UNIVERSITI PUTRA MALAYSIA

PHYSICAL AND THERMOMECHANICAL PROPERTIES OF OIL PALM ASH-FILLED UNSATURATED POLYESTER COMPOSITES

MOHD SHUKRI BIN IBRAHIM

ITMA 2012 5

PHYSICAL AND THERMOMECHANICAL PROPERTIES OF OIL PALM ASH-FILLED UNSATURATED POLYESTER COMPOSITES

MOHD SHUKRI BIN IBRAHIM

MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2012

PHYSICAL AND THERMOMECHANICAL PROPERTIES OF OIL PALM ASH-FILLED UNSATURATED POLYESTER COMPOSITES

By

MOHD SHUKRI BIN IBRAHIM

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

January 2012

DEDICATION

For all your advice and encouragements, this thesis is gratefully dedicated to my beloved parent, family and friends. Thank you very much for your continuous supports and efforts towards completion of this thesis.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

PHYSICAL AND THERMOMECHANICAL PROPERTIES OF OIL PALM ASH FILLED-UNSATURATED POLYESTER COMPOSITES

By

MOHD SHUKRI BIN IBRAHIM

January 2012

Chairman : Mohd Sapuan Salit, PhD, P.Eng.

Faculty : Institute of Advanced Technology

The main advantages of the oil palm ash are its availability at abundance, no cost material, high aspect ratio and good performance in high thermal condition. This research investigates the physical characteristics of oil palm ash filler and the effects of filler contents on mechanical and thermal properties of oil palm ash filled unsaturated polyester composite (UP/OPA). The composite specimens made of different filler contents of 0, 10, 20 and 30% of oil palm ash were prepared. All of these composites were fabricated using a conventional hand lay up technique. The mechanical tests such as tensile and flexural were carried out in according with American Society of Testing Material D 5083 and American Society of Testing Material D 790 standards respectively. Scanning electron microscope was used to study the surface morphology of UP/OPA composites of the fractured surface for tensile and flexural tests. The results of the experiments showed that the increasing of filler contents i.e. 0, 10, 20 and 30% of oil palm ash had significant effects on reduction of tensile strength (26.8MPa, 21MPa, 17MPa and 13MPa); flexural strength (88.48MPa, 78.17MPa, 71.70MPa and 62.5MPa) and elongation at break (5.55%, 3.11%, 2.52% and 2.36%); and increase of tensile

modulus (3.75MPa, 3.9MPa, 4.35MPa and 4.99MPa) and flexural modulus (200MPa, 214MPa, 222MPa and 233MPa) of the UP/OPA composites respectively. Investigation on thermal properties of UP/OPA composite involved thermogravimetric analysis (TGA) and differential scanning calorimeter (DSC) in order to investigate temperatures at maximum mass loss and to determine glass transition temperature (T_g) of the UP/OPA composites. The results have shown that increasing of filler contents i.e. 0, 10, 20 and 30% of oil palm ash for UP/OPA composites had improved their thermal stability because their initial decomposition of temperatures at 5% mass loss were increased 293.55, 356.64, 375.59 and 401.72°C respectively, temperatures at maximum mass loss were also increased 436.64, 460.90, 468.01 and 476.23°C respectively and glass transition temperatures slightly increased from 185.4 to 191°C with the additions of fillers for up to 30%.

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

SIFAT FIZIKAL DAN TERMOMEKANIKAL KOMPOSIT POLIESTER TAK TEPU DIISI-SERBUK ABU KELAPA SAWIT

Oleh

MOHD SHUKRI BIN IBRAHIM

Januari 2012

Pengerusi : Mohd Sapuan Salit, PhD, P.Eng.

Fakulti : Institut Teknologi Maju

Antara manafaat yang utama serbuk abu kelapa sawit adalah mudah diperoleh secara pukal, tanpa kos, nisbah aspek yang tinggi dan berfungsi dengan baik pada keadaan termal yang tinggi.

Penyelidikan ini bertujuan untuk mengkaji ciri-ciri fizikal serbuk abu kelapa sawit dan kesan-kesan kandungan pengisi ke atas sifat-sifat mekanikal dan termal bagi bahan komposit poliester tak tepu diiisi serbuk abu kelapa sawit (UP/OPA). Bahan ujikaji komposit yang disediakan menggunakan pengisi serbuk abu kelapa sawit pada peratusan kandungan berat yang berlainan iaitu 0, 10, 20 dan 30%. Semua bahan ujikaji disediakan menggunakan kaedah konvensional lapisan tangan. Ujian-ujian mekanikal seperti regangan dan lenturan dilakukan berpandukan kepada piawaian ASTM D 5083 dan ASTM D 790 mengikut turutan. Ujian pegesanan mikroskop adalah untuk mengkaji morfologi permukaan bahan komposit ujikaji yang telah melalui ujian regangan dan lenturan. Keputusan kajian menunjukkan peningkatan kandungan pengisi OPA iaitu 0%, 10%, 20% dan 30% memberikan kesan yang signifikan terhadap penurunan kekuatan tegangan (26.8MPa, 21MPa, 17MPa dan 13MPa), kekuatan lenturan (88.48MPa,

78.17MPa, 71.70MPa dan 62.5MPa) dan pemanjangan pada takat putus (5.55%, 3.11%, 2.52% dan 2.36%), serta meningkatkan modulus tegangan (3.75MPa, 3.9MPa, 4.35MPa dan 4.99MPa) dan modulus lenturan komposit (200MPa, 214MPa, 222MPa and 233MPa) komposit UP/OPA mengikut turutan. Penelitian ke atas sifat-sifat termal bahan komposit UP/OPA adalah berkaitan analisis termogravimetri dan pengesanan perbezaan kalorimetri dalam menentukan suhu maksimum kehilangan berat termal dan juga untuk menentukan suhu peralihan kaca bahan komposit UP/OPA. Keputusan ujian menunjukkan bahawa peningkatan kandungan pengisi iaitu 0%, 10%, 20% and 30% bagi komposit UP/OPA telah meningkatkan kestabilan termal kerana suhu permulaan kehilangan berat 5% telah meningkat 293.55, 356.64, 375.59 dan 401.72°C mengikut turutan, suhu kehilangan berat maksimum juga meningkat 436.64, 460.90, 468.01 dan 476.23°C mengikut turutan dan suhu peralihan kaca meningkat sedikit daripada 185.4 hingga 191°C setiap penambahan pengisi hingga 30%.

ACKNOWLEDGEMENTS

Bismillahirrahmanirrahim .

All praises only to Allah Subhanahu Wa Taala because of His bounties and His permission, have enabled me to complete this thesis. Without His helps, certainly I cannot do anything.

In this opportunity, I want to express my thank you to the chairman of supervisory committee Professor Ir. Dr. Mohd Sapuan Salit and the member of supervisory committee Dr. Faieza Abdul Aziz for the instructions, guidance and patience in carrying out this research project. Thanks are also extended to my fellow post-graduate members who have helped me during complete this thesis. Thanks also go to all my course mates that gave me a lot of supports in carrying of this work.

Special thanks are also extended to my beloved parents, my entire family and my fiancee that always prays for me, give supports and helps in carrying out this research and finally to complete this work.

Finally, I would like to request you for my success in this world and also in the hereafter.

I certify that a Thesis Examination Committee has met on 6th January 2012 to conduct the final examination of Mohd Shukri Bin Ibrahim on his thesis entitled "Physical and Thermomechanical Properties of Oil Palm Ash-Filled Unsaturated Polyester Composites" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohamad Amran b. Mohd Salleh, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Zulkiflle b. Leman, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Edi Syams b. Zainudin, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Azlan Bin Ariffin, PhD
Associate Professor
School of Material and Mineral Resources Engineering
Universiti Sains Malaysia
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia.

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Mohd Sapuan Salit, PhD, P.Eng.
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Faieza Abdul Aziz, PhD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

_____
BUJANG BIN KIM HUAT, PhD
Professor and Dean
School Of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

_____

MOHD SHUKRI BIN IBRAHIM
Date: 6th January 2012

TABLE OF CONTENTS