to forms the injection molding cycle to mold the plastic parts. Its starts with press the nozzle, then the mold will be close, the screw forward by using injection cylinder without turning after that the cavity melt when the injection process occurs, cooling time happen when the screw gripped holding temperature then screw return back and mold will be open, the product come out from the mold (Jagannatha, 2013). The most important things in a process of injection molding machines is a mold and also the material itself. The process begin with:

i. Firstly, close the mold that consists of at least two halves (part) and clamped to injection side. The plastic material coming from the raw material supplier in the form of powder or pellets is put into hopper. From the material enters the plasticizing unit, where a screw rotates in a cylinder and by this rotation, the melt is transported in front of the screw into the screw chamber which enlarges.

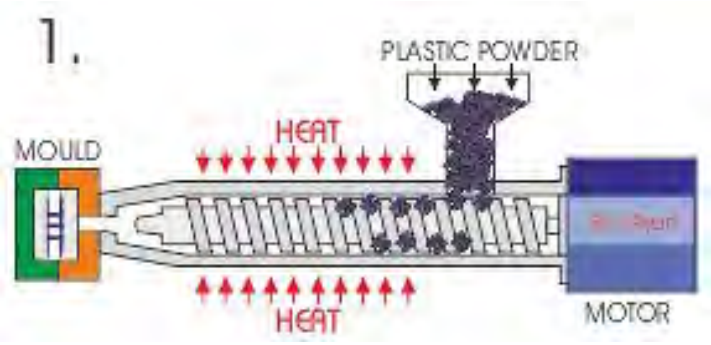

Figure 2.2: Granules of plastic powder fed into hopper

Source http://www.technologystudent.com/equip1/inject1.htm

ii. Subsequently, the plastic material is heated by friction and by additional heater bands around the plasticizing barrel. Thus the material is melted.

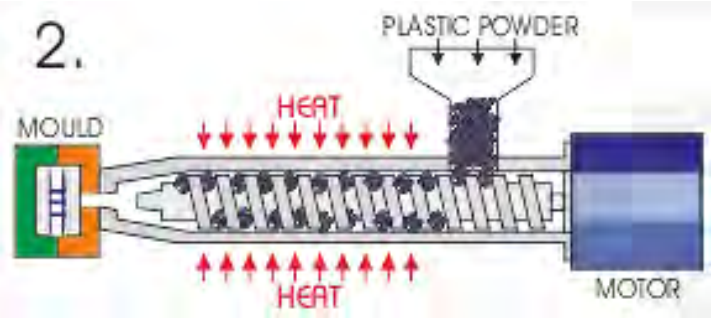

Figure 2.3: Heater heat up the tube

Source http://www.technologystudent.com/equip1/inject1.htm

iii. Next, the screw is forcing the melt from the screw chamber through the nozzle into the mold cavity. As the injected melt solidifies because of the cold mold walls, the screw presses addition melt into the mold under holding pressure to compensate for the volume contraction of the material as it cools.

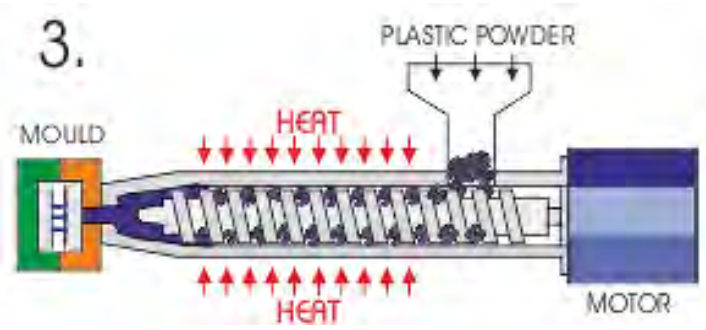

Figure 2.4: A motor turns a tread and pushed the granules along the heater

Source http://www.technologystudent.com/equip1/inject1.htm

iv. When the molded part is cool and stiff enough, the mold opens and the molding is ejected from the cavity with assistance from an ejector system inside the mold. This completes an injection cycle and next production cycle can start.

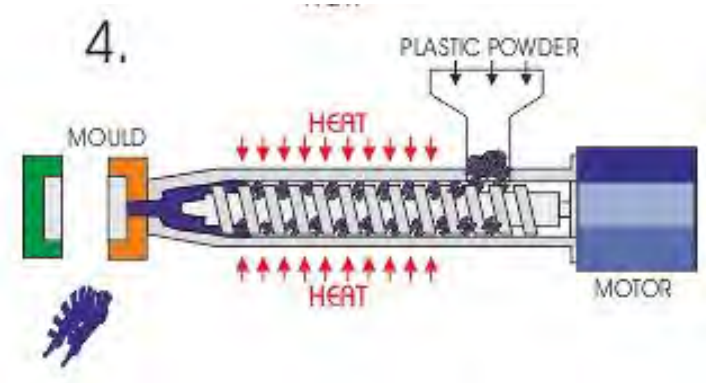

Figure 2.5: The mold then open the part is removed

Source http://www.technologystudent.com/equip1/inject1.htm

2.3 Material Used

Material used is divide by 2 which is for product and mold. Plastic material is usually use in product when using injection mold process and material for mold is depend the liquid that to be process.

2.3.1 Product

Two major categories plastics can be divide which is thermoplastic and thermoset. The different of this two plastics is thermoplastic polymer are formed by applying heat and can reformed in multiple times and for thermoset polymers are formed chemically by radiation or heat and are irreversible (Plastic One, 2016). There are many types of materials that can be used in the injection molding process and most polymers can be used is all thermoplastics. The Table 2.1 below show a sample of thermoplastic choice available on the market.

Table 2.1: A sample of thermoplastic available on the market

Amorphous	Semi-Crystalline
Acrylonitrite Butadiene Styrene (ABS)	Polyamide (PA/Nylon)
Amorphous Nylon	Polybutylene Terephthalate (PBT)
Polycarbonate (PC)	Polyetheretherketone (PEEK)
Polyetherimide (PEI)	Polyethylene (HDPE, LDPE)
Polyether sulfone (PAS)	Polyethylene Terephthalate (PET)
Polymethylmethacrylate (PMMA) or Acrylic	Polyoxymethylene (PMMA) or Acetal
Polystyrene (PS,HIPS)	Polyoxymethylene Sulfide (PPS)
Polysulfone (PSU)	Polyphtalamide (PPA)
Polyvinylchloride (PVC)	Polypropylene (PP)
Styrene Acrylonitrile (SAN)	Polytetrafluoroethylene (PTFE)

Thermoplastic performances pyramid a structure often depicted as a Commodity or standard thermoplastics, engineering thermoplastics (ETPs) and high-performance thermoplastics (HPTPs) at the top with the higher price and location in the pyramid. The pyramid is divide into three stages which is from the bottom to top are standard thermoplastics, engineering thermoplastics and high-performance thermoplastic with each stage split into two categories, amorphous and semi-crystalline. Plastic one (2016) state that, there is approximately a half thermoplastic of amorphous and semi-crystalline polymers to choose from throughout the

industry. Semi-crystalline plastics, at a monomer chain level, create ordered sections that pack tightly together. Amorphous is without ordered sections and does not pack as tightly together. Figure 2.6 show thermoplastic performance pyramid.

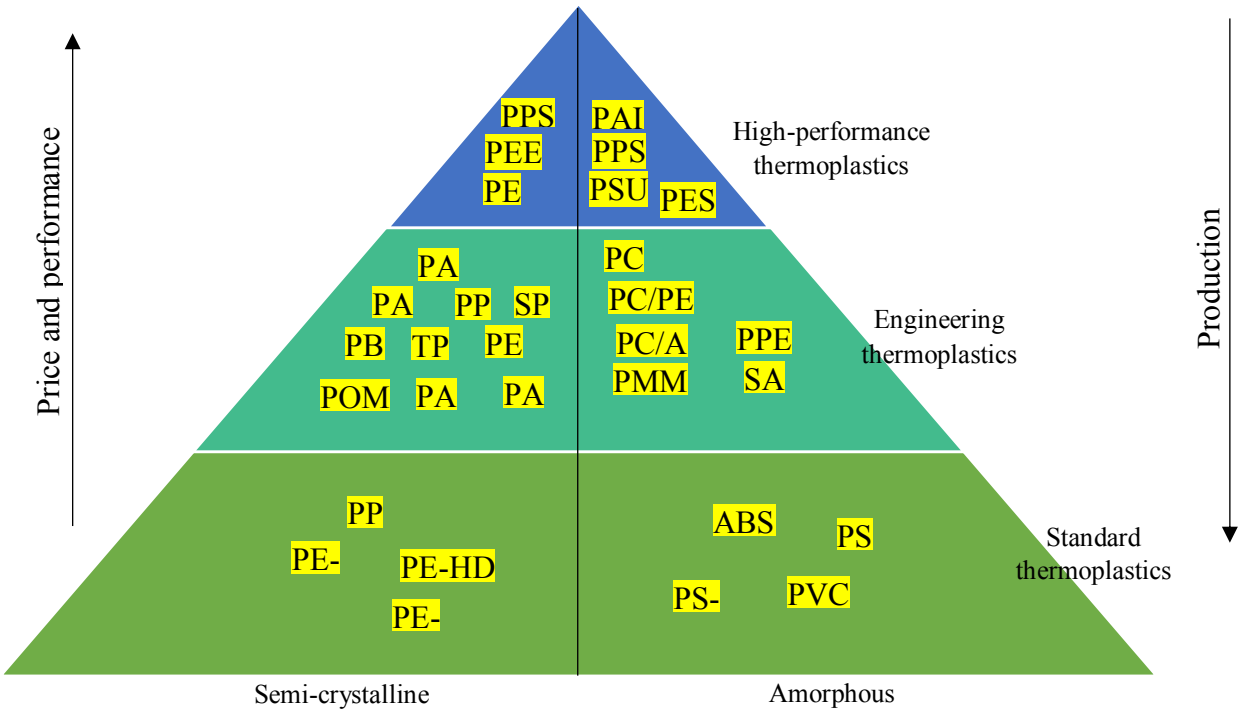

Figure 2.6: Thermoplastic performance pyramid (Yasmin, 2016)

2.3.2 Mold

The material selection for the mold must be selected carefully depending on the liquid or resin that to be processed. The important properties that has to be included during material selection is high wear resistance. This characteristic is consider important when the mold material need to be coat surface treatment. Other than that, corrosion is very destructive towards the metal material. Then high corrosion resistance must be consider when selecting the material for the mold.

In addition, Peter Unger (2006) stated that the mold must have good thermal conductivity in order to fulfill the quality needs with considering performance capability of molded part and course for economic reasons. Determine the rate of temperature change directly affect cooling