High Density Polyethylene Powder as a Binder in Coconut Pulp Particleboard Compared with Urea-Formaldehyde

Montip Lawsuriyonta*, Chuntip Kumnuantip, Tawatchai Meekeaw, Siriwan Pheansila, Suwadee Longsaman

Department of Materials and Metallurgical Engineering, Faculty of Engineering, Rajamangala University of Technology Thanyaburi, Thanyaburi, Pathumthani, 12110

E-mail: montipl@yahoo.com*

Abstract

This research was focused on the high density polyethylene (HDPE) powder as a binder compared with urea-formaldehyde in coconut pulp particleboard. In the first step, the researcher was varied the ratio of coconut pulp and high density polyethylene (HDPE) powder compared with urea-formaldehyde. It was mixed each formulas with the external mixer. Then, hand sprayed of urea-formaldehyde in coconut pulp, also hand sprayed the high density polyethylene (HDPE) powder in coconut pulp layer too.All the samples were shaped into tested specimens by a compression molding machine. The samples were characterized for their mechanical properties (impact resistance, flexural test, and hardness test) and the physical property (water absorption).

The results of experiment was found that, when increased the ratio of urea-formaldehyde and high density polyethylene (HDPE) powder, the mechanical properties were increased, but in the same time, the physical property was decreased.

Keywords: coconut pulp, urea-formaldehyde, high density polyethylene (HDPE) power, particleboard

1. Introduction

Particleboard is a wood-based board product manufactured under pressure and temperature using wood particles or other lignocellulosic materials and a binder. It is widely used in the manufacture of furniture, floor underlayment, cabinets, stair treads, home constructions, tabletops, vanities, speakers, sliding door, lock blocks, interior signs, displays, table tennis, pool tables, electronic game consoles, kitchen worktops, and work surfaces in offices, educational establishments, laboratories and other industrial products. [1]Accelerated deforestation and forest degradation, in addition to a growing demand for wood-based boards, have raised an important issue regarding the sustained supply of raw material to the above sectors for a long time. [2] Consequently, there is a need for alternative resources to substitute wood raw material. Therefore, researchers, both in industry and academic, are looking for new sources of lignocellulosic materials. Alternative fibers such as agricultural residues and non-wood plant fibers could play a major role in providing the balance between supply and demand for the manufacturing of composite panels such as particleboard [1].

Amongst agriculture production, coconut is in the beginning number of the export agriculture product from Thailand. Coconut is the main by-product from cereal harvesting and often is used as fuel, cattle feed, mulch, and bedding materials for animals [3].

Particleboard performance is mainly related to the properties of adhesive used and its compatibility with wood. Several types of resins have been used to produce wood-based particleboard. The most widely used resins are urea-formaldehyde (UF) and phenol-formaldehyde (PF) resins [4]. However, in addition to the possible environmental problem resulting from the toxic formaldehyde emissions of UF and PF bonded particleboard [5], these resins have very poor bondability (adhesion) with straw [4-6]. The inherent nonpolar and hydrophohic characteristics of straw surface due to silica and wax components are not compatible with the polar and hydrophilic nature of the UF and PF resins [2]. Therefore, there have been some attempts to used modified UF and PF resins[7-11].

The aim of this research was reduced urea-formaldehyde adhesive in particleboards, the researcher tried to look for the appropriate adhesive to replace urea-formaldehyde.

2. Materials and Method

2.1 Coconut pulp was supplied by Heng Ake Seng Co.,Ltd. Samut-Prakarn province Thailand, that was sieved as follow by ASTM standard sieve (ASTM C136-96a (2001).

The average size of the coconut fiber particles used in this work was in the range of 30-100 mash.

The sieved coconut pulp was dried in an oven at 80°C for 6 hours before used, and the moisture is 0.5% then coconut fiber particles were chemically untreated and the amount of the coconut fiber was varied.

2.2 High Density Polyethylene (HDPE) powder was supplied by Leng Seng Co., Ltd. Thailand, that was sieved with 30-100 mash and in this study used only which was pass through 100 mash the average size of the HDPE powder particles used in this work was less than 100 mash.

2.3 Urea-formaldehyde for adhesive was supplied by Eternal Resin Co.,Ltd. Thailand, grade EU-607-02.

2.4 The mixing agent, in this study, the researcher was used the cooking oil (for general cooking oil from the convenient store).

Table 1. shown the ratio of coconut pulp and HDPE power.

Coconut Pulp (%)	HDPE Powder (%)
60	40
65	35
70	30
75	25

(I) The Blending Procedure of Coconut Pulp and HDPE Powder

HDPE is the powder, the researcher had to drop the cooking oil 2% into HDPE powder for lubricate, then dry-blended with coconut pulp by using the mixer machine (WiseStir company,.Ltd.) before transferring into a compression molding machine (Lab Tech Engineering company,. Ltd.). The compressing temperature, heat time, cooling time and pressure were set at 190°C, 7 min, 5 min, and 120 kg/m^2, respectively. The compression mold size is 20x20 cm^2.

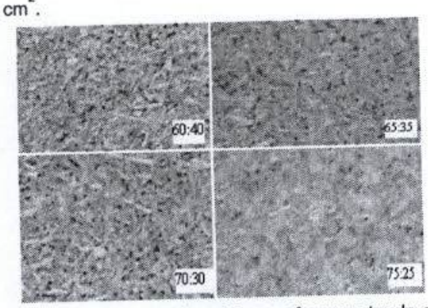


Fig 1. Shown the samples pictures of coconut pulp and HDPE powder in varied ratio.

Table 2. shown the ratio of coconut pulp and urea-formaldehyde.

Coconut Pulp (%)	Urea-Formaldehyde (%)
85	15
88	12
90	10
92	8

(II)The Blending Procedure of Coconut Fiber and Urea-Formaldehyde

Coconut pulp was mixing by the mixer machine, WiseStir Co.,Ltd. in speed of 1000 round/min, when the researcher was mixing the coconut pulp then they was spay the urea-formaldehyde by syring (medical syring 10 cc.), before transferring into a compression molding machine (Lab Tech Engineering company, Ltd.). The compressing temperature, heat time, cooling time and pressure were set at 150°C, 5 min, 6 min, and 120 kg/m^2, respectively. The compression mold size is 20x20 cm^2.

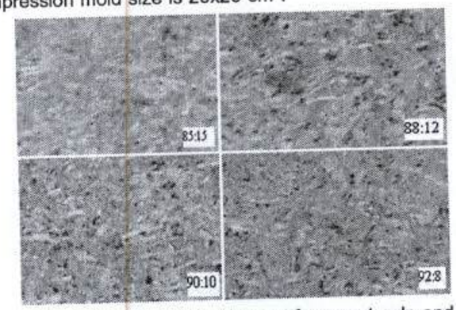
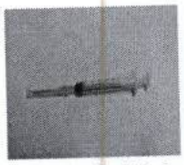
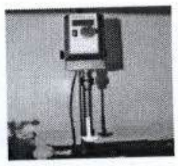


Fig. 3. Shown the samples pictures of coconut pulp and urea-formaldehyde in varied ratio.



(a) The Medical Syring



(b) The Mixer Machine

Fig, 4. Shown the equipment and the machine for mixing the samples.

3. Results and Discussion

Water Absorption Test was conducted according to ASTM D570. The results was shown in Figure 5and 6.

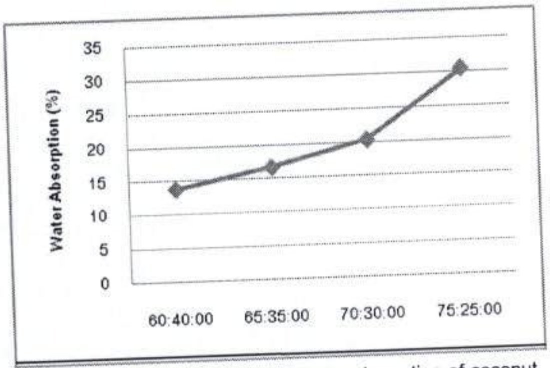


Fig. 5. Shown the percentage of water absorption of coconut pulp and HDPE powder.

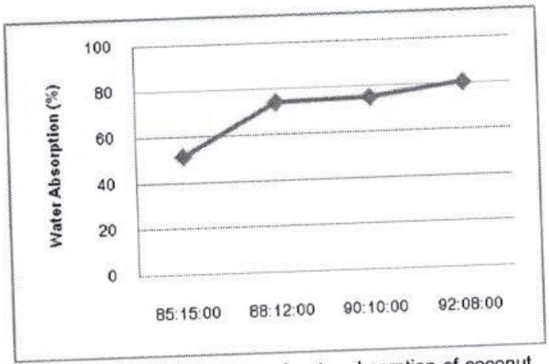


Fig. 6. Shwn the percentage of water absorption of coconut pulp and urea-formaldehyde.

The percentage of water absorption of coconut pulp and HDPE powder, with coconut pulp and urea-formaldehyde were found that, when load more HDPE powder and urea-formaldehyde the results are decreased. The HDPE powder is non-polar and it is compatibility with coconut pulp.

In the other hand, the structure of cellulose is hydrophobic, it's easy to absorbed the water.

Flexural Test was conducted according to ASTM D790. The flexural modulus were shown in Figure 7and 8.

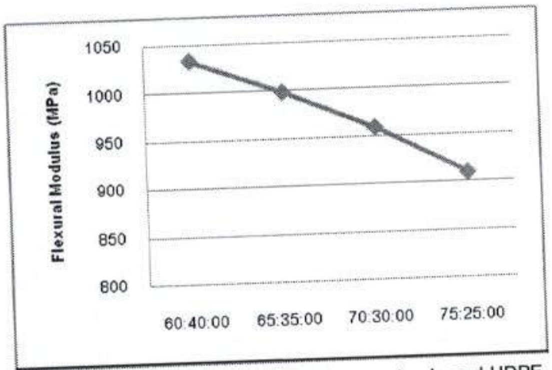


Fig.7. Shown the flexural modulus of coconut pulp and HDPE powder.

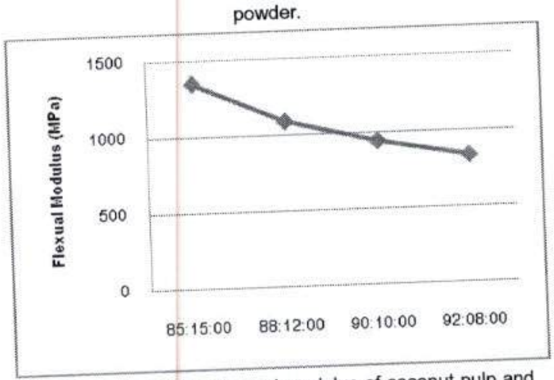


Fig. 8 was shown the flexural modulus of coconut pulp and urea-formaldehyde.

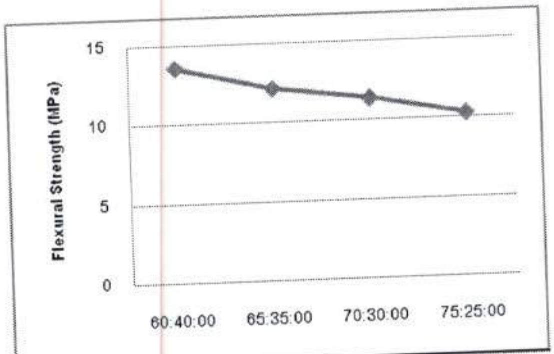


Fig. 9. Shown the flexural strength of coconut pulp and HDPE powder.

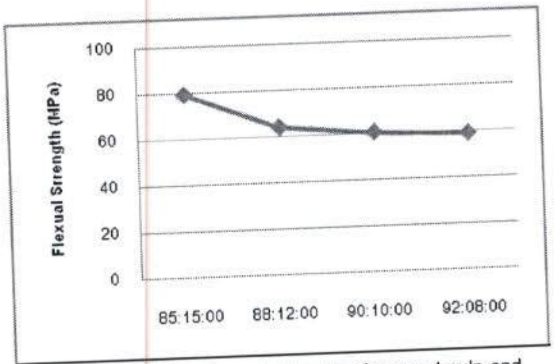


Fig. 10. Shown the flexural strength of coconut pulp and urea-formaldehyde.

The flexural tests were increased when load more of HDPE powder, and in the same as urea-formaldehyde. That can explain: HDPE powder and urea-formaldehyde are added for binder, that can glue phase by phase of coconut fiber. For urea-formaldehyde had higher flexural test than HDPE powder because of urea-formaldehyde structure is the rigid structure and HDPE powder is the flexible plastic.

Impact Resistance Tests was conducted according to

ASTM D256 were shown in Figure 11 and 12.

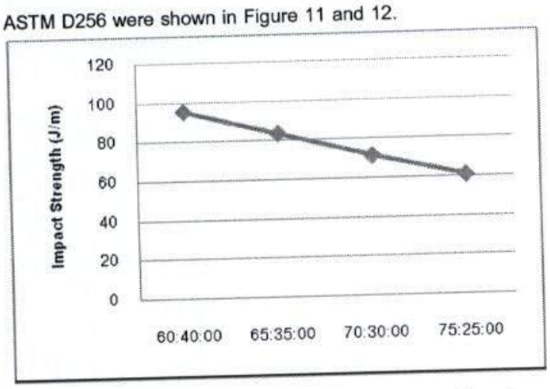


Fig. 11. Shown the impact strength of coconut pulp and HDPE powder.

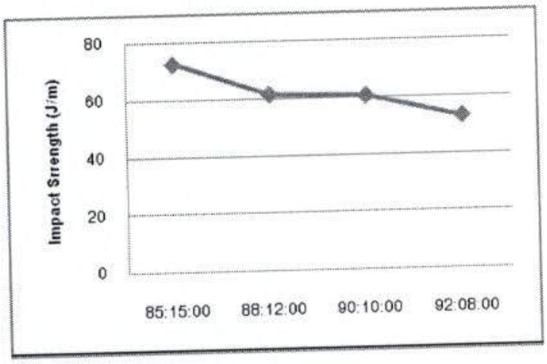


Fig. 12. Shown the impact strength of coconut pulp and urea-formaldehyde

When load more HDPE powder and urea-formaldehyde in coconut pulp were increased the impact strength results, HDPE powder and urea-formaldehyde act as a binder to the pulp. But the impact strength results of coconut pulp and HDPE powder is higher than the results of coconut pulp and urea-formaldehyde because of in the temperature room, urea-formaldehyde is the glassy state and the HDPE is the rubber state.

Hardness Tests was conducted according to ASTM D2240 Shore D were shown in Figure 13 and 14.

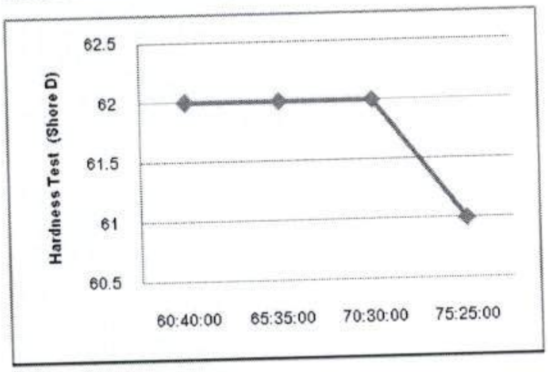


Fig. 13. Shown the hardness test shore D of coconut pulp and HDPE powder.

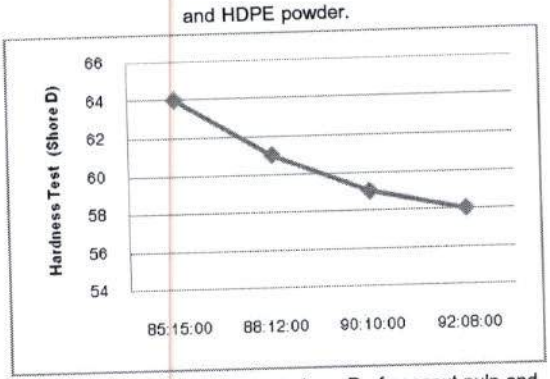


Fig.14.Shown the hardness test shore D of coconut pulp and urea-formaldehyde.

The results of hardness test shore D between coconut pulp with HDPE powder and coconut pulp with urea-formaldehyde are not different results when load more coconut pulp.

4. Conclusion

By increasing HDPE powder or urea-formaldehyde loading in coconut pulp, the flexural test, impact test, and hardness test were increased. But in the other way, the water absorption was decreased. From the results HDPE powder and urea-formaldehyde can be as a binder in particleboards but depend on the users, because of the properties of HDPE powder and urea-formaldehyde are different results in different ways.

5. Acknowledgments

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6. References

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