UNIVERSITI TEKNOLOGI MARA

PHYSIO-THERMO-MECHANICAL AND MORPHOLOGICAL PROPERTIES OFHYBRID POLYPROPYLENE/KENAF/RICE HUSK/CALCIUM CARBONATE COMPOSITE

MOHD MUIZZ FAHIMI BIN MOHAMED

MSc

May 2018

ABSTRACT

The abundance of lignocellulosic filler in the nature has driven researchers to develop new products from the material. This research has used plant sourced lignocellulosic material that is turned into composite filler due to its wide range of properties and flexibility. Lignocellulosic filler is widely researched because it is environmental friendly, readily degraded in natural environment, non-toxic and non-abrasive. This material is sourced from plant waste such as rice husk and sustainably grown kenaf thus making it cheap and green and thus added into polymeric material to conform into hybrid composite. The major material of the hybrid composite is polypropylene (PP) which has been reinforced with the addition of kenaf fiber and rice husk. Calcium carbonate ($CaCO_3$) was added to increase the impact strength of the hybrid composite for end consumer application. $CaCO_3$ is a cheap source of mineral filler and has been proven to escalate the hybrid composite by previous researchers. The hybrid composite pellets were then hot compressed into one piece and portioned into different sizes for characterisation purposes. The samples were then characterized for physical, mechanical, thermal and morphological properties. Formulations of the hybrid composite were done by keeping the PP and $CaCO_3$ ratios fixed while changing the percentages of kenaf fiber and rice husk particulate. The weight percentages of PP and $CaCO_3$ were kept constant by 40wt.% and 20wt.%, respectively. The remaining 40wt.% of composite elements were varied from 0wt.% to 35wt.% for kenaf fibers and vice versa for rice husk particulate. The formulations were made into seven hybrid formulations with systematic percentage variation. During compounding of hybrid composite, the Twin Screw Extrusion was set to temperature of 190°C at 50 rpm. Density and water absorption tests were done for physical properties. Tensile and flexural tests were performed to characterise its mechanical properties. In addition, thermal properties were exemplified by Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). Sequentially, morphological characteristics of the hybrid composite were distinguished by Field Emission Scanning Electron Microscope (FeSEM). Density test shows that formulation P1 has the highest value due to the highest ratio of rice husk particulate to kenaf fiber. Formulation P6 shows the lowest density value due to the lowest ratio of rice husk particulate to kenaf fiber. Water absorption test shows that water intake of the hybrid composite increases when the ratio of kenaf fiber increases and vice versa to rice husk particulate. Mechanical properties are portrayed by tensile, flexural and impact tests. Maximum tensile strength is shown by formulation P1 with 10.54 MPa and minimum tensile strength is shown by P6 with 7.38 MPa. Formulation P1 shows maximum flexural strength value which is 28.58 MPa while P6 shows 23.73 MPa. Formulation P1 shows highest impact strength and P6 has the lowest strength with value of 2.20 KJm^{-2} and 1.52 KJm^{-2}, respectively. DSC and TGA tests shows that the increase of the two lignocellulosic fillers increased the hybrid composite thermal stability. FeSEM micrograph of fracture impact shows occurrence of either bonding or de-bonding of fibers' matrices. This research conveys that the naturally sourced lignocellulosic filler helps to increase mechanical and thermal strength with 10wt.% of kenaf and 30wt.% of rice husk particulate, while its ability to absorb water decreases with the decrease of kenaf fibers. Hence, it is concluded that formulation P1 is the optimum blend of hybrid for industrial purposes with matched applications.

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim,

Alhamdulillah.
I am grateful to Allah SWT, for granting me with the opportunity and strength to complete this journey. Thank you Allah for blessing me with more than I can ever ask for. I appreciate all the good things in my life.

The success of this thesis can been attributed to the extensive support and assistance from my supervisor, Associate Professor Dr Rahmah Mohamed, who always gives valuable advice, guidance, comments, especially kindness, suggestions and also sacrifices her time for me. I would like to express my gratitude to her for supervising me on how to do this study systematically and consistently and providing proper guidance. Many thanks also to my co-supervisor, Dr Najmi Bonnia who guide me during on my research project.

I would like to acknowledge polymer laboratory assistance who were willing to assist me in completing my sample preparation and testing. I am grateful to all my friends who have participated in my life during this journey, but space does not permit me to name all of you. You all are true friends during this wonderful journey, who make me laugh, who make me happy, who encourage me, who push me, who challenge me and who celebrate happy times together.

I offer profound gratitude for their continuing and loving support to my parents Mohamed Awang and , sister and brother for their moral and
financial support, endless help and generous advice.

Finally, once again thanks to everyone who are involved scientifically and as friends during this journey. I immensely appreciate your time, effort, support, friendship and kindness. I think without all of you and my family, this journey might not have been smooth and satisfying.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

In this era of globalisation, communal awareness on environmental issues has shown its ups and downs due to ignorance to waste management and attentiveness to environmental campaign. Lack of natural source of raw materials such as timber has been a major issue as a result of overexploitation of forest resources and illegal logging. This issue is not only local but also a global problem especially in countries with lack of law enforcement and sustainability regulations. In order to overcome shortage of resources, researchers have come with cheaper and greener raw material alternatives. This research therefore focused on developing and characterizing newly developed composite that not only offers better flexibility and performance, but also wider application due to its properties.

Wide range of lignocellulosic fibers from plants source is known to be cheaper and readily available for fiber extraction. The utilization of natural fibers from different plant species therefore can be selected to develop advanced composite material. Besides that, agricultural wastes can be exploited as eco-friendly materials. The development of natural based composite, namely Wood Plastic Composite (WPC) can create a material having specific properties and low manufacturing cost. Lignocellulosic which is extracted from plants is abundant and readily available in nature. Therefore, by using natural lignocellulosic as composite filler, we can aim to reduce pollution of the environment. This is done through value added wood fiber composite towards green environment (Mustapa et al., 2005) based on the conservational characteristics.

Natural fillers are characterized as high specific strength and modulus, low density, low cost, renewable, biodegradability, absence of associated health hazards, easy fiber surface modification, wide availability and relative non-abrasiveness (Lei et al., 2007). Recently, researchers had developed potential composite from lignocellulosic fillers composite as sustainable and environmentally friendly product such as from oil palm fiber, kenaf and rice husk (Al-Oqla et al., 2014). [a]Yang et al.