



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**COMPARISONS OF MECHANICAL PROPERTIES BETWEEN
PURE POLYPROPYLENE AND POLYPROPYLENE FILLED
WITH TALC USING SINGLE GATE AND TWIN GATE MOULD**

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

by

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APPROVAL

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

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Dr. Mohd Amran bin Md Ali
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ABSTRAK

Polypropylene (PP) adalah salah satu bahan paling popular pada masa sekarang. Ia adalah sejenis plastik yang boleh diproses dengan mudah dan menjimatkan kos. Penambahan serbuk tepung ke dalam *polypropylene* boleh mempengaruhi prestasi *polypropylene*. Jadi, objektif kajian ini adalah untuk mengenalpasti ciri-ciri mekanikal maksimum yang ada pada produk plastik *dumbbell* di mana ia melalui laluan tunggal dan laluan berkembar menggunakan *polypropylene* asli dan *polypropylene* yang ditambah serbuk tepung. Ciri-ciri mekanikal yang dikaji adalah kekuatan tegangan, modulus kekuatan, dan peratus pemanjangan. Pertama sekali, suntikan acuan dilakukan untuk mendapatkan spesimen. Parameter yang telah ditetapkan untuk proses suntikan plastik adalah suhu acuan, suhu pencairan, masa suntikan, dan masa penyejukan. Nilai untuk setiap parameter bagi proses suntikan plastik diperolehi daripada simulasi *Moldflow*. Kemudian, ujian ketegangan dilakukan terhadap spesimen yang terhasil daripada proses suntikan acuan. Hasil ujian ketegangan seterusnya dianalisis oleh perisian Minitab 17 menggunakan kaedah taguchi dan analisis ANOVA. Kedua-dua kaedah ini membantu dalam mengenalpasti parameter yang paling signifikan terhadap hasil ujian. Keputusan menunjukkan kekuatan ketegangan tertinggi terhasil daripada *polypropylene* asli menggunakan laluan berkembar dengan parameter paling signifikan adalah suhu acuan. Untuk modulus kekuatan, nilai tertinggi adalah daripada *polypropylene* yang ditambah serbuk dengan suhu acuan menjadi parameter yang paling mempengaruhi keputusan. Untuk peratus pemanjangan, nilai tertinggi datang daripada *polypropylene* asli menggunakan laluan tunggal dan suhu acuan merupakan parameter paling signifikan. Keputusan ujian ini jelas dapat menyumbang dalam mana-mana sektor terutamanya industri automotif. Bahan terbaik untuk bahagian kereta seperti *spoiler* boleh ditentukan berdasarkan hasil dapatan kajian.

ABSTRACT

Polypropylene (PP) is one of the most popular plastic material nowadays. It is a type of plastic materials that can be processed easily and consume less cost. The addition of talc into polypropylene may affect the polypropylene performance. Thus, the objective of this study is to find out the maximum mechanical properties of dumbbell plastic products having single gate and twin gate using pure polypropylene and polypropylene filled with talc. The mechanical properties that investigated are tensile strength, modulus of strength and percent of elongation. Firstly, the injection moulding process was performed to get the specimens. The parameter that has been set for injection moulding process were mould temperature, melt temperature, injection time and cooling time. The suggested value of parameters for injection moulding process was gained from moldflow simulation. Then, tensile test applied to the specimens obtained from injection moulding. The result gained from tensile strength then analysed using Minitab 17 software by applying S/N ratio in taguchi method and ANOVA analysis. Both of this method helps in determining the optimum values of parameter to achieve highest value of mechanical properties. They also help in determine which parameter is the most significance to the responses. The result obtained shows that the highest tensile strength belongs to pure polypropylene using twin gate mould with the most significance parameter is mould temperature. For modulus of strength, the highest value comes from polypropylene filled with talc using single gate mould while the result most affected by mould temperature. For percent of elongation, the highest value gained from pure polypropylene using single gate mould with mould temperature as the most significance parameters. The results of this study clearly can contribute in any sectors especially in automative industry. The best material for the car parts such as spoiler can be determined based on the result obtained from this study.

DEDICATION

To My Father, Ismail Bin Mohamad Amin,

To My Mother, Rosmiah Binti Husin,

To My Sister, Nurul Fariha Binti Ismail,

To all my lecturers, for their continuous idea and guidance,

To all my friends, for keep giving motivation and support.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ASTM	-	American Society for Testing and Materials
EDM	-	Electrical Discharge Machining
°C	-	Degree Celcius
MPa	-	Mega Pascal
PP	-	Polypropylene
UTM	-	Universal Testing Machine
s	-	Seconds

CHAPTER 1

INTRODUCTION

This chapter provides the introduction related to this project. It gives brief review about the study that to be held which is comparisons of mechanical properties between pure polypropylene and polypropylene filled with talc using single gate and twin gate mould. This chapter has been simplified into 5 subtopics which are background, problem statement, objectives, scope of study and organisation of final year project.

1.1 Background

Among the numerous types of polymer, polypropylene (PP) is one of the most popular plastic materials. PP is a thermoplastic polymer resin. The benefits of PP are it can be easily processed and consume less cost (Azuma, Takeda, Watanabe, & Nakatani, 2009). Without human realised that most of the items around them are made from PP. Example plastic products that are produced from PP are household goods, packaging, industrial application and etc.

When designing the mould, gate location is needed to be considered. The selection of gate location decides the manner of material flows into the mould cavity (Yatish & Nagaraja, 2014). Then, the position of gate also important measures that affects the quality of injection moulding process (Yatish & Nagaraja, 2014). Besides that gate location and number of gate, others processing parameters that may result the product plastic quality are injection pressure, injection time, packing pressure, and melting temperature (Alireza & Mohammad, 2011).

To get the best parameters, design of experiment (DOE) using Taguchi method and ANOVA analysis are performed. In injection moulding, DOE is used to minimise the number of runs needed to obtain which set of experiment is significant to the desired output response (Rajalingam, Bono, & Bin Sulaiman, 2012). Analysis of variance (ANOVA) is statistically based, it functions as decision-making tool for detecting any differences in the average performance of groups of items tested (Prasad, 2011). These two methods are used to give out the processing optimum parameters. The parameters are not tested one by one on the Universal Testing Machine as it involves the huge amount of cost.

Injection moulding is widely used process especially for plastic-based products. As in other forming processes, the setting of injection moulding parameters are significantly affected to the plastic products. By adjusting the injection moulding machine parameters, it gives numerous benefits such as minimal losses from scrap and minimal finishing requirement. The defects that always found in plastic injection moulding product are voids, flash jetting, short-shot, flow mark, weld line, war page, and surface blemish (Mohamed, Yusoff, Harun, Hamid, & Ramly, 2007).

In this study, tensile testing is performed to find the mechanical properties such as tensile strength, tensile modulus and percentage of elongation. It well known that tensile

testing, it is one of the most basic type of testing that can be applied to any material. The specimens of tensile testing used is ASTM D638 (Saad, Mohammed, & Hashim, 2012). This project focuses on the mechanical properties between pure polypropylene and polypropylene filled talc using single gate and twin gate mould.

1.2 Problem Statement

Gate location is very important that affected the mechanical properties of plastic products. Therefore, the different gate location between single gate and twin gate is investigated. Two types of plastic materials used to be compared are pure polypropylene and polypropylene filled with talc. By addition of other materials such as talc to pure polypropylene may change the mechanical properties of pure polypropylene. Then, the tensile testing to be conducted to identify which one between pure polypropylene and polypropylene filled with talc to produce highest mechanical properties. Further, the flow front of twin gate always produced weldline between meetings of two flow fronts. Therefore, the tensile test is performed to compare which mechanical properties better between single gate and twin gate of plastic part.

1.3 Objectives

The main objective of this project is to find out the maximum mechanical properties of dumbbell plastic products having single gate and twin gate using pure polypropylene and polypropylene filled with talc.

- i. To find out the input injection moulding parameters such as melt temperature, mould temperature, injection time and cooling time on mechanical properties of dumbbell plastic products.
- ii. To investigate the mechanical properties such as tensile strength, modulus strength, and percentage of elongation of the polypropylene and polypropylene filled with talc.
- iii. To optimize the processing injection moulding parameters on the highest mechanical properties between the pure polypropylene and polypropylene filled with talc using Taguchi method and ANOVA.

1.4 Scope of Study

The main focus of this study is to investigate the maximum mechanical properties of polypropylene and polypropylene filled with talc. Both of them are in the form of dumbbell plastic parts that have single gate and twin gate. These two materials mechanical properties are compared based on modulus strength, tensile strength, and percentage of elongation. All of these properties are obtained through the tensile testing. The machine used for the testing is Universal Testing Machine (UTM). To get the optimum parameters for the output responses, design of experiment (DOE) using Taguchi method and ANOVA analysis are to be used.