# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DESIGN OF A LOW VISCOSITY BATTER DISPENSING SYSTEM TO IMPROVE THE PRODUCTIVITY OF KUIH REMPEYEK

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

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design of a low viscosity batter dispensing system to improve the productivity of kuih rempeyek**

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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) with Honours. The member of the supervisory is as follow:

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# ABSTRAK

Kuih rempeyek dianggap sebagai makanan tradisonal di Malaysia. Pada masa kini, kuih rempeyek menjadi sebagai makanan ringan yang boleh didapati di pusat membeli-bela dan pasar malam. Projek ini merupakan projek industri di bawah Teratak Traditional Food. Tujuan industri adalah untuk meningkatkan produktiviti kuih rempeyek untuk memenuhi permintaan pasaran harian. Satu konsep untuk mengubah barisan pengeluaran dari barisan pengeluaran manual ke barisan pengeluaran separuh automasi akan dilaksanakan dalam projek ini. Projek ini bermula dengan melawat ke industri Teratak Traditional Food. Lawatan ini telah dijalankan untuk memperkenal dan mempelajari barisan pengeluaran pembuatan kuih rempeyek. Di samping itu, beberapa pengumpulan data seperti masa bagi setiap proses pembuatan kuih rempeyek telah dikumpulkan. Proses yang mengambil masa yang terpanjang dalam barisan pengeluaran adalah proses mengeluarkan adunan kuih rempeyek yang ditakrifkan dengan menggunakan Arena simulation. Pada peringkat reka bentuk, sebuah mesin dispenser telah direka untuk mengatasi masalah proses mengeluaran aduan. 3D model bagi mesin dispenser telah dimodelkan dengan menggunakan Solidworks. Mesin ini mengandungi dua nozzle bagi mengeluarkan dua kapasiti dalam satu tangkapan. Kajian barisan pengeluaran reka bentuk semula telah dijalankan selepas peringkat reka bentuk. Tujuan kajian ini adalah menghapuskan proses yang mengambil masa terpanjang dan membuktikan mesin tersebut dapat meningkatkan hasil pengeluaran harian.

# ABSTRACT

Kuih rempeyek is a traditional food in Malaysia. Nowadays, kuih rempeyek become a popular snack which can easily find at shopping centre and night market. This project is a direct industry project under Teratak Traditional Food. The purpose of industry is to increase the productivity of kuih rempeyek to fulfil the daily demand of market. A concept of changing production line from manual production line to semi-automation production line is develop in this project. At the beginning of this project carry on, an industrial visit to Teratak Traditional Food was conducted to learn the production line of making kuih rempeyek. Besides that, some data collection such as time taken of each process was collected. The bottleneck of the production line is the dispensing process was defined by using Arena Simulation software. At the design stage, a low viscosity batter dispensing machine was design and develop to overcome the bottleneck process. A 3D CAD model of dispensing machine was drawn by using Solidworks software. The dispensing machine consists of two nozzles that can increase the process output of kuih rempeyek by dispensing in 2 cavities in one go. The study of redesign production line was carried on after designing the semi-automated batter dispensing machine. The purpose of study redesign production line is to prove the bottleneck of the production was eliminated and the desired batter dispensing machine was helping to improve productivity of kuih rempeyek.

# DEDICATION

This thesis is dedicated to my supervisor, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my parents and my friends, who taught me that even the largest task can be accomplished if it is done one step at a time.

# ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisor Mr. Kamarul Bin Amir Mohamed for the useful comments, remarks and engagement through the learning process of this thesis in innumerable ways. I would also like to thank all my fellow friend who help me through this project. Without their help and guidance, this final year project would not completely on time. Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents, whose love and guidance are with me in whatever I pursue.

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# CHAPTER 1

# INTRODUCTION

## 1.0 Introduction

This chapter will discuss regarding the overview of semi-automated production line to improve the productivity of kuih rempeyek. This section discusses about the problem statement, project objective, work scope and project methodology.

## 1.1 Overview

Kuih rempeyek is considered as a traditional food in Malaysia. The place of origin for kuih rempeyek is from Indonesia. Nowadays, kuih rempeyek has become a popular snack in Asia countries. The most common type of kuih rempeyek is peaunut rempeyek as shown in Figure 1.1. At the beginning kuih rempeyek is making a small-scale home industry, yet this traditional food has now been commercialised, it can be easily found at food stall, shopping centre and night market.

Figure 1.1: Peanuts kuih rempeyek (Zarini, 2013)

The main idea of this project is to enhance the production line of Teratak Traditional Food which making kuih rempeyek. The manual production line of making kuih rempeyek will convert into semi-auto production line. Semi-auto production line means that some of the process will be done by machine and other process will be done by man power. This project will be focus on the low viscosity batter dispensing system which the machine only suitable use to dispense the batter of kuih rempeyek. The dispenser system will be volume controllable. This system is using the refillable compressed air driven system to control it. The improvement of the system is to fix the dispense volume. The nozzle is the last part of dispensing system which dispense batter into mould. After the batter dispensed at the mould, peanuts will be added and proceed to the next process. The semi-automated production line will help the industry to improve the productivity of kuih rempeyek.

## 1.2 Problem Statement

Since kuih rempeyek has now been commercialised, the producer reached a large production scale to fulfil the demand of market. The industry found that the process of making kuih rempeyek by using manual production line will reduce the daily productivity. One of the longest process time is pouring the batter into specific mould. This means that pouring batter process is the bottleneck of current production line. Moreover, while workers pouring the batter into mould, the volume of batter will not constant every time, if want to make all mould are filling consistency, it will take some time to adjust it. Worker with lack experience also will affect the work progress becomes tardiness.

Thus, to solve the bottleneck, the semi-automated production line is carry on by using low viscosity batter dispensing system and implemented in this project. The purpose of using dispensing system is to dispense the batter volume accurate and consistency. Hence, the time taken in this process will be reduce and productivity of kuih rempeyek can be improved.

## 1.3 Objective

There are three objectives that need to achieve in this project, which are:

i. To define the bottleneck of manual production line by using ARENA software.
ii. To design a semi-automated batter dispensing system for kuih rempeyek production line by using Solidworks and motion animation.
iii. To improve the productivity of manual production line by using ARENA software.

## 1.4 Work Scope

This project will be focusing on a dispensing system that dispense the batter of kuih rempeyek. For the mixing batter process and frying process will not be consider. The function and application of dispensing system will be considered on the design stage, while the material of the dispensing machine and costing will not be considered. The 3D modelling part of dispensing system will be draw by using Solidworks. The design stage will cover until motion and animation, that show the desire dispensing system function. The dispensing system will not be prototype out at the end of this project. The research about low viscosity information will be collected for further stage. Arena simulation will use to define the bottleneck of current production line and the daily productivity of kuih rempeyek that can be produced.

## 1.5 Project Methodology

Firstly, an industrial visit to Teratak Traditional Food industry was conducted together with supervisor. The purposes of industrial visit were to collect data, conduct an interview section. An interview section was conduct to the owner regarding the process of making kuih rempeyek. Besides that, the problem faced by owner during the making kuih rempeyek will also be determined. Data tabulation was used to collect

and record data. The time taken for each process was collected 30 times to ensure the data is precise. After that, the standard time for each process was determined by using time study table.

After data collection process, a study of productivity for the current production line was conducted. The model of manual production line was transfer into Arena software by using Arena Input Analyzer and generate results. Based on the results get from Arena, the bottleneck of manual production line was determined. The daily productivity of kuih rempeyek also determined based on the data collected from industry. To eliminate the bottleneck, the manual production line was change to semi-automated production line.

A low viscosity batter dispensing system was design for kuih rempeyek at design stage. In design stage, information about dispensing system and application of dispensing system use in different field has been researched. Some research was done about nozzle parameter such as diameter and length. Nozzle is the final part of dispensing system, it play an important role for dispensing system to dispense the batter out. In this project, the nozzle diameter and nozzle length were defined in design stage. Instead of using single nozzle for dispensing system, a multi-dispensing system was implemented in this project. This is because it can dispense the batter into few mould in one shot. After that, the 3D modelling part of desire dispensing system was design by using Solidworks while motion and animation simulation use to show the analyse and animate motion of desire dispensing system.

A study of redesign production line has been carry on after low viscosity batter dispensing system simulation. The process time of "batter dispensing process" was exchange with the earlier manual process time. After that, run the simulation of redesign production system and new productivity of kuih rempeyek were analysed. The daily productivity was used to compare between current production line and redesign production line. This is to ensure the improvement of productivity of redesign production line and the operation time decrease after low viscosity batter dispensing system is implemented. Figure 1.2 shows the methodology flow chart for this project.

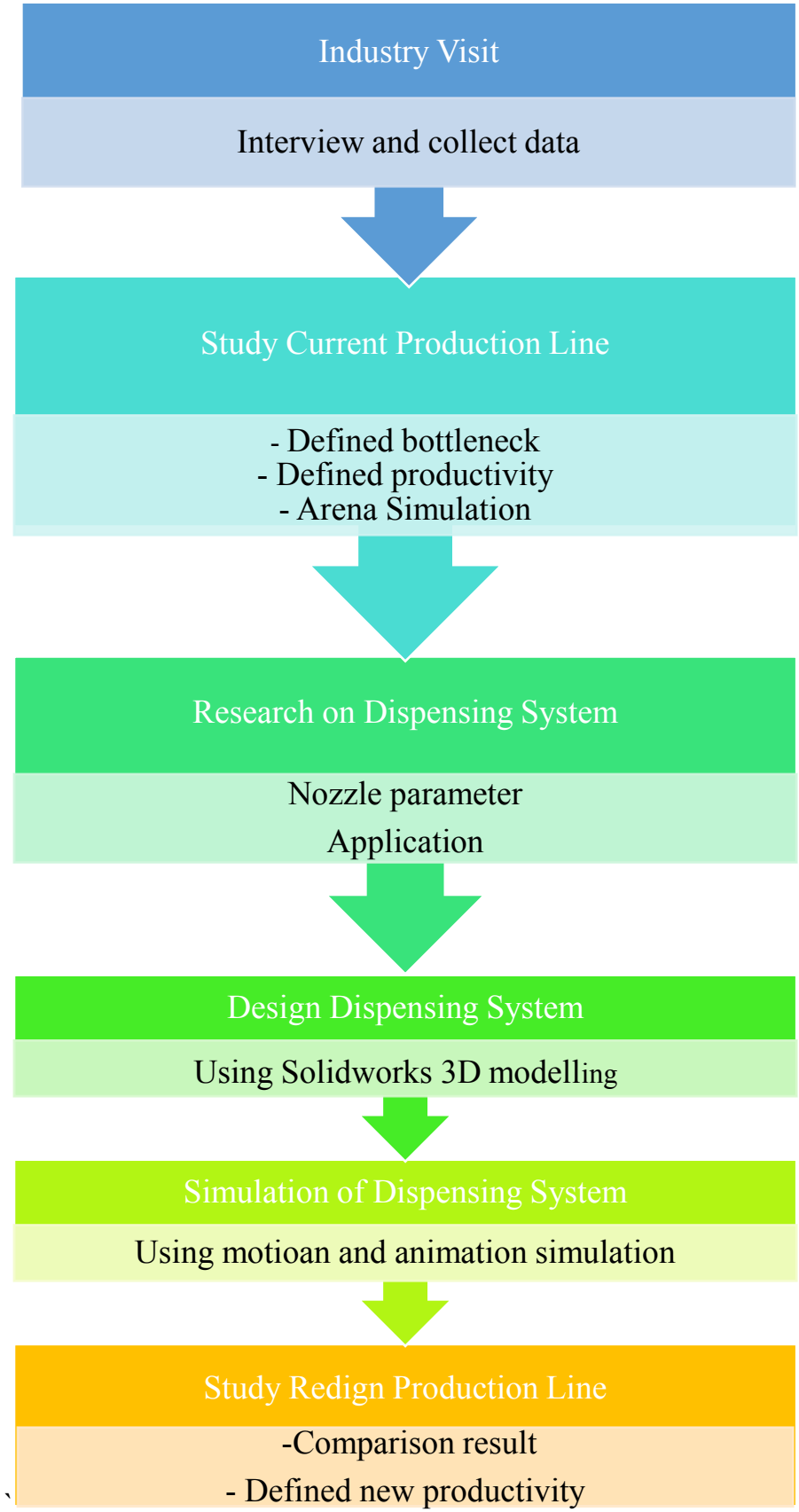


Figure 1.2: The flow chart of project methodology process

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

This chapter contains a literature review of study of fluid dispensing system. The sources of information were based on books, journals and reports. The main objective of this chapter is to study the criterial that needed to be consider in a fluid dispensing system. This chapter will focus on fluid properties, extrusion system, application of dispensing systems in different fields and effect of nozzle dimension. Fluid can be divide into liquid, gas or plasma. This chapter explained about the density, viscosity, specific weight, specific volume and specific gravity of fluid properties. The basic type of flow can be categorised as turbulent flow or laminar flow. Extruders can be categorised into three main type: piston, roller and screw extruders. At dispensing system, die nozzle is the final part which dispense the material. The diameter and length of nozzle changed will affect the performance of dispensing system.

## 2.1 Fluid Properties

A matter can be category into two group which are solid and fluid. Fluid can be further divide into liquid, gas and plasma. In solid, the particles are packed closely, and the shape is fixed no matter how to change them. While the shape of liquid and gas will follow the shape of the container and the particles inside are less closely packed. Compressible for solid is not possible but for liquid is almost negligible. In gas, the compressible is very high and can compress easily. Fluid properties used to accomplish engineering design and analysis of fluid flow problem. The most related physical and properties are density and viscosity. A best description to describe fluid

properties, which necessary a significant effect on hydrodynamic calculation (Saleh, 2002). The most basic properties of fluids are density, viscosity, temperature, pressure, specific volume, specific height and specific gravity. In fluids normally deal with continuous streams of fluid without beginning or end. Fluids having the property of fluidity due to support a shear stress in statics equilibrium. The molecules of a solid are usually closer together than fluid. However, the molecules of a gas are much farther apart than liquid. Figure 2.1 show the arrangement of particles for solid, liquid and gas. Liquids and gases are fluids because they yield to shearing forces, whereas solid resist them. Note that the extent of fluids yields to shearing forces (and hence flow easily and quickly) depends on a quantity called the viscosity (OpenStax, 2016).

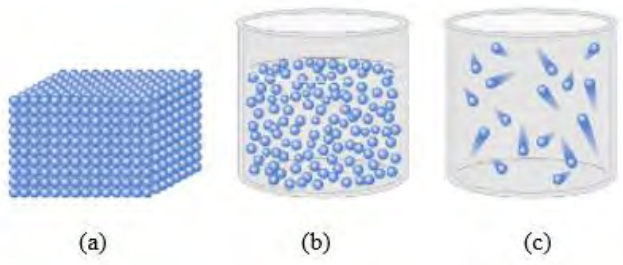


Figure 2.1: Particles in solid (a) closely packed. The particles in liquid (b) do not packed closely and free to move. Gas particles (c) are in random motion and move quickly in container (Spencer, et al., 2010).

### 2.1.1 Fluid Density

The mass flow rate, fluid velocity, and pressure drop calculation, is a function of the density property. The fluid density of a liquid respect to its temperature and pressure. The temperature and pressure play an important role in determining the density of a liquid. Fluid density is defined as fluid mass per unit volume of the fluid (OpenStax, 2016). The formula of fluid density as follow:

$$\rho = \frac{m}{v}$$

ρ = density of fluid

m = mass

v = volume

### 2.1.2 Specific Weight, Specific Volume and Specific Gravity

Specific weight ϒ represents the force exerted by gravity on a unit volume of fluid, and therefore must have the units of force per unit volume, such as pounds per cubic foot ($N/m^3$ in SI units) (Finnemore & B.Franzini, 2002). Density and specific weight of a fluid are related as:

$$\Upsilon = \rho g$$

ϒ = Specific weight

ρ = density of fluid

g = specific gravity

Specific volume υ is the volume occupied by a unit mass of fluid. It usually applies to gases, and usually express in cubic feet per slug ($m^3/kg$ in SI units) (Finnemore & B.Franzini, 2002) . Specific volume is the reciprocal of density:

$$\upsilon = \frac{1}{\rho}$$

Specific gravity s of a liquid is the dimensionless ratio:

$$S_{\text{liquid}} = \frac{\rho_{liquid}}{\rho_{water\ at\ standard\ temperature}}$$

### 2.1.3 Viscosity of liquid

Viscosity is defined as the resistance of a fluid to flow, which is caused by shearing stress within a flowing fluid and its container. For molecular level, viscosity will result the friction between the molecules in the fluid. Different fluid with different viscosity, it will also flow at different speed. Viscosity will

determine the energy required to make a fluid flow. The higher the interaction and bonding between the fluid molecules, the higher the fluid resistance to applied shear stress and the higher the fluid viscosity. Shear stress is defined as the shear force per unit area (Saleh, 2002).

$$\tau = \alpha \frac{dV}{dY}$$

$\alpha$ = absolute viscosity of fluid

$\tau$ = Shear stress

$\frac{dV}{dY}$ = Rate of shear strain

## 2.2 Basic Type of Fluid flow

The basic of fluid flow deal with fluid velocity and acceleration and without considering any forces involved. The fluid flow deal with velocity and flow paths without considering forces or energy is known as kinematics. An ideal fluid means that fluid has no viscosity, but this will not happen in idealized situation. Flow can also be classified as an incompressible or compressible fluid. Liquid can be treat as incompressible fluid. Flow may be steady or unsteady with respect to time. It may be laminar or turbulent flow (Finnemore & B.Franzini, 2002).

### 2.2.1 Laminar Flow

The first type of flow, which is laminar flow refer to the water appeared to move smoothly along streamlines. In laminar flow, the fluid appears to move by the sliding of lamination of infinitesimal thickness over adjacent layers, with relative motion of fluid particles occurring at a molecular scale (Finnemore & B.Franzini, 2002). The fluid flows in parallel layers with no disruption between the layers. Figure 2.2 shows the laminar flow is done in smooth layers, with the outside being the slowest.