UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND SIMULATION OF COOLING CHANNEL FOR PLASTIC INJECTION MOULDING

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

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (product design) (Hons.). The member of the supervisory is as follows:

……………………………………

(Project Supervisor)

ABSTRAK

Projek ini memperkatakan dengan reka bentuk dan simulasi saluran penyejukan untuk mereka bentuk dua plat acuan bahagian badan pengering rambut dengan menggunakan perisian CATIA dan memindahkan model 3D ke dalam simulasi perisian Autodesk Moldflow Insight 2014. Objektif projek ini adalah untuk mereka bentuk seni bina baru penyejukan saluran dan simulasi dengan menggunakan Autodesk simulasi Moldflow Insight 2014. Selain daripada itu adalah untuk membandingkan antara saluran penyejukan lurus konvensional dan seni bina baru saluran penyejukan. Reka bentuk produk yang akan dianalisis menggunakan Autodesk simulasi Moldflow Insight 2014 untuk mengurangkan kecacatan yang muncul semasa proses pengacuan suntikan. Selain itu, dalam proses suntikan plastik, prestasi saluran penyejukan adalah salah satu faktor yang paling penting kerana ia mempunyai kesan yang besar ke atas kedua-dua kadar pengeluaran dan kualiti bahagian plastik. Dalam usaha untuk mengurangkan masa kitaran, dan mengawal taburan seragam suhu, adalah perlu untuk mewujudkan seni bina penyejukan saluran baru, yang menepati bentuk rongga acuan dan teras. Projek ini membentangkan kajian simulasi jenis penyejukan saluran dalam suntikan teracu bahagian plastik dan membandingkan prestasi dari segi masa untuk mencapai suhu pelemparan, pengecutan isipadu, profil suhu, suhu litar penyejuk dan kecacatan bahagian untuk menentukan konfigurasi adalah lebih sesuai untuk menyediakan penyejukan seragam dengan masa kitaran minimum. Autodesk simulasi Moldflow Insight perisian 2014 digunakan untuk memeriksa keputusan prestasi saluran penyejukan

ABSTRACT

This project deals with design and simulation of cooling channel for designing two plate mould of body hair dryer part by using CATIA software and transfer the 3D model into Autodesk Moldflow Insight software. The objective of this project is to design a new architecture of cooling channel and simulate by using Autodesk simulation Moldflow Insight 2014. Other than that is to compare between conventional straight cooling channel and the new architecture of the cooling channel. The design of the product will be analysed using Autodesk simulation Moldflow Insight 2014 to reduce the defect that appears during the injection moulding process. Besides, in the injection moulding process, the cooling channel performance is one of the most crucial factors because it has a significant effect on both production rate and the quality of the plastic part. In order to reduce the cycle time, and control the uniform distribution of temperature, it is necessary to create the new architecture cooling channels, which conform to the shape of the mould cavity and core. This project presents a simulation study of different types of cooling channels in an injection moulded plastic part and compares the performance in terms of time to reach ejection temperature, volumetric shrinkage, temperature profile, circuit coolant temperature and part defect determine which configuration is more appropriate to provide uniform cooling with minimum cycle time. Autodesk simulation Moldflow Insight 2014 software is used to examine the results of the cooling channel performance.

DEDICATION

The sake of Allah, my Creator and my Master,

My great teacher and messenger, Mohammed (May Allah bless

and grant him), who taught us the purpose of life,

My beloved parents.

For their endless love, support and encouragement.

My supervisor Madam Umi Hayati Ahmad.

And my lecture Mr. Kamal bin Musa

For giving me knowledge and support my project.

My friends who encourage and support me,

All the people in my life who touch my heart,

I dedicate this research.

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In the Name of Allah, the Most Merciful, the Most Compassionate all praise be to Allah, the Lord of the worlds and prayers and peace is being upon Mohamed His servant and messenger.

First and foremost, I have to thank my parents for their love and support throughout my life. Thanks you both for giving me strength to reach for the stars and chase my dreams.

I would like to sincerely thank my supervisor, Madam Umi Hayati binti Ahmad, for her guidance and support throughout this study, and especially for her confidence in me.

To all my friends, thank you for your understanding and encouraging me during the whole research in my many moments of crisis. Our friendship makes my life a wonderful experience. I cannot list all the names here, but you are always on my mind.

This thesis is only a beginning of my journey.

Thank you.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ABS	-	Acrylonitrile Butadiene Styrene
PE	-	Polyethylene
PP	-	Polypropylene
IM	-	Injection Moulding
MPI	-	Moldflow Plastic Insight software

CHAPTER 1
INTRODUCTION

This thesis proposes a new architecture for cooling channel of injection moulding. This chapter presents the background of plastic injection moulding and the research objectives to design a new architecture of cooling channel and simulated by using Autodesk Simulation Moldflow insight 2014 and to compare between conventional straight cooling channel and the new architecture of the cooling channel.

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1.1 Project Background

1.1.1 Plastic Injection moulding

Nowadays, injection moulding product has been extensively used in the daily application, such as household appliances, industrial field, toys, medical device, electronics, computer, communication, auto parts and also in the sport equipment. Besides, the plastic material has the advantages such as lightweight, leakproof, durable, flexible and non-breakable compared to other material which also being used for such applications.

Figure 1.1(a): Example of Plastic Material Produce of Injection Moulding

Source: http://www.abspi.com/index.html

Moreover, people are more demanding on something that simple and less costly in their daily requirement. In order to meet customer needs, more company struggling with competitive market to produce low cost products high quality of product. Much research has been carried out that focusing on the increasing the efficiency and simplify the operation, especially both assembly and manufacturing process and cost.

This project is to analyze and simulate a hair dryer housing. The plastic material that will be used is polypropylene (PP). In achieving the goal of creating a new architecture of cooling channel depending on the part that have been chosen which is hair dryer housing, the process method will be carried out by using Autodesk simulation MoldFlow Plastics Insight software.

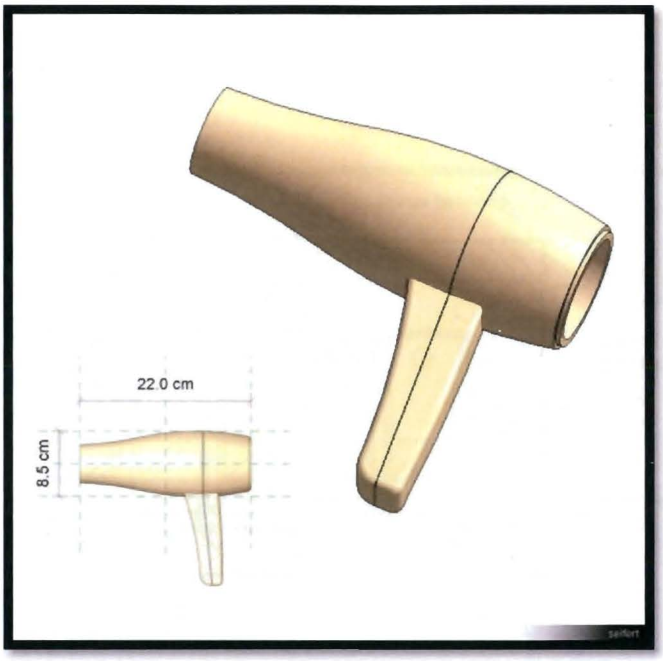

Figure 1.1 (b): Example of hair dryer housing

1.1.2. 2 Plate Mould

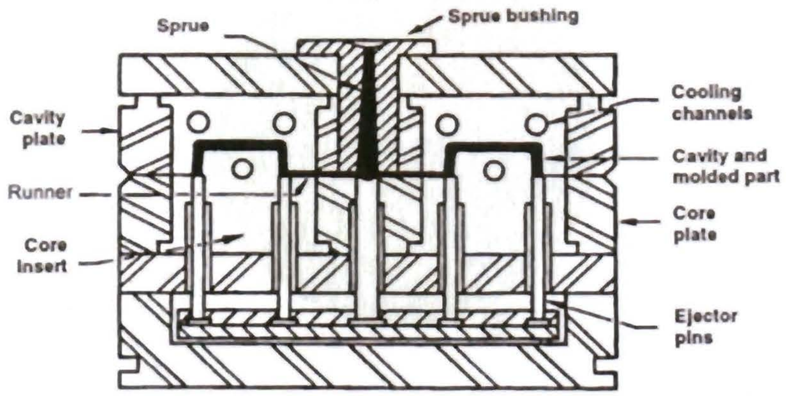

FIG. 8.4 Two-plate injection mold.

Figure 1.1.2: 2 plate moulds

The most simple and most reliable mould design is the two plate mould. It is because normally has the fewest number of moving parts and is more straight forward to manufacturing and run in production. 2 plate moulds are a simple construction usually cheaper to manufacture than a complex design. Besides, the simplicity of its design and manufacture, mould design should make sure that all possible by using two plate design have been exhausted before other more complex design are considered (John, 2008).

1.1.3. Cooling Channel

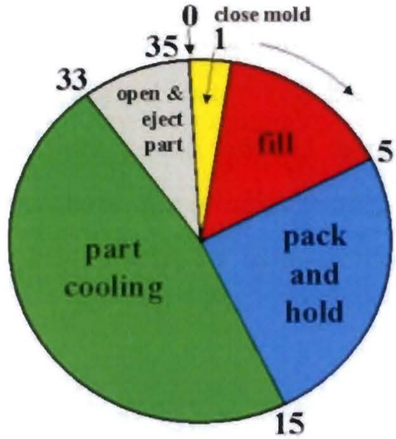

Figure 1.1.3: Typical Injection Moulding Cycle Clock

Cooling channel is the one of the parts in the injection moulding. Nowadays, the complexity of the plastics product has increased with more features. The industry is developing to be responsible for producing difficult geometry shapes besides to reduce long cycle time for whole process takes place. Cooling stage plays an important role, in fact, more than 2/3 of the cycle time depends on it solely (E. Sachs, 2000). However, the cooling time reduction will increase the production rate as well as reduce the cost (Shoemaker, 2006). But, when decreasing the cooling time the result will defect the part as well Meckley & Edwards,(2009). There is a need of a cooling technique to reduce the cycle time without compromising on part quality. (Khan et. al., 2014)

Furthermore, in the cooling phase, heat transfers between the molten material in the cavity and the cooling fluid flow through the cooling channels inside the mould, until the ejection temperature are achieved and part is stable to mould. Thus, this rate of heat exchange is very important and directly related to the time taken by the cooling phase. So it is important to understand and optimize the cooling channel design to optimize the rate of heat transfer in an injection moulding process. The proper design of the cooling channel is required for a faster cooling phase.

Historically, the cooling channels have been created by drilling several straight holes cooling channels inside the mould core and cavity. Such type of cooling channels is called as Conventional Cooling Channels (khan et. al., 2014). However the cooling process in conventional Cooling Channels is too long because of nonuniform cooling of the part. If the part's temperature can be reduced more quickly and uniformly, it will shorten the cooling time without compromising on part quality because nearly uniform temperatures can be held in part by using conformal cooling Meckley & Edwards, (2009).

1.1.3.1. Straight Cooling Channel

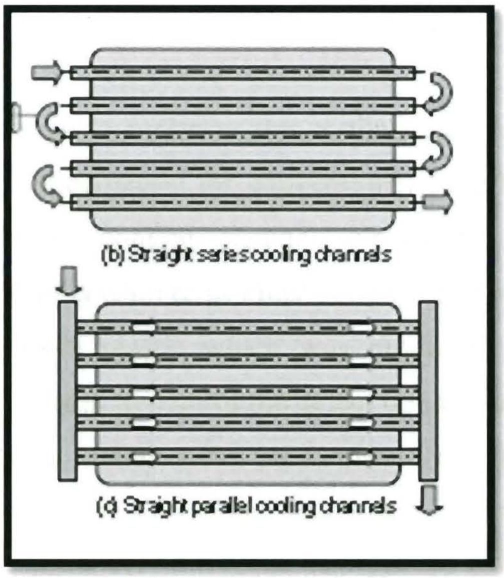

Figure 1.1.3.1: Straight drilled cooling channels are parallel and series

The common types of straight drilled cooling channels are parallel and series. Parallel cooling channels are drilled straight channels that the coolant flows from a supply manifold to a collection manifold. Cooling channels that are connected in a single loop from the coolant inlet to its outlet are called serial cooling channels. (Park & Dang, 2012).

1.1.3.2. New architecture Cooling channel

Research in new architecture cooling channel, the shape of cooling channel has conformed to the shape of the cavity in the mold. Research of conformal cooling channel is depending on simulation studies. Konsulova-Bakalova has used thermal simulation software, SolidWorks Simulation, and compared conformal cooling channels with circular and elliptical cross-sections. He has concluded that the cooling time of the part has been optimized by using conformal cooling channels and results translate a reduction in production cycle time and increase in the quality of the parts ("Application of solidwoks simulation for the design of the cooling system for injection molding").

1.1.4. Project Briefing

This project aims is to optimize the cooling channel for Plastic Injection Mould (2 Plate mould). Specifically for conventional straight cooling channel and create new architecture of cooling channel. Nowadays, global industries are increasing with the trend of consumer product designed that is getting smaller. Most of the cover is made from plastic which was produced by using an injection moulding process. It is difficult to control the defect on the part. Therefore, this study is performed purposely to evaluate the performance of the new architecture of cooling channel compared to the straight drilled cooling channel in order to minimize the defect on the part. Moreover, the result can get by using simulation through Autodesk Moldflow to get the optimization of cooling channel. However, cooling design of plastic injection mould is important because it not only affects part quality, but also the injection moulding cycle time.

1.2. Problem Statement

In every injection moulding process, the problem occurs after the molten plastic melts turns to solidify. Several defects will appear which will affect the performance of the part. Certain design of the cooling channel is not suitable to the curve part if using the straight cooling channel. The major problem needs to be concerned is the product defect. The focus should be on the cooling process of the product that is during cooling analysis and parameter of the cooling channel for the part which can reduce the defect. Moreover, the material also plays an important role in reducing the defects that might appear on the part. The aim of determining which cooling system configuration is appropriate for this part providing uniform cooling, minimum cycle time, less warpage and shrinkage. From the research the straight cooling channel takes a long time of cycle time, while conformal cooling channel design gives better cycle time, which ultimately increases production rate as well as fatigue life of the mould. It is important to determine a method to get the best result for the future mould of this part to minimize defects.

1.3. Objective

1. To design a new architecture of cooling channel and simulated by using Autodesk Simulation Moldflow insight 2014
2. To compare between conventional straight cooling channel and the new architecture of the cooling channel.