

THE EFFECT OF THERMOFORMING  
TEMPERATURE AND MOULD VENT HOLE TO  
THE THERMOPLASTIC CONTAINER MADE OF  
0.5 MM POLYPROPYLENE (PP) SHEET

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**LIST OF ABBREVIATIONS**

Al	Aluminium
ASTM	American Society for Testing and Materials
Avg	Average
CAD	Computer-aided drafting
Catia	Computer Aided Three dimensional Interactive Application
CNC	Computer Numerical Control
CAE	Computer-aided engineering
G-code	G programming language
Temp	Temperature
PP	Polypropylene

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## **ABSTRACT**

Polypropylene is one of the thermoplastic that can be used undergo thermoforming process. Thermoforming process is a process that changes form of thermoplastic sheet from flat surface to dimensional shape. There are three types of thermoforming process. In this project, vacuum process had been chosen to change the shape of flat thermoplastic sheet. Thermoplastic can be formed any shape by undergo heating process using specific heat temperature and its can return to the solid shape upon cooling. Polypropylene (PP) had been choose to be main raw material to form plastic container. The properties of PP sheet are lower density, higher softening point depend on thickness and good resist to fatigue issue. Therefore, the main objective on this project is to prepare plastic container using own fabricated thermoforming machine. Preparation of the design container, design and fabricate mould is the main important process to form a good container. Temperature and number of vent holes are the parameter that had been set to know the different of each container. The result shows that temperature 155 °C is an ideal temperature for 0.5 mm PP sheet and 4 vent holes will get a good appearance result than 1 vent holes.

## ABSTRAK

Polypropylene merupakan salah satu termoplastik yang boleh digunakan melalui proses termopembentukan. Proses termopembentukan adalah satu proses yang mengubah bentuk lembaran termoplastik daripada permukaan rata kepada bentuk dimensi. Terdapat tiga jenis proses termopembentukan. Dalam projek ini, proses vakum telah dipilih untuk mengubah bentuk lembaran termoplastik rata. Termoplastik boleh membentuk apa-apa bentuk dengan menjalani proses pemanasan menggunakan suhu haba tentu dan plastik boleh kembali ke bentuk yang kukuh ketika penyejukan. Polypropylene (PP) telah dipilih untuk digunakan sebagai bahan mentah utama untuk membentuk bekas plastik dalam projek ini. Sifat-sifat lembaran PP adalah ketumpatan yang rendah, titik lembut yang tinggi bergantung kepada ketebalan dan mempunyai kekuatan plastik untuk tahan lebih lama. Oleh itu, objektif utama projek ini adalah untuk menyediakan bekas plastik menggunakan mesin termopembentukan yang direka sendiri. Penyediaan reka bentuk bekas, reka bentuk dan reka acuan adalah proses utama yang penting untuk membentuk bekas yang baik. Suhu dan jumlah lubang angin adalah parameter yang telah ditetapkan untuk mengetahui perbezaan yang dihasilkan oleh setiap bekas. Hasilnya menunjukkan bahawa suhu 155 °C adalah suhu ideal untuk lembaran PP 0.5 mm dan 4 lubang angin akan mendapat hasil yang lebih baik daripada 1 lubang angin.



## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 INTRODUCTION**

This project investigates issues related to the preparation of polypropylene material for making containers with thickness of sheet is 0.5 mm. Before undertaking this project, it is important to know about the mechanical properties of materials and methods that should be used in this project. Besides that, to make this project succeed a few literature research has been done on the previous investigations in which to provide the necessary polypropylene food containers using thermoforming method.

Thermoforming is the process that involve of heating plastic sheet to a pliable status and forming it directed toward shape. Thermoforming offers processing advantages when do an injection moulding and blow moulding, which include decline pressures, degrade mould costs, work of multilayer structures, and soften of large parts. By using a multi cavity appliance, smaller, thin blank wall parts, a well known as those used for cuisine packaging, bounce be formed in lavish volume by all of relatively swiftly cycle time.

#### **1.2 PROBLEM STATEMENT**

The polypropylene used to make a container by using a method that called thermoforming. The process of thermoforming that need to use is a conventional machine (made by own) therefore, assume that it will be many problem occur during that process such as temperature control for the polypropylene sheet during thermoforming, pressure control during vacuum section, and plug assisted vacuum

thermoforming. However, by using this conventional method we can know more about the thermoforming process. To achieve the goals of this project, need to state and well known the problem will be occurs before doing this project. Therefore the design consideration for thermoplastic container is also important things. Besides that, design mould and fabricated process is an important process to produce a good plastic container. The number of vent holes and heating temperature may affect the thermoforming process.

### **1.3 PROJECT OBJECTIVE**

The objectives of this project are:

- i. To design plastic part and mould container using CATIA software.
- ii. To study the effect of thermoplastic temperature and vent holes to the polypropylene plastic container via thermoforming process.
- iii. To perform hardness test using Vickers Hardness machine and functional test on the fabricated plastic container.

### **1.4 SCOPE OF THE PROJECT**

This project used thermoplastic polypropylene as the main material for the preparation of thermoplastic container. The mould was designed in CATIA V5 software and had been considered accordingly all the design specification to make sure that there is no defect would be occurred and the simulation was successfully done to machine the mould by using CNC milling machine. When the mould is ready then proceed to the next process that is thermoforming. Thermoforming was processes that heat the plastic and give shape by using mould guided. Thermoforming process was selected because has less thermal stress compares to injection moulding and extruded moulding.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

This chapter will explore about the previous research that is related to this final project. There are previous research on preparation of thermoplastic polypropylene and thermoforming process. This is the important thing that involve in this project and main part of the project. The material that use is polypropylene sheet with thickness 0.05 mm. The thermoforming method will be use in this project to make a container from plastic sheet to form shape.

#### **2.2 THERMOPLASTIC**

A thermoplastic or thermo plastic is a plastic material, which become mouldable when heated and will become hard or solid when cooled. Thermoplastic material can be hot and cool a few times. Thermoplastic can be categories as material that can be recycled. The process that is normally use to change the shape of thermoplastic material are injection moulding, extrusion blow moulding, compression moulding and thermoforming process. The types of plastic are divided into two that is thermoplastic and thermoset. There are big differences of these plastic which is properties itself and application used. Nowadays, industry used thermoplastic widely as main material to produce product such as polypropylene, polyethylene, polysterene, ABS, acrylic and many more. In this project, the focus of thermoplastic is about polypropylene (PP) sheet type with thickness 0.05 mm.

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