



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND FABRICATION OF SMALL SCALE
WASTE PAPER RECYCLING MACHINE**

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

by

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

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ABSTRACT

The need of paper increasing day by day as it is one of the method to deliver message and information especially in education and office. However, the high consumption rate of paper also causes extraordinary amount of waste paper. Since paper produced from wood, high consumed paper indirectly causes deforestation thus increase global warming as well. Recycling the waste paper is one of the methods to overcome this issue. This project is intend to evaluate the paper consumption by lecturer in Department of Mechanical Engineering Technology as well as faculty's administration office, and to design and fabricate low cost mini waste paper machine prototype that can produced a recycled rough cardboard. The paper recycling machine developed by using mild steel as for main structure, PVC pipe used as rollers, and fabric mesh used as felt. The process in recycling the waste paper classified into three main process that is pulping process, forming process, and finally the drying process. The pulping process was done by mixing water and paper with the ratio of 30:1 respectively by weight. The forming process begin by pouring the pulp into the head-box. After that, the pulp was released from the head-box to a conveyor belt that transport the pulp to a dandy roller by rotating hand-wheel attached to the roller. The dandy roller is to ensure the initial thickness of the pulp sheet is uniform by 4 mm. Afterward, pulp sheet pass through a squeezing rollers to drain the pulp sheet from water. Later, the pulp sheet was compressed in the compressing section with approximately 40kPa. At this moment, the movement of the conveyor belt need to be paused until the applied pressure was releases. The wet recycled cardboard then taken out from the machine and dried under sun up to two days for the product to completely dry. Dimension analysis performed on the products shows average size of 241.4 mm × 251 mm × 1.962 mm rough cardboard with weight of 46.654 g. Tensile strength analysis of cardboard shows Young's modulus of 293.16 MPa with ultimate tensile strength of 0.669 MPa.

ABSTRAK

Penggunaan kertas semakin meningkat setiap hari kerana kertas merupakan salah satu kaedah untuk menyampaikan mesej dan maklumat terutamanya dalam pembelajaran dan pejabat. Namun, penggunaan kertas yang sangat tinggi menyebabkan pembaziran kertas yang banyak. Pembaziran ini secara tidak langsung mendorong kepada peningkatan kadar pembalakan hutan sehingga menyebabkan kenaikan suhu globalisasi. Salah satu cara untuk mengatasi permasalahan ini ialah dengan mengitar semula kertas buang tersebut. Projek ini bertujuan untuk menilai penggunaan kertas oleh pensyarah di Jabatan Teknologi Kejuruteraan Mekanikal dan pejabat pentadbiran fakulti, serta mereka cipta prototaip mesin mengitar semula yang berkos rendah yang mampu menghasilkan kertas kadbod kasar. Mesin kitar semula ini dibina dengan menggunakan keluli lembut untuk struktur utama mesin, paip PVC sebagai penggiling, dan kain kasa sebagai konveyor. Proses utama mengitar semula kertas terbahagi kepada 3 bahagian iaitu proses membuat pulpa, proses pembentukan kertas dan proses pengeringan. Proses membuat pulpa adalah dengan menyampurkan air dan kertas dengan sukatan berat menggunakan nisbah 30:1. Proses pembentukan kertas bermula dengan menuang pulpa kedalam "head-box". Kemudian pulpa dilarikan keatas "conveyor belt" yang digerakkan menggunakan pengayuh yang dipasang di penggiling. Pulpa kemudiannya dibawa ke "dandy roller" untuk memastikan ketebalan pulpa seragam bersaizkan 4 mm. Selepas itu, pulpa akan melalui "squeezing roller" untuk mengasingkan air daripada pulpa. Setelah itu, pulpa tersebut akan ditekan dengan tekanan sebanyak 40kPa. Pada masa ini, pergerakan "conveyor belt" perlu dihentikan sehingga tekanan dilonggarkan. Kemudian kadbod yang terhasil akan dikeluarkan daripada mesin dan dikeringkan dibawah matahari selama dua hari. Hasil analisa keatas produk mendapati bahawa saiz purata produk ialah 241.4 mm × 251 mm × 1.962 mm dengan berat 46.654 g. Hasil ujian ketegangan mendapati bahawa modulus young's produk ialah 293.16 MPa dan kekuatan tegangan ialah 0.669 MPa.

DEDICATION

To my beloved parents and brothers,

Louis Ajin

Kinioh Idau

Geldvess Louis

Geldveen Louis

Thank you for all the sacrifices, supports, patient and time that have being spend for me.

To my honourable supervisor and co supervisor,

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LIST OF SYMBOLS

θ	-	Angle resultant normal force
ϕ	-	Inverse tan of coefficient of friction
μ	-	Coefficient of friction
$^{\circ}$	-	Degree
\times	-	Multiplication
%	-	Percentage
$^{\circ}\text{C}$	-	Celsius
$^{\circ}\text{F}$	-	Fahrenheit
M	-	Moment
mm	-	Millimetre
m/min	-	Meter per minute
NO_x	-	Nitrogen oxide
r	-	Radius
SO₂	-	Sulphur dioxide
W	-	Vertical load

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
CAD	Computer-aided drafting
JTKM	Department of Mechanical Engineering Technology
LCL	Lower Control Limit
PVC	Polyvinyl chloride
TFT	The Forest Trust
UCL	Upper Control Limit

CHAPTER 1

INTRODUCTION

1.1 Background

The change of the climate has become one of the main issues that worrying the people all around the world. According to USA Today dated 11 April 2018, the melt of the tallest glacier in Alaskan has encounter the fastest pace in 400 years due to global warming. Today the melts of the ice core have increased 60 times than 150 years ago. The researcher found that the temperature at Mt. Hunter was increased at least 2°F to 3°F compare to the temperature during the 18th, 19th and the 20th centuries (Rice, 2018). One of the main factor that contribute to the global warming was the effect of the greenhouse. Trees play an important role in controlling the effect of greenhouse specifically through the decreases of carbon dioxide (CO₂). This is because trees store these CO₂ for photosynthesis. Unfortunately, according to Lallanilla, CO₂ would be released from the wood when the trees were destroyed (Lallanilla, 2015). It was reported that deforestation had caused billion ton of carbon released to the atmosphere every year and there only 19 percent of primary forest left and 9 percent of planted forest in Malaysia which contribute to the increasing of temperature level every year (Food and Agriculture Organization, 2010)

Tree is the main resource in making paper. There was billions of paper produced in a day. This is because the need of paper keep increasing day by day. In education and office application, paper is still one of the methods to deliver message and information as well as documentation even in the progressive current technology. However, the

excessive production of paper has contributed to the increases in percentage of paper waste. Therefore, an action need to be take in order to reduce the wasted paper and at the same time, reduce the consumption of trees for the future.

The best way to overcome the current issues is by reusing and recycling the wasted paper. According to the researchers in Kingdom of Saudi Arabia, it was estimated that there will be about 5.05 billion tons of paper wasted on that country when reaching years 2030. When the wasted paper is recycled, the country can save money up to US \$3.01 billion and 9.6 million of rough barrel oil for the uses of paper production together with reducing 4.5 million ton of CO₂ (Ouda, et al., 2017). According to Burns, the fundamental of recycling the wasted paper comprises the paper shredding, pulping, forming, draining, pressing and finally drying the paper sheet (Burns, 2004). In this project, a prototype of mini waste paper recycling machine was designed to achieve the objectives of this project in order to reduce the paper wasted in the Department of Mechanical Engineering Technology (JTKM). An explanation of the problem statement, objectives and the scope of the project was provided in this chapter.

1.2 Problem Statement

Today, the earth is facing the increases of global temperature. One of the main factors that contribute to this issue is the uncontrollable deforestation in order to improve the quality of live as well as to achieve modernization. The global warming can be very dangerous to human as well as to living thing such as the increasing of infection in water and food. As an example, a study in Bangladesh had proof that the number of cholera cases keep increasing due to the global warming (Kurane, 2010). Besides that, according to Vaughan, the increasing of the global temperature from 1979 until 2007 had caused

the melting of ice in the North Pole where the ice-mass in the North Pole was having decreases that can threat the arctic animal that living around that place (Vaughan, 2017). The decreasing of forest's volume had caused the increasing of greenhouse gases in the atmosphere. The uncontrollable deforestation causes the volume of carbon dioxide (CO₂) increase. In 2013, a study conducted in Hawaii found that the industrial revolution in that country had contribute the increasing in greenhouse gases which caused the mean carbon dioxide exceed 440ppm (Kosaka & Xie, 2013). According to the Energy Trend Insider, the emission of carbon dioxide globally had reach 1 trillion tons from 1965 until 2011. This amount of carbon dioxide that being released had caused an increasing of atmospheric carbon dioxide by 73 ppm (Rapier, 2012).

Tree store carbon dioxide for photosynthesis but when the tree was cut, the carbon dioxide was releases out from the tree (Lallanilla, 2015). It was reported that deforestation had cause billion ton of carbon released to the atmosphere every year and there only 19 percent of primary forest left and 9 percent of planted forest in Malaysia that contribute to the increasing of temperature level every year (Food and Agriculture Organization, 2010). It was reported that the forest growth in Malaysia had decreased by 0.4 percent loss in between year 2000 until 2010, where Sabah and Sarawak contribute 15 percent of Malaysia's forest (The Forest Trust, 2015). This is due to the expansionist programs to improve the infrastructure in order to fulfil the requirement of increasing population.

Forest is the main source of wood supply. Wood had been used for various purpose ever since the beginning of life. Even today, wood still being prefer as basis of most invention. Paper is a product made from wood. The need of paper keep increasing day by day. In education and office application, paper is still one of the methods to deliver

message and information as well as documentation even in the progressive current technology. Unfortunately, the huge amount of paper production had caused the increases in percentage of solid waste. According to the researchers in Kingdom of Saudi Arabia, it was estimated that there will be about 5.05 billion tons of paper wasted on that country when reaching years 2030. When the wasted paper was recycled, the country can save money up to US \$3.01 billion and 9.6 million of rough barrel oil for the uses of paper production together with reducing 4.5 million ton of CO₂ (Ouda, et al., 2017).

Academic department typically produce large amount of waste paper. Even though later the wasted paper will be return to the recycling factory, but the bundle of waste paper in the department make the department looks messy and of course discomfort the staff and the students. The process of recycles through recycling machine can reuse this waste. Although commercial waste paper recycle machine already available in worldwide, but the price were very expensive. Therefore, this project subjected to design the prototype of waste paper recycling machine to recycle the paper wasted in the department.

1.3 Objective

The objectives of this project are:

- i. To evaluate paper consumption by lecturer from Department of Mechanical Engineering Technology as well as faculty's administration office.
- ii. To design and fabricate a low cost mini waste paper recycling machine prototype that can produce a recycled rough cardboard.

1.4 Scope

The scopes of this project are:

- i. Design and fabricate waste paper recycled machine from low cost material.
- ii. Type of waste paper that can be recycled is A4 paper with 80gsm that commonly being used in the department.
- iii. The area of the study is in Department of Mechanical Engineering Technology of Faculty of Mechanical and Manufacturing Engineering Technology.
- iv. Nine (9) locations targeted as the resources of measuring the consumption of paper – Two (2) locations was from the admin's and JTKM lecturer's photocopy room, and the other seven (7) locations were from the JTKM lecturers offices.
- v. The product that would be produce by this prototype machine was a recycled rough cardboard.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays the world having crisis of the increasing of the global temperature. Globally the temperature increased for about 0.65°C in between 1951 – 1980 (Huang, et al., 2012). Everyday inventor and technologist keep inventing and improving the current technology to reduce the effect of greenhouse gases emission and global warming. The greenhouse effect is the main causes of global warming. Greenhouse gases is a term for the gasses in the atmosphere. These gases will absorb radiation that released by the Sun such as ultraviolet radiation and infrared radiation. When ultraviolet radiation passed through the greenhouse gases, the plants and trees would absorb these radiations. But, infrared radiation was weaker than ultraviolet radiation which make it difficult to passes the glass wall of greenhouse. This trapped infrared radiation however warmed up the greenhouse and causes global warming (Casper, 2010). The effect that caused by the global warming can be very dangerous to human as well as to living thing such as the increasing of infection in water and food. In Bangladesh, the number of cholera cases keep increasing due to the global warming (Kurane, 2010). According to Vaughan, the increasing of the global temperature from 1979 until 2007 had caused the melting of ice in the North Pole. Figure 2.1 shows the decreasing in ice-mass in the North Pole that can threat the arctic animal to live there (Vaughan, 2017).