EFFECTS OF AMMONIUM SULPHATE HARDENER AND AMINE COMPOUND ON FORMALDEHYDE EMISSION OF PARTICLEBOARD BONDED AT VARIES LEVELS OF UREA FORMALDEHDYE RESIN

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By

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ABSTRACT

Particleboard is an engineered wood that is manufactured from wood chips and synthetic resin or other suitable binder which is pressed. It is also known as a structural material that was made from wood particles, such as chips, shavings or even sawdust that are mechanically pressed into sheet form and bonded with or without resin. However, the uses of urea formaldehyde (UF) in the manufacturing of particleboard possess great disadvantage such as emission of formaldehyde which are irritation in the upper respiratory tract and combustion in the eyes. Several methods have been successfully developed in the reduction of formaldehyde emission (FE). One of the method that has been used is modifying the chemistry of UF resin by using hardener. The main objective of this study is to study the effects of ammonium sulphate and amine compound as hardener on formaldehyde emission of particleboard bonded of varies concentration of UF resin. In this study, raw materials consisting of rubberwood and five different concentration of Urea formaldehyde (UF) were applied to manufactured particleboard, which were 10%, 12% 14% and 16%. The temperature applied was 180^{o}C and pressing time was 4 minutes. The result showed that the formaldehyde emission increase as the concentration increase. The study was also found that density was increasing and the moisture content (MC) was decreasing along the increasing of concentration. The treatment was also found to increase the dimensional stability and mechanical properties of the particleboard. As regards with urea formaldehyde (UF) concentration, there was no significant different in mechanical properties but differ significantly in physical properties.

ABSTRAK

Papan partikel merupakan kayu kejuruteraan yang diperbuat daripada serpihan kayu dan resin sintetik atau pengikat lain yang sesuai yang dimampat. Ia juga dikenali sebagai bahan struktur yang diperbuat daripada zarah kayu, seperti serpihan kayu, atau habuk papan yang dimampat ke dalam bentuk kepingan dan terikat dengan atau tanpa resin. Walau bagaimanapun, penggunaan urea formaldehid (UF) dalam pembuatan papan partikel mempunyai kelemahan yang besar seperti pelepasan formaldehid yang merengsakan saluran pernafasan dan memedihkan mata. Beberapa kaedah telah berjaya dihasilkan di dalam pengurangan pelepasan formaldehid (FE). Salah satu kaedah yang telah digunakan adalah mengubahsuai kimia UF resin dengan menggunakan *hardener*. Objektif utama kajian ini adalah untuk mengkaji kesan ammonium sulfat dan sebatian amina sebagai *harderner* pada pelepasan formaldehid partikel terikat melalui perbezaan kepekatan UF resin. Dalam kajian ini, bahan-bahan mentah yang terdiri daripada serpihan kayu getah dan lima perbezaan kepekatan urea formaldehid (UF) telah digunakan untuk menghasilkan papan partikel iaitu 10%, 12% 14% dan 16%. Suhu digunakan adalah 180ºC dan masa mampatan adalah 4 minit. Hasilnya menunjukkan bahawa pelepasan formaldehid meningkat apabila kepekatan urea formaldehid (UF) meningkat. Kajian juga mendapati ketumpatan meningkat manakala kandungan kelembapan menurun apabila kepekatan urea formaldehid (UF) meningkat. Kajian ini juga menunjukkan peningkatan kestabilan dimensi dan sifat-sifat mekanik papan partikel. Bagi kepekatan urea formaldehid (UF), tiada perbezaan yang signifikan dalam sifat-sifat mekanikal tetapi terdapat perbezaan ketara dalam sifat-sifat fizikal.

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My Lovely Friends,

Whom always show me help and companion;

APPROVAL SHEET

I certify that this research project entitled **"Effects Of Ammonium Sulphate Hardener and Amine Compound On Formaldehyde Emission Of Particleboard Bonded At Varies Levels Of Urea Formaldehyde Resin''** by **Mohammad Waridwan Bin Wahab** has been examined and approved as a partial fulfillment of the requirements for the degree of Bachelor of Wood Science and Technology in the Faculty of Forestry, University Putra Malaysia.

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UF	Urea Formaldehyde
MUF	Melamine Urea Formaldehyde
FE	Formaldehyde Emission
MC	Moisture Content
TS	Thickness Swelling
WA	Water Absorption
IB	Internal Bonding
MOE	Modulus of Elasticity
MOR	Modulus of Rupture
EMC	Equilibrium Moisture Content

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Particleboard is an engineered wood that is manufactured from wood chips and synthetic resin or other suitable binder which is pressed. It's also known as a structural material that was made from wood particles, such as chips, shavings or even sawdust that are mechanically pressed into sheet form and bonded with or without resin. Particleboard basically has multipurpose uses especially in housing materials because its specially design for interior use of substrate applications including furniture, shelving, cabinets, flooring, table, counters, office drivers, wall and ceiling, and other industrial products. (Nemli et al, 2007). Besides that, particleboard has good thermal and sound absorption properties, processing performance and low density. Therefore it becomes one of the most popular wood based composite material in the world.

Urea formaldehyde (UF) is significantly used in the production of wood-based panels especially particleboard due to good bonding properties and low prices. UF is a resin that have solid, semi-solid, or pseudo solid organic material that has an indefinite and often high molecular weight usually has a softening or melting range and usually fractures conchoidally. However, UF applications have several disadvantages such as lack resistance of water and emission of formaldehyde vapors. Thus, it created health problems such as irritation of the eyes and upper respiratory tract and allergic reactions on the skin. (Nemli G

2006). Besides that, it is realized that formaldehyde has a cancer-causing impact on human healthy. Therefore, the reduction of free formaldehyde contents from composite wood has become a very important issue. Many studies have been done in order to reduce formaldehyde emission from particleboard. Based on previous studies, it was reported that the addition of formaldehyde scavenger can reduced formaldehyde emission from wood-based panels. (Pizzi A et al 1994, Tohmura S et al 2001). It is also can be reduced by changing the manufacture conditions that lead to changing the physical and mechanical properties of particleboards. In this study, hardener and amine compound acted as formaldehyde scavenger are used to aid the reactions between the woodchips and the UF resin.

1.2 Problem Statement and Justification

The uses of urea formaldehyde (UF) in the manufacturing of particleboard possess great disadvantage such as emission of formaldehyde which are irritation in the upper respiratory tract and combustion in the eyes. Therefore, regarding to this matter several methods have been successfully develop in the reduction of formaldehyde emission (FE). One of the method that has been used is called as a formaldehyde scavenger. These methods can restrains and decreases the liberation of formaldehyde content from wood based panels produced with formaldehyde based resins. Formaldehyde reactive chemicals penetrate the boards leading to a tremendous decrease in the formaldehyde

release of the boards as much as 50% of emission (Roffael, 1993). However incorporation of formaldehyde scavenger into UF resin might affect the resin curing system and subsequently reduces the properties of the particleboard. But, the incorporation of polyamine (secondary and tertiary amines) into UF improving the durability and stability and also the reaction with formaldehyde can reduced the amount of emitted formaldehyde and at the same time can act as curing agent to facilitate the curing rate and hence the properties of particleboard. Thus it has high potential to use primary amine compounds to enhance the physical and mechanical properties of the particleboard as well as reducing the formaldehyde emission. Primary amount compound primary amine compounds (propylamine) will be used as formaldehyde scavengers in this study.

There is another method to reduce formaldehyde emission by modifying the chemistry of UF resin by using hardener (ammonium sulfate). Hardener also called as curing agent is added into UF resin to speed up polymerization. Meanwhile the excessive amount of hardener use in the production will release formaldehyde emission because of the reacted hardener with the UF and it also called as formaldehyde scavenger Therefore, ammonium sulphate will be used as hardener in this study.

1.3 Objectives

The main objective of this study is to study the effects of ammonium sulphate hardener and amine compound on formaldehyde emission of particleboard bonded of varies level of UF resin.

The specific objectives of this study are:

1. To evaluate the effects of ammonium sulphate as hardener in UF-bonded particleboard.
2. To evaluate the effectiveness of add in propylamine as mean to reduce the formaldehyde emission of particleboard.

REFERENCES

Abdul Khalil, S. and H. Rokiah. 2005. *Komposit Panel Berasaskan Kayu*. Penerbit Universiti Sains Malaysia, Pulau Pinang.

Akers, L. E. 1966. *Particleboard and Hardboard* (1st Edn.). Pengamon Press.

Haygreen, J.G., and J.L., Bowyer. 1982. *Forest Product and Wood Science: An Introduction* (1st ed.). Lowa State University Press.

Izran, K., A. Zaidon, A.M. Abdul Rashid, F.H. Abood and M.J Saad *et al*., 2009. *Fire apropagation and strength performance of fire retardant-treated hibiscus cannabinus particleboard*. Asian Journal of Applied Sciences

Izran, K., A., Zaidon, G.Beyer, A.M. Abdul Rashid and F. Abood *et al*., 2010. *Optimizing treatment system for kenaf (hibiscus cannabinus) particleboard treated with free retardants.* Journal of Tropical Forest Science.

Jarusombuthi, S., N. Ayrilmis, P. Bauchongkol and V. Fueangvivat, 2010. *Surface characteristics and overlaying properties of MDF panels made from thermally treated rubberwood fibers*. Journal of Bioresources.

Loh, Y.W., P.S. Hng, S.H. Lee, W.C. Lum and C.K. Tan, 2010*. Properties of particleboard produced from admixture of rubberwood and mahang species.* Asian Journal of Applied Sciences.

Maloney, T. M. 1977. *Modern Particleboard and Dry-Process Fiberboard Manufacturing*. Hal Leonard Corporation

Marutzky, R. and B. Dix, 2004. *Adhesive related VOC- and formaldehyde emissions from wood products: Tests, regulations, standards, future developments.* In: Proceedings of the COST E34 Conference, Innovations in Wood Adhesives.

Moslemi, A. A. 1974. *Particleboard*. Southern Illinois University Press.

Nelms, L.H., M.A.Mason, and B.A.Tichenor 1986. *The Effect of Ventilation Rates and Product Loading on Organic Emission Rates from Particleboard*. Conference paper

Nemli, G., and A. Aydin. 2007. *Evaluation of the physical and mechanical properties of particleboard made from needle litter of Pinus pinaster Ait.* Industrial Crops and Products. CRC Press.

Nemli, G., I. Aydin and E. Zekovic. 2006. *Evaluation of some of the properties of particleboard as function of manufacturing parameters.* Building Environment 41.

Nemli. G.. Ozturk, I., 2006. *Influences of some factors on the formaldehyde content of particleboard.* CRC Press.

Pizzi A. 1994 . *Advanced Wood AdhesivesTechnology*, CRC Press.

Roffael,E. 1993. Formaldehyde release from particleboard and other wood based panels Kuala Lumpur.

Tang, X., Y. Bai, A. Duong, M.T. Smith, L. Li and L. Zhang. 2009. *Formaldehyde in China: Production, Consumption, Exposure Levels, and Health Effects.* Environment International 35.

Tohmura S., A. Inoue, S.H. Sahari. 2001. *Influence of the Melamine Content in Melamine-Urea-Formaldehyde Resins on Formaldehyde Emission and Cured Resin Structure*. Journal of Wood Science.

Yang, T.H., Lin, C.J., Wang, S.Y., Tsai, M.J., 2007. *Characteristics of particleboard made from recycled wood-wasted chips impregnated with phenol formaldehyde resin.* Building Environment 42.

Yong, L. L. 2008. *Strength Properties of Particleboard Manufactured from Rubberwood and Kenda Fiber Blends.*

Zaidon, A. 1995. *A structure and properties of rattan in relation to treatment with boron preservatives.* Ph.D Thesis, University of Aberdeen, Scotland, UK.

Zaidon, A., A.M. Norhairul Nizam, A Faizah, M.T. Paridah and H. Jalaludin et al., 2007. *Efficacy of pyrethroid and boron preservatives in protecting particleboards against fungus and termites.* Journal of Tropical Forest Sciences.

Zaidon, A., A.M. Norhairul Nizam, M.Y. Mohd. Nor, F. Abood and M.T. Paridah et al., 2007. *Properties of particleboard made from pretreated of rubberwood, EFB and Rubberwood-EFB Blend.* Journal of Applied Sciences.

Zaidon, A., Paridah, M.T., Sari, C.K.M., Razak, W. & Yuziah M. Y. N. 2004. *Bonding characteristics of Gigantochloa scortechinii.* Journal of Bamboo and Rattan.

Zanetti, M. and A. Pizzi. 2004. *Dependance on the adhesive formulation of the upgrading of MUF particleboard adhesives and decrease of melamine content by buffer and additives.* Holz als Roh –und Werkstoff 62(6).