BIODEGRADABILITY OF COMMERCIAL PLASTIC BAGS

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

(Engineering Process)(Hons.)

by

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I hereby, declared this report entitled “Biodegradability of Commercial Plastic Bags” is the result of my own research except as cited in references.

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Date : 1 July 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Engineering Materials) (Hons). The member of the supervisory committee are as follow:

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(PM. Dr. Nur Izan Syahriah Binti Hussein)

ABSTRACT

As of January 1, 2016, the Melaka state government has announced a total ban on plastic bags made from petroleum by-products at all supermarkets in Melaka. As such, Biotech has introduced and supplied biodegradable plastic bags made of plant-based materials. Since then, many biodegradable plastic bags are easily available in Melaka market. This raises the question of whether these plastic bags are genuinely biodegradable or not. It is also crucial to understand the plastic strength and degradation in the environment. This study aim to assess the degradation of biodegradable plastic bags in different conditions. A total of two samples of the plastic bags in which claimed as biodegradable, which came from supermarket F and M and one of them was an ordinary plastic bags labeled as C. The results were compared at the end of this study. The plastic bags was cut to a size of 15 cm x 15 cm. The samples were buried in soil with different moisture and acid levels. Six beakers were used to place the soil in which labeled as S1, S2, S3, S4, S5, and S6. The moisture levels were set to 30%, 45%, and 60%. The acidity levels were 4pH and 8pH. After 12 weeks buried under the soil, changes of moisture and acid content were measured. The sample was cleaned up for tensile test, percentage of weight loss and physical changes were monitored and measured. The sample from S4 has shown a significant decrease in weight, especially sample F. Sample F and M were biodegradable plastic. On the other hand, sample C was a common traditional petroleum-based plastic. Samples M and C showed subtle change in weight loss. In addition, all of the three samples showed significant in strength and elongation. The biodegradable plastic bags resulted with different strength and elongation were due to different material content. Sample F also showed change in color and holes were observed. Therefore, it was confirmed that sample F is a biodegradable plastic.

ABSTRAK

Pada tanggal 1 Januari 2016, kerajaan negeri Melaka telah mengumumkan bahawa tiada lagi beg plastik berasaskan produk petroleum di Melaka. Oleh hal yang demikian, pihak Biotech telah memperkenalkan dan membekalkan pelastik beg biodegradable. Semenjak dari itu, beg plastik biodegradable senang diperolehi di pasaran Melaka. Plastik ini menimbulkan persoalan sama ada beg plastik benar-banar biodegradable atau tidak. Ini sangat penting untuk tahu berkaitan kekuatan dan keleraian di persekitaran. Kajian ini bertujuan untuk mengkaji kebolehleraian beg plastik biodegradable dalam keadaan yang berbeza. Sebanyak dua sampel beg plastik di panggil sebagai 'biodegradable' telah diambil dari pasaraya F dan M dan satu darinya plastic biasa sebagai C. Keputusan telah dibandingkan di akhir kajian ini. Plastik ini di potong pada saiz 15 cm x 15 cm. Sampel telah ditanam didalam tanah dengan kelembapan dan kadar asid yang berbeza. Enam bikar telah digunakan untuk menempatkan tanah dan telah dilabelkan sebagai S1, S2, S3, S4, S5, dan S6. Tahap kelembapan telah di laraskan pada 30%, 45% dan 60% serta tahap keasidannya adalah 4pH dan 8pH. Selepas 12 minggu ditanam didalam tanah, perubahan kelembapan dan kadar asid telah diukur. Sampel kemudiannya dibersihkan untuk percubaan tensile, peratusan kehilangan berat dan perbandingan secara fizikal telah dilaksanakan. Sampel dari keadaan S4 telah menunjukkan banyak penurunan berat terutama sampel F. Sampel F merupakan plastik yang dikategorikan sebagai biodegradable seperti juga sampel M manakala sampel C adalah plastic biasa berasaskan bahan petroleum. Sampel M dan C hannya menunjukkan sedikit perubahan dalam pengurangan berat. Tambahan lagi, ketiga-tiga sampel hannya menunjukan sedikit perubahan apabila dilakukan ujian pemanjangan dan kekuatan. Ini menunjukkan bahawa plastik biodegradable mempunyai kekuatan dan pemanjangan yang berlainan berdasarkan perbezaan bahan yang terkandung di dalamnya. Sampel F juga menunjukkan perubahan pada warna dan mempunyai lubang apabila diperhatikan. Sampel F telah memberi petanda bahawa ia adalah plastik biodegradable.

DEDICATION

Only

my beloved father, Md Salleh bin Mat Il

my appreciated mother, Ruzita binti Che Omar

my adored sibling, Fadhlina, Ain, Izzat,Faris, Ainun, and Haikal

for giving me moral support, money, cooperation, encouragement and also understandings

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LIST OF ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
HDPE	-	High-density polyethylene
LDPE	-	Low-density polyethylene
LLDPE	-	Linear low-density polyethylene
PET	-	Polyethylene Terephthalate
PETE	-	Polyethylene Terephthalate
V	-	Polyvinyl Chloride
PP	-	Polypropylene
PS	-	Polystyrene
CO_2	-	Carbon Dioxide
H_2O	-	Dihydrogen Monoxide
TDPA	-	Totally Degradable Plastic Additives
d_2w	-	Pro-oxidants
PVA	-	Poly (vinyl acetate)
PE	-	Polyethylene
UV	-	Ultraviolet
HCL	-	Hydrochloric Acid
NaOH	-	Sodium hydroxide
AA	-	Accelerated Aging
ANTEC	-	Annual Technical Conference

TGA	-	Thermal Degradation Behavior
CFP	-	Cellulose Filter Paper
LCD	-	Liquid Crystal Display

LIST OF SYMBOLS

%	-	Percentage
^{o}C	-	Degree Celsius
pH	-	Potential of Hydrogen
ºC/min	-	Degree Celsius per Minute
mol	-	Mole
nm	-	Nano Meter
hr	-	Hour
mm	-	millimeter
MPa	-	Mega Pascal
min	-	Minute
σ	-	Stress
ε	-	Strain
s	-	Second
mW/cm^2	-	Milliwatts per Square Centimeter
cm	-	centimeter
β	-	Berta
^{o}F	-	Degree Fahrenheit
Pa	-	Pascal

CHAPTER 1

INTRODUCTION

This chapter describes the mechanical properties of biodegradable and traditional plastic bags and the need to study the factors that influence it. It includes the background of the study, problem statement, objectives, scope of the study, the significance of the study and chapter overviews.

1.1 Background of The Study

Plastic bags are usually used to carry goods from the market to the house. After that, the plastic bags will keep the store or reused and normally throw out in the dustbin. However, many people do not waste into dustbin but waste directly on the land. The environment pollution will occur. The pollution occurs because the plastic bags do not quickly dispose in the environment. It will take a longer time to dispose. Based on this situation, Melaka governments was announced about the ban of plastic bag in Melaka. Ban the plastic happens because to prevent the environment from pollution. After an announcement, Melaka was famous with new plastic bags which namely biodegradable. A biodegradable plastic bag is used to making easier to carry goods and replace the traditional plastic bags. Biodegradable plastic is degraded in short time than the traditional plastic in the environment. However, the biodegradable plastic bags in Melaka not have

evidence in term of their degradation. So the purpose of this study is to investigate and compare the properties in some factor that influence their degradation process.

There are many factors that influence the degradation process such as pH value, temperature, weather, time, moisture etc. On the other hand, type of soil also can cause the degradation occur. The degradation occurs when the sample showed their effect after the experiment. The samples were buried under the soil in the beakers. After that, the sample was left for 12 weeks. At the end of the experiment, the sample was taken photograph to compare their physical appearance before and after an experiment. The sample came from 100% degradable material such as corn starch are really degrade but if from the non-degradable material, the sample does not show any significant change (Adam Cova et al., 2013).

These studies conducted to ensure that the biodegradable plastics have at Melaka are real of the degradable material. So the study will conduct including the comparison of physical apparent, testing in tensile and calculate percent weight loss after buried under the soil.

1.2 Problem Statement

The Malacca government has declared a ban on the use of plastic into force on 1 January 2016 (The Star, 2015; New Straits Times, 2016). “Our landfills and drains are filled with paper bags and this doesn’t serve our ambitious plan to be a fully green state” (Yunos, 2016). According to National Geographic, in 2010, eight million tons, were dumped into the ocean, and it predicts that this will increase tenfold by 2020 (Borneo Post, 2015). Usually, people use the plastic bags for carrying goods, after being used to carry goods from the retailer to the house; most of the bags are stored for reuse or disposal. In either case, the plastic bags eventually reach the landfills (Magdalena et al., 2011). Besides that, Plastic does not readily decompose in the environment and therefore can be a waste to

an environment (Mohee et al., 2011). However, it does not mean that we have to completely stop using plastic bags. After declaring, the Melaka Biotechnology Corporation was started supplying biodegradable plastic bags to shopping malls to offset the ban on plastic bags. Up to now, many biodegradable plastics bags were used in all the supermarkets in Melaka. Among the types of biodegradable plastic bag used as biodegradable bio-based, 100% degradable plastic, Oxo-biodegradable. However, it is still not clear whether the biodegradable plastic bag that was used in all the supermarkets in Melaka is really biodegrading or just labels as biodegradable. To avoid the same problem as traditional plastic occurs, Biodegradable plastic bags need to be studied to determine whether it really degraded or not.

1.3 Objectives

The objectives of this study are:

i. To study the mechanical properties of non-biodegradable and biodegradable plastic bags under aerobic conditions.
ii. To compare the properties of non-biodegradable and biodegradable plastic bags.
iii. To suggest the degradation factors that has greatest effect on the mechanical properties.

1.4 Scope of The Study

The scopes of this project are:

a) Use the biodegradable plastic bags in Melaka market.
b) Two conditions were considered, such as moisture and pH value.
c) Soil as medium to test the biodegradable plastic bags
d) Sample will test for tensile test and analyze for physical appearance and percent weight loss.

1.5 Significance of The Study

A new knowledge will be discovered about the biodegradable plastics bags status in Melaka. It is important to avoid the company to cheating in the market. So that, it will know the quality of the biodegradable plastic bags. When the properties of two type of plastic which is traditional and biodegradable plastic bag are known, it will make the differentiation in term of their strength, degradation, and factors that influence their degradation process. From this knowledge, one solution can do to solve the problem of environmental pollution. The biodegradable plastic bags will user-friendly and the government not much worried to overcome the environmental pollution especially in land pollution. Hopefully, a new founding about biodegradable plastic bags can help reducing the land pollution.

1.6 Chapter Overviews

The final year project II cover five chapters that including the introduction, literature review, methodology, result and discussion, and conclusion and recommendation.

Chapter 1: Introduction; introduces the need to study biodegradable plastic bags. It consists of the background of the study, problem statement, objectives, scope of the study and the significant of study. Chapter 2: Literature review; covers the findings of many information from past research such as books, journals, articles, and websites. Topics that related to the study of biodegradable are included. Chapter 3: Methodology; discusses the flow chart, material preparation, experimental setup, design of experiment and testing for data analysis. Chapter 4: Result and discussion; shown the result from the experiment was done and analyze their result also discusses changes in the sample. Chapter 5: Conclusion and recommendation; conclude the overall the experiment and recommend the best way for future study.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the past study about non-biodegradable and biodegradable plastic bags and factors that influence mechanical properties. This chapter consists of review related to the material, process, parameters, and responses.

2.1 Type of Plastic

There is two type of plastic were study by past researcher in comparison of biodegradable and traditional (non-biodegradable) plastic. This two type of plastic is used in daily live as a medium to carry some goods. However, they have characterization can cause the environmental pollution.

2.1.1 Non-Biodegradable (Traditional)

Synthetic polymers and blends of natural and synthetic polymers which do not degrade completely are called 'partially biodegradable polymers' (Niranjan, 2012). Non-Biodegradable Plastic bags typically are made from one of three basic types such as high-density polyethylene (HDPE), low-density polyethylene (LDPE), or linear low-density polyethylene (LLDPE) (Lajeunesse, 2004). These types of plastic cannot break down or

decompose in an environment. They have a high strength and elongation percentage which allows them to be durable in any application. They are lightweight and also a good insulator (Jonathan et al., 2011). Table 2.1 list the plastic identification code.

Table 2.1: Plastic Identification Code (Source: Agri-Food & Veterinary Authority of Singapore, 2008)

Plastic Identification Code	**Type of plastic polymer**	**Properties**	**Common Packaging Applications**
	Polyethylene Terephthalate (PET, PETE)	Clarity, strength, toughness, barrier to gas and moisture.	Soft drink, water and salad dressing bottles; peanut butter and jam jars
	High Density Polyethylene (HDPE)	Stiffness, strength, toughness, resistance to moisture, permeability to gas.	Milk, juice and water bottles; yogurt and margarine tubs; trash and retail bags.
	Polyvinyl Chloride (V)	Versatility, clarity, eases of blending, strength, toughness.	Juice bottles; cling films
	Low Density Polyethylene (LDPE)	Ease of processing, strength, toughness, flexibility, ease of sealing, barrier to moisture.	Frozen food bags; squeezable bottles, e.g. honey, mustard; cling films; flexible container lids.
	Polypropylene (PP)	Strength, toughness, resistance to heat, chemicals, grease and oil, versatile, barrier to moisture.	Reusable microwaveable ware; kitchenware; yogurt containers; margarine tubs; microwaveable disposable take-away containers; disposable cups and plates.
	Polystyrene (PS)	Versatility, clarity, easily formed	Egg cartons; disposable cups, plates, trays and cutlery; disposable take-away containers; yoghurt and margarine containers