Studies on press drying-part I-A preliminary note on press drying of standard test sheets made from short fibred chemical pulp

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ABSTRACT

In this preliminary study on the effect of press drying techniques on sheet properties prepared from lightly beaten bamboo *(Thyrostochys oliverii)* chemical sulphate pulp have been described. Wet couched sheets were press dried under different temperatures (i.e. at 105°C, 115°C and 153°C) and time 30 seconds and 60 seconds) keeping other conditions constant. The results show that press drying is a suitable process for the consolidation of sheet. This process will produce a sheet similar to that preduced by conventional process at same level of freeness.

INTRODUCTION

In conventional process of manufacture of paper, the sheet forming fibers are suspended in water. The pulp suspension contains 99.5 to 99.8 percent water as it approaches the forming wire. This huge quantity of water is removed in steps by mechanical means like free drainage, surface tension of table rolls, wiping action at the deflectors, sustion at flat boxes and suction couch The wet sheet after couching is subjected to pressing or squeezing before starting the more expensive method of water removal by evaporation.

Removal of water from the sheet is mainly affected by nature of fibre surface and temperature of water suspension besides other variables. Less beating and higher temperature decrease resistance to flow of water through the fiber mat. Mason (1) invented a process called "Press drying process" for simultaneous removal of water and drying of sheet, but the process remained confined to building board made from coarse pulps.

In press drying, the temperature of the wet web is raised above 100°C while the sheet is still in pressing stage. At such elevated temperature the compressibility of the moist sheet is increased owing to plastisization of some of its components which leads to enhanced consolidation.

Press drying(2), in its simplest terms is the removal of water from a pressed web of paper while that web is simultaneously restrained in its length, width and thickness. Such restraint results in natural polymer flow and greater conformability of the fibres, thus, enhancing the interfibre bonding. Thin walled fibres subjected to a compressive force, collapse easily, thus, greatly enlarging the contact surface areas, increasing bonded areas and developing strong bonds. This is also the case with softwoods fibres or low yield hardwood fibers High yield hardwood fibre on the other hand are stiff and thick walled. When subjected to a sufficiently high compressive force they also flatten out, but they show a spring back action on release of pressure. This results in reduced contact areas between fibres, and reduces strength properties. Effect of press drying of non-woody thin walled fibres has not been studied as yet, and no literature is available.

In this preliminary laboratory study on press drying process the effect of temperature, pressure and time of pressing on physical strength properties of standard test sheets made from unbleached bamboo (Thyrostochys oliverii) sulphate pulp has been studied.

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EXPERIMENTAL

Preparation of pulp and standard test sheets

Unbleached bamboo (Thyrostochys oliverii) sulphate pulp was prepared in bulk. The pulp was cleaned before use. The kappa number of the pulp was 16.0.

The pulp was beaten in valley beater to 400 ml (CSF). Standard test sheets were made on British sheet making machine. The sheets were evaluated for their physical strength properties according to 1≃S≃O methods. The results are recorded in Table—I.

Table—1

1.	Apparent density,	g/cm³	= 0 60
2	Tensile index,	Nm/g	=39.11
3.	Burst Index,	KPam²/g	= 2.53
4.	Tear index,	mNm²/g	=13.29
5.	Porosity,	sec./100ml	= 4.2
6.	Sheet dryness after Couching,	%	—22.4
7.	Sheet dryness after pressing,	%	—67.6

Beaten Pulp was stored for preparation of standard test sheets for press drying studies.

Press drying of standard test sheets

In press drying process it is necessary that sheet on one side should be in contact with a hot surface while the other should be in contact with porous surface so that steam could escape through. To accomplish this, steam heated hydraulic press was used and the sheet was press dried using the following arrangements.

Standard sheets were prepared from the already beaten pulp (400 ml CSF) on British Sheet making machine and after couching were taken for press drying experiments. Simultaneously, glazed plate, standard blotters, wire mesh (old paper machine wire of 65 mesh aluminium plate were placed in the hot press so that they attain the temperature at which press drying was to be carried. For press drying standard test sheet stuck on standard blotter after couching was placed on the hot wire mesh and a hot glazed plate was placed over the test sheet as shown in Figure-1. The couched sheets was having about 77.0 per cent moisture. The sheets were subjected to press drying. After the period of press drying, pressure was released and each sheet with the blotter and glazed plate was removed. This process was repeated on ten standard test sheets for each set of conditions. After each condition of press drying, dryness in sheet was also determined, after immediately removing the sheet from the glazed plate and transfering the sheet in a weighning tube. The press dried sheets were then conditioned under standard conditions (65% RH and 27°C±1°C) and were evaluated for physical strength properties. Results of studies on process valiables are recorded in Tables II, III, & IV.

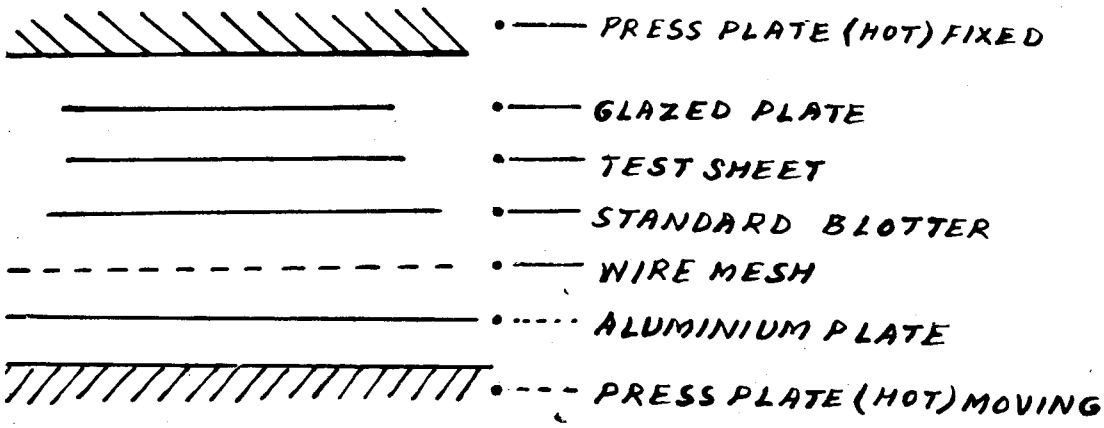

FIG. I.

Table—II

Effect of temperature on press drying of bamboo pulp sheet at 400 ml (CSF)

Pressing time — 30 seconds
Intensity of pressure — 56.90 kg/cm²

Press Temp. °C	PROPERTIES				
	Apparent density g/cm³	Sheet dryness %	Tensil index Nm/g	Tear index mNm²/g	Burst index KPam²/g
105	0.74	71.4	38.73	12.11	2.53
115	0.65	96.3	39.07	11.58	2.50
153	2.55	99.5	33.98	13.89	2 01

Table—III

Effect of pressure on press drying of bamboo pulp sheet at 400 ml (CSF)

Pressing time — 30 seconds
Press temperature — 115°C

Intensity of Pressure kg/cm²	PROPERTIES				
	Apparent density g/cm³	Sheet dryness %	Tensiie index Nm/g	Tear index mNm²/g	Burst index KPa.m²/g
56.90	0.65	96.3	39.07	11.58	2.50
85.35	0.81	98.0	41.09	10.79	2.60
113.80	0.86	98.2	44.31	9.57	2.55

Table—IV

Effect of time on press drying of bamboo at 400 ml (CSF)

Press temperature — 115°C
Intensity of pressure — 56.90 kg/cm²

Pressing time, Sec.	PSOPERTIES				
	Apparent density g/cm³	Sheet dryness %	Tensile index Nm/g	Tear index mNm²/g	Burst index KP am²/g
30	0.65	96.3	39.07	11.58	2.50
60	0.83	98.6	38.60	10.42	2.42

Also standard test sheet were prepared in laboratory from bamboo pulp beaten to 250 ml CSF. The couched sheets were pressed and air dried by conventional process. Sheets were conditioned and evaluated for physical strength properties. Results of which are recorded in Table—V.

Table—V

Apparent density,	g/cm³	= 0.63
Tensile index,	N. m/g	=43.43
Tear index,	mNm²/g	=12 02
Burst index	KPam²/g	= 3.17
Porosity,	Sec./100 ml	=17.00

DISCUSSION

Pulp used in this study was beaten to 400 ml CSF instead of 250 ml CSF, which it generally used for preparation of standard test sheets, for the reason that sheet should remain more porous and while removing water by pressing and/or drying, water as such or as water vapours could escape easily. The porosity of the sheet prepared from pulp beaten to 400 ml and 250 ml are recorded in Table I and V. Further, earlier work by authors ([3]) has shown that reduction in any level of beating results in energy conservation during stock preparation.

EFFECT OF TEMPERATURE :

While studying the effect of temperature, the wet test sheets were hot pressed for 30 seconds/at pressure intensity of 56.90 kg/cm² and at three different temperatures. Results are recorded in Table—II.

As the temperature of wet sheet is increased from 105°C to 153°C, the apparent density of the sheet decreases from 0.74 to 0 55, with simultanous decrease in physical strength properties of the sheet. This indicates that at very high temperatures the fibre to fibre bonding decreases although compressive force and period of hot pressing were the same. This may be due to fast removal of water from the sheet before fibres got flattened to increase bonding surface. This is clear from the dryness data of press dried sheets. This is further confirmed by the data at 105°C where the apparent density has gone to 0.74 and physical strength properties of sheet are at their maximum. Further, at 115°C, although the apparent density was 0.65 the physical strength propertins are comparable to 105°C except tear. In commercial production sheet will take longer period to get press dried at 105°C ; hence for studying other variables a temperature of 115°C was used.

EFFECT OF PRESSURE

Intensity of pressure of 56.90, 85 35 and 113.80 kg/cm² were used at 115°C (Table-III). The results indicate that the apparent density of sheet increase in intensity of pressure (0.65 to 0.86 g/cm³). There is substantial improvement in tensile index (39.07 N.m/g, to 44.31 N.m/g) with the increase in intensity of pressure applied, where as no improvement is observed in burst index. The tear index on the other hand decreases with increase in intensity of pressure Tear index[4] is mainly dependent on fibre length. Since in press drying the length factor not affected, the decrease in tear (20—30 percent) may be attributed to other factors, such as fibre bonding and intrihsic fibre strength.

EFFECT OF TIME

Results of press drying sheet for 30 and 60 second recorded in Table-IV show that by doubling the period of press drying, although the apparent density of the sheet increases from 0.65 to 0.83 g/cm³, but the prolonging press drying, the physical strength of the sheet deteriorates.

Comparison of data given in Table—I of conventional standard test sheets dried in air with press dried sheets indicate that at almost same apparent density (0 6 g/cm³ approx.) sheet of almost similar physical strength can be obtained by press drying process at some freeness level (400 ml CSF) except lower tear index. Similar observations have also been made by various workers([4]). Further on comparison of conventionally air dried sheets (Table—V) with press dried sheets of same apparent density, approximately, 0.6 g/cm³, results indicate that sheets made from pulp at 250 ml CSF and air dried are superior in physical strength properties particularly in bonding strength as compared to sheets made from pulp at 400 ml CSF and press-dried.

CONCLUSION

The preliminary study on the effect of press drying technique on sheet properties clearly shows that press drying process is a suitable process for consolidation of sheet. This process will produce a sheet similar to that produced by conventional process at same level of freeness, except tear index for which detailed studies are proposed for establishing the reasons. The studies carried out earlier by various workers confirm our findings on their index (1). Since this process will require less energy in stock preparation will eliminate wet press section and will also reduce the size of conventional drying section, detailed investigations are contemplated to optimize press drying conditions for chemical pulp obtained from various indigenous short fibred raw materials.

REFERENCES

1. Anthony J., Michell, Press Drying of Paper-An overview" Appita, Vol. 37, No. 4, 1984.
2. Setterholm and Koning, J.W. Jr., "Press dried paper", Appita, Vol. 37, No. 5, March, 1984.
3. Mathur, G.M., Mahajan, Unnikrishnan, K.P. and Sharma, Y.K. ; "Studies on sheet pressing-Part-I Effect of intensity of pressure during wet pressing on physical properties of standard test sheets made from short fibres", IPPTA, Vol. 24, No.3 (Suppt) Sept., 1987.
4. Law N. Knei and Koran, Zoltan, Effect of press drying on paper properties, Appita, Vol. 34, No.5 March 1981.