

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.

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SUMMARY

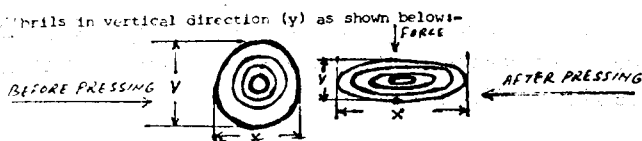
Laboratory experiments on wet pressing of standard laboratory test sheets, made from three short fibred furnishes, with varying intensities of pressure, have indicated that by reducing the beating and by increasing intensity of pressure during wet pressing, a sheet of equal or even higher physical strength can be obtained. Reduction in beating, besides saving energy significantly, helps in dewatering on sheet formers and in rate of removal of water during pressing.

With increase in freeness (C.S.F.) and increase in intensity of pressure the cost of evaporation of water during drying will also be reduced with simultaneous conservation of energy during the process of beating to produce a commercially acceptable sheet.

INTRODUCTION

Wet pressing, after formation of web of paper over paper machine wire, is a very important operation where the web is subjected to pressing action for removal of water. Besides, this during wet pressing development of strength in sheet also takes place due to consolidation of wet web.

Several workers^{1,12} have shown that wet pressing results in improvement of strength properties of sheet. During wet pressing of wet web of paper, fibres subjected to compressive forces perpendicular to the fibre axis. As a result of this, deformation of cell wall takes place in the horizontal direction (x) and packs the fibrils in vertical direction (y) as shown below:—



Deformation is dependent on anatomical structure of fibre degree of beating and wet pressing. Most of the studies relating to wet pressing are confined to conifers. No data is available on wet pressing of indigenous short raw materials.

During wet pressing, the wet web of paper is subjected to first increasing compressive forces and then decreasing pressure at paper machine presses. The pressure applied is opposed by the fibres to deform (recover) which is dependent on cell wall structure, shape and on degree of beating as well. Beating also reduces porosity and drainage rate. This effects ease of removal of water from sheet and increases rate of drying. In other words if a pulp is beaten less and pressed with higher intensity of pressure of removal of water will increase, production will increase and sheet produced may be equal or stronger than produced in normal set up.

Process of beating and/or refining of pulps prior to sheet formation is necessary as some minimum beating is essential to form a saleable sheet. Beating and/or refining consumes huge amount of power.

Workers¹³ in the field of wet pressing are in agreement that wet pressing can be substituted by reducing the degree of beating, which means saving of energy and better strength.

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In this investigation, efforts have been made to study in laboratory, if beating could be reduced by increasing the intensity of pressure during wet pressing to produce an equal or stronger sheet with special reference to indigenous short fibred furnishes commonly used in Indian Paper Industry. If this is possible, short fibres will give a better sheet than what we are producing today and paper makers will be able to increase production.

EXPERIMENTAL

I. Preparation of Pulp

Unbleached sulphate pulps were prepared from, Bamboo (*D. strictus*) Eucalyptus (*E. hybrid*) and from Mixed hardwoods (listed in appendix I). The pulps were cleaned and screened before further investigations in this study. Details of pulps are given below:—

	Degree of cooking		Average Fibre Dimensions	
	Kappa number	Fibre length mm	Fibre diameter mm	
Bamboo	22.4	1.65	0.012	
Eucalyptus	36.7	0.83	0.016	
Mixed hardwoods	31.1	1.04	0.020	

APPENDIX—I

List of the hardwoods from Middle Andaman Area used for preparing sulphate pulp

Sl. No.	Name of species
1.	Dipterocarpus spp.
2.	Parishia insignis
3.	Artocarpus chaplasha
4.	Diploknema butyracea
5.	Calophyllum spp.
6.	Neonauclea gageana
7.	Myristica spp.
8.	Polvalthia spp.
9.	Neonauclea gageana
10.	Semecarpus spp.
11.	Parishia insignis
12.	Knema spp.
13.	Diospyros spp.
14.	Diospyros spp.
15.	Erimycarpus racemosus
16.	Garcinia spp.
17.	Pometia pinnata
18.	Dehaasia Kurzii

All the above 18 species of wood were mixed in equal proportion on o. d. basis for pulping experiments.

II. Beating of Pulps

All the three pulps were beaten in valley beater according to Tappi Standard T 200 t-61. For each level of beating separate beating was done by taking virgin pulp sample. The pulps were first soaked in water overnight. After loading the beater with pulp, the pulp was dispersed for 15 minutes and thereafter standard pressure was given on bed plate. The time for beating and energy consumption was noted. Freeness after beating was determined. In case of unbeaten pulp, the dispersion of pulp was done in Valley beater.

III. Preparation of Standard Test Sheets

Standard test sheets of 60 g.s.m. were prepared in British Sheet making machine under standard conditions. After couching the sheets, they were pressed in an electrically operated hydraulic press for standard periods, i. e. for 5 minutes and 2 minutes, at varying intensity of pressures. During pressing in place of mirror polished stainless steel plates, sunmica plates of 0.65 mm thickness were used. Nine sheets were placed over a metallic plate with usual number of standard blotters and then covered with another metallic plate. The metallic plate was of the same size as that of press plates. At a time nine sheets from four different levels of freeness i. e. unbeaten, lightly beaten, well beaten and over beaten were pressed at a particular intensity of pressure.

After pressing, two sheets were immediately removed for determination of moisture content and seven sheets were dried in air using rings and plates. These sheets were used for evaluation of physical properties. The sheets were conditioned and evaluated for tear index, tensile index and burst index. Results in respect of each raw material are given in Table II, III & IV.

Standard test sheets at standard intensity of pressure (3.5 kg/cm²) were also prepared as a control. Results are given in Table—I.

STATISTICAL ANALYSIS OF RESULTS

The data emanated from the experiment viz., the values of tear index, tensile index and burst index calculated at various levels of freeness of the pulp for different intensity of pressures were statistically analysed.

TABLE—I

Results of pressing standard test sheets under standard conditions of
intensity of pressure (3.5 kg/cm)²

	Freeness ml (C.S.F.)	Apparent density g/cm ³	Tensile Index N.m/g	Tear Index m.N.m ² /g	Burst Index KPa m ² /g
Bamboo	690	0.49	33.727	12.61	1.02
	550	0.59	63.51	21.08	0.52
	400	0.62	71.91	19.59	4.79
	250	0.65	77.12	17.73	5.50
Eucalyptus	510	0.51	28.83	5.22	0.83
	400	0.57	40.34	5.60	1.77
	300	0.70	54.44	5.79	2.94
	205	0.76	61.26	5.87	3.70
Mixed hardwoods	550	0.50	20.30	4.50	0.49
	450	0.56	37.37	7.05	1.69
	355	0.61	48.47	7.81	2.45
	240	0.63	57.98	8.11	3.12

TABLE—II

Results of pressing standard test sheets at different intensities of pressure
prepared from Bamboo pulp

	Freeness of pulp ml (C. S. F.)	Intensity of Pressure Applied						
		10kg/cm ²	30kg/cm ²	60kg/cm ²	90kg/cm ²	120kg/cm ²	150kg/cm ²	180kg/cm ²
Apparent density g/cm ³	690 (Unbeaten)	0.27	0.48	0.57	0.61	0.62	0.64	0.66
	550 (Lightly beaten)	0.31	0.58	0.65	0.70	0.72	0.72	0.74
	400 (Well beaten)	0.49	0.60	0.70	0.71	0.74	0.74	0.76
	250 (Over beaten)	0.52	0.65	0.71	0.75	0.77	0.79	0.78
Tear Index m. N.m ² /g	690 (Unbeaten)	7.32	16.41	18.67	21.82	18.49	22.33	19.33
	550 (Lightly beaten)	24.06	20.94	20.58	22.40	20.85	17.70	17.93
	400 (Well beaten)	22.60	19.87	17.47	17.20	17.66	15.20	16.53
	250 (Over beaten)	19.32	16.83	15.85	14.30	16.40	17.39	15.45
Tensile Index N.m/g	690 (Unbeaten)	16.08	35.41	37.70	42.81	30.22	41.53	44.31
	550 (Lightly beaten)	46.37	57.93	61.64	71.95	61.31	68.01	71.76
	400 (Well beaten)	64.52	75.08	76.00	69.31	70.44	74.72	77.18
	250 (Over beaten)	68.69	84.70	78.29	89.10	81.54	84.13	83.04
Burst Index KPa m ² /g	690 (Unbeaten)	0.36	1.63	1.62	1.66	1.43	1.01	1.60
	550 (Lightly beaten)	2.72	3.52	3.29	4.57	3.66	3.99	3.97
	400 (Well beaten)	4.00	4.87	4.67	4.01	4.52	4.94	5.25
	250 (Over beaten)	4.81	5.95	5.35	5.58	5.38	6.05	5.67
Solid contents %	690 (Unbeaten)	52.18	60.86	64.32	73.20	74.01	76.49	74.07
	550 (Lightly beaten)	47.78	56.96	53.13	63.69	67.62	64.98	68.0
	400 (Well beaten)	41.70	52.48	56.56	64.49	65.81	70.96	68.11
	250 (Over beaten)	39.41	49.79	54.80	63.64	59.61	64.98	65.11

Results of Energy consumption during beating of Bamboo Pulp in Valley beater

Sl.No.	Degree of beating C. S. F.	Energy consumed in beating 360 g. (O.D) Pulp (K.W.H.)	Energy saved* (K.W.H.)	Percentage* saving
1.	Unbeaten (Disintegrated) 690 ml (C. S. F.)	0.05	—	—
2.	From 690 to 550 ml (C. S. F.)	0.02	0.025	11.1
3.	From 690 to 400 ml (C.S.F.)	0.225		
4.	From 690 to 250 ml (C.S.F.)	0.325	0.100	30.7

* To Obtain same or higher strength.

TABLE—3 III

Results of pressing standard test sheets at different intensities of prepared from Eucalyptus hybrid pulp

	Freeness of pulp, ml (C.S.F.)	Intensity of pressure applid						
		10kg/cm ²	30kg/cm ²	60kg/cm ²	90kg/cm ²	120kg/cm ²	150kg/cm ²	180kg/cm ²
Apparent density g/cm ³	510(Unbeaten)	0.34	0.53	0.70	0.71	0.80	0.77	0.81
	400(Lightly beaten)	0.35	0.63	0.75	0.80	0.83	0.81	0.86
	300(Well beaten)	0.48	0.72	0.79	0.82	0.86	0.87	0.88
	205(Over beaten)	0.59	0.74	0.82	0.88	0.93	0.91	0.91
Tea Index m.N.m ² /g.	510(Unbeaten)	2.86	4.40	5.46	5.27	5.83	5.99	5.90
	400(Lightly beaten)	4.09	5.28	5.91	6.14	6.20	6.39	6.43
	300(Well beaten)	6.35	6.61	6.84	6.49	6.39	6.46	6.62
	205(Over beaten)	6.91	6.74	7.31	7.46	6.49	6.42	6.64
Tensile Index N.m./g	510(Unbeaten)	17.77	24.09	41.56	42.67	48.11	42.63	48.91
	400(Lightly beaten)	26.27	36.34	49.28	53.90	52.87	55.85	55.66
	300(Well beaten)	47.69	54.78	55.02	61.48	64.23	66.31	63.19
	205(Over beaten)	51.49	58.97	67.40	70.79	71.06	72.36	62.80
Burst Index KPam ² /g	510(Unbeaten)	0.56	0.98	2.03	2.08	1.97	2.41	2.08
	400(Lightly beaten)	1.07	2.12	2.79	3.02	2.88	3.06	3.03
	300(Well beaten)	2.68	3.08	4.03	4.08	4.04	4.15	3.80
	205(Over beaten)	3.34	3.86	4.33	4.53	4.42	4.90	3.41
Solid Contents %	510(Unbeaten)	37.31	53.11	51.90	63.91	64.52	64.76	65.30
	400(Lightly beaten)	35.42	51.15	53.55	59.18	63.42	63.51	64.75
	300(Well beaten)	36.32	39.16	53.16	60.04	61.91	58.58	62.72
	205(Over beaten)	34.06	48.55	52.54	56.50	64.13	63.69	63.10

Results of Energy Consumption during beating of
Eucalyptus Pulp Valley beater.

Sl. No.	Degree of beating C.S.F.	Energy consumed in beating 360 g. (O.D.) Pulp (K. W. H.)	Energy Saved* (K. W. H.)	Percentage Saving*
1.	Unbeaten (Disintegrated) 510 ml. (C.S.F.)	0.05	—	—
2.	From 510 to 400 ml (C. S. F.)	0.10	0.10	50
3.	From 510 to 300 ml (C. S. F.)	0.20		
4.	From 510 to 205 ml.(C. S. F.)	0.25	0.05	20

*To obtain same higher strength

TABLE—IV

Results of pressing standard test sheets at varying intensities
of pressure made from Mixed hardwoods pulp.

	Freeness of pulp, ml. (C.S.F.)	INTENSITY OF PRESSURE APPLIED						
		10kg/cm ²	30kg/cm ²	60kg/cm ²	90kg/cm ²	120kg/cm ²	150kg/cm ²	180kg/cm ²
Apparent density g/cm ³	550(Unbeaten)	0.33	0.52	0.54	0.61	0.64	0.64	0.65
	450(Lightly beaten)	0.41	0.59	0.64	0.67	0.72	0.71	0.75
	355(Well beaten)	0.48	0.64	0.66	0.70	0.75	0.75	0.76
	240(Over beaten)	0.52	0.67	0.70	0.74	0.75	0.77	0.80
Tear Index m.N.m ² /g	550(Unbeaten)	2.93	4.75	5.62	5.81	5.58	5.52	5.47
	450 Lightly beaten)	6.13	6.68	5.46	8.06	7.16	6.97	7.61
	355 (Well beaten)	7.67	7.93	7.77	7.75	7.88	8.11	7.55
	240(Over beaten)	8.09	8.01	8.17	8.37	7.90	7.83	7.35
Tensile Index N.m/g	550 (Unbeaten)	11.53	24.46	22.08	29.94	29.55	27.63	70.87
	450(Lightly beaten)	26.33	39.09	43.23	43.43	43.00	43.95	45.57
	355 (Well beaten)	40.23	54.40	57.75	55.26	57.20	56.88	57.25
	240 (Over beaten)	49.27	58.90	60.66	61.03	60.87	63.27	61.21
Burst Index K.Pam ² /g	550 (Unbeaten)	0.07	0.73	0.86	0.97	1.02	0.96	1.09
	450(Lightly beaten)	0.83	1.76	1.73	2.17	2.17	1.90	2.44
	355(Well beaten)	2.07	2.92	2.81	2.89	2.97	3.35	3.04
	240(Over beaten)	2.48	3.37	3.19	3.26	3.62	3.51	3.76
Solid Contents %	550(Unbeaten)	27.67	37.85	46.19	35.47	41.47	44.70	48.58
	450(Lightly beaten)	38.28	36.31	40.98	37.38	40.55	46.16	49.12
	355(Well beaten)	29.73	34.15	35.94	35.74	40.43	43.10	46.67
	240(Over beaten)	32.71	31.11	33.12	32.74	35.57	40.61	42.78

Results of Energy consumption during beating of Mixed hardwoods pulp in Valley beater

Sl. No.	Degree of beating C.S.F.	Energy consumed in beating 360 g. (O.D.) pulp. (K.W.H.)	Energy saved* (K.W.H.)	Percentage saving
1.	Unbeaten (Disintegrated)	0.07	—	—
2.	From 550 to 450 ml. (C.S.F.)	0.10	}	28.6
3.	From 550 to 355 ml. (C.S.F.)	0.14		
4.	From 550 to 240 ml. (C.S.F.)	0.17		

*To obtain the same or higher strength.

The analysis was carried out for each level of freeness and for each species separately. The plotting of the raw data (by taking pressures along the X-axis and the properties along the Y-axis) suggested a curvilinear relationship between the characters in almost all the cases. Scrutiny of the data for possible elimination of outliers was also carried out. The cleaned data was further analysed using the computer to arrive at the

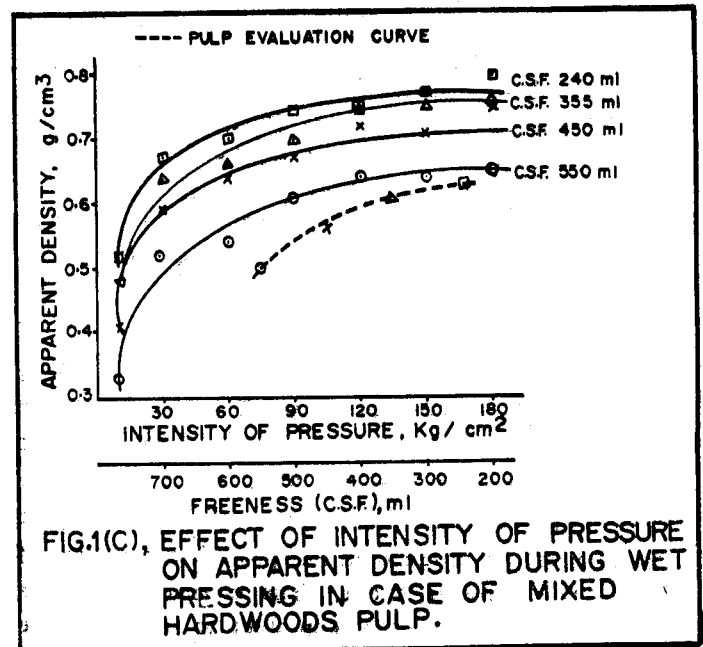
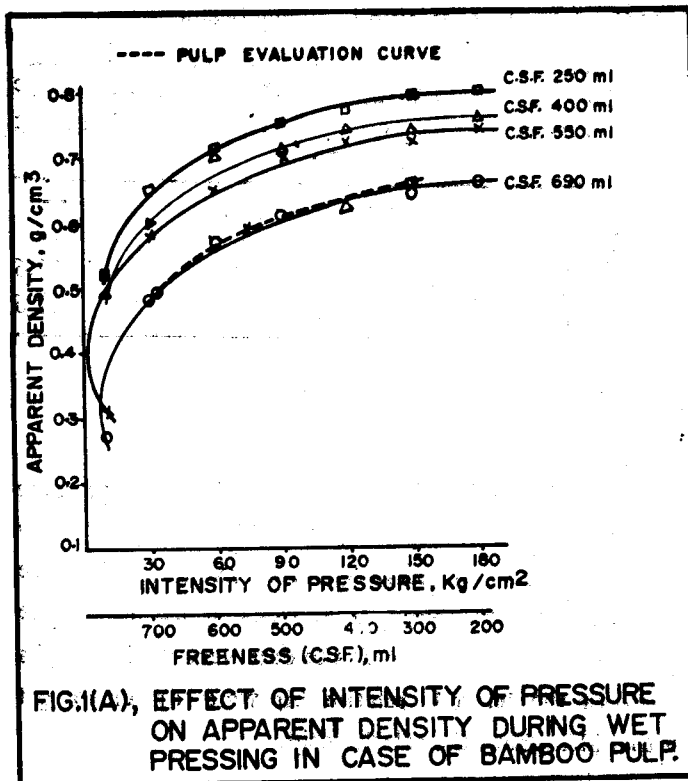
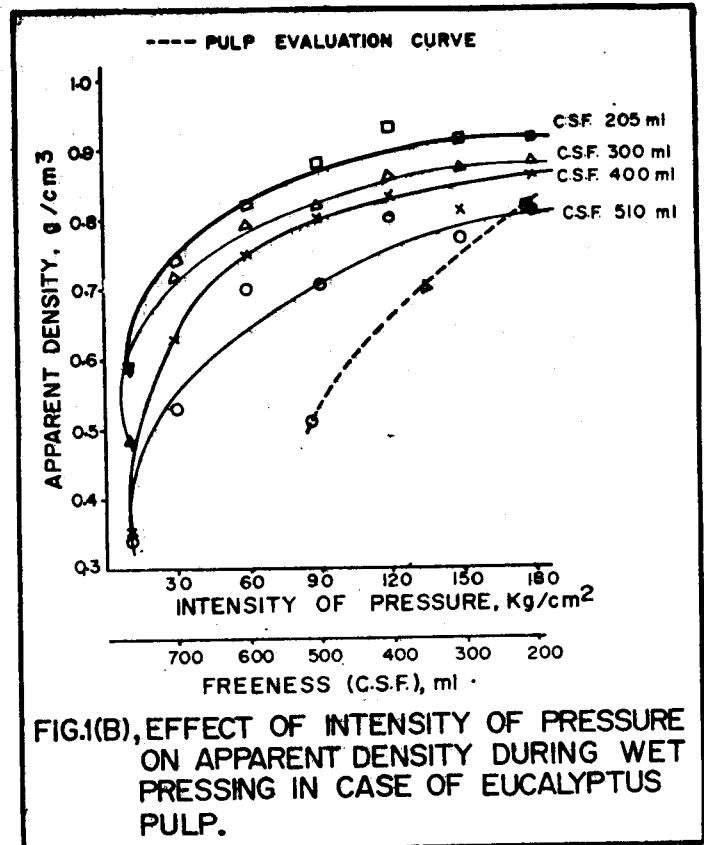
polynomial function that related the character pressure (taken to be the independent variable) and the study character viz., tear index, tensile index etc (taken to be the dependent variable). In all cases a second degree polynomial was found to fit the data very well. Graphs based on the derived relationship were drawn to get visual idea about the relationship.

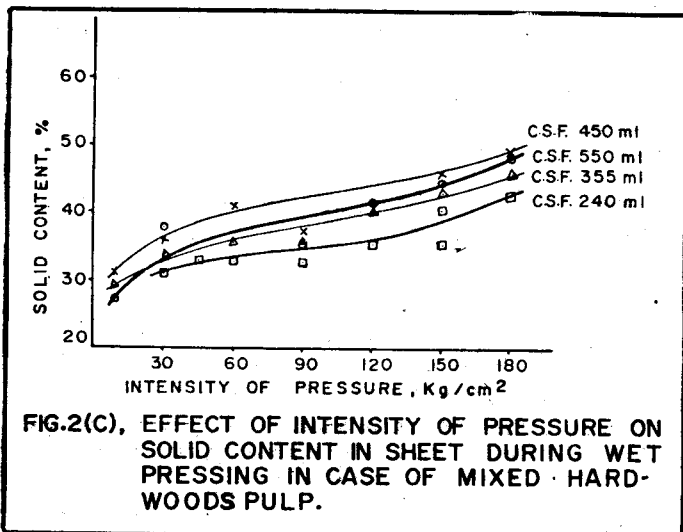
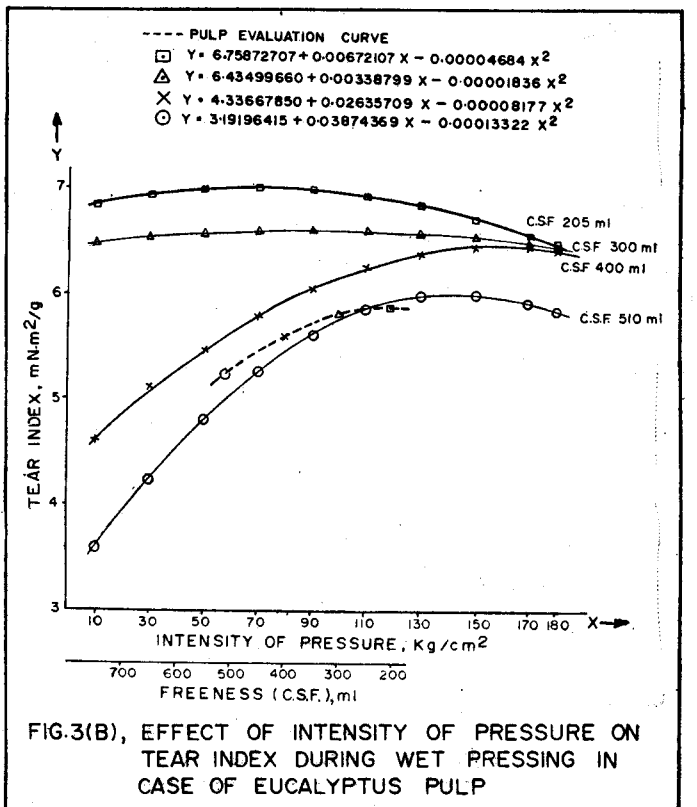
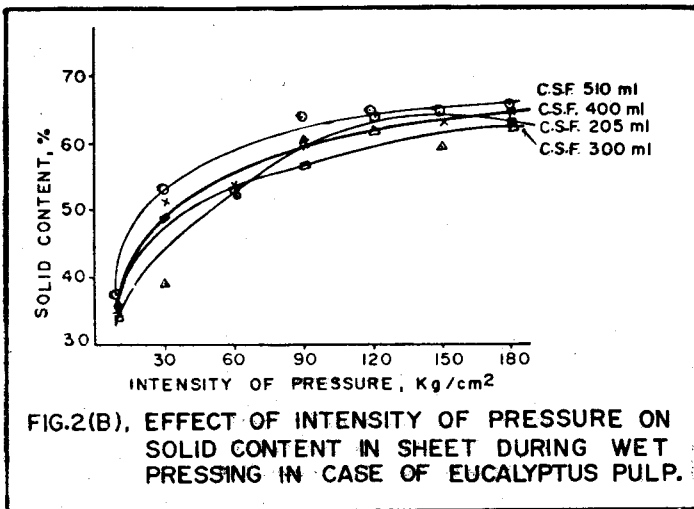
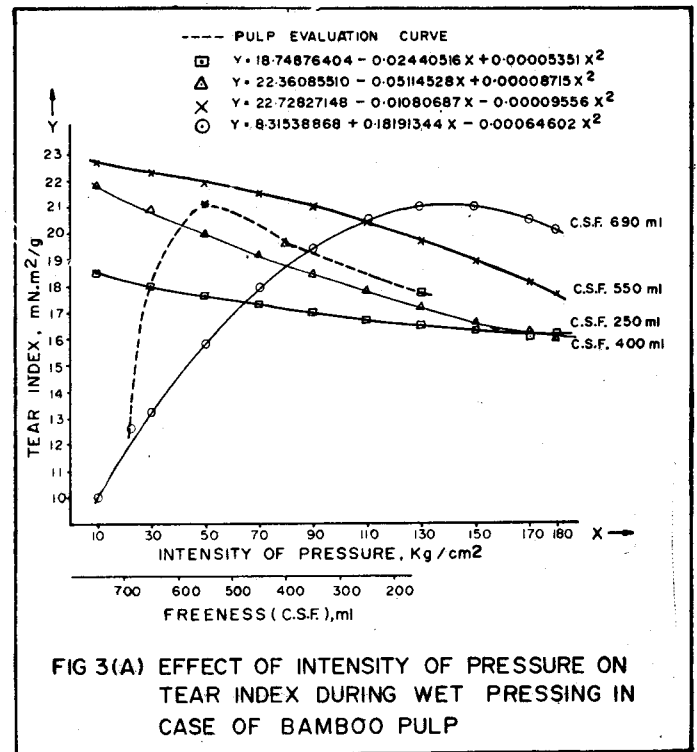
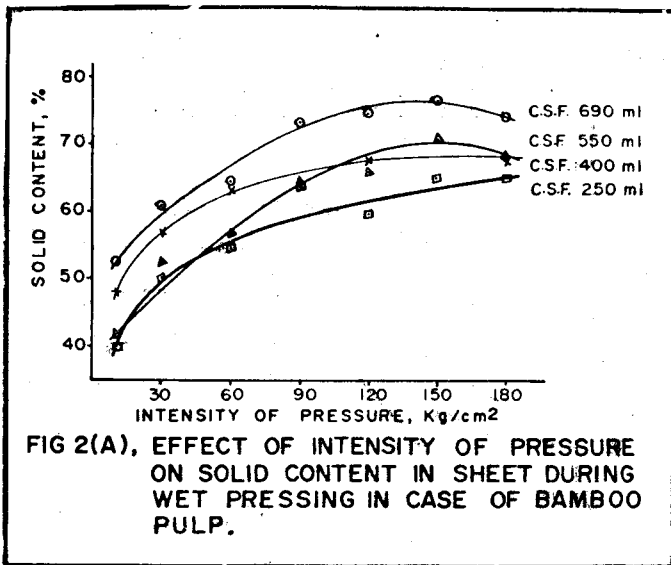
DISCUSSIONS

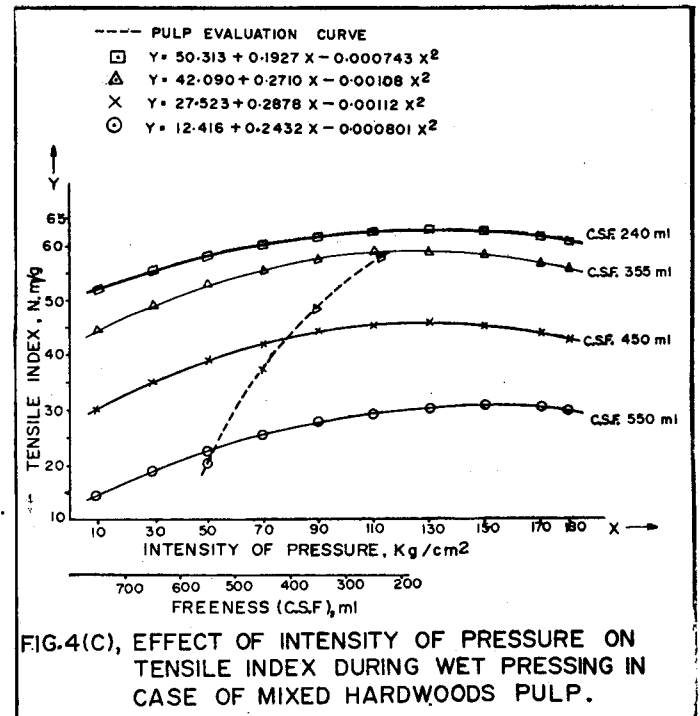
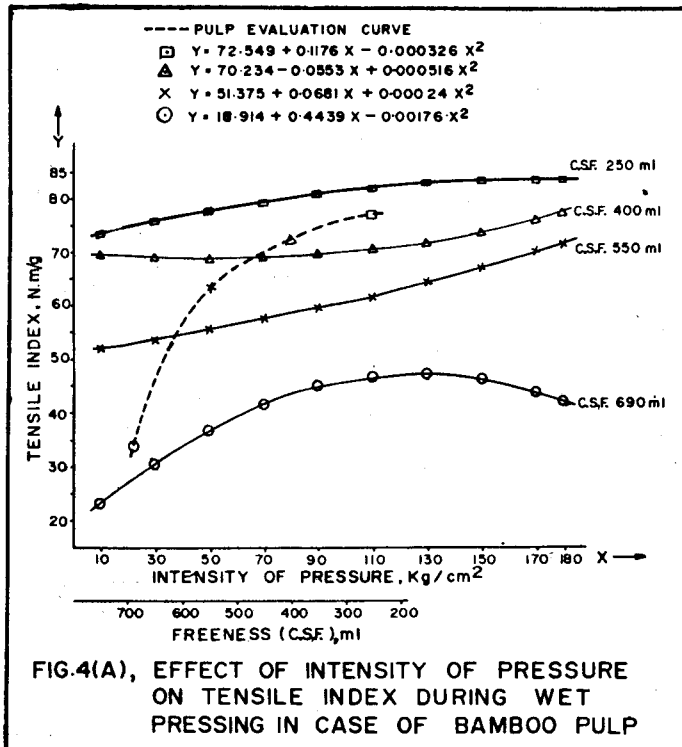
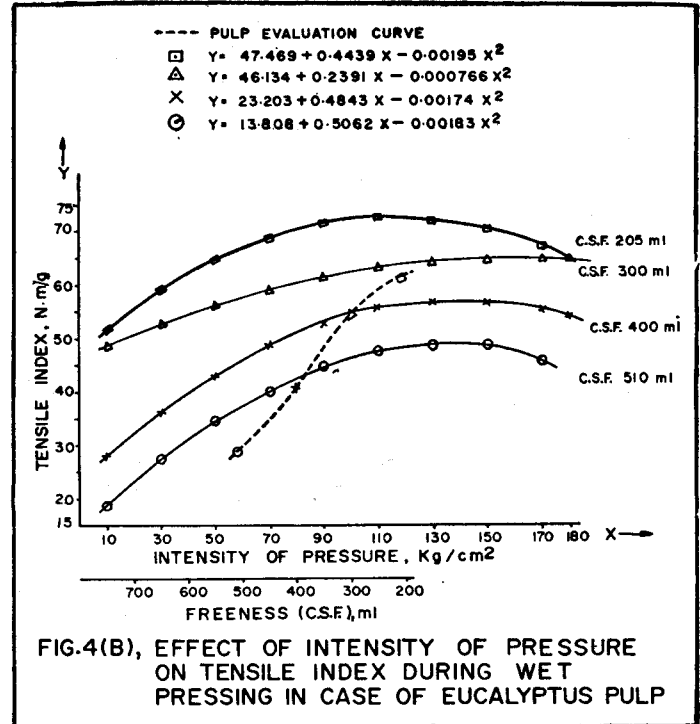
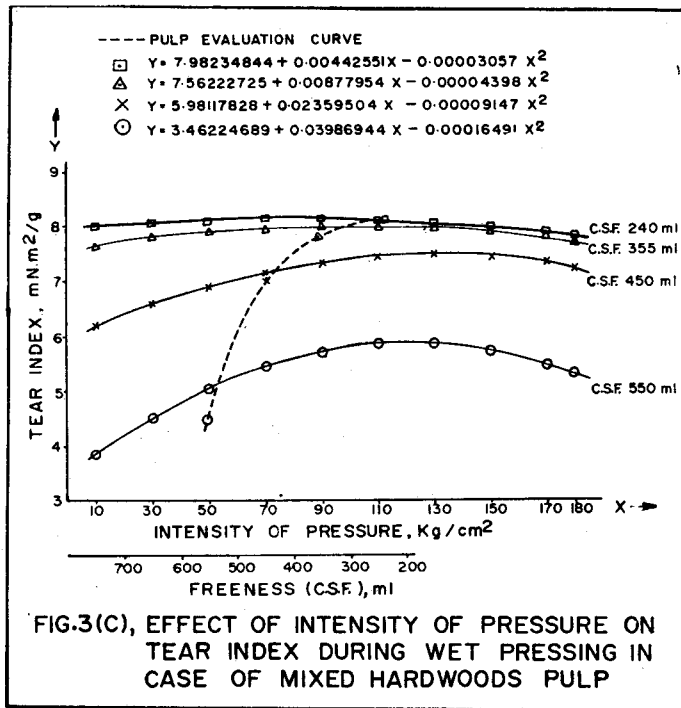
In this study efforts have been made to study if wet pressing of standard test sheets at varying higher pressures could reduce beating of pulp and whether a sheet of equal or stronger physical properties could be made. The results generally show that :—

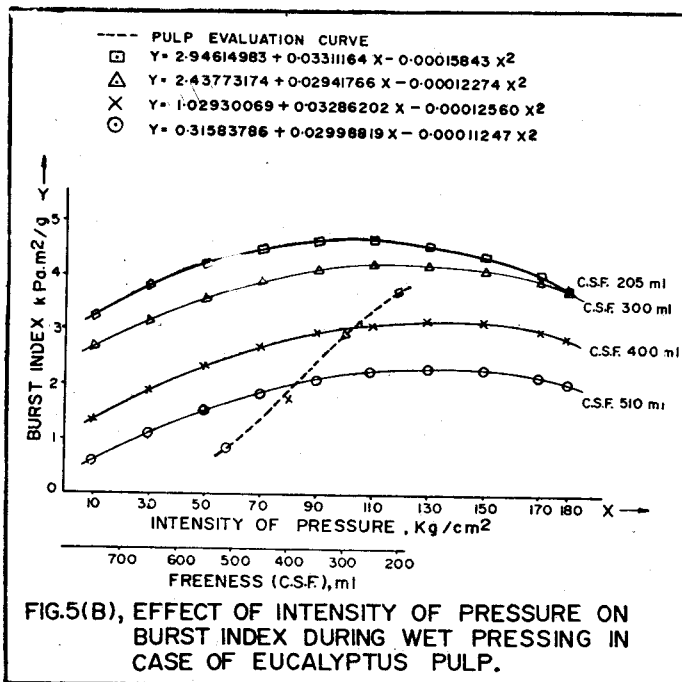
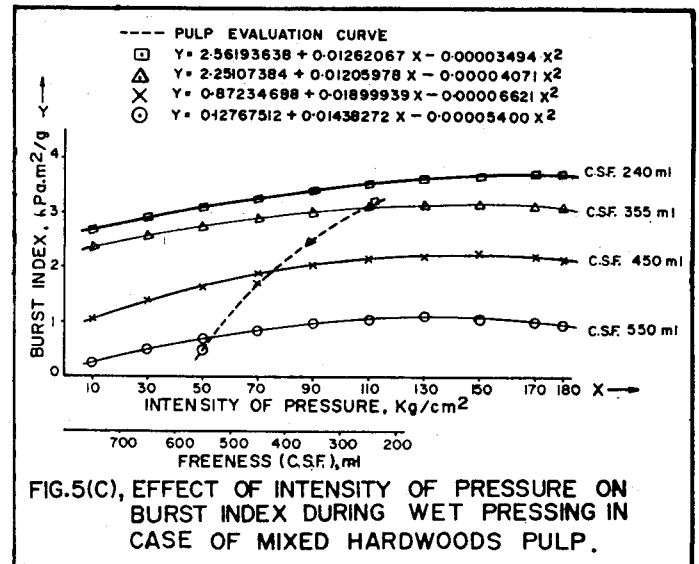
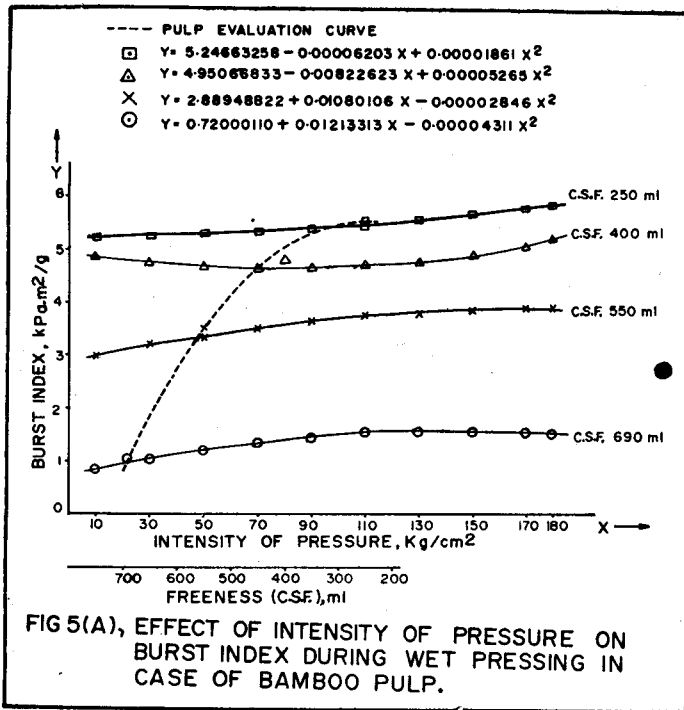
- i) When standard test sheets are wet pressed at varying higher intensities of pressure, pressure intensity beyond 90 kg/cm^2 give little advantage in increasing the apparent density of the sheet (Figure I A, B & C).
- ii) As the freeness decreases pressure intensity has to be increased to obtain the same solid content (Figure—II, A, B & C).

Regarding effect on physical properties of standard test sheets with increasing intensity of pressure during wet pressing behaviour of each pulp towards tear index (Figure—III, A, B & c), tensile index (Figure—IV, A, B & C) and burst index (Figure—V, A, B & C) were studied and results are discussed below :—









TEAR INDEX

i) Bamboo Pulp

Maximum tear index of 21 in case of Bamboo has been obtained under standard conditions and at freeness of 550 ml (C.S.F.) (Figure—III A).

This value of tear index can be obtained at a freeness level of 550ml (C.S.F.) at a pressure intensity around 90 kg/cm² or at a freeness of 400ml (C.S.F.) and at pressure intensity around 25.0 kg/cm². There is an indication that tear index beyond 21 could be obtained if standard test sheets are pressed at higher intensity of pressure compared to standard pressure and at higher levels of freeness. Bamboo pulp has a peculiarity that they give maximum tear index at a very low intensity of pressures and it decreases as intensity of pressure increases in case of beaten pulps.

ii) Eucalyptus Pulp

Maximum tear index of 5.87 has been obtained under standards conditions and at freeness of 205 ml (C.S.F.) in case of Eucalyptus pulp (Figure—IIIB).

This value of tear index can be obtained if sheets are pressed at a pressure intensity around 80 kg/cm² and at freeness of 400ml (C.S.F.) There is also an indication that at freeness level of 300 ml (C.S.F.) or 205ml (C.S.F.) by increasing the intensity of pressure,

a tear index of the order of 7 can be obtained. But beyond pressure intensity around 90kg/cm^2 no improvement in tear index is obtained in case of well beaten pulps.

iii) Mixed Hardwoods Pulp

Maximum tear index of 8.1 has been obtained under standard conditions and at a freeness of 240ml (C. S. F.) in case of mixed hardwoods pulps (Figure III C).

This tear index could only be obtained at freeness of 240ml (C.S.F.) at intensity of pressure around 50kg/cm^2 . The results also indicate that well beaten and over beaten pulps do not show any improvement in tear index on increasing the intensity of pressure.

TENSILE INDEX

i) Bamboo Pulp :

Maximum tensile index of 77 has been obtained under standard conditions and at freeness level of 250ml (C.S.F.) (Figure IV A).

This tensile index can be obtained at freeness level of 400ml (C.S.F.) and at pressure intensity around 180kg/cm^2 . There is also an indication that at freeness level of 250ml (C.S.F.) and at a pressure intensity around 120kg/cm^2 a tensile index around 82 could be achieved in case of bamboo.

ii) Eucalyptus pulp

Maximum tensile index of 61.26 could be obtained under standard conditions at freeness level of 205ml (C.S.F.) (Figure IV B).

This tensile index can be attained at freeness level of 300 ml (C.S.F.) and at a pressure intensity of around 90kg/cm^2 . There is also an indication that at freeness level of 205 ml (C.S.F.) with pressure intensity around 100kg/cm^2 a tensile index around 72 could be achieved or at freeness level of 300ml (C.S.F.) and by applying pressure intensity between $140\text{-}160\text{kg/cm}^2$, tensile index around 65 could be achieved.

iii) Mixed hardwoods pulp

Maximum tensile index of the order of 57.9 has been obtained under standard conditions at a freeness level of 240 ml (C.S.F.) Figure-IV C).

This value of tensile index can be achieved at a freeness level of 355 ml (C.S.F.) with pressure intensity around 100kg/cm^2 . There is also an indication that at freeness level of 240 ml (C.S.F.) and at pressure intensity around 100kg/cm^2 a tensile index around 62.0 could also be obtained.

BURST INDEX

i) Bamboo Pulp

Maximum burst index obtained under standard conditions is 5.5 at a freeness of 250 ml (C. S. F.) (Figure-V A).

In case of Bamboo pulp, burst index of the order of 5.5 could not be achieved at higher freeness levels, however results indicate that sheets prepared from pulp beaten to 250ml (C.S.F.) and if pressed at higher intensities of pressure, slight improvement in burst index will be possible.

ii) Eucalyptus pulps

Maximum burst index of 3.7 was attained under standard conditions at freeness of 205 ml (C. S. F.) (Figure-V B).

This burst index can be achieved at freeness level of 300 ml (C. S. F.) at a pressure intensity around 60kg/cm^2 . Further if sheets of 300 ml (C. S. F.) freeness are pressed under intensity of pressure around 100kg/cm^2 , slight improvement in burst index is possible.

iii) Mixed hardwoods Pulps

Maximum burst index of 3.21 could be attained under standard conditions at a freeness of 240 ml, (C.S.F.) in case of Mixed hardwoods pulp (Figure-V C).

In case of mixed hardwoods pulp this value of burst index could not be achieved at higher freeness levels. However, like bamboo pulp, if sheets made at 240 ml (C.S.F.) freeness are pressed at higher intensity of pressure slight improvement in burst index is possible.

ENERGY CONSUMPTION

As already mentioned that while beating the pulps every time fresh sample of pulp was taken and energy consumption was noted to beat the pulp to a particular level of freeness. Results of energy consumption are given in Table II, III & IV. Percentage saving in energy

consumption/energy saved to obtain equal or higher physical strength has also been recorded in the above tables. Results indicate that reduction in level of beating reduces energy consumption depending on the pulp. Reduction in energy consumption is significant. However this needs confirmation on a pilot plant.

CONCLUSION

In general this study on indigenous short fibred pulps has shown that beating can be reduced by increasing the intensity of pressure during wet pressing of standard test sheets. By reducing the level of beating a sheet of equal or even higher physical strength can be produced.

Reduction in beating will increase sheet porosity and will significantly help in removal of water from the sheet during pressing and drying.

This study will help the paper machine manufacturers in designing press sections for indigenous short fibred furnishes. With increase in freeness (C.S.F.) and increase in intensity of pressure the cost of evaporation will be reduced with simultaneous conservation of energy during process of beating to produce a commercially acceptable paper.

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REFERENCES

1. Maclaurin, D.J., and Whalen, J. F., Tappi 37, 608 (1954).
2. Corcoran, J.C., U.S. Pat. 1, 690, 402 (November 6, 1928).
3. Argy, R.E., U.S. Pats, 1, 712, 374 and 1, 712, 375 (May 7, 1929).
4. Doughty, R.H., Paper Trade J. 93, No. 2:39-44 (July 9, 1931).
5. Doughty, R. H., Paper Trade J. 93, No. 15:44-49 (Oct. 8, 1931).
6. Doughty, R. H., Paper Trade J. 94, No. 9:29-39 (March 3, 1932).
7. Doughty, R. H., Paper Trade J. 95, No. 10 : 31-38 (Sept. 8, 1932).
8. Chilson, W.A. and Baird, P.K., Paper Trade J. 97, No. 14 : 43-46 (Oct. 5, 1933),
9. Annergren, G., Svensk Paperstidn, 39, No. 9, 162-166 (May 15, 1936).
10. Annergren, G., Svensk Paperstidn. 39, No. 9, No. 23: 433-439 (December 15, 1936).
11. Pease, R.F., and Rankin, A. D., Tappi 45 : 150 A (July, 1962).
12. Alexander, S.D., and Marton, R., Tappi 51 : 283 (1968).
13. Didwania, H.P., Ippa Vol. XVI, No. 2, 78-80 (June, 1979).