A Development of Laminating Mulberry Paper by Biodegradable Films

S. Ithisoponakul[1], A. Memon[2], S. Pramoonmak[3], L. Montip[4] and P. Nateechai[5]

***Abstract* —** Nowaday, the ecological friendly products were meditated. The product from mulberry paper mean the invention from the mulberry paper and might have composing inventory other for apply the advantage, such as, general wares, use be of decorate. Process education to laminate the mulberry paper with biodegradable films was the procedure that help to develop usability mulberry paper format has the varieties, correspond to the development the modernity products and green products. In this research, the laminating machine was design and construct. It has size 98 x 118 x 126 centimeter. The machine composed of the roller driver and the infrared heater. The laminate film was pull by roller driver. It passed the latex glue and infrared heater. It was coat on the mulberry paper by the rubber roller that compress laminate film contact with the paper. The results obtained as the follow. The best laminating was shown at speed 3.72 m/min. The biodegradable film had thickness 0.04 μm and tensile strength was 40.22 MPa. Tensile strength of normal mulberry paper was 37.07 MPa, after laminated it was 79.14 MPa. The laminated mulberry paper was more attractive, strengthening, also protected water or humidity to decline them. The product from this process had smooth surface easily to screen printing and clean out the dirt.

Keyword— **Biodegradable plastic films, Mulberry paper, Laminating of mulberry paper, Latex glue, Laminating machine**

1. INTRODUCTION

The mulberry paper was hand-made paper as shown in figure 1. Many product were used mulberry paper as main structure or used for decorated them. Now a day, mulberry papers were developed in many styles for made products as lantern, packaging, book cover, decoration product, office equipment etc,. Mulberry paper may decorate or reinforce by fiber of leafs and dried flowers, make it colorful and more attractive. Mostly, this paper was declined by water, humidity and light. Those environment make them had short life time and unattractive. One choice to improve this problem is laminating this paper by plastic films. They have good strength, transparent and high temperature used.

This research aimed to develop the widely use of mulberry paper for produced modern products and evironment friendly. After laminated, this paper had higher strength, more glossy, water and humidity proofed, smooth surface and protected dirt to decline them. Thus, we can design and develop many products from these laminated papers.

Dry laminate was the process to combine 2 materials together by adhesive. The first step, adhesive was coated on first materials and half dry the layer of adhesive by appropriate temperature. In the next step first materials and half dry layer were laminated with the second materials by roller. This process can used with many type of films and adhesive.

Figure 1 Mulberry paper

Biodegradable films are plastics that will decompose in natural by composting and landfill in environments. Biodegradation of plastics can be achieved by enabling microorganisms in the environment to metabolize the molecular structure of plastic films to produce an inert humus-like material that is less harmful to the environment. They are plastics whose components are derived from renewable raw materials. Biodegradable films are recently-developed eco-friendly alternative made of corn starch.

Therefore, in this research interested to laminate mulbery paper by biodegradable films to enhance the usage of it and ecologically friendly materials. The dry laminate was the fabricate technique and Latex glue was used as adhesive.

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Anin Memon, et al. [1] designed a prototypr laminating machine size 0.45 x 0.9 x 0.8 meter for laminate the matters by cellulose-propionate films and used Latex glue as adhesive. In this research used the matter from inject printing process because this process was wildly used in printing and suitable for infinitesimal matter, also had low cost and faster. The matter was printed on coated and uncoated papers 210 gram, size 297 x 420 millimeter (size A3). The laminating use temperature 160 ^{o}C for half dry latex glue, laminating speed was 45 second per sheet. The results obtained as the follows. The matter durable to scratched than non laminate matter. After dropped water on laminate matter, it could protect the color of matter as its original and the paper was not swell. The density tests of color in inject ink found the different 0.11% between laminated and non-laminated mater, test by Densitometers. This process could protect the evaporation of the water base ink, which keep colorful of the matter.

Wutinant Kongtud, et al. [2] studies physical properties of Thai hand-made paper from saa and rice straw pulp were studied. The ratio between saa pulp and rice straw pulp used in this experiment were 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100. Methods according to TAPPI standard were used for analysis of the resulting paper physical properties and the results showed that the most appropriate ratio of saa pulp and rice straw pulp was to be 70:30. It was indicated that paper obtained from this ratio can be used as substitute of 100 % saa paper for handicrafts and packaging. Its physical properties were as follows: basis weight 64.23 g/m2. thickness 0.286 mm, density 0.224 g/cm3, brightness 78.88%, tensile index 27.76 Nm2/g, stretch index 3.63%, smooth index 11.38 sec, folding endurance 112 times, burst index 3.08 kPa.m2/g and tear index 588.22 mN.m2/g.

Somchai Maneewan [4] studied the physical properties of mulberry paper according to international organization for Standardization (ISO) and attempted to standardize the mulberry paper obtained from the north of Thailand. The mulberry papers from three sources were examined, including the mulberry paper from: Ban Naluang, Wiangsa, Nan; Ban Sanian, Muang, Nan; and ban Yang, Nachornthai, Phitsanulok. It was found that the maximum tensile strength for the dry mulberry paper was 16.811 kN/m. After the immersion in water, the maximum tensile strength was 1.089 kN/m. The water absorpveness was 3.500 g or 462 %. The basic weight, tickeness and density were 127.590 g/m^2, 0.372 mm, and 383.821 kg/m^3, respectively.Thus, it is concluded that the physical properties of the mulberry paper are appropriate to replace the imported celpads.

2. MATERIALS AND EXPERIMENTAL

The mulberry papers used for this research had size 55 x 75 centimeters. It was hand-made paper from small and micro community enterprise (SMCE), Song district, Phare, Thailand. In this research used mulberry paper with out decoration as shown in figure 1. The laminating machine was design and construct. It has size 98 x 118 x 126 centimeter as shown in figure 2. The machine composed of the roller driver and the infrared heater. The laminate film was pull by roller driver. It passed the infrared heater and coat the mulberry paper by the rubber roller that compress laminate film contact with mulberry paper. The laminate film was biodegradable films from Advance Packaging Co.,Ltd. as shown in fig 3. It was produced from bio-plastic resin without any polyethylene component, 100% biodegradable by biological process or compost, flexible, soft and durable.

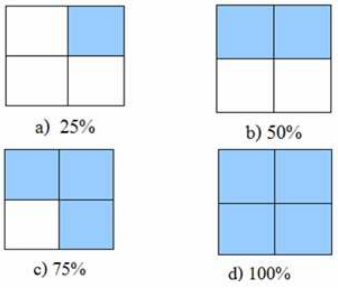
Figure 2 Laminating machine for Laminated mulberry paper

Figure 3 biodegradable films from Advance Packaging Co.,Ltd

The biodegradable film was coated by latex glue and half dry by infrared heater. Feeding speed of mulbery paper was measured by Sino meter model DT5236B. Coated half dry film was compressed on mulberry paper by compression from rubber roller. The latex glue will spread out over paper and film was laminated on them. The tensil strength which conducted according ASTM D882 with a tensile tester as shown in figure 4. The sample was cut size 2 x 10 centimeter. Each value obtained represented the average 5 samples. The ability of laminated was measure by used the 660 tables on plastic sheet as shown in figure 5.

Figure 4 Tensile tester

a) Table for measure the ability of laminated



b) The percentage of lminated

Figure 5 The testing chart for ability of laminating

3. Results and Discussion

Laminated mulberry paper was glossy and more attractive, strengthening, also protected water or humidity to decline them. The product from this process had smooth surface easily to clean out the dirt. The percentage of laminating ability versus feeding speed were shown in figure 6. The slow feeding speed shown low percentage of laminating ability and slightly increase when speed higher. The speed between 2.21-3.72 m/min was the appropriated speed. The best laminating was shown at speed 3.72 m/min. It was shown the slighly decrease when speed faster than 4.46 m/min.

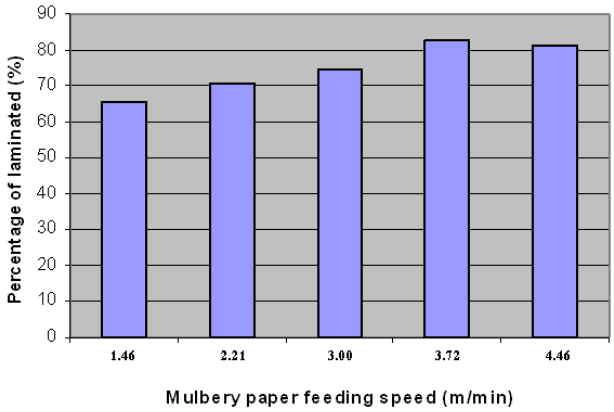


Figure 6 The laminating ability of mulbery paper

The tensile strength of un-laminate and laminated mubery papers were shown in figure 7. Biodegradable films 0.04 μm had tensile strength 40.22 MPa. Tensile strength of normal mulberry paper was 37.07 MPa, after laminated it was 79.14 MPa. Their tensile strength was increase due to biodegradable films was laminatd on mulbery paper as reinforcement. The tensile specimens after test were shown in figure 8.

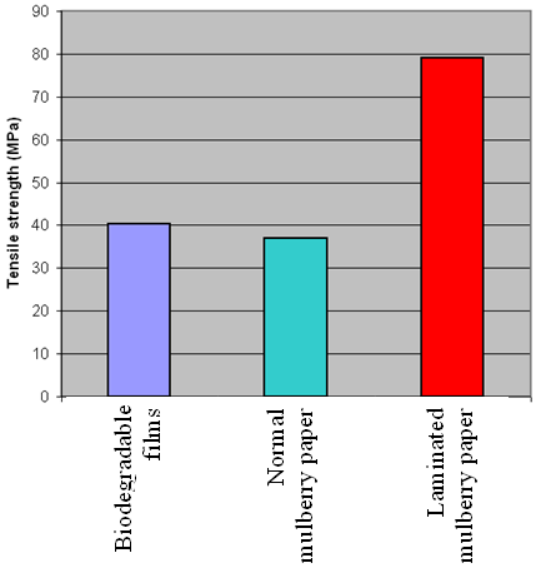
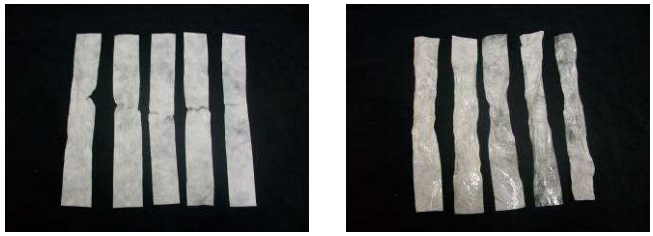


Figure 7 The tensile strength of mulbery paper



a) Un-laminated reinforcement mulberry paper

b) Laminated reinforcement mulberry paper

Figure 8 Tensile test specimens

4. CONLUSION

The laminating biodegradable films on mulberry paper by latex glue was developed the usage for multifunction, widely used and representation as eco-friend product. The experimental constructed laminating machine size 98 x 118 x 126 centimeter. The best laminating was shown at speed 3.72 m/min. The biodegradable film had thickness 0.04 μm and tensile strength was 40.22 MPa. Tensile strength of normal mulberry paper was 37.07 MPa, after laminated it was 79.14 MPa. The laminated mulberry paper had smooth surface and more attractive, strengthening, also protected water or humidity to decline them. The product from this process had smooth surface easily to screen printing and clean out the dirt. The machine could be apply to laminated biodegradable films on the other natural papers. Figure 9 shown sample products note book using banana paper laminated biodegradable films.

Figure 9 Sample of products used biodegradable laminated on banana paper

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References

[1] Anin Memon, Somsak Itthisophonakul, Sirichai Torsakul, Ekachai Tholuang and Janprapa Poungsuwan, **Laminating for Publishing in Non Impact Printing by Latex Glue**, 2nd Conference on Sustainable Community Development at Khon Kaen University, 29-30 January 2008 : p296-302.

[2] Wutinant Kongtud, Warunee Thanapase, Vichai H. Thanasan, Chaiyaporn Sampoompuang, and Pirun Srinuan, **Physical properties of Thai hand-made paper from saa and rice straw pulp for handicrafts and packaging**, Kasetsart Agriculture and Agro-Industrial Product Improvement Institute, Kasetsart University.

[3] Somchai Maneewan, **Investigation of Physical properties of mulberry paper for evaporative cooling system**, Naresuan University Journal 2007;15(2) : p63-67.

[4] Roongaroon Watthanawong and Supawadee Tewasano, 1997, 4th, **Printing materials**, Printing house of Sukhothai Thammatirat Open University, Nonthaburi.

[5] Supawadee Tewasano, 1997, **Post-Press Techniques**, Printing house of Sukhothai Thammatirat Open University, Nonthaburi.

[6] Bristow, J., and Kolseth, P., 1986, **Paper Structure and Properties**, New york: Marcel Dekker Inc.

[7] J.H. Briston and L.L. Katan, 1990 **"Plastics Films"**, Longman Singapore publishers (Pte) Ltd., Singapore.