UNIVERSITI PUTRA MALAYSIA

FIBRE-PLASTIC COMPOSITES: OIL PALM FROND AND RUBBERWOOD FIBRES BLENDED WITH POLYPROPYLENE

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By

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LIST OF ABBREVIATIONS

ABS:	Acrylonitrile-butadiene-styrene
ASTM:	American Society for Testing and Materials
DOS:	Department of Statistic
FELCRA:	Federal Land Consolidation and Rehabilitation Authority
FELDA:	Federal Land Development Authority
HDPE:	High density polyethylene
JIS:	Japanese Industrial Standard
MRRDB:	Malaysian Rubber Research Development Board
p:	probability
PMMA:	Polymethyl methacrylate
PP:	Polypropylene
PVA:	Polyvinyl acetate
RISDA:	Rubber Industries of Smallholders' Development Authority
wt:	weight

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LIEW KANG CHIANG

MARCH 1998

Chairman : Dr. Jalaluddin Harun

Faculty : Forestry

Natural lignocellulosic fibres have become more important nowadays because "new" types of composite material can be produced from them. The objectives of this study are to evaluate the suitability of producing fibre-polypropylene composite using oil palm frond fibre and rubberwood fibre. The effects of different fibre size and fibre content on the physical and mechanical properties of the composite produced are assessed to give an insight into fibre-matrix adhesion and fibre damages.

In this study, crude fibres of oil palm fronds were atmospherically refined into fine fibres whilst rubberwood fibres were obtained from a local fibreboard plant. These fibres were later screened into different sizes: < 0.5 mm, 0.5 - 1 mm, 1 - 2 mm and > 2 mm. The screened fibres were melt-blended with polypropylene at different ratios in a Brabender Plasti-Corder equipped with a mixer of type W 350 E - 2 Heating Zones. The mixing condition was set at a rotor speed of 30 rpm at 180^0C for 30 minutes. Moulded composites were prepared for evaluation of tensile, flexural, IZOD impact resistance - notched and ROCKWELL hardness according to ASTM standards.

Results indicate that both oil palm frond and rubberwood composites showed reduction in tensile strengths but increment in tensile modulus as fibre content increase. Oil palm frond composite possessed higher tensile strength and modulus than rubberwood composite. As fibre size increased, the strength of both types of composites also increase. Flexural modulus for oil palm frond and rubberwood composites increased with fibre content. Rubberwood composite using coarser fibre sizes (1 - 2 mm, > 2 mm) exhibit higher modulus. Unlike rubberwood, oil palm frond composite shows higher modulus when finer (< 0.5 mm, 0.5 - 1 mm) fibres were used. IZOD impact resistance - notched test piece showed a decreasing impact for oil palm frond composite as the fibre content increases but rubberwood composite experienced the opposite effect. An increase in fibre size increases the

impact strength of both types of composites. ROCKWELL hardness decreased for oil palm frond and rubberwood composites as fibre content and fibre size increases.

All evaluations are statistically analysed at $p<0.05$. Supportive photographic evidences of the above results are shown by Scanning Electron Micrographs.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

**KOMPOSIT GENTIAN-PLASTIK:
ADUNAN GENTIAN PELEPAH KELAPA SAWIT DAN KAYU GETAH DENGAN POLIPROPILENA**

Oleh

LIEW KANG CHIANG

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Pengerusi : Dr. Jalaluddin Harun

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Bahan lignoselulosa telah menjadi semakin penting pada masa kini kerana komposit "baru" boleh dihasilkan daripadanya. Objektif penyelidikan ini adalah untuk menilai kesesuaian dalam menghasilkan komposit gentian-polipropilena dengan menggunakan gentian pelepah kelapa sawit and gentian kayu getah. Kesan saiz gentian dan kandungan gentian yang berlainan dalam sifat-sifat fizikal dan mekanikal pada komposit juga dikaji bagi memberi pandangan ke dalam perekatan gentian-matrik dan kerosakan gentian.

Dalam penyelidikan ini, gentian kasar daripada pelepah kelapa sawit dikisar secara atmosfera kepada gentian halus sementara gentian kayu getah diperolehi dari kilang tempatan yang menghasilkan papan gentian. Gentian-gentian ini kemudiannya ditapis kepada saiz berlainan; < 0.5 mm, 0.5 - 1 mm, 1 - 2 mm dan > 2 mm. Gentian ini diadun-lebur dengan polipropilena menggunakan "Brabender Plasti-Corder" yang dilengkapi dengan pengadun jenis W 350 E - 2 Zon Pemanasan, pada kandungan gentian berlainan. Keadaan adunan ditetapkan pada kelajuan 30 rpm pada 180^{0}C untuk 30 minit. Komposit dibentuk dan disediakan untuk ujian tegangan, lenturan, ketahanan impak IZOD - berlekuk dan kekerasan ROCKWELL berdasarkan piawaian ASTM.

Keputusan memberi gambaran yang kedua-dua komposit pelepah kelapa sawit dan kayu getah menunjukkan pengurangan dalam kekuatan tegangan tetapi kenaikan dalam modulus tegangan apabila kandungan gentian meningkat. Komposit pelepah kelapa sawit mempunyai kekuatan tegangan dan modulus yang lebih tinggi daripada komposit kayu getah. Apabila saiz gentian meningkat, kekuatan kedua-dua jenis komposit juga bertambah. Modulus lenturan untuk komposit pelepah kelapa sawit dan kayu getah meningkat dengan kandungan gentian. Komposit kayu getah menggunakan saiz gentian yang lebih kasar (1 - 2 mm, > 2 mm) mempamerkan modulus yang tinggi. Berlainan dengan kayu getah, komposit pelepah kelapa sawit menunjukkan modulus yang lebih tinggi bila gentian yang lebih halus (< 0.5 mm, 0.5 - 1 mm) digunakan. Ketahanan impak IZOD -

berlekuk menunjukkan penurunan impak untuk komposit pelepah kelapa sawit bila kandungan gentian meningkat tetapi komposit kayu getah mengalami kesan yang bertentangan. Kenaikan dalam saiz gentian juga menaikkan nilai impak untuk kedua-dua jenis komposit. Kekerasan ROCKWELL menurun untuk komposit pelepah kelapa sawit dan kayu getah apabila kandungan gentian dan saiz gentian meningkat.

Semua penilaian dianalisa secara statistik pada $p<0.05$. Bukti sokongan untuk keputusan di atas diperkuatkan melalui gambar "Scanning Electron Micrographs".

CHAPTER I

INTRODUCTION

In the early days, human beings used wood to make their tools, weapons and shelter to keep them from the sun and rain. Wood possesses flexible cellulosic fibres arranged in an amorphous matrix of lignin and hemicellulosic polymer. This renewable resource has changed in terms of its properties over the years through the expansion of man's knowledge such as making the wood stronger and last longer. They have also modified the wood through coating or filling the porous structure of wood with tars, pitches, creosote, resins and salts (Meyer, 1982). In short, human beings have learnt to modify wood to produce better and more expensive products.

Due to their characteristics, products made from hydrophilic lignocellulosic material such as wood and non-wood vary greatly in mechanical properties and dimensional stability. The composites produced are more susceptible to moisture making them easily decayed by fungi and other biodegradation agents.

Furthermore, due to constant change in weather conditions, their dimensions would be altered as a result of fibre movements which would in turn make it unstable. Over the years, extensive research were carried out to incorporate lignocellulosic materials with different kinds of plastics to improve its inherent properties. With the introduction of thermoplastic polymer, these works take another route of application. These thermoplastic polymers are strong, lightweight, durable and resistant to microorganisms. Furthermore, synthetic plastics possess a hydrophobic character whereby they inhibit natural enzymatic activities. Chemical treatments have been used on wood to improve its strength and stability through chemical impregnation, acetylation of hydroxyl groups, cross-linking of the cellulose with formaldehyde, cyanoethylation, ethylene oxide addition to the hydroxyl groups, ozonolysis, propiolactone grafting of side chains, polyethylene glycol (PEG) bulking of cell walls and phenol-formaldehyde treatments (Meyer, 1982). Through these treatments, improvements on wood properties were achieved and many new products were developed.

In recent years, the abundance of oil palm and rubber tree biomass have posed a disposal problem to plantation owners. Currently, the abundant lignocellulosic resources are either burnt, thus causing pollution to the environment, or just left to deteriorate at the plantation site for nutrient cycling. With the ever changing technology nowadays, fibres produced from these resources can be put into better use as they can be converted into composite products such as particleboard and fibreboard. Apart from the conventional particleboard and medium density fibreboard, these fibres can also be incorporated into plastic material. Usually, wood flour are used as a cheap filler in the matrix. The cost, availability, renewability, and recyclability of lignocellulosics offer the production of large volume, low-cost, high performance structural composites which are most suited to the automobile industry and durable goods market (Narayan, 1992). Research has shown that oil palm biomass have a potential future for the production of composite products and into commercialisation. Among the areas studied were conversion of oil palm trunk into sawn timber and veneer (Ho *et. al.*, 1985), particleboards (Chew and Ong, 1985; Lim and Khoo, 1986), cement-board (Lim and Khoo, 1986; Rahim *et. al.*, 1991), gypsum-bonded particleboards (Khozirah *et. al.*, 1991), pulp and paper (Mohd. Nor, 1985; Khoo and Lee, 1985) and animal feed (Ismail *et. al.*, 1991; Abu Hassan *et. al.*, 1991).

Wood or non-wood fibres can be used as reinforcing materials for the plastic industry products (Balatinecz and Woodhams, 1993; Elbert, 1993; English, 1993; Klodt, 1991; Peng and Balatinecz, 1992; Peng, 1992; Woodhams *et. al.*, 1990; Woodhams and Balatinecz, 1992) due to the fact that these materials are low in cost. According to Bashay *et. al.*, 1985, Kokta *et. al.*, 1990 and Woodhams *et. al.*, 1984, these materials also have relatively superior high stiffness and strength