



**UNIVERSITI PUTRA MALAYSIA**

**PRODUCTION OF PARTICLEBOARD USING NEW FORMULATION  
MELAMINE UREA FORMALDEHYDE ADHESIVE FOR LOW  
FORMALDEHYDE EMISSION**

**LOH YANG WAY**

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**By**

**LOH YANG WAY**

**This thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
Fulfillment of the Requirement for the Degree of Master of Science**

**August 2011**

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

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**Chair: H'ng Phaik San, PhD**

**Faculty: Faculty of Forestry**

Particleboard is an engineered wood panel product consisted of particle bonded with formulated adhesives together with heat and pressure. In recent years, air pollution had become a concerning issue around the globe, as formaldehyde was classified as a type of carcinogen which can cause cancer. Urea formaldehyde (UF) is a common type of adhesive which used as a binder for production of particleboard. However, studies found out that the amount of formaldehyde emitted from particleboard bonded with UF was higher. With the stringent enforcement in air pollution, other types of adhesives were introduced as binder of particleboard, including melamine urea formaldehyde (MUF) resin. The aim of this study is to determine the physical and mechanical properties and formaldehyde emission from the application of MUF resin in particleboard production. In this study, two phases of study were carried out. For the initial phase, the effect of surface-to-core ratio, which is the amount of fine particle and thick flake respectively in three-layered particleboard, was studied. Five different ratios were applied to

manufactured particleboard, which were 70% core and 30% surface; 60% core and 40% surface; 50% core and 50% surface; 40% core and 60% surface; and 30% core and 70% surface. The temperature applied was 180°C and pressing time was 10.5 minutes by using RD 111 as the MUF resin. From this study, particleboard with 60% core and 40% fine was observed to provide the optimum result for strength properties and lowest formaldehyde emission. For the second phase of this study, all particleboards were produced with 60% core and 40% fine. Three MUF resins were prepared in different melamine content, which were 14.8%, 19.1% and 13.0% for RD 111, RD 114 and RD 218 respectively. Three different pressing temperatures was applied for each MUF resin, which were 170°C, 180°C and 190°C respectively, and three different pressing times of 9.5 minutes, 10.5 minutes and 11.5 minutes were applied for each pressing temperature. This study showed that MUF resins with different melamine content interacted significantly with pressing time and pressing temperature. RD 218 with lowest melamine content of 13.0% provided the optimum strength properties and formaldehyde emission. In short, all MUF-bonded particleboard obtained Super E0 (F\*\*\*\*) classification according to JIS A 1460, with the average formaldehyde emission ranged from 0.08mg/L to 0.18mg/L. All particleboard produced complied JIS A 5908 for strength properties, except for particleboard bonded with RD 114 resins recorded some undesired strength properties.

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

**PENGHASILAN PAPAN SERPAI DENGAN MENGGUNAKAN PELEKAT  
FORMULASI MELAMIN UREA FORMALDEHID YANG DIPERHAHARUI  
UNTUK MENGURANGKAN PELEPASAN FORMALDEHID.**

Oleh

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**Ogos 2011**

**Pengerusi: H'ng Phaik San, PhD**

**Fakulti: Fakulti Perhutanan**

Papan serpai merupakan satu produk kejuruteraan panel kayu yang terdiri daripada zarah kayu yang diikat oleh pelekat berformulasi dengan bantuan haba dan tekanan. Kebelakangan ini, pencemaran udara telah menjadi satu isu global yang membimbangkan, kerana formaldehid telah diklasifikasikan sebagai sejenis karsinogen yang boleh menyebabkan kanser. Urea formaldehid (UF) adalah sejenis pelekat yang biasanya digunakan sebagai pengikat untuk penghasilan papan serpai. Tetapi, kajian menunjukkan jumlah formaldehid yang dihasilkan oleh papan serpai yang menggunakan urea formaldehid adalah lebih tinggi. Dengan penguatkuasaan yang lebih ketat dalam isu pencemaran udara, pelbagai jenis pelekat telah diperkenalkan untuk penghasilan papan serpai, contohnya melamin urea formaldehid (MUF). Tujuan kajian ini dijalankan adalah untuk menentukan ciri-ciri fizikal dan mekanikal dan juga penghasilan formaldehid daripada aplikasi pelekat MUF dalam pengeluaran papan serpai. Kajian ini terbahagi kepada dua fasa. Sebagai fasa permulaan, kesan-kesan nisbah permukaan-dengan-terbas,

iaitu jumlah zarah kayu halus dan kepingan kayu tebal dalam pengeluaran papan serpai yang mempunyai tiga lapisan, telah dikaji. Lima nisbah yang berlainan telah digunakan dalam pengeluaran papan serpai, iaitu 70% teras and 30% permukaan; 60% teras and 40% permukaan; 50% teras and 50% permukaan; 40% teras and 60% permukaan; and 30% teras and 70% permukaan. Suhu yang dikenakan ialah 180°C dan masa penekanan ialah 10.5 minit dengan menggunakan RD 111 sebagai pelekat MUF. Pada kajian ini, papan serpai yang terdiri daripada 60% teras dan 40% permukaan telah memberi keputusan optima dari segi ciri-ciri kekuatan dan penghasilan formaldehid yang terendah. Untuk fasa kedua dalam kajian ini, semua papan serpai telah dihasilkan dengan nisbah 60% teras dan 40% permukaan. Tiga jenis pelekat MUF telah disediakan dalam tiga kandungan melamin yang berlainan, iaitu 14.8%, 19.1% and 13.0% untuk RD 111, RD114 dan RD218 masing-masing. Tiga suhu penekanan yang berlainan telah digunakan untuk papan serpai yang diperbuat daripada pelekat MUF, iaitu 170°C, 180°C and 190°C masing-masing, dan tiga masa penekanan yang berlainan iaitu 9.5 minit, 10.5 minit dan 11.5 minit telah digunakan untuk setiap suhu penekanan. Kajian ini menunjukkan bahawa pelekat MUF berinterak dengan ketara dengan masa penekanan dengan suhu penekanan. RD 218 yang mengandungi sebanyak 13.0% kandungan melamin yang terendah memberi ciri-ciri kekuatan dan penghasilan formaldehid yang paling optimum. Kesimpulannya, semua papan serpai yang dihasilkan oleh pelekat MUF memperoleh klasifikasi *Super E0 (F\*\*\*\*)* mengikut JIS A 1460, dengan purata penghasilan formaldehid antara 0.08mg/L hingga 0.18mg/L. Semua papan serpai yang dihasilkan mencapai JIS A 5908 untuk ciri-ciri kekuatan, kecuali papan serpai yang dihasilkan oleh RD 114 yang menghasilkan ciri-ciri kekuatan yang kurang dikehendaki.

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*My Grandparents,*

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*Whom always show me endless support, and guide me to the correct path of my life;*

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*My Girlfriend,*

*Whom always love me and support me with all her heart;*

*My Lovely Friends,*

*Whom always show me support and companion;*

I certify that the Examination Committee has met on 11<sup>th</sup> August 2011 to conduct the final examination of Loh Yang Way on his Master of Science thesis entitled Production of “Particleboard Using New Formulation Melamine Urea Formaldehyde Adhesive for Low Formaldehyde Emission” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the student be awarded the (Master of Science).

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## DECLARATION

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

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**LOH YANG WAY**

Date: 11 August 2011

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