Fabrication and Physical Testing Compressed Durian Fiberboard

A. Watanapa and W. Wiyaratn

***Abstract*—The objective of this study was to development free-formaldehyde compressed fiberboard from durian fiber and polyvinyl alcohol for use in building. Polyvinyl alcohol has the ability as binder because of good adhesive properties and film forming. It is relatively environmentally friendly. The durian fiber/ polyvinyl alcohol ratios from 2% polyvinyl alcohol to 4% by weight, and its properties i.e. water absorption and swelling thickness were examined following JIS A5905-1994. The compressed durian fiber boards were carried out by hot compress at pressure 15 ton and a temperature of 150 °C with total pressing was 12 min. Our results show that the optimum ratio between durian fiber with polyvinyl alcohol is 1:4 (by weight), and 4% for alkyl ketene.**

***Index Terms*—Durian fiber, AKD, polyvinyalchol, particleboards.**

I. Introduction

With rapid development of furniture manufacturing and building construction, the shortage of wood resources is in concerned. The wood-based substitute materials such as medium density fiber board (MDF), particleboard, natural material is required for construction material instead of wood, steel. Therefore, biomass has been highly promoted as an alternative resource for wood-based substitute materials, several studies revealed new substitutes for wood particles, using lignocelluloses fibers such as coconut shell, coconut coir, saline jose tall wheatgrass, sawdust of bamboo, durian mixture coconut [1]. Thus, natural fibers have shown a great potential for use in building. Moreover they are interesting due to low cost, reduced waste in aquiculture, and saving energy.

Durians are abundant in Thailand and are popular in the world. However the peels of durians are abandoned that caused of environmental pollution. Some research works have been studied in durian peel and other aquiculture such as coconut for composites material in building and insulation particleboards via hot compressed process with urea-formaldehyde (UF) as binder [1]-[4]. In additional, new durian compressed fiberboards have been produced from durian's fiber for compressed fiberboards were mixing-latex as binder instead of UF [5]. The durian's fiber-latex composites to form compressed fiber boards can be achieved by hot compression processing that no volatile of formaldehyde contaminated in environment. The particleboards free UF is good for furniture production, material in house or office. Another point of health care is low risk to disease in breathe system or known as sick building syndrome (SBS). Moreover, this particleboard is suite in gym floor and children playground because of latex properties. Another good advantage of compressed durian fiberboards was low-thermal conductivity. Therefore these materials can be utilized as insulator. In this work, it aims to continually develop the compressed durian's fiber boards with other binders such as poly vinylalchol, which is expected to have better properties than using latex. Polyvinyl alcohol has attractive properties with excellent film forming, emulsifying and adhesive properties. It is odorless, nontoxic and has high tensile strength, flexibility. As a good properties of polyvinyl alcohol should not release the toxic organic volatile to environment. Thus, in this work, we preliminary report studies on the proportional mixture ratio of durian fiber and polyvinyl alcohol as binder and physical properties of compressed durian fiberboards have been examined.

Manuscript received June 27, 2012; revised September 28, 2012.

The authors are with the Production Technology education, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi, Thailand (e-mail: anucha.wat@kmutt.ac.th, wisitsree.wiy@kmutt.ac.th).

II. Experimental

A. Material

Fresh peel durians were collected from many provinces in Thailand. Sodium Hydroxide (NaOH) was purchased from Merck. Silica oxide was purchased from Evonik industries. AKD was received from SCG and Azadirachtin was (40%) was commercial grade. Polyvinyl alchol and titanium dioxide were purchased from sigma and Aldrich.

B. Preparation of Compressed Fiber Board

Fresh durian peels were chopped and dried under sunlight then the dried peels were boiled with 0.63 M sodium hydroxide in pressure pot for 10 hr and controlled the pressure in the range 40-40 psi after that the durian fibers have been received. Next the durian fibers were washed dried, washed and put in an oven for reduce moisture. From the previous research it found out that the proportional mixing of durian's fiber and latex was 3:1 by weight, 40% asadilactin of durian fiber, 30% silica of latex and 4%AKD of durian fiber [5]-[6]. So in this experiment of compressed durian fiber, the fiber was selected at same ration between the proportional mixing of durian's fiber and latex. The polyvinyl alcohol was used instead of latex and the ratio varying of polyvinyl alcohol from 0- 4% of durian fiber has been investigated. After mixing durian's fiber, chemical substance, polyvinyl alcohol, the mixture was placed into rotary drum mixer. The mixture was then hot compression to form durian compressed fiberboards at pressure 15 ton and a temperature of 150 °C with total pressing was 12 min. Finally,

the compressed durian fiberboard was coated with lacquer mixed titanium dioxide at 0.4 % of durian fiber. Durian compressed fiber board samples were pre-conditioned at 25°C for 24 h to adjust the moisture before testing the physical and mechanical properties. The compressed durian fiberboard samples were shown in Fig. 1.

C. Characterization

For water adsorption and thickness swelling, durian compressed fiberboards were cut into 50×50×0.5 mm^3, and soaked in water lower 20 mm, room temperature for 24 h. Compressed fiberboard thickness and weight were measured before and after 24 h of water immersion according to JIS A5905-1994.

Fig. 1. Durian compressed fiber board.

III. Result and Discussion

A. Effect of Polyvinyl Alcohol on Water Absorption Property

Table I shows the water absorption properties of compressed durian fiberboard filled with varying polyvinyl alchol from 2%,3% to 4% wt ratio, 30% silica of polyvinyl alchol , and 4% asadilactin of durian fiber. The water absorption was 181.91, 160.28, and 143.71 ,repectively, while compressed durian fiberboard without polyvinyl alchol could not be formed because of no binder. The water absorption significantly decreased when polyvinyl alchol content increased. Presence of polyvinyl alcohol could have positive effect on molding the compressed durian fiberboard. From the experiment ratio between durian fibers mixed with polyvinyl alcohol 4%wt, the lowest water absorption property of compressed durian fiberboard was observed.

TABLE I: Water Absorption Property of Compressed Durian Fiber Boards Mixed with Polyvinyl Alcohol.

	Percentage of polyvinyl alcohol			
Compressed Durian fiberboard mixed polyvinyl alcohol	0	2	3	4
Water absorption	-	181.91	160.28	143.71

B. Effect of Polyvinyl Alcohol on Swelling Thickness Property

Table II shows the swelling thickness of compressed durian fiberboard filled with varying polyvinyl alchol from 2%,3% to 4% wt ratio, 30% silica of polyvinyl alchol , and 4% asadilactin of durian fiber. The decreasing of swelling thickness was observed when polyvinyl alchol increased from 2 to 4% wt. The swelling thickness was 30, 27.45, and 20.69 ,repectively. The trend of swelling thickness of compressed durian fiberboard was quite similar to water absorption property. Absence polyvinyl alchol as binder, molding of compressed durian fiberboard has not achieved. Durian fibers mixed with polyvinyl alcohol at 4%wt were successfully used.

TABLE II: Swelling Thickness Property of Compressed Durian Fiber Boards Mixed with Polyvinyl Alcohol.

	Percentage of polyvinyl alcohol			
Compressed Durian fiberboard mixed polyvinyl alcohol	0	2	3	4
Swelling thickness	-	30.00	27.45	20.69

C. Physical Property

With the optimum experiment, the physical properties of compressed durian fiberboard and compressed durian fiberboard without polyvinyl alcohol as binder are shown in Table III.The specific gravity, and density are similar to MDF ,whereas the moisture content are a little higher than MDF. It is noticed that the compressed durian fiberboard was high particle boards (high density) so have less space and void than compressed durian fiberboard without polyvinyl alcohol (low density) that effected to water adsorption and thickness swelling properties. Comparing the water adsorption and thickness swelling of durian compressed fiberboards to MDF, the results show are higher than MDF. These results were expected to binder, porous, void among the fibers that was observed in many of natural fiber composites.

TABLE III: Property of Compressed Durian Fiber Boards.

Physical properties	MDF	Compressed durian fiberboard With latex [5]	Durian fiberboard with polyvinyl alcohol
Specific gravity	0.79	0.70	0.80
Moisture content (%)	5.46	4.12	8.52
Density (g/cm^3)	0.84	0.74	0.80
Water absorption (%)	9.17	109.38	105.50
Swelling thickness (%)	9.13	49.05	45.58

IV. Conclusion

A compressed durian fiberboard was fabricated and

examined the properties. The compressed durian fiberboard fabricated with hot compressing was developed based on as friendly material in building. In the study, polyvinyl alcohol was binder, the optimum compressed durian fiberboard are obtained with a mixture ratio of durian fiber with polyvinyl alcohol is 1:4 (by weight), and 4% for alkyl ketene dimmer. The experiment results showed that addition of polyvinyl alcohol can significantly improve physical properties. Therefore using polyvinyl alcohol as binder to produce the compressed durian fiberboard is possible and more interesting.

ACKNOWLEDGMENT

The authors wish to thank Assoc Prof. Vanchai Laemlaksakul, Department of Industrial Engineering Technology, King Mongkut's University of Technology North Bangkok for providing facilities.

REFERENCES

[1] P. Lertsutthiwong, S. Khunthon, K. Siralertmukul, K. Noomum, and S. Chandrkrachang, "New insulating particleboards prepare from tissue paper manufacturing and corn peel," *Bioresource Technol.*, vol. 99, no. 5, pp. 4841-4854, July 2008.

[2] Z. Pan, A. Cathcart, and D. Wang, "Properties of particle boards with rice bran and polymeric methylene disphenyl diisocyanate adhesives," *Ind Crops Prod*., vol. 23, no. 1, pp.40-45, January 2006.

[3] J. Khedari, S. Chavoenvai, and J. Hirunlabh, "New insulating particlesboards from durian peel and coconut coir," *Build Environ*., vol. 38, no. 3, pp.435-441, March 2003.

[4] J. Khedavi, N. Nankongnab, J. Hirunlab, and S. Teekasap, "New low-cost insulation particlesboards from mixture of durian peel and coconut coir," *Build Environ*., vol. 39, no. 1, pp. 59-65, January 2004.

[5] W. Wiyaratn, A. Watanapa, and T. Phothitontimongkol, "Properties of fiberboard from durian composite with latex and alkyl ketene dimmer," *J. Eng Appl Sci*., vol. 7, no. 1, pp. 67-71, January 2012.

[6] J. Busum, T. Ouppatum, W. Suksri, N. Rodchdroen, W. Wiyaratn, A. Watanapa, and N. Tipsotnaiyana, "Study natural material from durian and latex for using in Industry," in *Proc*. 2009 *IE net work conf*., pp. 157-157, 2009.

A. Watanapa was born in Thailand. He graduated bachelor degree in production engineering, at King Mongkut's University of Technology Thonburi, Thailand , material engineering in mater degree at, King Mongkut's University of Technology Thonburi, Thailand and and PhD in learning innovation at Mongkut's University of Technology Thonburi, Thailand. He published fundamental of metal forming, ISBN978-616-08-0203-6: SE-ED, and engineering drawing2nd, Bangkok: McGraw-Hill, 2010. He is lecturer at Production Technology education, faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi, Thailand. The current and previous research is focused on material field.

W. Wiyaratn was born in Thailand. she graduated bachelor degree in food process engineering, at Changmai University , Thailand , biotechnology in mater degree at, King Mongkut's University of Technology Thonburi, Thailand and and PhD in environmental technology at Mongkut's University of Technology Thonburi, Thailand. She is lecturer at Production Technology education, faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi, Thailand. The current and previous research is focused on fuel cell, material and plant layout field.