UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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OPTIMIZATION OF INJECTION MOLDING PROCESS ON NAME TAG PLASTIC PRODUCT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering Technology (Process and Technology) with Honours

by

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TAJUK: **Optimization of Injection Molding Process on Name Tag Plastic Product**

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I hereby, declared this report entitled "OPTIMIZATION OF INJECTION MOLDING PROCESS ON NAME TAG PLASTIC PRODUCT" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

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....

(Project Supervisor)

ABSTRAK

Projek ini fokus untuk mengkaji parameter yang akan mempengaruhi masalah pengecutan dalam proses pengacuan suntikan plastik. Empat parameter penting telah dipilih. Antaranya ialah tekanan memegang, masa memegang, masa penyejukan, dan tekanan suntikan yang akan disiasat untuk mengoptimumkan proses pengacuan suntikan pada tag nama pemegang plastik produk manakala parameter lain dikekalkan. Reka bentuk eksperimen akan digunakan untuk menyiasat dan mengoptimumkan parameter. Dalam kajian ini, polipropilena dipilih sebagai bahan untuk menghasilkan produk plastik. Untuk menentukan pengecutan dalam produk plastik, alat pengukur, Menyelaras Mesin Mengukur (CMM) digunakan untuk mengukur dimensi produk. Berdasarkan analisis kedudukan Taguchi, tekanan memegang adalah faktor penting yang memberi impak pengecutan. Pengecutan boleh dikurangkan dengan meningkatkan tekanan pegangan.

Kata kunci: pengecutan, parameter, proses pengacuan suntikan plastik, reka bentuk esperimen, analysis Taguchi

ABSTRACT

This project specifically studies the parameters that will influence the shrinkage problem in plastic injection molding process. The four significant parameters are selected. There are holding pressure, holding time, cooling time, and injection pressure to investigate the optimum injection molding process on name tag holder plastic product where the others parameters will as a constant. Design of Experiment (DOE) will be used to investigate and optimize the parameters. In this study, Polypropylene is selected as a material to produce the plastic product. To determine the shrinkage in plastic product, the measuring device, Coordinate Measuring Machine (CMM) is used to measure the dimension of the product. Based on the ranking of Taguchi analysis, holding pressure is the significant factor that affected the shrinkage. The shrinkage can be minimize by increasing the holding pressure.

Key words: shrinkage, parameters, injection molding process, design of experiment, Taguchi Analysis, measuring device

DEDICATIONS

To my beloved family

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CMM	-	Coordinate Measuring Machine
DOE	-	Design of Experiments
FTK	-	Fakulti Teknologi Kejuruteraan
HDPE	-	High Density Polyethylene
IM	-	Injection Molding
LDPE	-	Low Density Polyethylene
MFR	-	Melt Flow Rate
OA	-	Orthogonal Arrays
PP	-	Polypropylene
S/N	-	Signal-to-Noise
UTeM	-	University of Technical Malaysia Melaka

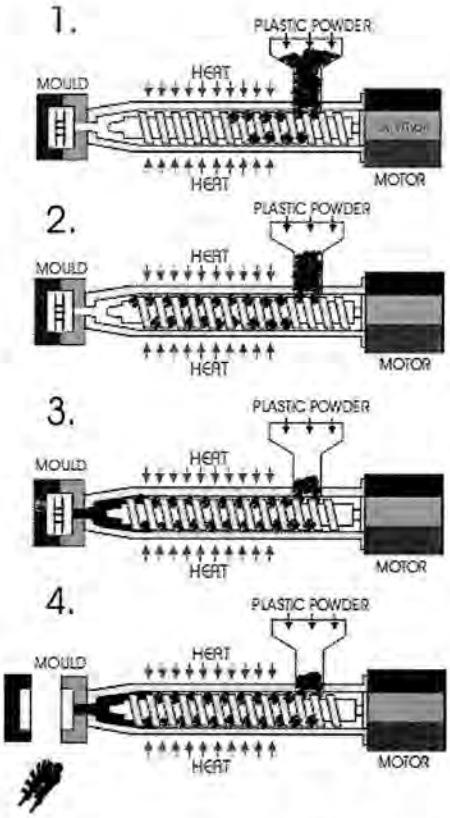
CHAPTER 1
INTRODUCTION

1.0 Introduction

In first section of the report, few parts will be describe which are background, problem statement, and objective of the study. Scope will discuss about parts have covered and the limitation of this project.

1.1 Background

Injection molding is a most common method of part manufacturing. It is a manufacturing process with injecting material or granule into a mold to produce part from glasses, metals, thermoplastic and thermosetting plastic. Material is fed into heated barrel and forced to push the material into mold cavity. Where the material cools and hardens to the configuration of the mold cavity. Figure 1 described the process of injection molding.



1. The plastic granule is fed into a hopper, which stores it until it is needs.

2. A heater heats up the tube. When it reaches a high temperature, a screw thread starts turning.

3. A motor turns a thread, which pushes the granules along the heater section, which melts, into a liquid. The liquid is forced into a mold where it cools and hardens into the

4. The mold then opens and the unit is removed.

Figure 1.1: Process of Injection Molding

The materials that can be used for plastic injection molding are thermoplastic and thermosetting plastic. Polypropylene (C_3H_3) is a thermoplastic saturated polymer that widely used in variety applications. Polypropylene is good in chemical resistance, fatigue resistance, and heat resistance. A product that has a good value in market, the first consideration is the quality of the product and followed by appearance or design. Therefore, polypropylene can be dye in various color with various ways without affecting the quality of the product.

In the area of manufactured plastic, injection molding is an important process for mass production of plastic. It has the benefits in fast production that can produce large amount of parts per hour that we are unthinkable. The record of the cycle time is in between 15-30 seconds per part. The material characteristic, mold design and the process conditions will affecting the quality of the injection moldings.

The process conditions including the parameters. For example, injection speed, holding pressure, injection pressure, barrel temperature, holding time, and cooling time. Some defect, for example shrinkage and warpage are a huge problem we face nowadays. Shrinkage and warpage will affected the parts result, the defects in dimensional stability. Shrinkage of the plastic product represents the volume size of the product and mold cavity is different. In other words, the dimension of the product is different with the mold cavity dimension.

To minimize this problem, the parameters optimization and the design of experiments are needed to produce high quality products for process injection molding. From several researches, they are using Taguchi Method, Signal-to-noise ratio to reduce shrinkage and warpage problems by obtain the suitable process parameters. Taguchi Method is developed by Dr. Taguchi of Nippon Telephones and Telegraph Company. The purpose was to reduce the variances of the experiment by optimum settings of control parameters. The Signal-to-noise (S/N) is a log functions of desired output which predict and analysis data of optimum result by control factors. It has two categories to treats the optimization problems, which are Static Problems and Dynamic Problems. Static problem is the optimization that involves determining the best control factor levels so that the output is at the target value. If the signal input that directly decides the output, the optimization involves the determining of best control factors level so that the ratio of input signal by output is a smallest value, which is Dynamic problems. The diagrams bellow shown the best explained of Static Problems and Dynamic Problems respectively.

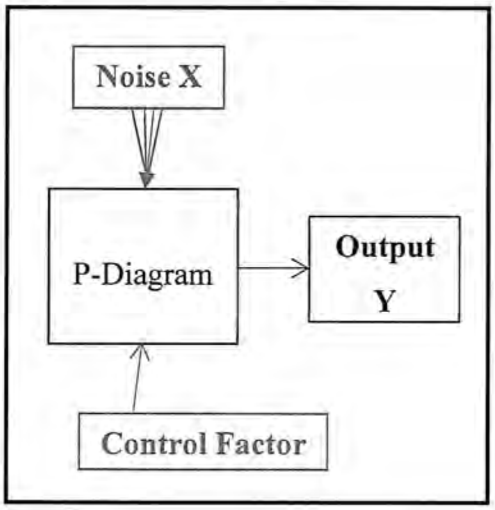


Figure 1.2: P-Diagram for Static Problems

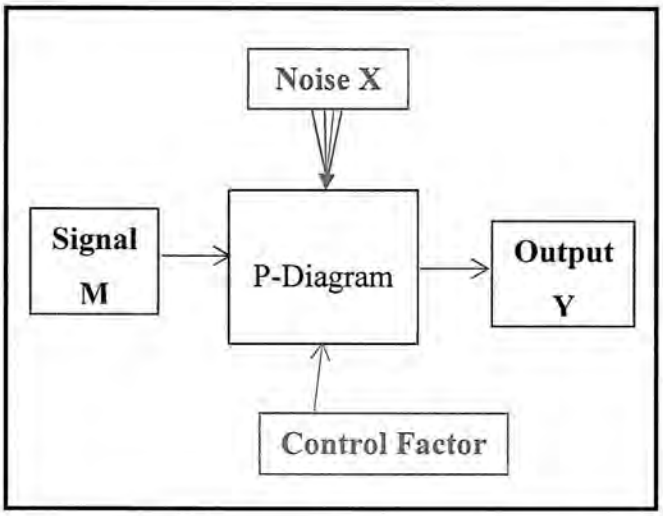


Figure 1.3: P-Diagram for Dynamic Problems

1.2 Problem Statement

The major problem in the area of manufactured plastic product is a shrinkage problem. The problem statement addresses the need for controlling and minimizes the part of shrinkage formation in plastic materials for name tag product. For conventional method, it is trial and error method to find the suitable parameters. This method is time consuming and not cost effective. Moreover, this method is take time to determine the significant factors that will affecting the part of shrinkage. Taguchi Design of Experiment method will be utilized in this study and the process factors will be analyzed. Besides, the analysis of the Taguchi results with wrong approach will affected the decision-making. Therefore, the factors level is need to investigate. It will affected the dimension of the product.

1.3 Objective of the Research

The purpose of the study is to minimize the shrinkage problem for plastic name tag holder product. In order to achieve it, the following objectives are to determine:

a) The significant factor affecting the part shrinkage.
b) Optimum process parameter factors for name tag holder plastic product.

1.4 Project's Scope

The scope is the guideline for the reader to areas that have or have not been covered. It is impossible to investigate everything in the study and project. Therefore, the study will cover primarily on the scopes are:

a) Material used in this project is Polypropylene (PP).
b) Plastic injection molding process is selected in this research study.
c) Design of Experiment (DOE) is used to analyze the data.
d) Name tag holder product is selected for this process evaluation.
e) Electrical Injection Molding (ZHAFIR Plastic Machinery VE1200 ton) is used during shrinkage process evaluation study.
f) Dimension inspections are measured the length and width of the name tag holder plastic product.
g) CONTURA G2 Coordinate Measuring Machine is used during inspection process.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter provides a detailed of plastic injection molding includes the history, process, concept, and machine. The process factors involve and the materials that used in this project will be included in this chapter. Besides that, this chapter also includes the history and information about Taguchi Design of Experiment method.

2.1 Injection Molding

2.1.1 History of Injection Molding

In the late of 1800's, injection molding was steady growth up, the method has progressed from the production of buttons, hair combs, and collar stays to aerospace products, major customer, medical, and industrial. In year 1868, John Wesley Hyatt created a method which injecting celluloid into a mold to make a billiard ball. Nevertheless, the first injection molding machine was patented by John and his brother Isaiah Hyatt which was suitable for their goal in year 1872. Inside the cylinder, have a basic plunger to inject the plastic material into a mold. Industry exploded rapidly during 1940, as the World War II created a demand for inexpensive, mass-produced products. In 1946, the first screw with auger design of injection molding machine has been to replace Hyatt's plunger. Inside the cylinder, contain auger and mixes the materials. After that, pushing forward the auger and injecting the material into the mold cavity. (Moulding, 2007), (Ramlee, 2007), (Hamid, 2010)

2.1.2 Injection Molding Machine (Council, 2016)

The injection molding process is a process of inject the plastic material into a mold cavity and cold to become the desired product shape. Therefore, injection molding machine can melts the materials to molten plastic and inject into the mold cavity with pack that through the cooling process to become final molded part. It consists of six major component,

a) Injection system
b) Hydraulic system
c) Mold system
d) Clamping system
e) Control system

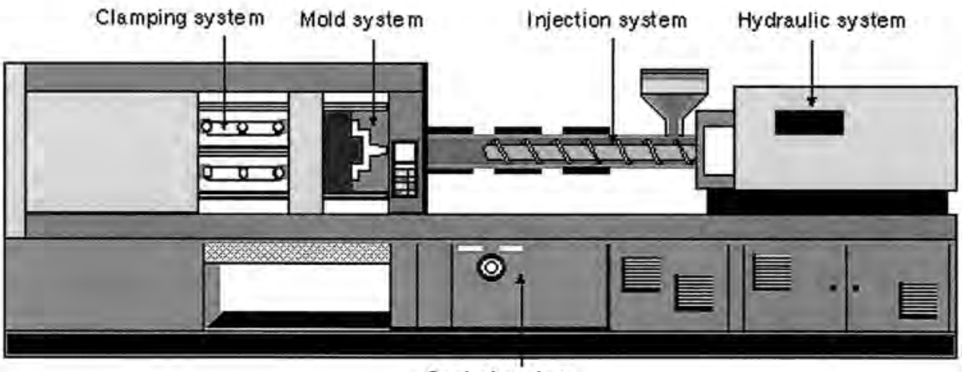


Figure 2.1: Injection Molding Machine with Component (PMOLDS, 2004)

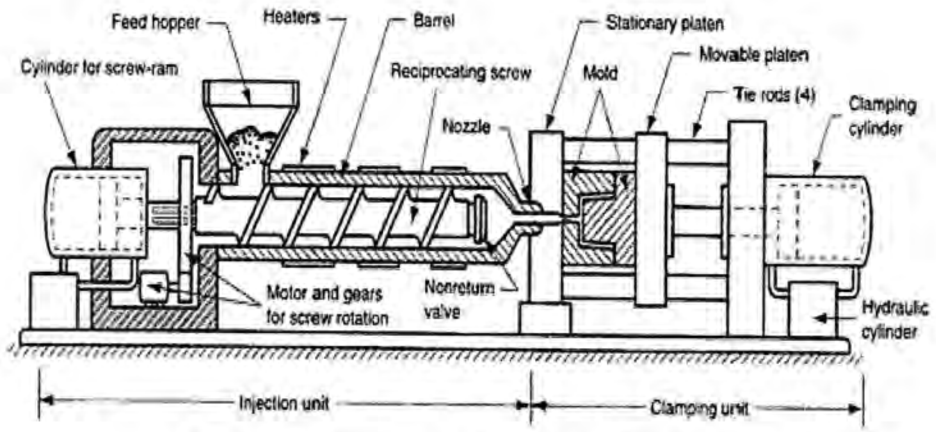


Figure 2. 2: Structure of Injection Molding Machine

Based on the function of injection molding machines, it can be categories into three types, there are general-purpose machines, precision with tight-tolerance machines, and high-speed with thin-wall machines. The size of the machine can identify by the clamping tonnage and the shot size for the machine specification. The parameters that will affected the process include injection pressure, injection rate, mold thickness, distance between tie bars and screw design. The resin dryers, mold-temperature controllers, granulators, part-handling equipment, chillers, and part-removal robots are the major equipment auxiliary for the machine of injection molding. (Hamid, 2010)