



UNIVERSITI PUTRA MALAYSIA

***KENAF (*Hibiscus cannabinus L.*) UNDER VARIED THERMO-MECHANICAL
PULPING AND ITS INFLUENCE ON MEDIUM DENSITY
FIBREBOARD PERFORMANCE***

AISYAH HUMAIRA ALIAS

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**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA**

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By

AISYAH HUMAIRA ALIAS

© Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Master of Science

January 2013

DEDICATION

My Beloved Mother, Hajjah Faizah Jaafar

My Supportive Father, Haji Alias Mohamad @ LED

My Brothers :

Yassir

Aswad Umair

Aiman Ihsan

Ahmad Faiz

My sisters :

Atiyah Nasyrh

Amirah Rumaisya

Ainun Mukhlisah

May Allah bless us!

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

KENAF (*Hibiscus cannabinus* L.) UNDER VARIED THERMO-MECHANICAL PULPING AND ITS INFLUENCE ON MEDIUM DENSITY FIBREBOARD PERFORMANCE

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AISYAH HUMAIRA ALIAS

January 2013

Chairman : Professor Dr. Paridah Md. Tahir, PhD

Institute : Institute of Tropical Forestry and Forest Products

The medium density fibreboard (MDF) industry is facing shortage of wood resource and tends to utilize non-wood as main raw material. Kenaf (*Hibiscus cannabinus* L.) has been recognized as one of the potential lignocellulosic materials to replace wood in this industry. Kenaf consists of two major parts : bast and core, and there were identified have greatly different properties in term of anatomy, physical and chemical content. Due to these differences, both parts are refined separately and the behaviour of these fibres were observed.

In this study, MDF were manufactured from bast and core fibres of kenaf using various refining conditions from thermo-mechanical pulping (TMP). The fibres

were refined at three different digestion pressures of 3, 5 and 7 bar and at temperatures of 140, 160 and 180°C, respectively. Two heating refining times of 3 and 5 minutes were used. The fibre morphology, surface, buffering capacity and size distribution were evaluated. The resulting fibres were used to manufacture MDF panels at a target density of 700 kg/m³ and using 12% of urea-formaldehyde as binder. The panels were then evaluated according to Malaysian Standard 1787.

Generally, the TMP condition affects the fibre properties of bast and core fibres. Bast produced longer and wider fibres with high aspect ratio compared to core. At highest pressure (7 bar), the waxy surfaces of bast fibres melted while core contained more fines. The pH of core was more acidic compared to bast after refining, where the core was more sensitive to acid and bast was more sensitive to alkaline.

Among the three refining conditions, the fibres from bast refined with 5 bar pressure for 5 minutes resulted in better mechanical and physical properties of the panels. The panel recorded highest modulus of rupture (MOR) of 22.9 MPa, modulus of elasticity (MOE) of 2113 MPa and internal bonding (IB) of 0.17 MPa.

The panel properties were affected by the fibre length and the presence of wax on fibre surfaces.

For core panel, fibres refined at 7 bar pressure for 5 minutes resulted in better mechanical and physical properties with the value of 30.3, 3619 and 0.66 MPa for MOR, MOE and IB, respectively. The bending strength of the panels were influenced by the availability of more fines produced at higher pressure. The bonding was affected by the properties of the core that was sensitive towards acid, resulted in the sufficient curing between the fibres and adhesive during pressing, thus was producing panels with good bonding properties. The dimensional stability of core panels were more stable compared to bast panel as indicated by the low values in thickness swelling and water absorption.

The overall results indicated that bast and core fibre can be used as raw material for MDF manufacture, with right selection of TMP conditions. Panel from core fibre produced better panel properties than bast panel. Thus, core fibre is suitable to be used in the fibreboard productions.

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

**KENAF (*Hibiscus cannabinus* L.) DARIPADA KEPELBAGAIAN
TERMO-MEKANIKAL PULPA DAN PENGARUHNYA TERHADAP PRESTASI
PAPAN GENTIAN BERKETUMPATAN SEDERHANA**

Oleh

AISYAH HUMAIRA ALIAS

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Industri papan gentian beketumpatan sederhana (MDF) menghadapi masalah kekurangan sumber kayu dan cenderung untuk menggunakan sumber bukan kayu sebagai bahan mentah utama, dan kenaf (*Hibiscus cannabinus* L.) telah dikenalpasti sebagai salah satu bahan lignosellulosa yang berpotensi untuk menggantikan kayu dalam industri ini. Kenaf terdiri dari dua bahagian utama, iaitu kulit dan teras, dimana keduanya mempunyai sifat anatomi, fizikal dan komposisi kimia yang berbeza. Disebabkan oleh perbezaan ini, kedua-dua bahagian ini diproses secara berasingan dan sifat gentian diperhatikan.

Dalam kajian ini, MDF dihasilkan dari kulit dan teras dengan menggunakan proses termo-mekanikal pulpa (TMP) yang berbeza. Gentian diproses pada tiga

keadaan tekanan berbeza, 3, 5 dan 7 bar iaitu pada suhu 140, 160 dan 180°C. Dua masa pemanasan digunakan iaitu 3 dan 5 minit. Morfologi gentian, sifat permukaan gentian, kapasiti penampakan dan analisis saiz gentian dinilai. Gentian yang terhasil digunakan dalam pembuatan MDF dengan anggaran ketumpatan 700 kg/m³ dengan menggunakan 12% urea-formaldehid sebagai resin. Sifat panel kemudiannya diuji berdasarkan Malaysia Standard 1787.

Umumnya, keadaan semasa TMP mempengaruhi sifat gentian kulit dan teras. Kulit menghasilkan gentian yang panjang dan lebar dengan kadar nisbah yang tinggi berbanding teras. Pada tekanan yang tinggi iaitu 7 bar, permukaan pada kulit yang mengandungi lapisan lilin akan cair manakala teras pula menghasilkan banyak gentian halus. Teras mempunyai pH yang lebih bersifat asid berbanding kulit, dan bersifat lebih sensitif terhadap asid, manakala kulit sensitif terhadap alkali.

Dari kesemua keadaan TMP, kulit yang diproses pada tekanan 5 bar selama 5 minit menghasilkan sifat mekanikal dan fizikal panel yang paling baik. Panel pada keadaan ini merekodkan kekuatan papan gentian (MOR) bernilai 22.9 MPa, modulus elastik (MOE) bernilai 2113 MPa dan kekuatan rekatan dalaman (IB) bernilai 0.17 MPa. Sifat panel dari kulit ini dipengaruhi oleh penjang gentian dan kehadiran bahan bersifat lilin pada permukaan gentian.

Panel dari teras yang diproses pada tekanan 7 bar selama 5 menit menghasilkan sifat mekanikal dan fizikal panel yang baik dengan nilai 30.3, 3619 dan 0.66 MPa, masing-masing untuk MOR, MOE dan IB. Kekuatan MOR dan MOE dipengaruhi oleh kehadiran 'habuk' dari tekanan tinggi yang digunakan dalam TMP. Kekuatan ikatan rekatan dipengaruhi oleh sifat teras yang sensitif terhadap asid, menghasilkan panel yang 'masak' secukupnya antara gentian dan perekat, dan menghasilkan panel yang mempunyai ikatan rekatan yang tinggi. Panel dari teras mempunyai kestabilan dimensi paling stabil berbanding panel dari kulit yang ditunjukkan melalui nilai pembengkakan ketebalan dan penyerapan air yang rendah.

Secara keseluruhannya, kulit dan teras kenaf boleh digunakan dalam pembuatan papan gentian berketumpatan sederhana, dengan memilih keadaan proses TMP yang betul. Panel dari teras menghasilkan sifat panel yang lebih baik berbanding panel dari kulit. Oleh itu, teras sangat sesuai untuk digunakan dalam penghasilan papan gentian.

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I certify that an Examination Committee has met on **10 January 2013** to conduct the final examination of Aisyah Humaira Alias on her Master of Science thesis entitled “**Kenaf (*Hibiscus cannabinus* L.) fibres under varied thermo-mechanical pulping (TMP) conditions and their influence on MDF performance**” in accordance with Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia and [P.U.(A) 106] 15 March 1998. The committee recommends that the candidate be awarded the Master of Science.

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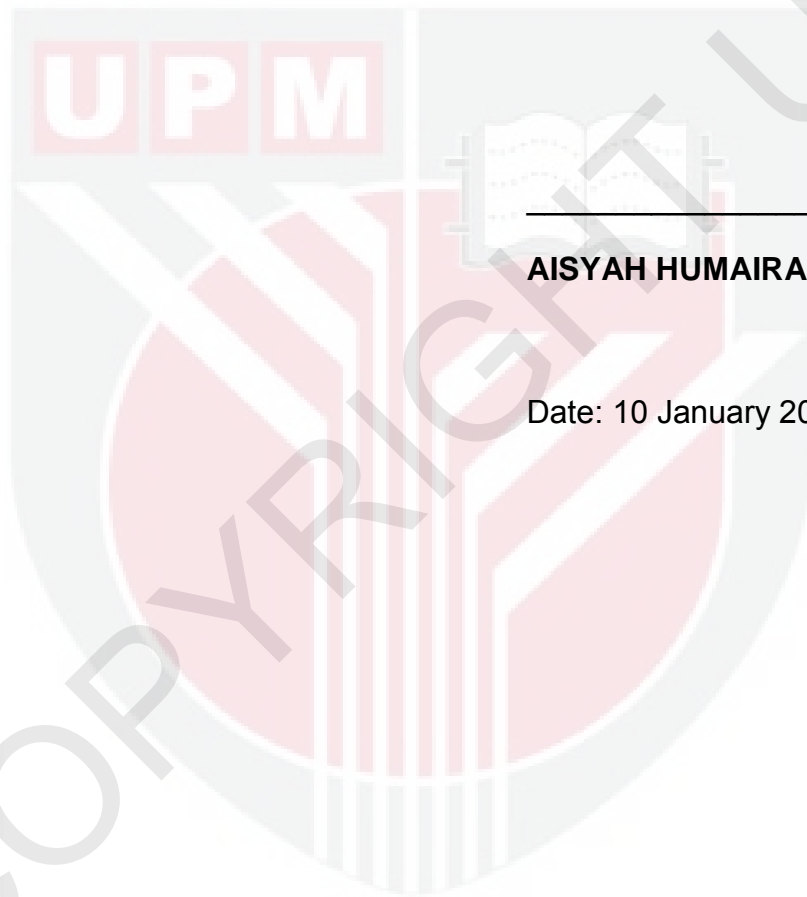
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DECLARATION

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.



AISYAH HUMAIRA ALIAS

Date: 10 January 2013



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