UNIVERSITI PUTRA MALAYSIA

PROPERTIES OF WOOD PLASTIC COMPOSITE PRODUCED USING INJECTION MOULDING PROCESS

HANG CHIT MENG

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By

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

May 2010

SPECIAL DEDICATION TO …

To my beloved father, mother, brothers,

friends and specially remembered one

Thanks you for everything …..

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

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Chairman: H'ng Paik San, PhD

Faculty: Faculty of Forestry

The rapidly changing economic and environmental friendly needs of society are causing increasing conversion and efficient use of wood waste resources, producing more wood fine using environmentally friendly processes and technologies, and remaining competitive in the global market place. The competition in high volume markets has focused attention on low priced materials that offer a more favorable strength to weight ratio. Wood plastic composite (WPC) has the lowest material cost has been highly focusing by many industries. However, in current market, WPC is only limited in extrusion processing method where it constrain the WPC processing move into profile extruding such as flooring, decking and column ects. As the WPC processing consume a high technology machineries and high electrical consumption, it cause the WPC process cost is high against low raw material cost. This is the main reason cause the slow

down development of WPC industry due to the WPC products selling price is higher than market expected.

Due to the above issue, the proposed study on WPC injection moulded method where able to enhance the multi shape wood composite products development to push the WPC products development into new arena of business opporcunity. With injection molded methods, WPC can easily inject and able to mould any wood composite products in any shapes without required any further process such as engraving, shearing, nail, gluing and machining. This will effectively reduce of labor cost and enhance the value of WPC products.

With the study, the enhancement of WPC formulation against physical and flexural performance has been studies with different wood fine loading and coupling agent concentration. Test samples have been produced by simple piston injection moulded method with single cavity injection mould to form WPC plate. Those WPC plate has been cut to required specimens size as ASTM standard D1037-99 stated for further testing used. Physical and flexural properties of those WPC test specimens has been analyse and the optimization of wood fine loading and coupling agent concentration has been determined. The result shows the effect of wood fine loading was significently increase the water absorption rating of WPC in injection moulding. 65% wood fine loading seem to be the optimum formulation in both physical and flexural performance of WPC.

The WPC formulation optimization has been further enhance on studies the effect of different industries grade coupling agent and the concentration to further evaluate the effect to the properties of WPC. Coupling agent of Exxelor PO 1020 with 4% concentration provided better

properties performance compare to other coupling agent used. It shows that coupling agent Exxelor PO 1020 given the better linkage effect to matrix fiber-PP in WPC material. It significently perform better in flexural strength as well as in physical performance. The final selection of WPC formulation with 4% Exxelor PO 1020 concentration had been continuing studies the physical and flexural behaviors against injection mould temperature and inject pressure setting with different Wood Fine loading. The mould temperature effect shows significently improved the flow of WPC during injection process. This cause better PP coverage surface with wood fine for this composite material given better resistant to water absorption. The inject pressure effect provided the WPC higher packing pressure during cavity moulding as well as improve the density of the material. Lower pressure cause the short moulding of components and higher pressure causes the biggest backpressure and flushing problem. Both mould temperature and inject pressure shows the factor of improvement of WPC properties in WPC injection moulding processing method. The data obtain from this studies is very useful for most of the industralise injection moulding process for higher viscosity material as wood plastic composite.

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

SIFAT – SIFAT KAYU KOMPOSIT PLASTIK HASIL DARIPADA PROSES SUNTIKAN ACUAN

Oleh

HANG CHIT MENG

May 2010

Pengerusi: H'ng Paik San, PhD

Fakulti: Fakulti Perhutanan

Ekonomi yang berubah dengan cepat dan keperluan persekitaran masyarakat mempercepatkan peningkatan penukaran dan penggunaan sumber-sumber serat kayu, memproduksi lebih banyak serat dengan menggunakan proses yang ramah lingkungan dan teknologi, dan tetap kompetitif dalam pasaran global. Komposit di pasar dengan keupayaan pengeluaran yang tinggi telah menumpukan perhatian pada harga rendah bahan-bahan yang menawarkan lebih menguntungkan nisbah kekuatan terhadap berat. Kayu komposit plastik (WPC) mempunyai kos bahan rendah telah banyak menang tumpuan oleh industri. Namun, di pasaran saat ini, WPC terlalu dihadkan dalam kaedah proses penghasilan profil di mana hanya pengeluaran profil seperti lantai, decking dan tiang dan lain – lain dipentingkan. Disebabkan pengolahan WPC memerlukan mesin teknologi yang tinggi dan penggunaan kuasa elektrik yang tinggi telah menyebabkan kos buatan WPC produks yang tinggi namun kos bahan mentah yang agar rendah. Akibat ini benar-benar

melambatkan perkembangan industri WPC kerana produk WPC harga jual lebih tinggi daripada yang diharapkan oleh pasaran.

Oleh sebab itu, kajian yang dicadangkan dengan pemprosesan WPC produk dengan kaedah suntikan acuan dimana kaedah ini boleh mempertingkatkan rekabentuk ciptaan produk komposit kayu yang akan menggalakkan pembangunan produk WPC ke arena baru. Dengan kaedah suntikan acuan, WPC boleh dengan mudahnya menyuntik dan mampu cetakan setiap produk kayu komposit dalam perbagai bentuk reka cipta tanpa proses tambahan seperti ukiran, mencukur, pempakuan, pelekatan dan permesinan. Kaedah ini dipercayai akan mengurangkan kos tenaga kerja dan meningkatkan nilai produk WPC dengan lebih berkesan.

Dengan kajian ini, peningkatan WPC terhadap fizikal dan prestasi dilentur telah diuji dengan perbezaan kandungan serat kayu dan peringkat kandungan agen coupling. Uji sample telah dihasilkan oleh piston suntikan dalam kaedah cetakan acuan untuk membentuk WPC sample. WPC sample yang dihasil setelusnya akan dipotong kepada saiz yang diperlukan seperti kehendak standard ASTM D1037-99 untuk pengujian yang lebih lanjut. Sifat Fizikal dan sifat lentur WPC sample uji telah dianalisis dan optimalisasi kandungan serat kayu dan ajen coupling telah ditentukan. Hasil menunjukkan kesan daripada kenaikan muatan serat kayu secara signifikan meningkatkan penyerapan air di kedudukan WPC injection moulding. 65% kandungan serat kayu menjadi rumusan optimum baik bagi sifat fizikal and sifat lenturan WPC.

Dalam kajian ini, kesan daripada jenis agen hubungan dan tumpuannya telah dikaji untuk menilai kesan sifat WPC. Agen hubungan Exxelor PO 1020 dengan 4% candungan memberi prestasi lebih baik berbanding dengan agen hubungan yang lain. Ini menunjukkan bahawa agen

hubungan 1020 PO Exxelor memberi kesan rangkaian yang lebih baik dalam rangka serat - PP dalam bahan WPC. Secara signifikan, ia berprestasi lebih baik dalam kekuatan lentur serta prestasi fizikal. Akhirnya, WPC dengan 4% kepekatan Exxelor PO 1020 telah dipilih untuk melanjutkan pengajian lentur and fizikal terhadap perubahan suhu cetakan suntikan dan tekanan penyuntikkan. Kesan suhu cetakan menunjukkan kesan signifikan meningkatkan kesan aliran WPC dalam proses suntikan acuan. Hal ini meningkatkan kesan liputan permukaan PP yang lebih baik di permukaan serat kayu dalam bahan komposit ini mengakibatkan komposit bahan ini lebih tahan terhadap penyerapan air. Kesan tekanan dalam penyuntikan WPC akan memberi lebih tinggi tekanan suntikan semasa proses telah meningkatkan ketumpatan bahan WPC. Tekanan rendah mengakibatkan ketumpatan komponen yang kurang baik manakala tekanan yang lebih tinggi mengakibatkan tekanan tentangan yang tinggi serta masalah pembilasan. Kedua-dua kesan cetakan suhu dan tekanan penyuntikkan menunjukkan peningkatan sifat fizika dalam WPC untuk kaedah muat suntikan acuan. Matlumat yang diperolehi dalam kajian ini adalah pedoman yang sangat berguna bagi industri pengacuan suntikan untuk suntikan bahan kelikatan yang tinggi seperti kayu komposit plastik.

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I certify that an Examination Committee has met on 25 May 2010 to conduct the final examination of Hang Chit Meng on his Master of Science thesis entitled "PROPERTIES OF WOOD PLASTIC COMPOSITE PRODUCED FROM INJECTION MOULDING PROCESS" 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 Examinations Committee were as follows:

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

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duty 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.

HANG CHIT MENG

Date: 25 May 2010

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