MANUFACTURING OF PARTICLEBOARD FROM PAPER MULBERRY (*BROSONATIA PAPYRIFERA*) WOOD

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Abstract

Particleboards with densities of 0.60–0.70 g/cm^3 were manufactured from Paper mulberry (*Brosonatia papyrifera*) wood having specific gravity of 0.50. Boards were bonded with urea-formaldehyde resin glue. Mechanical properties (MOE, MOR, IB strength and screw-withdrawal resistance) and dimensional stabilities (Thickness swelling, water absorption and Linear expansion) of the boards were determined. Mechanical properties of boards of paper mulberry increased with board density. The boards with density 0.66 g/cm^3 have better dimensional stability than those with the density lesser or greater than this value.

Introduction

Brosonatia papyrifera is a medium deciduous tree, 3 to 12m in height. It is a native tree of Japan, South East Asia and China. In Pakistan it is successfully planted and established in the plains and hills. It has become a weed in Islamabad and measures are being taken to eradicate it as it is an allergen causing cold, sneezing and cough. It is a low density wood with high growth rate. The sapwood is grayish white and the heartwood is light brown in colour. The wood is straight grained and coarse textured (Sheikh, 1993).

Different grades of particleboards have woody raw material choice basing upon their density and specific gravity. Technically, low wood density is the deciding factor to utilize the wood species for this purpose. Since the low density wood species can be compressed into medium density particleboard for achieving enough bonding strength due to the maximum inter-particle contact during pressing. Particleboard is a wood substitute provided it offers properties good enough to cater the varying end uses (Carre, 1974). Wood density is considered the most important species variable that affects the particleboard properties. In general the board properties are inversely related to the density of wood species. Lower density woods will give panels of desired specific gravity and superior strength properties than that of higher density wood species (Vital, 1975).

In this study paper mulberry wood was selected because of its lower density and availability to find out its suitability for the manufacture of resin bonded

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particleboard, standardize manufacturing parameters as well as to determine the optimum board density possible to be achieved.

Materials and Methods

Procurement of raw material

A ten year old tree of paper mulberry was harvested on the campus of Pakistan Forest Institute, Peshawar. Only the branches and under size stem pieces with a minimum diameter of 6 centimeters were used as wood raw material.

An aqueous suspension of urea formaldehyde condensate having solid content 60% was used as binding material for manufacturing of the particleboards.

Wood Particle Preparation

The wood was converted into blocks and soaked in water to achieve moisture content above the fibre saturation point (Fischer, 1972). The wood was converted into 0.30 mm thick particles by using German made "small shredding machine μK–20". The particles generated by the machine were dried to 7-9 percent moisture content and then screened by passing through 1-½ inch mesh wire and then through ½ inch mesh wire. Those retained on the smaller wire mesh were classified as acceptable particles. Fine and oversized particles were discarded.

Test panels manufacturing

5 replicate panels with target densities 0.60, 0.62, 0.64, 0.66, 0.68 and 0.70-g/cm^3 were made from the particles blended with liquid urea formaldehyde resin glue to 8 percent resin solid (based on oven dried wood weight). The blended material was spread into a mat in a wooden framing device manually. The mat was pressed in a hydraulic press at pressing temperature of 140°C. Pressing time was 10 minutes to closing against ½ inch stop.

Evaluation of Test Panels

Test specimens were made in accordance with the standard procedure (ASTM D1037-78) to evaluate modulus of rupture (MOR), modulus of elasticity (MOE), internal bond (IB), face screw withdrawal (FSW) and edge screw withdrawal (ESW), thickness swelling (TS) and water absorption (WA) after soaking in water and linear expansion (LE) with change in moisture content.

Results and Discussion

The mechanical and hygroscopic properties for each independent variable

(board density) of paper mulberry particleboard were evaluated. The results were statistically analyzed and reported in terms of mean, standard deviation and coefficient of variation.

Mechanical Properties

Table 1, shows the results of mechanical properties of varying density particleboards. All particleboards with density ranges from 0.60 to 0.70-g/cm3 exceeded the minimum values of MOR, MOE, IB, and FSW and ESW requirements for 1-M-3 grade particleboard (ANSI A208.1-1979).

Table 1. Strength properties of varying density particleboards made from paper mulberry wood.

Parameters Measured	Density g/cm^3						
	0.60	0.62	0.64	0.66	0.68	0.70	Std. Req
Modulus of rupture (psi)							
Mean	4145	4250	4478	4615	4765	4951	2400
SD[a]	93	136	63	53	60	106	
CV[b]	2.2	3.2	1.4	1.1	1.3	2.1	
Modulus of elasticity (10^3 psi)	410	427	435	442	452	466	400
Mean	15.2	11.9	16.1	13.9	12.2	8.6	
SD	3.7	2.8	3.7	3.2	2.7	1.8	
CV							
Internal bond (psi)							
Mean	110	114	117	119	124	127	80
SD	3.0	2.4	2.8	3.0	4.0	5.3	
CV	2.7	2.1	2.4	2.5	3.2	4.2	
Screw withdrawal (lbs)							
Face	276	281	290	299	307	317	250
Mean	5.4	3.6	4.8	10.5	5,8	5.8	
SD	2.0	1.3	1.7	3.5	1.9	1.9	
CV							
Edge							
Mean	240	245	252	260	268	276	200
SD	6.0	8.6	7.2	5.1	6.2	5.3	
CV	2.5	3.5	2.8	1.9	2.3	1.9	

aSD = Standard deviation
bCV = Coefficient of variation

Comparison of mechanical properties of varying density particleboard

indicates that the highest average values were obtained from panels with density 0.70 g/cm^3 and the lowest from the panels with density 0.60 g/cm^3 whereas other panels stood in order in between. It was also investigated that in case of paper mulberry board, delamination took place when board density was increased beyond 0.70 g/cm^3.

Hygroscopic Properties

The results shown in Table 2 and Figure 1 indicated that an increase in board density ultimately reduced the thickness swelling and water absorption after both 2 and 24 hours water soaking periods, but opposite trend was observed for panels with density 0.68 and above.

Table 2. Thickness swelling, water absorption and linear expansion of varying density particleboards made from paper mulberry wood.

Parameters Measured	Density (g/cm^3)						
	0.60	0.62	0.64	0.66	0.68	0.70	Std. Req.
Thikness swell. (%)							
2 hour							
Mean	5.2	4.9	4.6	4.3	4.4	4.5	-
SD[a]	0.13	0.16	0.25	0.18	0.14	0.1	
CV[b]	2.5	3.3	5.4	4.2	3.2	2.0	
24 hour							
Mean	20.6	18.4	16.9	15.4	17.0	18.0	-
SD	1.0	0.49	0.54	0.77	0.58	0.56	
CV	4.9	2.7	3.2	5.0	3.4	3.1	
Water absorpt. (%)							
2 hour							
Mean	17.4	14.4	11.0	8.6	8.9	11.1	-
SD	0.65	0.82	0.85	0.67	0.80	0.72	
CV	3.7	5.7	7.7	7.8	8.9	6.5	
24 hour							
Mean	36	31	28	26	27	29	-
SD	1.9	1.4	1.4	1.6	1.3	1.9	
CV	5.4	4.8	5.3	7.4	4.8	6.3	
Linear expansion(%)							
Mean	0.51	0.48	0.45	0.39	0.42	0.43	0.35
SD	0.01	0.007	0.01	0.006	0.008	0.01	
CV	2.1	1.5	2.4	1.5	1.9	2.2	

aSD = Standard deviation
bCV = Coefficient of variation

Fig.1. Effect of board density on thickness swelling of paper mulberry board

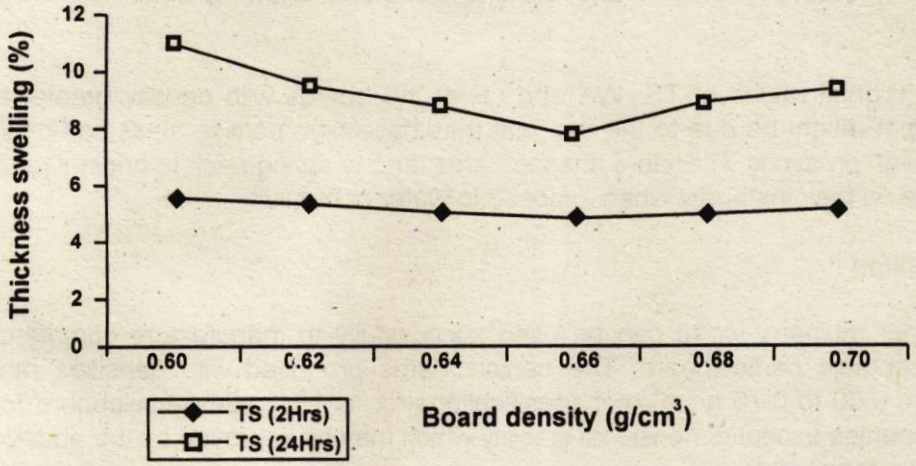
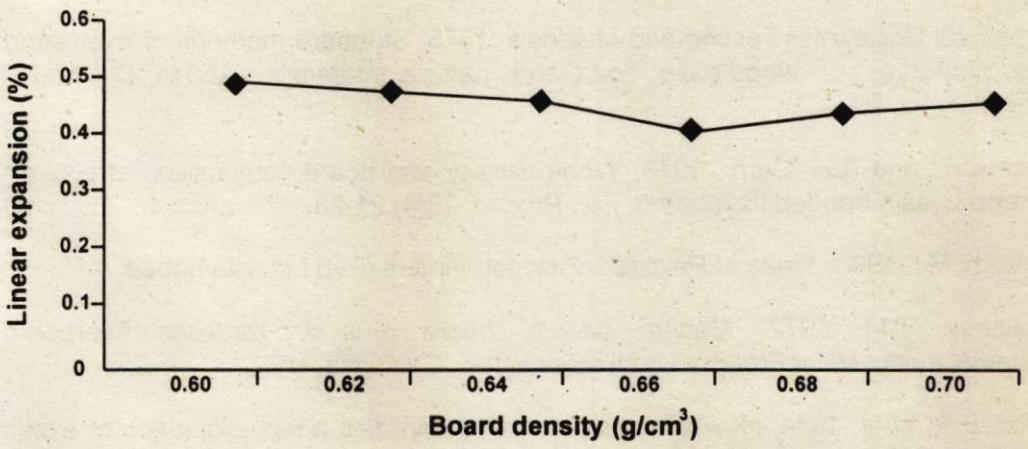


Fig.2. Effect of board density on linear expansion of paper mulberry board



Linear expansion (LE) with change in moisture content also showed the same trend as shown in Figure 2. LE was minimum for a board with density of 0.66 g/cm^3. but did not exceed the minimum standard requirement.

Based on the results it appears that the boards of density 0.66 g/cm^3 had minimum value of TS, WA and LE and therefore, showing better dimensional stability.

Higher values of TS, WA and LE of the boards with density greater than 0.66 g/cm^3 might be due to the fact that they have high particle mass compressed under high pressure. Therefore, these boards tend to spring back to original position to make up their instability when exposed to water or humidity.

Conclusion

- Paper mulberry wood can be used successfully to manufacture commercially acceptable particleboard. The particleboards produced with densities ranges from 0.60 to 0.70 g/cm^3 met specifications for 1-M-3 grade particleboard for all properties except dimensional stability which may be improved by the addition of water repellents.
- The optimum value of mechanical properties as well as dimensional stability of the board can be achieved when the board density is 0.66 g/cm^3.

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