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合作
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No. 19
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臺灣竹材牛皮紙漿製造之研究

趙順中　潘登灶

Manufacture of Kraft Pulp From Taiwan Bamboos

by

S. C. Chao　T. T. Pan

中華民國六十一年四月
臺灣省林業試驗所印行
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提要（Abstract） 本試驗以麻竹、桂竹、刺竹、長枝竹及竹變五種竹材爲試材，蒸煮條件爲：用藥量（Na_2O）爲15%、16%、17%；溫度 160°C 及 165°C；時間保持2小時結果 以15%、160°C 較佳。游離度 500ml、60g/m² 紙張之裂斷長在 7.05 至 7.90km之間，破裂比在 64.05 至 73.10 之間，撕裂强度特高，竹變漿之撕力比可達 311，透氣度特快，僅有 3 至 7 秒/100ml。紙漿收率在42%至48%之間，紙漿白度以麻竹漿爲最高，未漂漿達 31%GE，經三段漂白後，白度爲 86%GE，漂白條件爲：第一段氯化，有效氯 6%，第二段碱萃，苛性鈉 2%，第三段次氯酸鈣漂白，有效氯 2%。

一、緒　言（Introduction）

竹材爲理想之造紙原料，本省最適宜於種竹，但目前本省紙廠使用竹材造紙者却極少，未免可惜。

臺灣光復之初，使用竹材造紙者並不少，有數家紙廠幾乎全部使用竹材，當時並有工廠專門加工生產竹絲供給紙廠，後來因竹材來源減少，價格提高，紙廠不得不被迫改用其他原料。

本省氣候最適宜種竹，各紙廠現正迫切需要長纖維造紙原料，因此提倡種竹，發展竹材造紙，應爲當然之事。

本所已成立竹類研究中心，專門研究竹類之培植、性質及用途，農復會爲提倡種竹，特訂有獎勵辦法，並有貸款，另有技術輔導。爲發展竹材造紙，特補助本所經費，預計三年內從事有系統之竹材造紙試驗。

竹材纖維細長，强靭有力，可代替針葉樹材作爲造紙原料，本省正需要長纖維紙漿，故首先利用五種竹材試製牛皮紙漿，尋求適當之製漿條件，提供紙廠參考，實驗過程中疏漏之處難免，尚祈專家學者指教是幸，本試驗承國科會暨農復會補助經費，工作期間承農復會森林組楊組長志偉暨潘技正長弼賜予協助，長網抄紙機抄紙實驗承本所技士邱俊雄協助，得以順利完成至爲感激，謹此敬申謝忱。

二、試材與方法（Raw Materials and Methods）

1、試材採集（Collection of Raw Materials）本試驗所用之五種竹材均採自本省南部高雄縣六龜鄉本所六龜分所之扇平，海拔750公尺以上，均爲三年生，其名稱如下：

（1）麻竹Dendrocalamus latiflorus Munro.

（2）桂竹 Phyllostachys Makinoi Hay.

（3）刺竹 Bambusa stenostachya Hackel.

（4）長枝竹 Bambusa dolichoclada Hay.

（5）竹變 Bambusa beecheyana Munro Var. pubescens (Li) Lin.

2、試材製備 (Preparation of Raw Materials) 用手工切成長約 30～35mm.，寬約 10～20 mm.，厚約 1～2mm. 之竹片，令其自行風乾備用。

3、製漿抄紙 (Pulping and Papermaking)

根據本所過去闊葉樹及竹材試驗結果，決定本試驗之蒸煮條件如下：

（1）蒸煮最高溫度 160°C 及 165°C 兩種。

（2）用藥量 13%、15%及17%三種，均以 Na_2O 計算對絕乾原料而言。

（3）蒸煮時間 達到最高溫度需要時間2小時，最高溫度保持2小時。

（4）硫化度 25%。

（5）液比 4：1

蒸煮設備爲3立升之蒸煮罐，電熱器間接加熱，蒸煮後經 100目不銹鋼絲網洗滌清潔，散漿機打散；1.0% 时平篩篩選，然後測定收率，打漿設備用藍平球磨機 (Lampen mill)，抄紙設備採用 TAPPI 標準型手抄機，紙漿經過篩選打漿後抄成紙張，並測定其物理性質以鑑定其品質，紙張物理性質在相對濕度65%之標準溫濕度控制室試驗，其他各項操作及分析均按照 TAPPI 所規定之方法。

4、紙漿之漂白 (Bleaching of Pulps)

（1）紙漿漂白所用紙漿之蒸煮條件爲：最高溫度 160°C，用藥量15%，紙漿經洗滌篩選後，測定其游離度，白度及高錳酸鉀值，以備漂白。

（2）漂白方法採用次氯酸鹽三段漂白 (Three-Stage Bleaching With Calcium Hypochlorite)，各項條件如下：

A. 第1段 (First-Stage) 氯化 (Chlorination)
紙漿濃度3%，紙漿溫度24°C、時間1小時，有效氯用量爲 6%及7%（對絕乾紙漿重量）。

B. 第2段 (Second-Stage) 碱萃 (Alkali Extraction)
紙漿濃度10%、溫度70～75°C、時間1小時，氫氧化鈉用量均爲2%。

C. 第3段 (Third-Stage) 漂白 (Bleaching)
紙漿濃度10%，溫度 38～40°C、時間2小時，有效氯用量爲2%、1%及0.5%三種條件。

紙漿漂白進行期間，爲使紙漿保持 PH 8 以上，補加少量氫氧化鈉，並於每種藥品加入前後，測定其 PH 值，漂白完畢後，抄成漿板，風乾後測定其白度，並分析其高錳酸鉀值（K價）。

三、實驗結果 (Results of Experiments)

1、紙漿收率 (Pulp yield)

五種竹材，六種蒸煮條件，所得紙漿之收率如下：

蒸煮條件 Cookihg Conditions		麻竹 DLM	桂竹 PMH	刺竹 BSH	長枝竹 BDH	竹變 BMVL
160°C	13%	46.50	45.43	46.25	50.25	47.15
	15%	43.92	42.52	43.10	48.05	45.07

	17%	42.46	40.18	41.18	45.80	42.60
165°C	13%	44.87	44.15	44.50	48.85	46.10
	15%	43.45	42.25	42.83	46.50	44.85
	17%	40.05	39.15	40.14	43.70	40.74

2、紙張物理性質 (Physical Properties of Paper)

下列六表爲每種試材六種不同蒸煮條件紙漿所抄紙張之物理性質。

(1) 蒸煮溫度 (Cooking Temperature) 160°C

A. 用藥量 (Chemical used) 13%

試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	385	535	300	520	505	530	295	510	380	540
透氣度 Porosity Sec/100ml	17	3	30	5	6	4	32	6	18	2
乾基重 Oven dry Basis Weight g/m²	58.36	58.11	56.32	56.34	58.31	58.65	59.50	59.03	56.68	56.54
裂斷長 Breaking Length km.	7.88	6.72	7.90	7.03	7.65	6.84	8.72	7.15	8.70	7.33
破裂比 Bursting Factor	72.35	60.10	76.22	63.76	72.79	61.47	79.50	62.15	83.45	66.63
撕力比 Tearing Factor	141.02	174.85	107.43	125.31	156.16	179.33	145.14	167.35	160.17	300.84

B. 用藥量 (Chemical used) 15%

試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	340	540	280	535	460	535	260	415	290	500
透氣度 Porosity Sec/100ml	25	3	42	3	8	2	47	10	35	7
乾基重 Oven dry Basis Weight g/m²	59.08	58.58	58.29	59.29	58.17	58.02	58.84	59.15	57.85	57.22
裂斷長 Breaking Length km.	8.41	7.49	9.14	7.55	8.36	7.05	9.02	8.13	9.25	7.90
破裂比 Bursting Factor	80.43	66.94	86.37	67.83	80.34	64.05	82.88	74.95	88.96	73.10
撕力比 Tearing Tactor	149.47	188.73	140.05	169.48	179.14	222.60	159.14	190.35	178.09	311.92

C. 用藥量 (Chemical used) 17%

試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	360	510	295	540	500	540	345	530	350	520
透氣度 Porosity Sec/100ml	20	6	32	2	7	3	24	4	22	5
乾基重 Oven dry Basis Weight g/m²	58.87	59.38	57.99	58.36	58.11	57.48	58.79	59.39	58.52	59.09
裂斷長 Breaking Length km.	7.73	6.78	7.52	6.55	8.00	7.16	8.50	7.37	8.70	7.64
裂破比 Bursting Factor	74.10	62.83	72.73	61.67	73.39	66.39	78.34	68.54	81.39	71.62
撕力比 Tearing Tactor	154.37	193.60	153.15	179.87	184.30	229.46	171.05	241.34	192.52	307.43

（2）蒸煮溫度 (Cooking Temperature) 165°C

A. 用藥量 (Chemical used) 13%

試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	375	535	415	540	490	540	350	510	320	535
透氣度 Porosity Sec/100ml	19	3	10	3	7	2	21	6	25	3
乾基重 Oven dry Basis Weight g/m²	59.12	58.74	56.65	56.72	57.76	57.81	59.77	59.49	58.18	57.97
裂斷長 Breaking Length km.	8.00	6.83	7.71	6.69	8.13	6.85	7.88	7.25	8.26	7.41
破裂比 Bursting Factor	77.08	63.35	76.07	62.22	76.84	66.67	76.71	66.73	80.39	68.13
撕力比 Tearing Tactor	130.17	179.93	122.38	159.80	153.41	200.13	155.60	181.73	220.36	257.11

B. 用藥量 (Chemical used) 15%

試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	395	545	295	535	370	540	375	515	340	545
透氣度 Porosity Sec/100ml	14	2	33	3	18	2	18	5	24	2
乾基重 Oven dry Basis Weight g/m²	58.04	59.35	57.74	56.61	57.70	58.79	59.71	59.15	59.00	59.16
裂斷長 Breaking Length km.	8.37	6.85	8.84	6.78	8.55	7.30	8.55	7.77	8.59	7.84
破裂比 Bursting Factor	80.78	62.50	80.79	61.51	83.35	67.90	83.31	72.75	84.46	73.16
撕力比 Tearing Tactor	156.45	208.02	136.38	174.67	161.92	207.87	163.29	218.12	193.69	337.79

C. 用藥量 (Chemical used) 17%

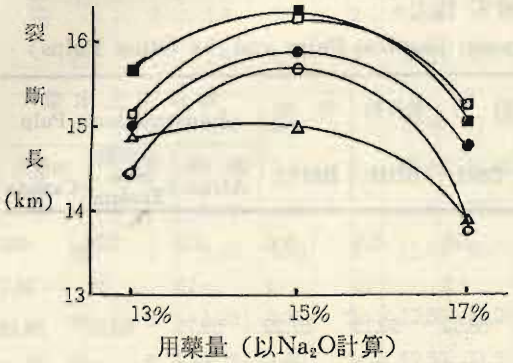
試材 Sample	麻竹 DLM		桂竹 PMH		刺竹 BSH		長枝竹 BDH		竹變 BMVLP	
游離度 Freeness C.S.F. ml	460	550	395	530	410	545	340	520	410	545
透氣度 Porosity Sec/100ml	8	1	31	4	10	2	24	5	12	2
乾基重 Oven dry Basis Weight g/m²	58.75	59.34	58.64	57.92	56.60	56.43	59.42	58.50	56.45	56.45
裂斷長 Breaking Length km.	7.76	6.04	7.41	6.35	8.07	6.71	8.11	7.11	8.08	6.96
破裂比 Bursting Factor	70.38	57.07	70.82	61.78	75.04	63.31	78.07	65.76	78.45	60.65
撕力比 Tearing Tactor	178.49	221.05	132.68	170.83	174.90	223.27	154.79	210.29	208.03	317.92

（3）紙張物理性質圖解(Diagram of Physical Properties of the Different Papers)

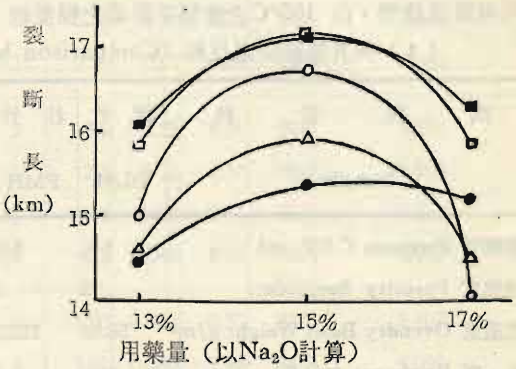
根據上列物理性質，茲將五種竹材紙張之裂斷長、破裂比及撕力比分別繪圖表示，以便比較（各種强度均以兩種游離度之和表示圖中△爲麻竹、○爲桂竹、●爲刺竹、口爲長枝竹、■爲竹變。

A. 裂斷長 (Breaking Length)

(a) 165°C

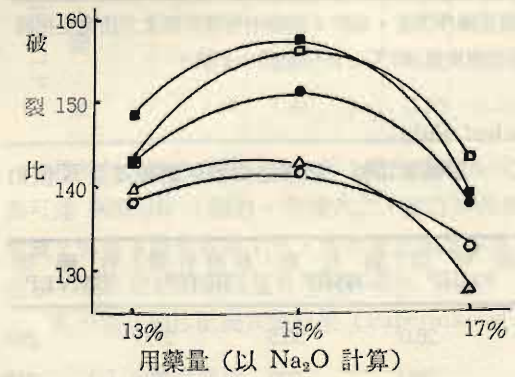


(b) 160°C

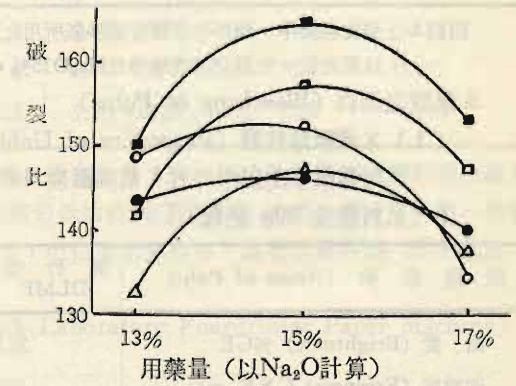


B. 破裂比 (Bursting Factor)

(a) 165°C

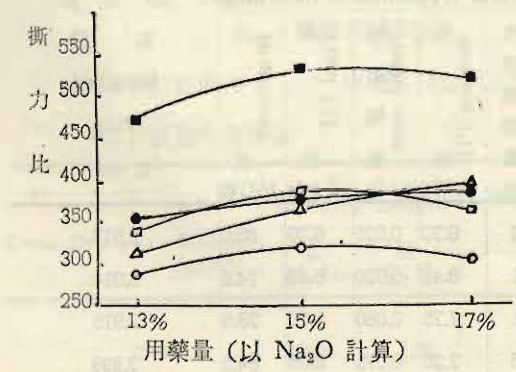


(b) 160°C

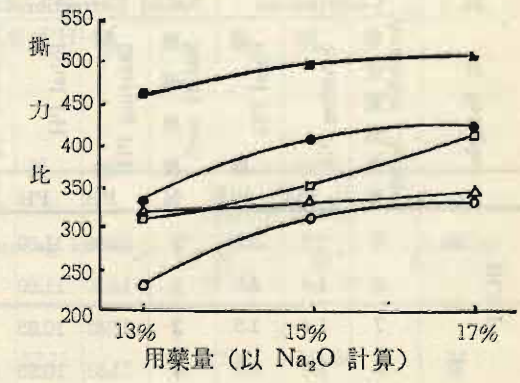


B. 撕力比 (Tearing Factor)

(a) 165°C



(b) 160°C



根據上列物理性質可知以下兩點：(1)抗張力及頂破力在 160°C 之情形下較高，而撕力有相反之結果， 160°C 反較 165°C 情形下爲低，但 165°C 情形下，藥量超過15%時，撕力逐漸降低， 而 160°C 時仍繼續升高，但升高之幅度漸低，(2)抗張力及頂破力在用藥量15%時均最高，用藥量17%時均有降低趨勢，但 165°C之情形下降低之程度較 160°C 爲大。

（4）與其他紙漿之比較 (Comparison between Bamboo Pulps and the Other Pulps)

試材名稱 Sample	麻竹 DLM	桂竹 PMH	刺竹 BSH	長枝竹 BDH	竹變 BMVL	進口牛皮木漿 Imported kraft Pulp 非洲 Africa	紐西蘭 New Zealand	加拿大 Canada
游離度 Freeness C.S.F. ml	540	535	535	415	500	510	520	500
透氣度 Porosity Sec/100ml	3	3	2	10	7	18	10	26.7
乾基重 Ovendry Basis Weight g/m²	58.58	59.29	58.02	59.15	57.22	59.75	60.57	59.19
白度 Brighness %G.E.	31.0	26.0	30.5	27.0	29.0	19.0	19	22.90
裂斷長 Breaking Length km.	7.49	7.55	7.05	8.13	7.90	8.38	8.19	8.53
破裂比 Bursting Factor	66.94	67.83	64.05	74.95	73.10	78.47	76.83	78.75
撕力比 Tearing Factor	188.73	169.48	222.60	190.35	311.92	157.46	142.65	141.11

附註：上列比較表中，進口牛皮漿打漿抄紙所用之設備及操作方法，均與本試驗中竹漿所用之方法完全相同，以便比較，竹漿之蒸煮條件爲Na_2O15%，最高溫度爲160°C，保持時間2小時。

3. 紙漿之漂白 (Bleaching of Pulps)

（1）未漂紙漿性質 (Properties of Unbleached Pulp)

所用紙漿之蒸煮條件：最高溫度 160°C ，用藥量15%，紙漿之白度，游離度及 K 價如下（試料重量 30g 絕乾）：

紙漿名稱 (Name of Pulp)	麻竹漿 DLMP	桂竹漿 PMHP	刺竹漿 BSHP	長枝竹漿 BDHP	竹變漿 BMVLP
白度 (Brightness) %GE	31.0	26.0	30.5	27.0	29.0
游離度 (Freeness) C.S.F. ml	650	760	720	710	715
K 價 (K no.)	17.57	19.24	17.52	19.54	18.95

（2）漂白結果 (Results ol Bleaching)

試材 Sample	氯化 Chlorination 有效氯用量% Available Cl_2 used	開始PH Starting PH	最後PH Final PH	鹼萃 NaOH Extraction 燒鹼用量% NaOH used	開始PH Starting PH	最後PH Final PH	次氯酸鈣漂白 Calcium Hypochlerite Bleaching 有效氯用量% Available Cl_2 used	開始PH Starting PH	補加鹼量g NaOH used	最後PH Final PH	白度%GE Brightness	漂白漿K價 Bleached Pulp K no.
DLMP 麻竹漿	6	1.9	2.0	2	12.80	11.60	2	8.70	0.025	6.30	86.0	2,817
	6	1.9	2.0	2	12.80	11.60	1	8.45	0.020	6.35	74.6	3,014
	7	1.4	1.5	2	11.81	10.85	1	7.75	0.080	6.70	78.5	2,915
	7	1.4	1.5	2	11.81	10.85	0.5	7.20	0.075	8.35	64.5	3,899

PMHP	桂竹漿	6	1.7	1.8	2	12.30	11.40	2	8.60	0.01	6.10	83.0	3,063
		6	1.7	1.8	2	12.30	11.40	1	8.10	0.02	7.45	66.5	4,194
		7	1.6	1.7	2	11.51	10.75	1	7.15	0.10	6.70	68.0	3,210
		7	1.6	1.7	2	11.51	10.75	0.15	7.20	0.07	8.35	54.0	4,637
BSHP	刺竹漿	6	1.95	2.40	2	12.40	11.45	2	8.1	0.05	6.70	85.0	3,358
		6	1.95	2.40	2	12.40	11.45	1	7.3	0.02	6.60	68.5	3,800
		7	1.40	1.42	2	11.53	10.65	1	7.8	0.08	7.10	76.0	3,112
		7	1.40	1.42	2	11.53	10.65	0.5	6.2	0.085	8.45	59.0	3,899
BDHP	長枝竹漿	6	1.75	1.80	2	12.50	11.20	2	7.95	0.060	6.50	83.0	3,407
		6	1.75	1.80	2	12.50	11.20	1	7.21	0.080	7.15	64.7	4,096
		7	1.45	1.55	2	11.75	10.10	1	7.50	0.085	7.20	68.0	3,801
		7	1.45	1.55	2	11.75	10.10	0.5	6.30	0.085	8.60	53.0	4,194
BMVLP	竹變漿	6	1.95	2.00	2	12.30	10.80	2	7.80	0.065	6.35	84.0	2,965
		6	1.95	2.00	2	12.30	10.80	1	6.80	0.050	7.20	63.2	4,194
		7	1.30	1.40	2	11.85	10.10	1	8.00	0.050	7.10	73.0	3,407
		7	1.30	1.40	2	11.85	10.10	0.5	7.20	0.075	9.45	57.0	4,243

根據以上漂白結果可知，第1段有效氯6％，第3段有效氯2％，漂白效果最好，麻竹漿白度最高可達 86%GE ，刺竹、竹變次之，桂竹及長枝竹漿最低白度爲 83%GE 在另一情況下，第一段有效氯7％第3段有效氯1％，有效氯之總量亦爲8％，但白度相差甚多，麻竹漿最高爲 78.5%GE，長枝竹漿及桂竹漿最低僅有 68%GE。

4. 小型長網抄紙機實驗結果 (Papermking with Laboratory Fourdrinier Paper machine)

（1）製漿條件：

A. 蒸　煮　Na_2O15%、溫度 160°C 、保持時間2小時。

B. 打　漿　打漿設備：標準型試驗用荷蘭式打漿機，打漿時間 125分鐘，紙漿濃度 2.28%，打漿後紙漿游離度350ml。

C. 加　膠　松香皂 1.5%　　紙漿 PH 7.9

硫酸鋁 3.0%　　紙漿 PH 4.5

（2）抄紙條件　　車速1.78公尺／分。

（3）紙張物理性質

乾基重 Oven Dry Basis Weight (g/m^2)	裂斷長(km) Breaking Length 縱 M. D.	裂斷長(km) Breaking Length 橫 C. D.	破裂比 Bursting Factor	撕力比 Tearing Factor 縱 M. D.	撕力比 Tearing Factor 橫 C. D.	透氣度 Porosity Sec/100ml
57.78	8.04	3.56	53.11	97.41	141.84	54

四、結　論 (Conclusions)

1. 根據實驗結果，五種竹材紙漿之强度均佳，尤其撕力特高，爲其共同特性、其中竹變之撕力最高，其他四種較低，但均超過針葉樹牛皮紙漿。

2. 所實驗之六種蒸煮條件中，比較最適當之條件爲：用藥量15%，最高溫度 160°C ， 保持時間 2 小時，蒸煮總時間 4 小時。

3. 一般而言，蒸煮溫度160°C 之下，抗張力較在 165°C 之下爲高，但撕力則相反，在 165°C之下反高。不過在 165°C 下，用藥量超過15%時撕力逐漸下降，但在 160°C 之下仍繼續升高。

4. 竹漿之透氣度特別快，爲其另一特性，游離度在 450～500ml 之範圍內，透氣度僅有 3～7 秒 /100ml。

5. 紙漿收率以長枝竹較高，可達48%以上，其他均在42%以上，（蒸煮條件爲：用藥量15%，溫度 160°C ，保持 2 小時）。

6. 在相同游離度之情況下，竹材牛皮紙漿之抗張力較針葉樹牛皮紙漿略低，但撕力則超過甚多，若竹漿之游離度降低，其抗張力即提高，可與針葉樹漿相比。

7. 未漂紙漿之白度，以麻竹漿最高，可達 31%GE ，桂竹漿最低僅有 26%GE 。

8. 由漂白結果可知，最佳之漂白條件爲：第一段有效氯 6 %，第三段有效氯 2 %，麻竹漿白度可達 86%GE ，若將第一段有效氯增加至 7 %，第三段減少至 1 %， 有效氯總量仍爲 8 %，但白度即相差甚多，麻竹漿白度僅達 78.5%GE 。

五、英文摘要 (Summary in English)

Manufacture of Kraft Pulp From Taiwan Bamboos

1. The fiber of bamboo is fine and long, it is an ideal raw material for papermaking. The climate of Taiwan is very suitable for growing bamboo and the paper mills are in urgent need of long-fibered raw materials, so it is quite logical to promate the planting bamboo and to use it as raw material for the development of the paper industry.
2. Five species of bamboo were used in this experiment. They were
   (1) Dendrocalamus latiflorus Munro (麻竹) 。
   (2) Phyllostachys Makinoi Hay (桂竹) 。
   (3) Bambusa stenostachya Hackel (刺竹) 。
   (4) Bambusa dolichoclada Hay (長枝竹) and
   (5) Bambusa (beechegana Munro Var.) pubescens (Li) Lin (竹變) 。
   The first three species had been used for paper making, the other two species had not been used yet.
3. Sulfate process was used in this experiment, The cooking conditions were as follows :
   (1) Maximum Temperature : 160°C and 165°C
   (2) Percentage of chemicals used : 13%, 15%, and 17% (as Na_2O based on oven dry chips)
   (3) Cooking schedule: 2 hrs (time to max. Temp.)
   2 hrs (time at max. Temp.)

(4) Sulfidity: 25%

(5) Liquor ratio: 4:1

After cooking, the pulp was treated in the following steps:

(1) Washing on a 100 mesh wire screen

(2) Difiberating by the disintergrator

(3) Screening by the flat screen (1% inch)

(4) Measuring the pulp yield.

Before being made into the paper sheet the pulp was treated by Lampen ball mill to the proper freeness. The TAPPI standard hand-sheet machine was used. The method for papermaking was the TAPPI standard method. All tests of physical properties were made in an air conditioned room at relative humidity 65% and temperature 20°C

4. The cooking conditions of pulp for bleaching were that the maximum temperature was 160°C and the chemical used was 15%. The bleaching process was the three-stage bleaching consistion of chlorination, alkali extraction and hypochlorite. The conditions were as followa:

lst. stage	Chlorination	
	Concentration of pulp	3%
	Temperature	24°C
	Time	40min.
	Available chlorine	6%, 7%
2nd. stage	Alkali extraction	
	Concentration of pulp	10%
	NaOH	2%
	Temperature	70°C
	Time	60min.
3rd. stage	Hyprochlorite bleaching	
	Concentration of pulp	10%
	Temperature	38-40°C
	Time	60min.
	Available chlorine	2%, 1% 0.5%

5. Results of experiment

(1) In the six different cooking conditions, the best condition for good strength was that the chemical used was 15% and the maximum temperature was 160°C.

(2) The strengths of the five bamboo pulps were good, especially the tearing strengths of them were very high. This was their common characteristics. The tearing strength of BMVL (竹變) was the best of all. Those of other four soecies were lower, but all of them were better than the kraft soft wood pulp.

(3) The tensile and bursting strengths were better under 160°C than that under 165°C; but the tearing strength was not, it was lower than that under 165°C. The tearing strength decreased when chemical used was over 15% under 165°C, but it increased under 160°C.

(4) The air permeability of the bamboo pulp were very fast, this was another common

characteristics, They were only 3-7 sec/100 ml at the freeness 450-500ml.

(5) As for the pulp yield, the BDH (長枝竹) pulp was the highest, it would reach over 48% at the cooking conditions-Ns_2O 15%, Max. Temp. 160°C. The yields of others were over 42% under the same conditions.

(6) Comparison between the bamboo pulps and the kraft soft-wood pulps showed that the tensile and bursting strengths of the bamboo pulps were not as good as those of the softwood pulps at the same freeness, but the tearing strengths of the bamboo pulps were much better than that of the softwoos pulps. If the freeness of bamboo pulps were further lowered, the strength of them could compare with that of the kraft softwood pulp.

(7) The brightness of DLM (麻竹) pulp was the hightest of all the five species of bamboo unbleached pulps. It could reach 31% GE. The PMH (桂竹) pulp was the lowest, it was 26% GE.

(8) From the results of bleaching, it could be seen that the best condition would be available Cl_2 6% at lst stage and 2% at 3rd stage. The brightness of DLM (麻竹) pulp could reach 86% GE. If the available Cl_2 Was 7% at lst stage and 1% at 3rd stage, the total available Cl_2 was also 8%, but the brightness of bleached DLM(麻竹)pulp was only 78.5% GE. It was much lower.

六、參考文獻 (Literature Cited)

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