UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF THERMOPLASTICS CORNSTARCH COMPOSITE BLEND WITH AGAR ON MECHANICAL, PHYSICAL AND ENVIRONMENT BEHAVIOUR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical and Manufacturing Engineering Technology (Automotive Technology) 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 Technology) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Tujuan penyelidikan ini adalah untuk mengkaji kesan agar apabila dicampur dengan tepung jagung termoplastik (TPCS). Campuran tepung jagung termoplastik/agar disediakan dengan memasukkan agar ke dalam TPCS dalam nisbah 0 hingga 40 (wt%). Di antara pelbagai jenis bahan yang ada, agar telah dipilih didalam kajian ini kerana ia mampu membentuk gel yang kuat dan mempunyai titik lebur yang tinggi di atas suhu awal gelaterian. Agar juga boleh meningkatkan sifat tepung seperti meningkatkan pemanjangan dan kekuatan tegangan, kebolehtelapan air, mengurangkan keterlarutan dan rintangan haba. Tepung jagung termoplastik/agar dicampur, kemudian dipanaskan melalui cara penekapan pada suhu 165 °C selama 15 minit. Sampel TPCS/Agar komposit akan menjalani 5 ujian yang berbeza, iaitu ujian mekanikal, ujian fizikal, ujian persekitaran, ujian analisis termogravimetrik dan pengujian melalui mikroskopi elektron. Kesan perbezaan nisbah TPCS /Agar komposit juga dikaji. Keputusan daripada ujian mekanikal menunjukkan bahawa penggabungan TPCS dengan agar telah mengurangkan kekuatan tegangan dan kekuatan impak. Walaubagaimanapun, ujian lenturan TPCS/Agar komposit telah menunjukkan peningkatan pada nisbah Agar 20 (wt%). Keputusan ujian fizikal menunjukkan bahawa penggabungan agar dapat meningkatkan sedikit penyerapan air dan penyerapan kelembapan. Kandungan lembapan pula menunjukkan sedikit penurunan. Peningkatan kecil dalam pengukuran kepadatan diperhatikan untuk TPCS selepas dicampurkan dengan agar pada nisbah 20 (wt%). Keputusan ujian keterlarutan di dalam air dan didalam tanah telah meningkat pada penggabungan 40 (wt%) agar dengan TPCS. Ujian Thermogravimetric (TGA) dilakukan pada semua sampel pada julat suhu 40 hingga 500 °C. Keputusan menunjukkan bahawa modulus penyimpanan semua sampel menurun secara beransur-ansur dengan peningkatan suhu. Pengimbasan mikroskop elektron (SEM) menunjukkan struktur komposit pada 40 (wt%) kandungan agar lebih padat dan sekata. Sebagai kesimpulan, penambahan agar telah meningkatkan struktur tepung jagung termoplastik dan juga meningkatkan pergerakan rantai polimer pada suhu tinggi.

ABSTRACT

The aim of this research is to study the effect of agar blended with thermoplastics cornstarch (TPCS). The blended of TPCS/Agar were prepared by incorporation of Agar into TPCS in the range of 0 to 40 (wt%). Among the many types of materials available, agar has been selected in this study because the capable of forming strong gels characterized by melting points well above the initial gelation temperature. Agar also could improve the starch properties such as increased elongation and tensile strength, water permeability, reduced solubility and heat resistance. The mixture was melt-mixed and then used the hot pressed at 165°C for 15 min. The sample TPCS/Agar composites will undergo 5 different tests, which are mechanical testing, physical testing, environment testing, thermogravimetric analysis testing, and scanning electron microscopy testing. The effect of different ratios of TPCS/Agar were also studied. Results from mechanical test showed that incorporation of agar has slightly decreased the tensile strength and impact strength. However, flexural test of TPCS/Agar composites has shown an increase with incorporation of 20 (wt%) agar. Results for the physical test showed that incorporation of agar has slightly increased the water absorption and moisture absorption. Moisture content has showed slightly decrease. Slight increment in density measurement was observed for TPCS after incorporation with agar at 20 (wt%). Water solubility and soil solubility of TPCS was slightly increased with incorporation at 40 (wt%) agar. Thermogravimetric (TGA) testing was conducted on all sample at temperature range of 40 to 500°C. The result show that the storage modulus of all sample decreased gradually with increase in temperature. Scanning electron microscopy (SEM) of composite at 40 (wt%) content of agar showed a compact and homogeneous structure. In conclusion, the addition of agar has increased the microstructure of thermoplastic cornstarch also enhanced the polymer chain movement of the material at high temperature.

DEDICATION

This project report is lovingly dedicated to my beloved family members, especially to my father, Mokti Bin Hj Ghazali and my mother, Auliah Binti Hj Sanusi who have been my constant source of inspiration. They have given me the drive and discipline to tackle any task with enthusiasm and determination. Without their loves and support this project would not have been made possible.

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LIST OF SYMBOLS

wt%	-	Weight percent
mm	-	Milimetre
T	-	Temperature
P	-	Pressure

LIST OF ABBREVIATIONS

SH	Starch
CS	Cornstarch
TPCS	Thermoplastic Cornstarch
RH	Relative Humidity
TGA	Thermogravimetric analysis
SEM	Scanning Electron Microscopy

CHAPTER 1

INTRODUCTION

1.1 Background

Natural pollution has recently been the hot and undeniable subject that has influenced our lives. With a rising attention in reduction of the carbon content of materials, there is a modern agreement to expand eco-friendly materials all the more attractive, for example, bio-based or recyclable materials (Kinvi-Dossou et al. 2019). Analysis from a few parts of science prescribed the creation of biodegradable short-lived thermoplastics as a fractional response to this issue. As an outcome, appropriate segments removed from biomass, such as starch, lignin, fiber and related biopolymers, were considered comprehensively (Morais et al. 2010).

Manufacturing procedures for polymer network lean composites are characterized by an outgrowth of innovation in fiber glass. The clarification of this innovation to strong composites of the metal matrix was problematic. The need for higher temperature preparation in the manufacture of composite metal frames gives the premise of a considerable number of individualities in the clarification. The warm effects on the individual components and the resulting composite become introductory considerations along these lines (Thornton 1968).

Thermoplastic matrixes have become an striking option for non-recyclable thermosetting networks with regard to composite materials, then drawing in the automotive, aviation and maritime business (Kinvi-Dossou et al. 2019). Epoxy resin is one of the best known polymers for modern requests because of decent mixture, mechanical and physical properties. The network dominates the general behavior as it can, the makeweight is a key issue in polymer composite declaration of convincing properties. In particulate strengthened composites, the properties don't rely upon the course of estimation, however, in strong composites, the last is huge parameter which is out of our discussion. Generally, particulate rein-compelling operators are extremely viable in the expansion of the young or hardness composite module (Farzi et al. 2019).

1.2 Problem Statement

Starch is a natural polymer which a numerous special properties and some deficiency at the same time. Starch is renewable from water, sunshine, and carbon dioxide. It is biodegradable and also easy to modify in physical or chemical applications. However, starch is weak to moisture following high-ratio (HR) retention and poor mechanical properties and methodological capability. These are some of the limit factors for starch-based materials operation. In science materials, blending is prepared to improve the physical characteristics of the dominant polymers. Blending polymers can be a mature technology. Once starch is mixed with the other matrix like agar, a polymer blend is considered to be the mixture. Blending starch with various polymers is a vital way to overcome the same starch limitations. Blending polymer is generally a convenient process.

Blending the polymers are cheaper and simpler than producing new ones. The most disadvantage of the blends is coupled to the non- miscibility of polymers, that is thanks to the variations in their chemical structures. In a compatible blend of two or other polymers, a homogenous material is made when a compounding method, leading to a single-phase system with improved properties. In distinction, a suited blend could be a varied system with sensitive adhesion between the parts. Due to the poor sticking between the polymers, it is need to use compatibilization strategies in unfixable blends. Immiscible polymer could also be represented as compatible once its blends do not display gross signals of polymer separatism and when the components adhere smartly (Debiagi, Mello, and Mali 2017).

1.3 Objectives

The following are the main objective of this study:

1) To fabricate composite between thermoplastics corn starch and agar.
2) To identify the optimum of agar ratio in the thermoplastics corn starch and agar composite.
3) To study the effect of agar on the properties of blended thermoplastics cornstarch and agar composite.

1.4 Scope

The scope of this project are as follow:

1) To produce sample composite by using daily basis food grade.
2) To investigate the modulus of elasticity, tensile strength, and elongation and fatigue limit via using tensile testing.
3) To measure the physical testing of the composite.
4) To check the toughness of sample by using impact test.
5) To conduct the environment testing using soil solubility and water solubility.
6) To study the Thermogravimetric Analysis (TGA).
7) To identify the interaction of the Agar and TPCS by using SEM.

CHAPTER 2

LITERATURE REVIEW

2.1 Composite

A composite material is produced by regularly joining at least two materials with completely different properties. The two materials work together to create extraordinary properties for the composite. In the course of the most recent 30 years, composite materials have replaced some metallic weight structures (Arhant et al. 2019). This composite structure enables both strong and ductile material (Rosewitz, Choshali, and Rahbar 2019). Thermoplastic frameworks have become an striking option for non-recyclable thermosetting networks as regards composite materials, pulling in the automobile, aviation and maritime business (Kinvi-Dossou et al. 2019). Because of their predominant explicit properties, composite materials find expansion in vast business aircraft (Peeters et al. 2019).

The majority of composites used in a marine environment today are composites based on thermosets (epoxy, polyester). The weight container, initially made by fiber winding, involve high thicknesses (over 10mm) and it is a test to obtain such thicknesses without deformation. After restoration, the remaining burdens and delamination are normal and may prompt early deceptions. From a science perspective, the majority of earlier research on these materials concentrated on airplane constructions, that is to say, thin composite structures and several studies have linked manufacturing to microstructure (Arhant et al. 2019).