As the immediate steps to realize expansion of No. 4 machine, the following must be pursued:

a) Unit II produces cigarette paper to compete with imported cigarette paper. Efforts must be made to improve the production technologies and to expand the sales outlet.

b) Unit II must plan increase of production after reducing the production of non-profitable grade products and stabilizing the paper quality. The excess of production capacity thus realized should be used for middle grade cigarette paper production.

3-9-2 Locational Conditions

PPM is located about 150km from Jakarta, about 30km from Bandung and about 1,000km from Surabaya. Although this location is not as advantageous as most private paper mills are, PPM is more favorably located than other government-owned paper mills are.

The selling district varies by paper type, but roughly, products of Unit I are sold in the metropolitan area and products of Unit II are sold in central Java. The breakdown of Unit I product selling district is 58% in Jakarta area, 25% in Bandung area, 11% in central Java, and 6% in other areas.

Since the majority of Unit II products are cigarette paper, they are sold in central and eastern Java where most of the cigarette manufacturers are located. Since the selling price per kg of cigarette paper is high, differences of transportation cost can be absorbed by the selling price.

Since Padalarang is close to Bandung, PPM has the advantage of using the Institute of Fibre Technology for quick testing and research. This institute must be actively used for testing of developing products.

3-9-3 User Configuration

Due to the purpose of mill establishment, Unit I sells the products to governmental and municipal organs. The breakdown of users is 10% to governmental offices, 70% to agents and dealers, and 20% to converters, but more than 50% of end users are governmental organs. The largest user is Perum Perce Takan Uang Republic Indonesia (Government Security Printing Company) and this consumes 30% or more of Unit I products.

The main agent is P.T. Margono Dian Graha, who handles much of cigarette paper as well.

The users of Unit II products are cigarette companies which form one of the very important industries in Indonesia. Because of quality problems, Unit II products are not sold to the three largest cigarette manufacturers, and the sales are limited to small to medium cigarette manufacturers, most of which are located in Bandung, Semalang and Kudus areas.

3-9-4 Equipment and Cost

(1) The characteristic points of Unit I, as evaluated from the viewpoint of sales are that it has straw pulp making equipment and is suitable for small lot production. On the other hand, its production cost is high.

It is estimated that the production cost is Rp200/kg higher than competitors, comparing the cost on the same product. Therefore, Unit I must produce specialties that make the best use of the equipment.

On the finishing process, the following improvements are necessary to raise the image of the product.

a) Wider space in the product warehouse
b) Complete pavement of the floor of finishing plant and product warehouse
c) Improvement of transportation equipment (installation of clamp forks, for example)
d) Better product handling (The current handling damages the product too much.)
e) Driving out of poor packing materials (The packing kraft paper easily breaks, the plates for bale packing are not uniform, etc.)
f) Improvement of pallet and bale legs to facilitate the handling
g) Better looking labels

(2) Unit II has no serious problem with the equipment to produce cigarette paper. The productivity is about ten tons a day, which is not bad on an international comparison.

However, a quality guarantee system must be established as quickly as possible.

Unit II has no equipment to produce rolled paper, and the current product cannot be sold for use for machine rolled cigarette which is increasing in the market.

Additional finishing machine and slitter are absolutely necessary. Since Unit II has the groundwork in competing with imported paper, we certainly expect that it changes the production and sales to compete with imported paper by improving the manufacturing technologies and quality control system.

3-9-5 Quality Evaluation in Market and Selling Price

Table 3-9-1 shows the product prices of Unit I, and except for HVS there is no objective to compare the price with. There is a large difference in the quality between items that are profitable and not profitable. We hear that Perum, governmental organ, evaluates Unit I products lowly and users say that almost no paper is produced to the specifications. The basis weight, paper thickness and sizes are always varied and the paper always contains stains.

The number of sheets per ream is not steady, or less than 500 in most cases. The designation position of the watermark is shown in the reverse way, and thus there are many complaints.

The prices of Unit II products are shown in Table 3-9-1, and these prices indicate that products are sold about Rp1,000 per kg lower than imported paper. Also, there is a weight loss of about 8% in the basis weight ($24g/m^2$ on imports and $26g/m^2$ on PPM products).

For all these reasons, the establishment of production and control technologies to compete with imports and establishment of sales outlets are required as quickly as possible.

Table 3-9-1 Sales Price of PPM (1984 Budget)

Unit I Brand	Rp/Kg	Unit II Brand	Rp/Rim
H.V. Offset	872	Silver Bird	6,300
H.V.S. Export	335	Golden Bird	6,500
Cyclostyle	671	Eagle Bird	8,500
Mailzegel	2,155	Eagle Bird Special	11,000 – 12,000
Bandrol 60 g	2,027		
Reform	933	Imported from France	12,000 – 15,000
S.P.R.	2,133		
Cheque Note	951		
Kertas Water Mark	1,659		
Post Wesel	824		
Kartu Post	870		
Door Slag	915		
Bank Post	861		
Sigaret	1,191		
Couverture	644		
H.V.O. 80 g	434		
" 200 g	363		
H.V.O. Birtua 70 g	295		
Kraft Coklat 45 g	316		

3-9-6 New Products Recommended for the Time Being

We recommend that the production of non-profitable items of Unit I be sequentially changed to production of middle grade cigarette paper.

As to Unit II, we think it important that it can produce grades that can compete with imports and machine rolled cigarette paper.

3-10 Investigation of Specialty Paper

In 3-3, we listed oil-proof paper, paper for lamination, computer form paper and cigarette paper as recommendable items. This clause describes these items and NCR.

3-10-1 Computer Form Paper

There are several types of computer form paper; 52.3g/m^2, 64g/m^2, 104.7g/m^2, 127.9g/m^2 and 157g/m^2, and the common types are 52.3 – 64g/m^2.

There are two types of colors, solid (white) and colored, and the majority is in solid. In Japan, the quotation of base paper is ¥270 – 280/kg, and since the computer form paper quotation is 80% of that, the price in Japan is ¥216 to 224/kg.

The price of imported form paper is about Rp1,700/kg including 70% of tariff and commission, and it is a high price grade for wood-free paper.

Since this paper has a rather high growth rate, we recommend that the paper be trially made by both mills and the two mills be made ready to start any time. We recommend that BRPP produce the form paper in the category of 52.3 to 64g/m^2 and PPM 104.2 to 127.9g/m^2.

The papermaking conditions are rather severe on (1) expansion/shrinkage, (2) dust and crease, (3) uneven thickness and (4) core crush. The size of paper for mounting ranges widely from 8.6 inches to 18.2 inches.

3-10-2 Base Paper for Lamination

Various types of paper like pure white machine-glazed paper, fine paper, one-side coated paper, glassine paper, separate paper, and kraft paper are used for lamination depending on the usage. We are recommending fine paper as a type that can be produced by both of BRPP and PPM.

The basis weight of fine paper ranges from 40 to $80g/m^2$, and it can be used for either printing/writing or lamination. In using it for lamination, at least one side should be glazed, and since it is used for foodstuff wrapping often, all virgin pulp must be utilized. The base paper is laminated with an aluminum film, polyethylene or OPP or aluminum is vapored on it.

The price of base paper in Japan is market price ¥200 per kg. The export price is about ¥185/kg, FOB Japan, which comes to about Rp1,500/kg when sold in Indonesia.

Depending on the usage, either domestic or imported paper is used and the ratio between the two is unknown.

The following precautions must be paid when making base paper for lamination:

No dust
The thickness must be uniform.
A certain strength is necessary since it is processed from roll to roll.

Also, the paper mill must consult with the laminator on the requirements of paper in advance.

3-10-3 Oil-proof Paper (Similar Grease-proof Paper)

The most of them, a paper which has been sold as named grease-proof paper in Indonesia market, be seemed oil-proof paper. Therefore, we would like to explain the outline of oil-proof paper as recommendable items as belows.

Oil-proof paper is made in the material furnish combination of fine paper but added with oil-proof agent. Since the paper has a oil-proof effect, it is used for wrapping or bags for bread, doughnuts, fried bread, or fried food in which edible oil is used.

At present, Indonesia imports most of the oil-proof paper from China, Japan, Taiwan, and West Germany. The oil-proof paper from China is low-priced, those from Japan are priced higher and those from Europe are priced highest.

The price of oil-proof paper is about Rp1,260 per kg, which is about twice as high as that of general wood-free paper.

There are two basis weights; 38g and 40g. Since oil-proof paper is much used for wrapping of popular food like bread and fried bread, the paper is sold to small to medium-sized foodstuff processors, and naturally the paper is sold in the flat form (75×100) mostly.

Although it is conceivable that the share of oil-proof paper will be taken by CPP and others gradually, the demand will slightly increase in the sense of absolute quantity.

3-10-4 NCR

The customs clearance for import of NCR in Indonesia for 1982 is 372tons, and the quantity of import may be interpreted as the quantity of consumption. However, during 1982, Japanese customs clearance of NCR for export to Indonesia was 1,896.2tons (investigated by Japan Paper Manufacturers' Association), and we think that the statistics of the Indonesian side is incorrect. When smuggled NCR and NCR imported from countries other than Japan are calculated, the demand exceeded 2,000tons even in 1982.

In the coming ten years or so, an increase of demand of 5% per year is expected. Pusakaraya Co. introduced the coating technique from West Germany and started the production in 1983. The daily production capacity is said to be 5t/d but the actual coating is 3t/d, with sure expectation of reaching 5t/d by the end of this year. This is equivalent to 1,500t/y. Since the target is 10t/d, or 3,000t/y, the demand in Indonesia is exceeded by the production of Pusakaraya only. Ciwi Kimia has also determined to obtain a license from the United States, and the company will start the production in 1984.

There is information that Pakerin will start the production of NCR in the near future. In addition, we hear that several printing companies are planning production. Accordingly, the plan of PPM and BRPP starting the NCR production at this point is a plan that neglects the actual situation.

In addition, production of NCR bears the following risks:

a. Development of base paper

b. A capsule production unit must be installed anew.

c. Coating equipment must be installed.

d. It takes at least two years before Items a, b, and c are completed.

e. The production capacity of two years later will substantially exceed the domestic demand.

f. Even if the production is in excess, exporting NCR would be difficult because of the licensing arrangement.

   Even if it could be exported, there is simply no prospect of winning the competition with advanced countries (Japan, USA, West Germany) in the quality, price and production scale.

g. Extreme care is needed to transport NCR since the NCR color develops when a shock is given. The handling equipment, packaging and transportation system with shock prevention effect are needed, and the current handling of PPM and BRPP is not suitable at all.

   This is especially serious to BRPP since it is away from large consumption areas of Jakarta, Surabaya and Semarang, and to transport NCR for such long distances is not normal.

h. The price obtainable for NCR is about double that of the base paper.

i. We have obtained product samples of Pusakaraya and conducted a coloring test. The response is not quick, and anyone who has used NCR of advanced countries tends to dislike the Pusakaraya product.

Thus, the mill will have to carry much risk on the production and sales of NCR final products. Therefore, even if steps could be taken for development and production of base paper for NCR, we cannot recommend PPM or BRPP starting the vertical production of NCR up to coating.

With regard to the development of base paper for NCR, Pusakaraya uses imported base paper for their production of NCR at present, and it looks as if satisfactory NCR cannot be made out of base paper domestically produced under the current technology. Therefore, we recommend that efforts be made to develop such base paper, thereby raising the demand in this aspect.

CHAPTER 4 CURRENT SITUATION OF BRPP MILL

CHAPTER 4 CURRENT SITUATION OF BRPP MILL

4-1 History

This mill was established in 1962 for production of printing/writing paper out of bamboo pulp, and the production started in 1969.

The initially designed capacity was 30t/d. The bamboo material became scarce and in the early part of 1974, the mill had to start using additional materials like pine and broad-leaved trees, and at present, bamboo material shares only 10%.

In 1976, the improvement program had been implemented, and the production was increased from 30t/d to 45t/d. At that time, the electrolytic facilities were newly installed and the mill started producing chlorine and caustic soda for bleaching by itself.

This mill was constructed out of the Japanese reparation for World War II, and the relationship with Japan has been close, with assistance rendered from the Japanese government and private concerns.

4-2 Location: Banju Wangi City, East Java

4-3 Area of Mill: 50ha

4-4 Sales Amount

(Unit: ton)

	1979	1980	1981	1982	1983
Paper	11,274	10,245	10,579	10,663	10,431
Notebook	1,397	1,471	1,899	1,280	1,461

4-5 Number of Employees and Management System

4-5-1 Number of Employees: 735 persons (as of 1984)

4-5-2 Management System: The management system is shown in Table 4-5-1.

4-6 Major Equipment

4-6-1 Bleaching Plant

Daily production capacity:	30ADt/d
Chipper	4units
Digester	2units of $50m^3$ vertical type
Washing and screen	1set
Bleaching plant	1set of 5-stage (C-E-H-E-H) bleaching facilities

4-6-2 Papermaking and Finishing Plant

Daily production capacity:	45t/d of a printing/writing paper as design
Paper machine	Wire width: 2,850mm Basis weight: 45–200g/m^2 Speed: 60–250m/min
Finishing equipment	1double cutter 1winder

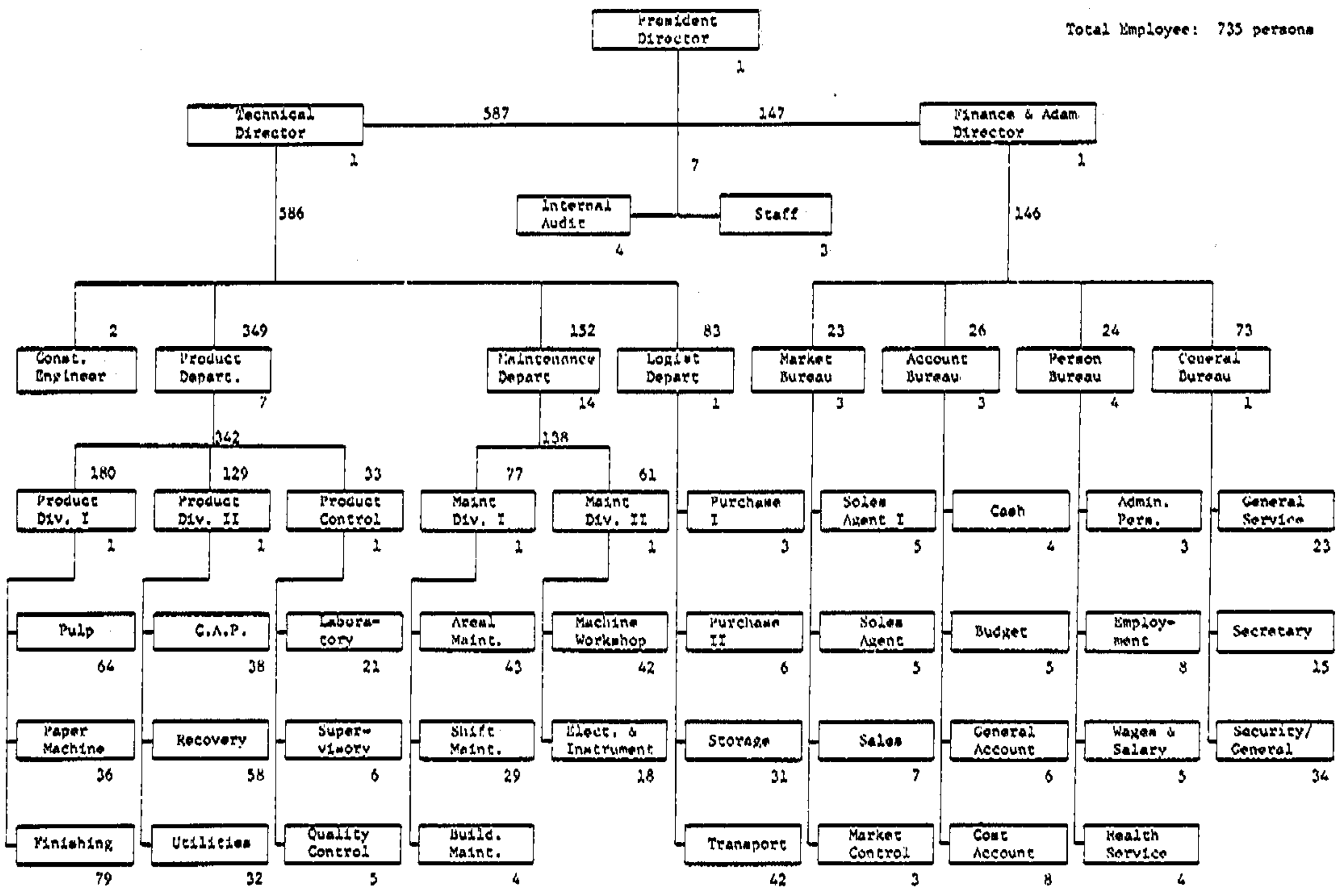
4-6-3 Chemical Recovery Plant

Evaporator	1line (5-body 5-effect)
Recovery boiler	1set
Causticizing equipment	1set

4-6-4 Auxiliary Facilities

Electrolytic equipment	1set (1,200kW)
Power boiler	1unit (10t/h)
Diesel generator	5units (1,500kW×3, 2,710kW×2)

Table 4-5-1 Organization Chart
as of March 1984, BRPP



CHAPTER 5 CURRENT SITUATION AND MAJOR PROBLEMS OF PLANT MANAGEMENT

CHAPTER 5 CURRENT SITUATION AND MAJOR PROBLEMS OF PLANT MANAGEMENT

5-1 Situation of Income

(1) Table 5-1 shows the situation of income of BRPP. Up to 1981, the operation brought profits, but became unprofitable in 1982, and the deficit has been increasing since then.

The inactive market is the major cause but the increase of production cost accelerates the trend.

Major changes on the economic situation in the past several years are as follows:

Devaluation	November 1978:	425 → 625 Rp/US $
	March 1983:	625 → 970 Rp/US $
Increase of heavy oil price	May 1980:	45 → 75 Rp/lit
	January 1982:	75 → 125 Rp/lit
	January 1983:	125 → 200 Rp/lit
Economic growth rate	1981:	7.09%
	1982:	2.25%
	1983:	3.00% (estimate)
Increase of consumer prices	1981:	7.09%
	1982:	9.69%

Table 5-1-1 Income, Production, Selling Price and Major Costs

Item		1980	1981	1982	1983
1. Profit	1,000 Rp	721,160	53,105	–502,642	–1,574,936
2. Production	ADt/y	12,873	12,702	12,595	11,787
3. Selling price	Rp/kg	507	574	576	568
4. Production cost	Rp/kg	356	473	503	559
5. Material cost for self-made pulp	Rp/kg	–	293	219	207
6. Repairing cost	Rp/kg	41	42	59	47
7. Depreciation	Rp/kg	35	36	41	38
8. Personnel expenses	Rp/kg	–	91	103	102
9. Others	Rp/kg	86	88	121	167
10. Number of employees		–	776	775	751
11. Personnel expenses RP 1,000/year/person		–	1,494	1,675	1,596

5-2 Mill Management

On a mill campaign, everyone makes efforts to achieve a set target (profitability and economy). In order to have this renovation plan processed smoothly, not only the equipment renovation but the mill managements must also be reviewed. The profitability of BRPP can substantially be raised when the equipment renovation and improved mill management are combined in favorable conditions.

5-2-1 Production Management = Mass Balance Control

(1) The data on the operation and financial matters is amply available. If the data is systematically organized by difference of purposes and used for the field management, the productivity and profitability will be increased.

The existing problems and measures to be taken are outlined below.

i) The measurement of daily paper production should be altered to a system of measurement of finished paper production (ADt/d) instead of the existing system of paper production (ADt/hr) on reel.

ii) The meaning of various efficiencies should be made clear.

iii) Improvement of the various efficiency standard figures and its firm implementation.

iv) Arrangement and unification of calculation on goods in-process (including discarding).

v) Reinforcement of production control department

vi) Further promotion of QC activities

5-2-2 Quality Control

Drop of the product's quality may be immediately linked to lowering of the marketing strength, and the product's quality is a very important control point. At present, SQC (Statistic Quality Control) is the first step of the total quality control under the leadership of the top managers. The virtue of quality control must be fully utilized and connected with productivity increase. In this regard, the following actual campaigns are needed.

(1) Good communication must be kept between the sales department and production department, and information obtained from users reflected into the product quality.

For example, the quality of competitors products, frequent color unmatching between each lot, too quick discoloring during storage in users, etc., must be immediately fed back to the production department.

(2) On such problems as mentioned above, changing of the pulp furnish combination or chemical adding rate must be investigated.

(3) Countermeasures must be taken to decrease range of valuation of quality.

(4) Induction of system for improvement proposal.

(5) Induction of small circles activities.

5-2-3 Cost Control

Induction of the cost control at the operation site is very effective in increasing the productivity and economy. The countermeasures for this purpose are described in 5-2-1.

5-2-4 Finished Products Control and Sales Control

At present, all finished products are controlled satisfactorily. So, it is better to give heed to the following points.

(1) Whether or not this renovation project is successful depends on the selling of new products.

(2) As described in Chapter 3, the BRPP selling ability to users is not so powerful at present. So, the sales organization must be improved as quickly as possible and at the same time, new members must be added to spread more marketing strength.

5-2-5 Maintenance Management

(1) The actual repairing costs are shown in Table 8-1-1, and these costs occupy about 8% of the paper sales price. Usually those typical figures are 4—5% of the paper sales price. The number of maintenance units per one maintenance department person is about 21, which is not a large number.

(2) The total stoppage hours of the paper machine by causes of maintenance department (mechanic section) was about 190 hours in 1983, which is abnormally long. Upon studying all troubles that have occurred in the last three years, we found many cyclic troubles or repetition of the same trouble at the same place.

(3) The following are conceivable as the causes for these troubles.

a) Lack of periodical repair of facilities
b) Insufficiency in pursuing trouble causes
c) Insufficient repairing works

(4) The situation as described in the above matter shows that the maintenance control conducted by BRPP at present is only BM (Breakdown Maintenance) and not PM (Preventive Maintenance). Also, a critical factor that contributes to insufficient control of the maintenance is that the repairing costs are not controlled by the maintenance department itself. Such a practice is beyond our comprehension.

5-2-6 Purchasing Management

The quality and purchasing price of logs for self-made pulp and purchasing chips greatly influence the productin cost.

(1) Logs must be purchased based on a long-term plan and the quality of logs must be carefully selected to provide the required quality to the paper.

(2) The purchasing price must be adjusted according to the water contained in the logs and barks sticking to the logs.

(3) The same principle applies to the purchasing of chips.

5-3 Logs for Self-Made Pulp

5-3-1 Consumption

The log consumption in the last three years is shown in Table 5-3-1.

Table 5-3-1 Log Consumption

Year		Log		Purchasing chip		BKP. BDt Rate (Estimate)		
		SM	RP/SM	ADt	RP/kg	Log	P. chips	Total
1981	N	71,821.5	8,082	–	–	4,205	–	9,358
	L	83,685.5	8,968	2,600	32.3	4,606	542	
1982	N	57,265.5	10,657	–	–	3,762	–	9,298
	L	47,658.5	8,978	9,388	33.6	3,309	2,227	
1983	N	52,411.5	7,893	–	–	4,006	–	8,862
	L	31,292.5	7,540	9,134	32.5	2,334	2,552	

Note) The bamboo material is divided in half between N and L materials.

The details of above are shown in Table 6-2-1.

The ratio of N and L in self-made pulp of BKP rate is about 45:55.
The quantity of purchasing chips for L-BKP is increasing year by year, and in 1983, it occupied about 52% in the L-BKP rate.

5-3-2 Quality of Logs

The operation of wood preparation has many problems in the aspect of pulp quality stabilization. Those problems are as follows.

(1) The mixing ratio of N and L chips is not accurate, nor is it possible to control this ratio correctly with the existing equipment.

(2) All logs and purchasing chips are covered with barks. The ratio of barks is 2 to 5% with pinus and 14 to 15% with purchasing chips. Usually chips for BKP are prepared as debarked chip.

(3) There are many species used in the chip for L-BKP and that consumption ratio is not fixed. The used logs are of smaller size, and also, branches are often used so the BKP quality cannot be kept even.

(4) Use of mangrove wood for LBKP started several years ago. Use of mangrove wood should be stopped as quickly as possible for the following reasons.

   i) Mangrove wood is not easily cooked.

   ii) Salt contained in mangrove wood damages mild steel of the digester and corrodes blow tanks.

(5) The SM unit is used to measure the quantities of wood purchase and consumption. This unit is applied to measure the wood quantity piled in a volume of 1 m^3. Therefore, in case of calculation of pulp production by this unit, production figure is undependable and there is lower reliability for large variations of SM unit. Actual volume (BDt if possible) should be used to check often by laboratory things such as moisture content in wood, bark ratio, etc.

5-4 Production Capacity and Actual Production

5-4-1 General

The approximate capacities (designed or nominal capacities as opposed to the actual production) of the existing equipment are as follows:

Log preparation plant:	60%
Cooking plant:	50—55%
Washing plant:	105—110%
Bleaching plant:	95%
Evaporator plant:	105 —110%
Recovery boiler:	105 —110%
Main boiler:	95%
Recausticizing plant:	90%
Stock preparation:	75%
Paper machine:	80%
Finishing room:	95%

As a whole, the production capacity of BRPP is subjected to the capacities of the chemical recovery process like washing plant (washer), evaporator and, recovery boiler. The rate of chemical recovery of BRPP is 65 ± 6%, which is extremely low when compared with the typical rate of 90 to 95%.

5-4-2 Actual Production of Existing

(1) Self-made pulp production

The production of self-made pulp is shown as below. (Details are shown in Tables 5-4-3-1 and 7-1-1)

Item	Unit	1981	1982	1983
Self-made pulp production	BDt-BKP/y	9,353	9,298	8,863
Average daily production	BDt-BKP/y	28.9	29.0	28.9
Recent daily production	BDt-BKP/y	–	–	32.8
Ratio of self-made pulp to whole pulp used	%	83.7	84.4	86.4
Ratio of self-made N-pulp	%	45.0	41.5	45.2
Ratio of self-made L-pulp	%	55.0	59.5	54.8

(2) Problems on production

i) Grasping of the production (yield) of UKP has not been standardized.

(Note) The quantity of pulp production is measured in the bleaching department only. The quality of pulp (except problem of logs) is almost determined by the Roe-NO of the cooking conditions. Cooking yield is determined as above result. Among the two, the Roe-NO is a very important key point for pulp production control that even influences the production cost. The cooking yield is the result of cooking condition (mainly Roe-NO) and determines the quantity of pulp production (UKP).

ii) There is no correlation between the log unit and pulp production quantity, therefore, they must be revised to match as quickly as possible.

(Note) The correlation factor of the above was about –5.7% in 1982 and about –17.7 in 1983, while the error was small in 1981.

iii) The chemical recovery rate was about 65 ± 6%, which is an extremely poor rate.

(Note) The reason for the poor recovery rate is that the cooked pulp cannot be washed clean enough because of structural defect of the washer. This increases the cooking chemical loss, raising the cooking chemical cost by about 32 to 33 Rp/BD kg pulp, and raising the load of effluent.

iv) The amount of speck contained in the paper sheet is about four times as much as that of competitors' products. This poor result is caused by use of unbarked logs for pulp making and improper maintenance of the centri-cleaner pump.

(3) Estimation of pulp yield

The existing pulp yield is estimated as follows.

Yield at cooking	42.73%
Yield at bleaching	87.55%
Total yield	37.41%

The actual total yield in 1982 was 35.9%. Normally, the above yield is 42 to 45% as typical base. The reasons for the lower yield seem to be high rate of bark on logs, high rate of wood dust content and high variation range of moisture content in the logs (income logs recently are not dried enough).

(4) Evaporator capacity

The evaporator capacity in February 1984 is shown Table 6-6-3. The major data are as follows.

Black liquor generation in cooking process	About 1.8t/BDt-UKP
Supply to evaporator	About 1.2 −1.3t/BDt-UKP
Unrecovered portion at washing plant	About 0.5 −0.6t/BDt-UKP

[Evaporator processing, February 1984]

Black liquor solid as inlet	20.15%
Black liquor solid as outlet	46.60%
Steam consumption	0.825t.steam/t.BL
Evaporation rate	3.57
Black liquor solid	55t BL/24 h

From the above data, it can be said that the capacity is 55t.BL/24 h is about the limit. The nominal capacity is 44.2t.BL/24 h at the conditions 18.5% of inlet BL solid and 52% of outlet BL solid.

Therefore, the evaporator operation will be very tight, so a weak black liquor tank must be installed as a new one to stabilize the evaporator operation.

5-4-3 Paper Production

(1) Actual production

The actual paper production is as follows. Details are given in Tables 5-4-3-1 and 5-4-3-2.

		1981	1982	1983
Annual production	ADt/y	12,702	12,595	11,787
Average daily production	ADt/d	37.2	36.5	34.1
Available operation days (*)	d/y	341.6	345.4	345.6
Production rate of HVS	%	73.7	77.6	61.7
Production rate of HVO	%	17.7	10.6	9.1
Rate of ream vs rolled paper	%	–	98.1	88.6
Rate of second grade				
HVS	%	16.6	13.5	9.4
HVO	%	5.1	9.14	3.3

Note: That marked with * means as follows:

A = B – C

A: Available operation days

B: Annual days as one year

C: Number of scheduled shutdown days plus number of non-operation with a justified reason to count as scheduled (for example, change of the wire cloth, felt and canvas, etc.)

(2) Kind of paper

BRPP produced 5kinds of paper in 11 grades in 1981, 5kinds of paper in 10grades in 1982 and 6kinds of paper in 18 grades in 1983. On all of them, the major products are HVS and HVO, and these two occupy 80 to 90% of the amount of products. Especially, the four grades of HVS50 and 60, HVO60 and CS70 occupy about 75 to 80% of amount of products.

(3) Pulp furnish combination

The furnish combination of pulp is as follows:

	1981	1982	1983
Self-made pulp/purchasing pulp	84/16	84/16	86/14
NBKP/LBKP	42/58	41/59	44/56

(4) Problems on production

The problems on production are outlined in the following.

1) Because of the daily production control by the on-reel system, it is difficult to directly grasp the feeling of actual daily production as finished. As a result, the operaters can not feel encouraged in the productivity improvement such as improvement of the total efficiency, improvement of quality, and decrease of the consumption unit.

2) Since the quality standards and operation manual are not properly established or are not well observed, the variation of quality is apt to expand. This problem is particularly apparent on such operation as checking of freeness and consistency of pulp and of the flow volume in process and adjustment method of the quantity of chemicals to add.

3) Insufficient implementation of periodical maintenance and improper cleaning of each equipment of paper machine due to shortage of time.

(5) Problems on equipment

1) The primary refiner in the stock preparation uses super refiner attached steel blades. This refiner is effective in cutting the fiber, but not suitable for fibrillation of the fiber to improve the paper property. Installation of double disc type refiner must be studied.

2) The flow box and approach system are obsolete and their performance has substantially degraded. If the production in the future is limited to printing and writing paper only, these equipment may be usable with renewal of partial equipment or parts, but the majority of these equipment should be renewed in order to produce high value paper in the future.

3) The designed speed and actual speed of existing paper machine are 300m/min and 240m/min respectively. However, this paper machine can be operated at a speed of up to 350m/min basically, and we recommend that the equipment be partially renewed and faster speed operation pursued gradually.

4) The initial retention rate at the wire part is 50 to 55%, which is rather high. Therefore, the clay yield is lower than the standard figure. The rewatering equipment and wire cloth on the wire part must be reviewed.

5) The moisture content of wet-web at the dry part inlet is 64%, which is rather high. Therefore, the steam consumption is 3.1 t/t paper base on the reel and 3.62t/t paper base on the finished daily production, both of which are higher than the standard figure. The reason of higher steam consumption is low nip pressure operation at the press part.

6) The existing cutter and winder are obsolete and have greatly degraded. Minor repairing will not recover the performance accuracy. The cutter and winder must be changed with new ones.

5-4-4 Efficiency of Paper Machine

(1) The contents of using efficiency of paper machine are adequate. However, the classification method of these contents seems to be unsuitable to exactly grasp the problems on the production.

Therefore, we have calculated the efficiency values in our own system, and the results are shown in Table 5-4-4-1.

The actual downtime of the paper machine, breakdown of each causes, is shown in Table 5-4-4-2.

(2) Problems

The stoppage of paper machine for causes attributable to the production department was about 3.5 times frequenter than the stoppage for causes attributable to the maintenance department in 1983. The major troubles are frequent sheet break (large variation range of freeness and consistency of pulp and lump of stock) and troubles caused by paper machines. All these troubles can be substantially reduced by improving the equipment and operation procedures.

5-5 Utility Unit

5-5-1 Utility Unit of Existing Operation

The unit consumption of steam, electricity and mill water at the existing operation are as follows.

			1981	1982	1983
Steam	Consumption	ton	123,482	127,096	106,661
	Unit cons.	t/t paper	9.7	10.1	9.1
Electricity	Consumption	kWh	20,053,115	19,939,263	19,663,643
	Unit cons.	kWh/t paper	1,578.7	1,583.1	1,668.3
Mill water	Consumption	m^3	5,241,965	4,991,730	4,912,985
	Unit cons.	m^3/t paper	412.7	396.8	416.8

5-5-2 Estimation of Unit Consumption for Each Process

The above units are calculated based on December 1983 and later months. Resulted figures are shown in Table 10-6-2.

Approximate unit consumption of major processes in 1983 are as follows.

	Steam	Electricity
Cooking plant	2.74 t/BDt-BKP	51.46 kWh/BDt-BKP
Pulp plant (excluding cooking plant)	2.65 t/BDt-BKP	892.68 kWh/BDt-BKP
Boiler	1.83 t/BDt-BKP	–
Stock preparation	–	290.86 kWh/ADt-paper
Paper machine	3.62 t/ADt-paper	529.20 kWh/ADt-paper

5-5-3 Problems

The steam unit consumption of paper machine is fairly high, and the reasons seem to be as follows.

(1) The moisture content of wet-web at the dryer inlet is as high as 64%.

(2) The performance of drainage system is poor and the drain exhaust efficiency is low.

5-6 Paper Quality

5-6-1 The samples of HVS and CS (including competitors' products) obtained during our stay in BRPP were measured in the Central Laboratory of Honshu Paper Co., and the results are shown in Tables 5-6-1 and 5-6-2.

5-6-2 Problems on HVS

(1) Smoothness...The smoothness of BRPP's HVS is about 25% poorer than others.

(2) Tensile strength...Lower by about 7% than others

MD/CD ratio of tensile strength...Other products; Average 2.25/1

BRPP products; Average 2.60/1

(3) Number of specks...About 4 to 6 times more than others

The values of (1) and (2) in the above cause lower printability to printing companies, the end users of HVS.

Also, as critical problems that could not be measured at the laboratory, we discovered that the following could occur during storage in a printing company.

(4) Quick discolorment

(5) Un-matching color between lots

5-6-3 Countermeasures

(1) Installation of a supercalender is reviewed as a method to improve the smoothness. The target of smoothness is set to 70 to 100 sec.

(2) The following are reviewed to improve the tensile strength:

a) Change of pulp furnish combination and move control of freeness

b) Modification of existing flow box (Target of MD/CD ratio is set to about 2:1.)

(3) To decrease the number of specks, the logs should be barked and the centri-cleaner pumps and approach system are to be improved.

(4) To improve the discolorment and un-matching color between lots, the pulp should be washed more thoroughly through the filter of bleaching plant control of the stock preparation and use of an anti-fading agent is reviewed.

These countermeasures must definitely be studied.

5-6-4 Others

There is no particular problem on CS quality.

Table 5-4-3-1 Actual Paper Production

Own pulp = Self-made pulp

Description		1 9 8 1	1 9 8 2	1 9 8 3	1 9 8 4 Feb	Remarks
1. Finished production	BDt	11,812.86	11,713.35	10,873.56	978.28	as 7% moisture
Starch					0.65	as 60% of remained in sheet
Clay	Ton	1,200.32	1,254.10	1,124.42	95.34	as 60% of remained in sheet
Own pulp	BDt	8,885.00	8,832.80	8,419.51	774.69	
Purchased pulp	BDt	1,727.54	1,626.45	1,329.63	107.60	
Total		11,812.86	11,713.35	10,873.56	978.28	
2. Operating days	Days	341.6(308.2)	345.4(311.7)	345.6(309)		Figure in () are shown effective operation days
3. Average daily prod.	ADt/d	37.2(41.2)	36.5(40.4)	34.1(38.1)		
4. Required pulp	BDt		11,009.73	10,262.25	941.01	
Own pulp	BDt	% 9,352.63(83.7)	100% 9,297.68(84.45)	% 8,862.64(86.36)	as 93.76% 826.25(87.8)	95% of fiber yield
Purchased pulp	BDt	1,818.46	1,712.05	1,399.61	114.76	95% of fiber yield
Total		11,171.09(100)	11,009.73(100)	10,262.25(100)	941.01(100)	
5. Own pulp at Bleaching		9,352.63	9,297.68	8,862.64	826.25	
Bleaching sect.	BDt	9,352.63	9,297.68	8,862.64	826.25	as 89.34% yield at Bleaching
Washing sect.	BDt	10,468.58	10,407.07	9,920.13	924.84	as 98.08% yield at Washer
Cooking sect.	BDt	10,682.23	10,619.46	10,122.58	943.71	
*Operation Day	Day/y	323.78	320.63	306.32		
AV Daily Product	BDt/d	28.89	29.0	28.93		
6. Purchased pulp	•	1,818.46	1,712.05	1,399.61	114.76	
NBKP	BDt	509.78	788.10	486.54	86.22	as 10% moisture
LBKP	BDt	1,129.90	816.0	819.96	-	as 10% moisture
CTMP	BDt	178.78	107.95	93.11	28.54	as 10% moisture
Total		1,818.46	1,712.05	1,399.61	114.76	

Table 5-4-3-2 Detail of Actual Paper Production

Paper			1981 Production	1981 Cost	1982 Production	1982 Cost	1983 (May - Dec) Production	1983 (May - Dec) Cost	Remarks
			ADt/y	RP/kg	ADt/y	RP/kg	ADt/y	R/P	
Ream	HVS	Q1	7,809.73 (83.4)	500.39	8,458.55 (86.49)	550.67	4,168.70 (90.59)	534.66	
		Q2	1,555.30 (16.6%)	443.49	1,321.50 (13.51)	490.62	432.89 (9.41)	483.17	
	Sub total		9,365.03 (100) (73.73%)	490.94	9,780.05 (100) (77.65%)	542.56	4,601.59 (100) (61.70%)	529.82	
	HVO	Q1	2,129.14 (94.90)	473.64	1,213.38 (90.86)	560.23	658.91 (96.74)	542.43	
		Q2	114.31 (5.10)	447.88	122.07 (9.14)	445.51	22.21 (3.26)	471.77	
	Sub total		2,243.45 (100) (17.66%)	472.33	1,335.45 (100) (10.60%)	549.74	681.12 (100) (9.13%)		
Rolled	HVS		4.57	983.15	244.87	608.36	663.08	530.84	
	HVO		-	-	-	-	183.16	557.98	
	Sub total		4.57	983.15	244.87 (1.94%)	608.36	846.24 (11.35%)	536.71	
	CS		714.66	502.94	903.21	568.95	616.23	497.6	
	Kraft		146.38	394.69	122.41	460.87	120.95	427.06	
	BC		228.20	474.24	209.46	530.80	127.15	511.88	
	Crambar		-	-	-	-	464.30	552.53	
	Av./total		12,702.29 (100%)	487.10	12,595.45 (100%)	545.44	7,457.58 (100%) (1,1786.94 t/y)	528.32	

Table 5-4-4-1 Total Efficiency and Actual Operation Days

1. Actual Operation Days

Description		1981	1982	1983	Recommendation	Remarks
1. Annual peration	Day/y	365.0	365.0	364.71	365.0	Long-S.D 5 Day
2. Schedule shut down	Day/y	23.348	19.562	19.071	23.0	Maintenance S.D 1.0 Day x 5 = 5 Day; 1.5 Day x 6 = 9 Day
3. Available operation	Day/y	341.652	345.438	345.639	342.0	Others 4 Day; Total 23 Day
4. Stoppage (unschedule)						
as operation	Day/y	27.394	30.848	28.646	10.667	
as maintenance	Day/y	6.078	2.888	7.989	3.333	
Sub total		33.472	33.736	36.635	14.00	
5. Effective operation	Day/y	308.180	311.702	309.004	328.00	

2. Total efficiency

Description		1981	1982	1983	Recommendation			
					No-Super Cal.	G. Proof	HVS 45	HVS. HVG
1. Operating efficiency	%	91.98	91.07	91.71	96.88	92.76	96.24	96.88
2. Reeling efficiency	%	98.22	99.16	97.69	99.00	98.00	98.00	99.00
3. Finishing efficiency		84.12	85.81	85.17	89.67	88.00	88.00	88.62
Width efficiency	%	(97.00)	(97.00)	(97.00)	(97.0)	(97.0)	(97.00)	(97.00)
Finishing efficiency	%	(86.72)	(88.46)	(87.80)	(92.44)	(90.72)	(90.72)	(91.36)
4. Total efficiency	%	76.0	77.49	76.31	86.0	80	83	85

Table 5-4-4-2 Detail Actual Down Time Analysis in Paper Machine Operation

Revised

Description		1981		1982		1983		Recommendation	Remarks
1. Annual operation	Days/y	365.0		365.0		364.71		365.0	
2. Schedule shut down	Days/y	23.348		19.562		19.071		23.0	
Maint. schedule		17.281		15.676		13.491			A-1, A-7
Paper grade changing		1.076		1.738		2.226			A-4
Calender roll resetting		3.991		1.417		2.659			B-1
Wire, canvas changing		1.000		0.731		0.695			C-2
3. Available operation	Days/y	341.652		345.438		345.639		342	
4. Stoppage (unschedule)									
4-1) Cause of operation									
Cleaning	Hr/y	94:47		92:36		83:43			A-2
Sheet break		408:05		510:03		464:44		1) Sheet break 15 min. x 2.5 x 342 day = 213.75 Hr	A-6
Dandy roll changing		17:10		17:08		28:53			A-3
Carrier rope changing		4:18		9:07		6:08			C-3
Trouble on doctors		3:03		4:32		7:23		2) Others	a part of B-1
Trouble on operation		18:40		36:58		53:31		42.25 Hr	C-1
Trouble on stock quality		18:00		21:45		27:03			A-5
Change or trouble of wire cloth, Canvas or felt		93:24		48:12		16:05			C-4
Sub total	Hr/y	657:27		740:21		687:30		256:00	
	Days/y	(27.394)		(30.848)		(28.646)		(10.667)	
4-2) Cause of Maintenance									
Maintenance section	Hr/y	92:14	64.57	27:47	40.10	50:06	26.12	40:00	
Electrical section		23:53	16.73	30:27	43.94	128:26	67.0	30:00	
Instrument section		1:25	1.00	8:47	12.67	4:00	20.91	4:00	
Trouble of diesel		2:56	2.05	2:17	3.29	6:23	3.3	4:00	
Trouble of steam		0		0		1:45	0.91	2:00	
Others		22:22	15.65	0		1:04	0.55	0	
Sub total	Hr/y	145:52	100:00	69:18	100:00	191:44	100:00	80:00	
	Days/y	(6.078)		(2.888)		(7.989)		(3.33)	
Total	Hr/y	803:19		809:39		879:14		336:00	
	Days/y	(33.472)		(33.736)		(36.635)		(14.0)	
5. Effective operation	Days/y	308.18		311.702		309.004		328.0	

Table 5-6-1 Comparison of Printing/Writing Paper Quality

Description		BRPT				Suruya Kertas	Indah Kiat	Leces		Ciwi Kimia		Remarks
		HVS 45	HVS 50	HVS 80	HVS 80	45 g/m²	60 g/m²	50 g/m²	60 g/m²	50 g/m²	80 g/m²	
Basis weight	g/m²	46.5	50.1	83.6	80.7	44.1	60.7	50.7	60.0	52.0	83.4	
Thickness	mm	0.061	0.064	0.112	0.110	0.061	0.07	0.067	0.080	0.065	0.106	
Density	g/cm³	0.76	0.78	0.75	0.73	0.72	0.79	0.76	0.75	0.80	0.79	
Brightness Face	%	81.5	82.5	81.0	80.0	81.0	81.5	78.0	83.2	84.1	85.0	Photovolt
Back	%	81.5	83.0	82.0	80.6	81.0	82.0	78.9	84.0	84.5	86.0	Photovolt
Opacity	%	72.0	77.5	91.0	92.0	74.5	87.0	76.5	82.7	79.2	87.1	Photovolt
Smoothness Face	sec	34.0	34.0	25.0	39.0	44.0	57.0	40.0	40.0	95.0	46.0	
Back	sec	36.0	34.0	23.0	31.0	43.0	45.0	35.0	23.0	83.0	22.0	
Speck	mm²/100g	-	-	-	102.0	29.6	16.6	8.93	9.09	26.9	12.8	
Tensile MD/CD	kg	3.66/1.53	3.41/1.21	5.13/2.15	5.03/2.24	3.44/1.24	4.10/1.39	3.82/1.85	3.92/1.93	3.75/2.65	6.60/3.95	
Elongation MD/CD	%	-	-	-	1.6/3.1	1.3/3.0	1.8/4.4	1.9/3.9	1.7/6.0	1.8/3.8	2.4/5.5	
Breaking L. MD/CD	km	-	-	-	4.16/1.85	5.2/1.87	4.50/1.53	5.02/2.43	4.36/2.14	4.81/3.40	5.28/3.16	
Stiffness MD/CD	cm/100	-	-	-	98.0/35.1	28.6/10.9	38.7/17.3	35.1/16.4	42.5/19.5	35.1/21.0	84.9/59.3	Clark
Air permeability	sec	100.0	84.0	72.0	52.0	63.0	65.0	130.0	125.0	62.0	223.0	Clark
Sizing	sec	15.0	10.0	-	32.0	8.0	4.0	6.0	15.0	11.0	31.0	
Picking Face	A	-	-	-	Less 2.0	2.0	2.0	3.0	2.0	3.0	3.0	
Back	A	-	-	-	Less 2.0	2.0	2.0	2.0	2.0	3.0	2.0	
Ash	%	5.0	10.6	12.8	10.1	6.3	15.3	7.6	10.1	9.1	8.1	
Moisture	%	-	-	-	7.0	7.4	6.8	7.5	7.6	7.5	7.6	

Table 5-6-2 Comparison of Cyclo Paper Quality

Description		BRPP		Indah Kiat	Saras-Wati	LECES		Remarks
		70 g/m²	70 g/m²	70 g/m²	70 g/m²	70 g/m²	70 g/m²	
Basis weight	g/m²	71.50	69.5	75.2	70.6	71.4	81.8	
Thickness	mm	0.147	0.149	0.200	0.144	0.118	0.131	
Density	g/cm³	0.49	0.47	0.38	0.49	0.61	0.61	
Brightness Face	%	78.0	77.0	81.7	74.7	79.8	80.3	Photovolt method
Back	%	78.0	75.2	82.4	73.9	78.2	80.4	Photovolt method
Opacity	%	72.0	90.7	91.2	92.8	94.5	88.8	Photovolt method
Smoothness Face	sec	-	6.0	8.5	5.5	11.0	8.5	Bekk method
Back	sec	-	3.1	5.1	5.1	5.8	6.1	Bekk method
Speck	mm²/100g	-	103.0	6.38	98.8	27.9	32.7	
Tensile M.D.	kg	3.28	3.71	4.35	2.26	5.48	5.38	
Elongation M.D.	%	-	1.4	1.2	1.2	1.6	2.2	
Breaking L. M.D.	km	-	3.56	3.86	2.46	4.09	4.38	
Air permeability	sec	8.0	9.8	11.0	6.0	45.0	64.0	
Sizing	sec	10.5	-	14.0	71.0	0	36.0	
Picking Face	A	-	Less 2.0	2.0	Less 2.0	Less 2.0	2.0	
Back	A	-	Less 2.0	2.0	Less 2.0	Less 2.0	Less 2.0	
Ash	%	10.7	9.2	15.3	7.6	14.9	5.7	
Moisture	%	-	7.1	6.5	7.3	7.8	7.9	

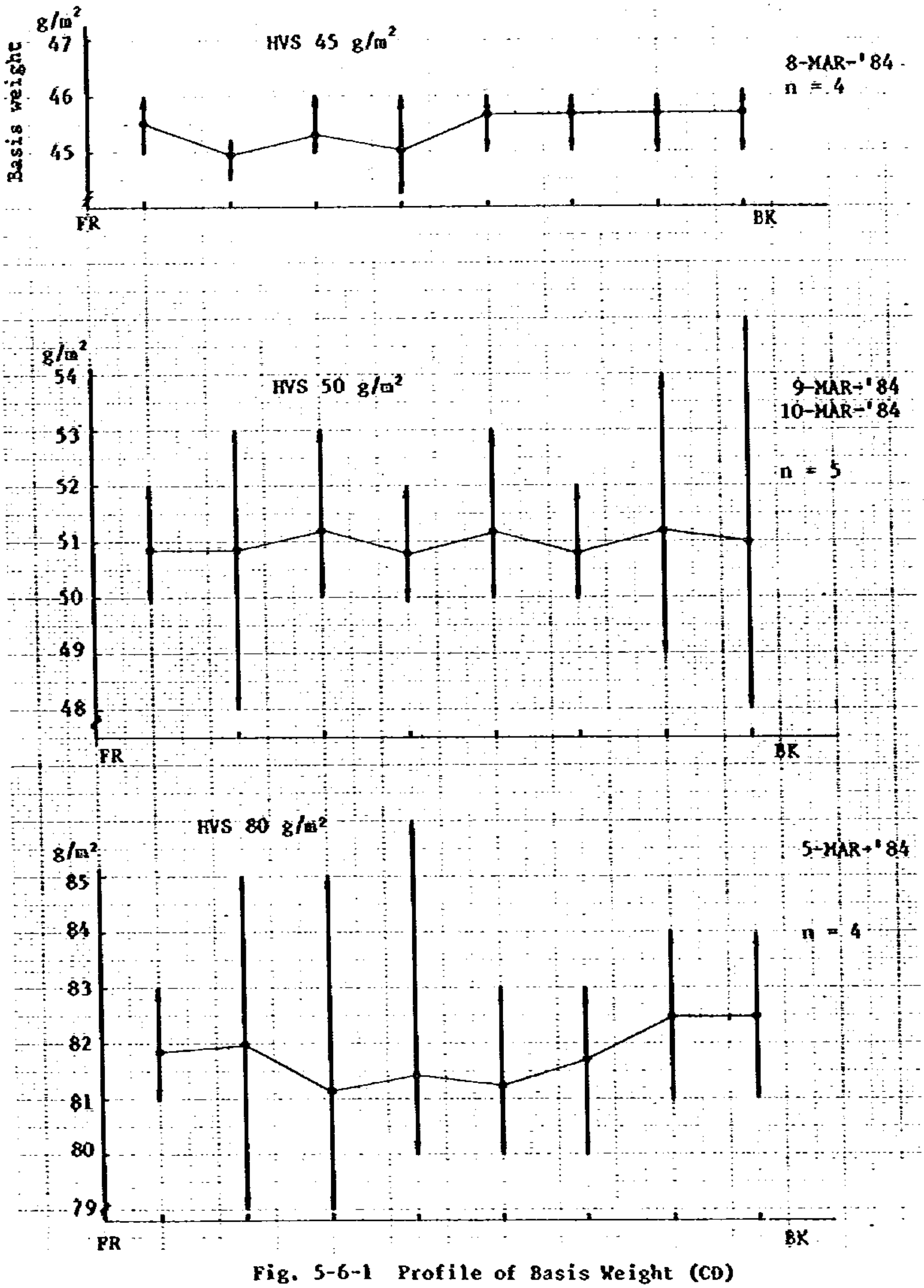


Fig. 5-6-1 Profile of Basis Weight (CD)

CHAPTER 6 CURRENT SITUATION AND PROBLEMS OF PULP DEPARTMENT

CHAPTER 6 CURRENT SITUATION AND PROBLEMS OF PULP DEPARTMENT

6-1 General

The existing pulp plant was designed for 30ADt a day and the operation started in 1961. Since then, the equipment was partially expanded to increase the production capacity to 42ADt a day.

In the beginning, bamboo available in the surrounding area was used as the raw material, but as bamboo became scarce, wood was mixed, and the raw material used now is almost completely wood. It is said that bamboo will not be available at all in 1988.

Coniferous tree log (N-wood) and broadleaved tree log (L-wood), both without barking, are made into chips, and cooked into a digester to make the pulp.

The first basic point to stabilize the pulp quality is to determine and maintain an optimum compounding ratio of mixed chip, N and L-wood, however, due to the restrictions on the existing equipment, it is difficult to maintain a reasonable compounding ratio of mixed chip and to control those quantities. This weak point illy influences the pulping and bleaching, and forms the main cause for uniform cooking and unstabilized pulp quality.

6-2 Wood Preparation Plant

6-2-1 Capacity

(1) Chipper capacity

Four wood chippers are installed and they can process logs at a rate of $60m^3$/hr (refer to Table 6-2-2).

The quantity actually chipped in recent three months (December 1983 to February 1984) as a total of the N and L-wood is 16,972.5SM (3,008.74BDt). The breakdown is 10,824.63SM (1,991.72BDt) of Pinus, 5,744.14SM (971.81BDt) of L-wood and 403.73SM (45.21BDt) of bamboo (refer to Table 6-2-3).

The species used the most in the L-wood is Albasia (2,856.61SM – 414.19BDt), followed by Turi (2,117.15SM – 321.79BDt). The quantity of Mangrove used is 576.26 SM (203.41BDt), and the volume ratio (SM) in the L-wood is 10.03%, weight ratio (BDt) is 20.93%. No bamboo was used in January and February, 1984.

Table 6-2-1 Log Consumption (by Chippers)

Log name	Dec. '83		Jan. '84		Feb. '84	
	SM	BDt	SM	BDt	SM	BDt
1. Pinus	2,942.17	541.35	3,376.09	621.20	4,506.37	829.17
2. Bamboo (1/2N) (1/2L)	403.73	45.21	0	0	0	0
3. Turi (L)	494.85	75.21	508.72	77.32	1,113.58	169.26
4. Mangrove (L)	199.93	70.57	62.11	21.92	314.22	110.92
5. Albasia (L)	558.41	80.96	892.65	129.43	1,405.55	203.80
6. Lamtoro (L)			0	0	194.12	32.42
Total	4,599.09 SM	813.3 BDt	4,839.57 SM	849.87 BDt	7,533.84 SM	1,345.57 BDt

SM: Stere Measure

Table 6-2-2 Chipper Performance

	No. 1 chipper	No. 2 chipper	No. 3 chipper	No. 4 chipper
Disc diameter	62"(1,575 mm)	1,020 mm	1,020 mm	1,020 mm
No. of knives	6	6	6	6
Motor power	190 kW	75 kW	75 kW	75 kW
Knife speed	735 rpm	480 rpm	480 rpm	480 rpm
Capacity	30 m^3/hr	10 m^3/hr	10 m^3/hr	10 m^3/hr
Cutting logs	N-wood Large size diameter logs	L-wood Small size diameter logs	L-wood Small size diameter logs	L-wood Small size diameter logs
Chipper manufacturering maker	Carthrge Co. USA	Chugoku Machinery Co., Japan		

Note: 12 disc knives can be mounted to No. 1 chipper.

	No. 1 chipper	No. 2 chipper	No. 3 chipper	No. 4 chipper
Available continuous operating time	10 hr	8 hr.	8 hr.	8 hr.
Disk knife				
Interval times of chipper for knife changing	Once/1-2 days	Every 8 hours	Every 8 hours	Every 8 hours
Hours for change	2 hours	1 hour	1 hour	1 hour
Bed knife				
Interval time for bed knife changing	Once/2-3 hours	Once/week	Once/week	Once/week
Hours for change	2 hours	1 hour	1 hour	1 hour
Timing for change the chipper knife	After finished of chipping	Stopped and changed as needed.		

Note: Available continuous operating time means the operating time from after changing a knife to next change.

Table 6-2-3 Actual Chipper Operating Time

No. of Chipper	Dec. 1983		Jan. 1983		Feb. 1984	
	Operating time	Non-operating time	Operating time	Non-operating time	Operating time	Non-operating time
	hr-min	hr-min	hr-min	hr-min	hr-min	hr-min
No. 1	118:15	404:00	124:00	365:00	103:30	476:45
No. 2	17:30	700:45	0:00	744:00	11:00	662:00
No. 3	42:15	612:30	16:30	706:00	108:30	467:15
No. 4	137:15	376:50	149:00	308:00	199:30	232:00
Total	315:15	2,094:05	289:30	2,123:00	422:30	1,838:00

Note:
1. The time for chipper knife change is not included in this table.
2. The operating rate of No. 1 chipper is about 22%.
3. The average operating rate of No. 2, No. 3 and No. 4 chippers is about 20%.

(2) Log yard and log storage capacity

The log yard is about a 4.2ha area and its effective storage area is 2.6ha. Logs are carried into the mill by trucks.

The quantity of logs stored as of March 13, 1984 was 6,307SM, which accounts for only about 15% of the storage capacity. The quantity of stored N-wood is for about a 10-day production and that of L-wood is for about one-month production.

Purchased chips of L-wood are carried in from a nearby chip plant by trucks and immediately are fed into the chip silo by belt conveyor, leaving almost no chips to be stored in the chip yard.

In order to stabilize the pulp quality, we recommend that an appropriate storage period of logs in the log yard is maintained. The period should be at least three months for both of the N and L-wood, for the following reasons.

1) Giving seasoning to the logs eliminates reducing the pitch trouble and bubbling trouble of the black liquor in washing plant.
2) Uniformity of moisture content in logs, thereby stabilizing the cooking (stabilization of the quality, decrease of variation on the black liquor solid).
3) Maintenance of the stabilized compounding ratio of the mixed chips without being influenced by short time troubles of log transportation which are outside of the pulp plant control.

6-2-2 Compounding Ratio of Chip and Material Volume Control

(1) Compounding ratio of chip

The compounding ratio of chip is almost standardized for each paper grade (refer to Table 6-2-4). However, chips of N and L-wood from two or three chippers and purchasing chips of L-wood are carried by one belt conveyor and stored in one chip silo. It is impossible in actually to mix the N and L-wood chips as determined ratio at the belt conveyor.

However, the total quantity of chips that are supplied to the digester can be measured by the conveyor weight scale before the digester.

(2) Countermeasures to improve the mixed chip ratio

On this renovation project, mixing of the N and L-wood chips must be measured in a correct ratio to stabilize the pulp quality. Accordingly, we recommend installation of chip silos ($150m^3 \times 2$) and one belt conveyors, so that N and L-wood chips can be stored separately.

Chips from under each chip silo should be fed to digesters and cooked separately by two digesters (N and L chips).

Table 6-2-4 Standard of Compounding Ratio of Chip (%)

		Pinus	Turi	Mangrove	Procured chips
Printing paper	HVS	50	15	–	35
Writing paper	HVO	50	15	–	35
Litho paper	CS	50	–	15	35
Packaging kraft paper	KRAFT	70	30	–	–
Drawing paper	GAMBAL	70	–	–	30

6-2-3 Details of Pulp Log

(1) The current consumption of the above pulp logs are 45% of N-wood and about 27 to 28% of L-wood, converted into self-made pulp (BKP), and purchased L-wood chips occupy about 27 to 28%.

(2) The kinds of N-wood are fairly constant but on L-wood, there are many kinds and the order of consumption quantity varies each time (refer to Table 6-2-1). Furthermore, the diameter of almost all logs is up to 10cm.

(3) The diameter of L-wood for the purchased chips (mostly Lamtoro) is about the same as that of Item (2). In addition, even branches are chipped.

(4) We think stabilization of the pulp quality is nothing but stabilization of kinds of logs.

Therefore, careful consideration must be always given to quality, purchase, and other related plans for L-wood.

6-2-4 Use of Mangrove Logs

Use of mangrove logs must be stopped since they have no merits as pulp logs for the following reasons.

(1) A mangrove log is difficult to cook. The permeation of cooking chemicals is slow and there are many knots.

(2) A mangrove log is very hard, so the life of the chipper knife is about 50% shorter than with the case of other logs.

(3) Because of the salt contained in mangrove logs, material (mild steel) of digester, blow tank are damaged by corrosion.

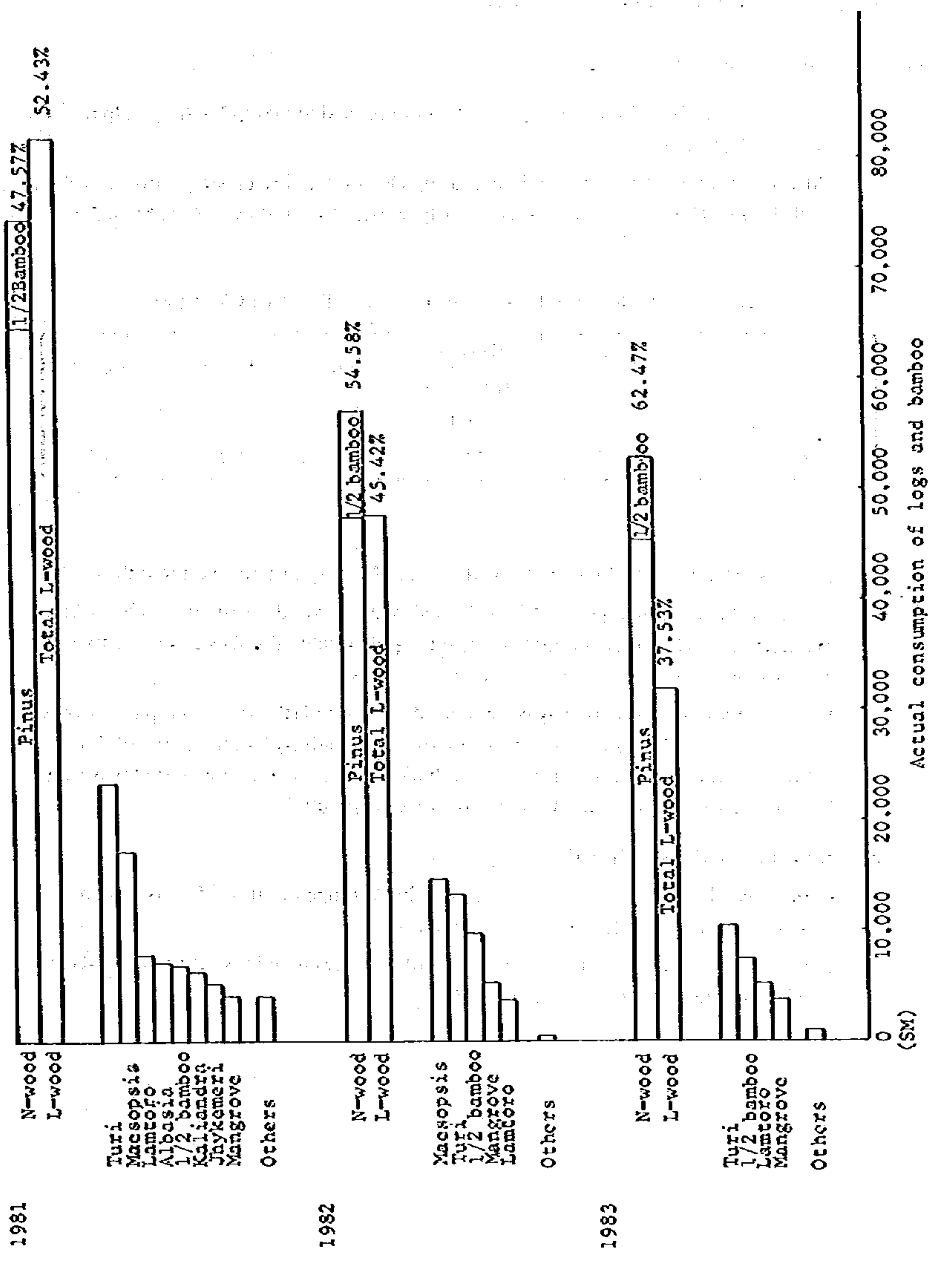


Fig. 6-2-1 Consumption of Logs and Bamboo

6-2-5 Quality of Log and Purchasing Chips

(1) Ratio of bark on log

a) Normally both N and L chips without barks are cooked to make bleaching pulp to maintain the high quality.

At present, most of the logs and purchasing chips which are brought into the mill are with barks. The quantity of barks is fairly substantial as shown in Table 6-2-5.

Table 6-2-5 Ratio of Bark in Log Chips and Procured Chips (%)

	Pinus	Procured chips (Lamtoro)	Turi	Albasia	Co. H
Before screen	–	15.4	–	–	–
After screen	2.0 – 5.0	14.5	6.6	0.1	1.0

It is desirable that the logs are barked before chipping to improve the pulp quality. However, barking of logs is difficult in reality on L-wood, most of which are small diameter logs. Therefore, improvement of the pulp quality should be pursued by using a chip screen, thereby removing at least wood dust.

Barking of logs should definitely be conducted on N-wood (Pinus). This is recommended because, first of all, diameters of L-wood are comparatively large, and the bark comes off during transportation and storage, so bark volume remaining on the logs is rather low. Therefore, barking work in mill is not so difficult.

b) Influence of chips with bark to pulp yield

Ordinarily, the rate of bark to the log is within a range of 10 to 25% as weight, and this rate is greater on logs of small diameters.

For reference, we are showing a comparison of cooking conditions between mixed chips of 8% bark rate and 0% in Table 6-2-6.

Table 6-2-6 Influence of Chips with Bark to Yield

	Yield (BD)	Organic substances	Digesting chemical (AA 17%)	Total	Total solid t/UKPt (BD)	Total solid t/UKPt (AD)
Without bark	45.61%	54.39%	26.55%	80.94%	1.77	1.60
With 8% bark	41.96%	58.04%	26.55%	84.59%	2.02	1.82

(2) Chip size of wood

As shown in Table 6-2-6, the ratio of bark in chips after the chip screen is 2 to 5% in the case of Pinus, 6 to 7% in the case of turi and 14.5% in the case of purchased chips (Lamtoro), especially, bark ratio of purchased chips is greater than the others.

On the conditions of 20mm diameter hole pass and 6.73mm diameter hole on, 81.8% or more of chips are sent to the next process after the chip screen. The rate of chips that pass through 6.73mm is 4.4% on Pinus and 11.4% on purchased chips, indicating that purchased chips contain many small-sized chips.

This dust is cooked in the same conditions as normal-sized chips. Therefore, overcooking results on most of the dust, causing lower paper property, increase of solids in the black liquor and plugging trouble at the strainer in the digester.

Therefore, the ratio of dust must be kept to the lowest possible level. Normally, the hole diameter of existing bottom chip screen is 3mmϕ, and it is assumed that this causes the large rate of dust contained in the chips after the chip screen. The estimated dust ratio when the hole diameter of bottom chip screen is changed to 5mmϕ is 3% on Pinus and 8 to 9% on purchased chips (Lamtoro). In the case of bleached pulp chip, the limit of dust ratio after the chip screen is 2% in Japan.

Table 6-2-7 Chip Size Distribution after Screen (%)

	Pinus	Procured chips (Lamtoro)	Turi	Albasia	Co. H
20	0	6.8	0	5.5	–
6.73 mm ON	95.6	81.8	99.6	94.1	–
2.83 mm ON	4.1	9.8	0.1	0.2	–
2.83 mm PASS	0.3	1.6	0.3	0.2	–
Total	100	100	100	100	–

Note: One log each of pinus, turi and albasia was chipped for sampling.

6-2-6 Purchased Chips

(1) Quantity of chips received

Since its use started in July 1981, the quantity of L-wood purchased chips gradually increased and, as of 1983, the ratio of purchased chips in the self-made L-pulp was 51.93%, or 2,521.9BDt in the LBKP conversion. The details are as shown below. Quality of purchased chips greatly influences the pulp quality, because use of purchased chip ratio is high. So, the quantity, price and quality of them must always be carefully watched.

Table 6-2-8 Consumption of Purchasing Chips

		1981	1982	1983
Procured quantity	ADt	2,599.96	9,388.50	9,133.81
BKP conversion	BDt	541.91	2,262.34	2,521.90
Ratio to self-made mixed pulp	%	5.8	24.33	28.45
Ratio to self-made L-pulp	%	10.53	40.87	51.93

Note: 1. Since the use was started in July, the quantity for 1981 is for a 6-month portion.
2. The reason for difference on the ratio between the procured quantity and BKP converted BDt value is that we revised the data based on annual reports.

(2) Review on purchased chip price

The following compares the price of purchasing chips based on the obtained data of 1983 and the calculated price of the chips supposing that they were produced by BRPP.

a) Purchased chips

The price of purchased chips (Lamtoro) during 1983 was as follows:

Price of purchased chips	35.51 Rp/ADkg
Assuming that the average moisture content is 30%	46.44 Rp/BDkg

b) Self-made chips

i)	Log price	4,439.28 Rp/SM
		1SM = 167BDkg
		26.58 Rp/BDkg
ii)	Electricity cost and chipping expenses	5 Rp/BDkg
iii)	Self-made chip price	26.58 + 5 = 31.58 Rp/BDkg

c) Comparison

Procured chips	46.44 Rp/BDkg
Self-made chips	31.58 Rp/BDkg

The price of purchased chips is as much as 1.47times that of the self-made chips, and this is quite a high price.

6-2-7 Working System

(1) Number of workers

The number of workers in the wood preparation section is as follows:

Foreman	1person
Plant employees:	
12persons/shift × 2shifts/day	24persons
General labors	15persons
Total	40persons

(2) Review of working system

Since the existing operating time of chippers is about 20 to 22%, as shown in Table 6-2-3, the chipping works can be done by daytime work only.

Also, since this renovation project plans installation of two chip silos (one each for L-wood chips and L-wood purchased chips), the labor situation will be easier than the existing one.

We recommend that the excess workers in the wood preparation section should be assigned to other jobs. The saving of expenses by the assignment change of workers should be applied to expenses of barking on pinus logs.

[Reference] Review on workers necessary for pinus barking

The following preconditions are set:

The required Pinus wood pulp is 13.21 BDt-UKP/d.
2.2 m^3/BDt of Pinus wood is needed.
The quantity of Pinus wood to produce 1BDt-UKP is 2.63 BDt.
The ratio of bark attach with wood is 30%.

When barking is conducted by labores, one person can bark 1.8 to 2.5 m^3/d (8 hours). When a calculation is made based on 1.8 m^3/d, the number of workers necessary for the barking is as follows:

$13.21 \times 2.2 \times 2.63 \doteqdot 76.43 m^3/d$
$76.43 \times 0.3 = 22.93 m^3/d$
$22.93 \div 1.8 = 12.74$ workers/day

Since the workers are given one day off per week:

$12.74 \times 7/6 = 14.6 \fallingdotseq 15$ (workers)

Considering an allowance of 3 workers, the final number of workers to assign is:

$15 + 3 = 18$ (workers)

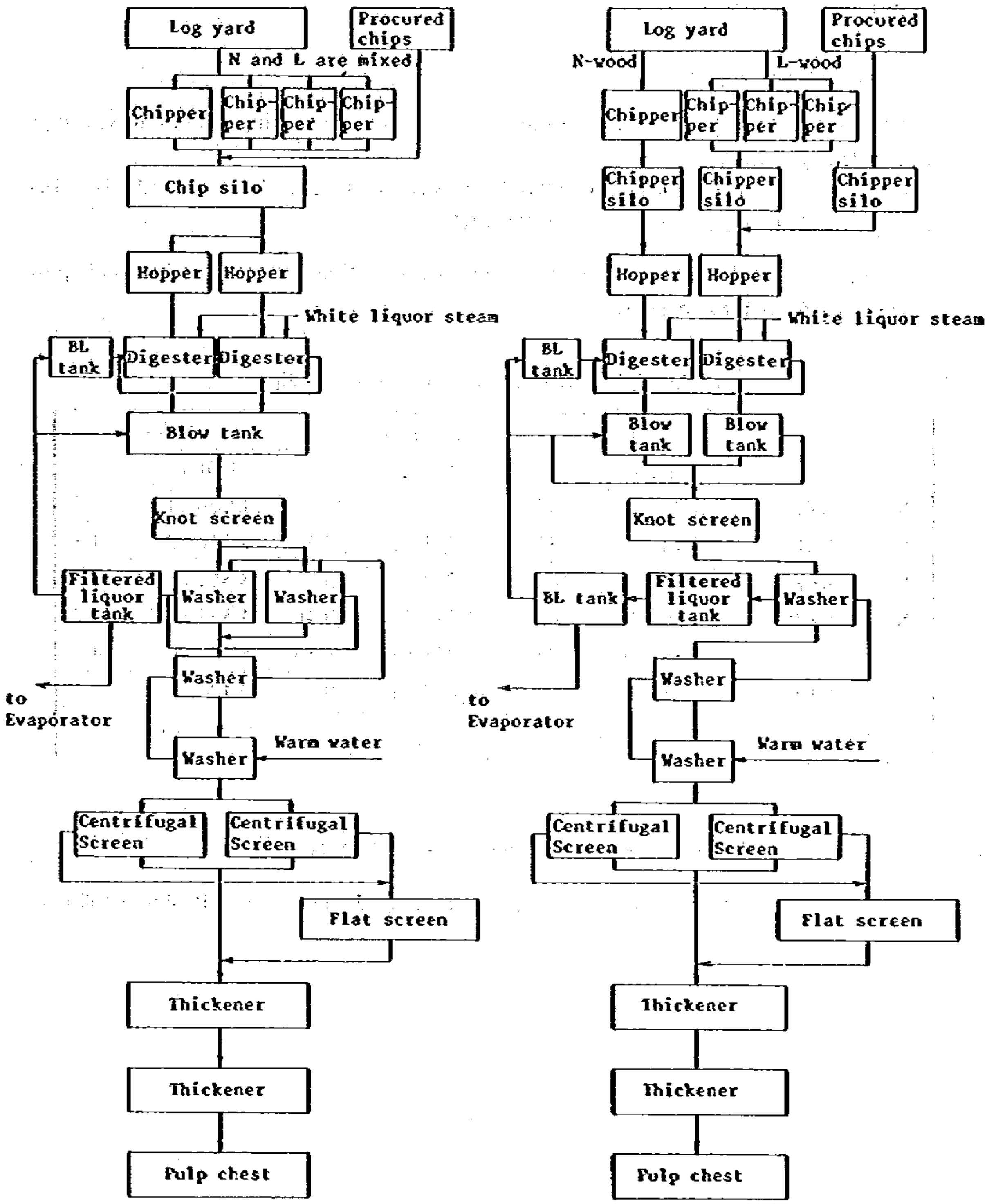


Fig. 6-2-2 Pulp Flow Sheet

6-3 Cooking Facilities

6-3-1 Actual Production

(1) Annual production

BRPP has two $50m^3$ (volume) digesters and both digesters are cooking N and L mixed chips in a batch system.
The actual production in 1983 is about 9,000BDt-BKP, working for 349 days, and this makes an average daily production about 29 BDt-BKP.

The following shows the production by N and L classification and total production in past three years from 1981 to 1983.

Table 6-3-1 Actual Annual Production of Pulp

	1981		1982		1983	
	BDt/y	%	BDt/y	%	BDt/y	%
N BKP	4,205.23	45	3,761.96	40.46	4,006.31	45.2
L BKP	5,147.65	55	5,535.72	59.54	4,856.33	54.8
N+L BKP	9,352.88	100	9,297.68	100	8,862.64	100
N UKP	4,805.21	45	4,298.70	40.46	4,577.91	45.2
L UKP	5,881.80	55	6,325.53	59.54	5,549.20	54.8
N+L UKP	10,687.01	100	10,624.23	100	10,127.11	100
Working days	346.8		347.9		349.3	

(2) Situation and yield of recent production (Dec. '83 – Feb. '84)

a) The actual monthly production during December 1983 and February 1984 is as follows.

Table 6-3-2 Recent Actual Production

	Chip consumption BDt	Pulp production BDt-UKP	Yield %	Cycles of digestion Batch
Dec. '83	1,473.010	634,350	43.06	139
Jan. '84	1,730,430	789,500	45.52	165
Feb. '84	2,148,040	948,200	44.18	210
Total	5,351,480	2,372,050	132.82	514
Average	1,783,830	790,680	* 44.38	171.3

* The yield value calculated by Honshu is 42.73%.

b) Actual yield of pulp

The estimated monthly yield of pulp during December 1983 and February 1984 is shown in Table 6-3-2.

c) Cooking time

The average cooking time during December 1983 and February 1984 is shown in Table 6-3-3.

The average cooking cycle at normal situation is 7.1 batches per day by two digesters (refer to Fig. 6-3-1).

Since the average pulp production per batch is 4.615 BDt-UKP, therefore the daily pulp production is $4.615 \times 7.1 = 32.76$ BDt-UKP.

Table 6-3-3 Actual Cooking Time

	Filling	Steaming	Retention	Blowing	Total
Average	30 min.	184 min.	92 min.	20 min.	5 h 26 min.
Maximum	30	190	190	20	6 h 50 min.
Minimum	30	140	80	20	4 h 30 min.

[Estimation of maximum production capacity]

If enough steam is supplied, the capacities of black liquor heater and black liquor circulation pump are increased and more cooking chemical is used (increase of active alkali addition), the cooking time could be reduced to 200 minutes per batch.

In such a case, the pulp production will be as follows:

1,440/200×2dig.×0.9×4.615=60BDt-UKP/d

So that the maximum capacity will be 50 to 60BDt-UKP per day.

6-3-2 Current Cooking Conditions

The cooking conditions applied during December 1983 and February 1984 are shown in Table 6-3-4.

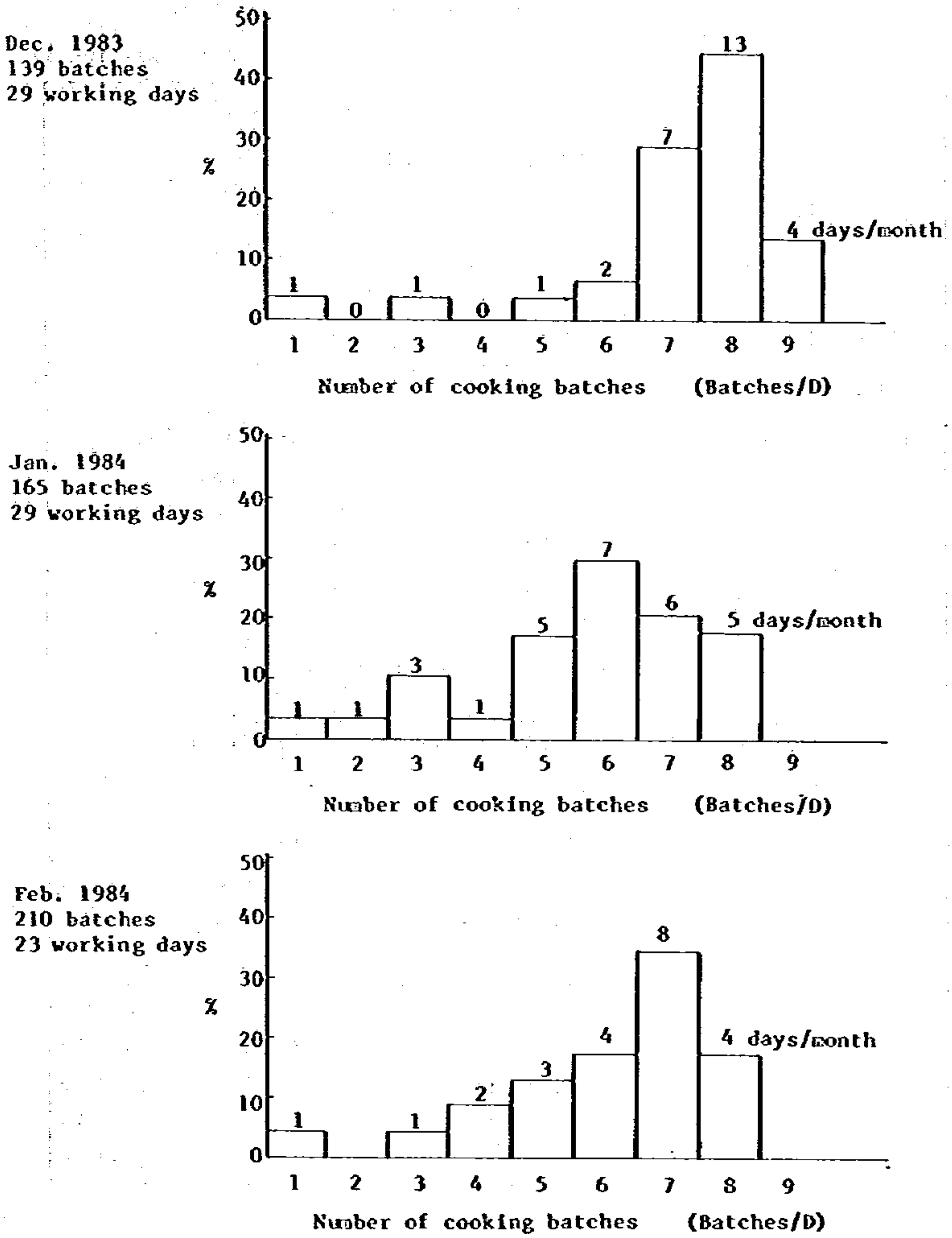


Fig. 6-3-1 Numbers of Cooking Batches

Table 6-3-4 Current Cooking Conditions (Dec. '83 - Feb. '84)

A-1 (Existing-1)

	Item	Current actual	
1)	Cooking method	Mixed chip with kraft process	
2)	Role No.	Standard	4.0 ± 0.3
3)	Active alkali addition (Na_2O)	Standard	17%/BD chip
4)	Sulfidity	Actual	23.7%
5)	Liquid ratio	Actual	3.2
6)	Cooking yield		44.38% (* 42.73%) N/L = 45/55
7)	Washing yield	Standard	98%
8)	Bleaching yield	Actual	89.34%
9)	Total yield	 (1982 average:	38.86% (* 37.41%) 35.9%)
10)	Cooking conditions of unbleached pulp	Recent data (1983 average:	29.76 BDt/d 29.83 BDt/d)
	Quantity of chips filled		10.4 BDt-chip/batch
	Pulp production/batch	10.4 x 0.4438 =	4.615 BDt-UKP/batch
	Cooking cycles/day	Average	7.1 batches/D
	Quantity of cooking liquid required	Liquid ratio: 3.2	10.4 x 3.2 = 33,280 kgs/batch
	Quantity of WL required	10.4 x 0.171 x 1000/91.44	= 19.472 m^3/batch
		WL 19.472 x 1.1 =	21,419 kg
		Moisture content in chip	5,600 kg
		Black liquor	6,261 kg
		Total	33,280 kg

Table 6-3-4 (Continuing)

A-2 (Existing-2)

	Item	Current actual
11)	Solid materials (BD) in black liquor	from chips 10,400 - 4,615 = 5,785 kg from cooking chemicals $\frac{0.27}{0.17}$ x 91.44 x 19.472 = 2,828 kg Total 8,613 kg
12)	Filling content of digester	Chips 10,400 kg Moisture content in chips 5,600 kg White liquor 21,418 kg Black liquor 6,260 kg Vapor exhausting Δ 5,000 kg
13)	Stock consistency in blow tank	$\frac{4,615}{38,680}$ x 100 = 11.93%
14)	Solid content of BL in blow tank (excl. solids in BL for liquid ratio adjustment)	$\frac{9,132}{38,680 - 4,615}$ x 100 = 25.29%
	Solid content of BL in blow tank (incl. solids in BL for liquid ratio adjustment)	6,260 x 0.2 = 1,252 kg $\frac{1,252 + 8,613}{38,680 - 4,615}$ x 100 = 28.96%
15)	Generated solids in black liquor (excl. solids in BL for liquid ratio adjustment)	$\frac{8,613}{4,615}$ = 1.866 kg/BDt-UKP

6-3-3 Pulp Quality

(1) Quality

The quantity of self-made pulp in 1983 accounts for about 85% (about 9,200BDt/y) of the whole pulp consumed.

Therefore, the quality of paper largely depends on the quality of self-made pulp and stabilization of the self-made pulp quality is especially important.

The quality of self-made pulp can be stabilized by stabilizing the furnishing mixed wood chips and by maintaining stabilized cooking conditions.

However, it is difficult to furnish stable mixed chips with the current equipment, so that Roe No., which is a factor used to judge the pulp cooking ability, largely fluctuates and the pulp quality by no means is stabilized.

(2) Roe No.

The standard value of BRPP for Roe No. of wood chips is 4.0 ± 0.3. The actual Roe No. in the three months from December 1983 to February 1984 is 4.14, 4.10 and 4.0, as the average of each month, and they are within the range of standard value.

However, when Roe No. for each batch is checked, the rate of the Roe No. being within the standard value is 31.4%, 26.2% and 40.2% of the total batches in each of these three months, indicating large fluctuation of Roe No. (refer to Fig. 6-3-2). The reasons why the Roe No. has to fluctuate so largely are as follows.

a) The N and L-wood are not mixed properly.

b) The moisture content of wood is not constant.

   In BRPP, the logs storage period is not long enough, and logs delivered to BRPP storage are mixing of dry and wet logs and the ratio of dry and wet is not constant.

c) The end of digestion is confirmed by the person who is in charge of cooking, then the pulp is blown.

   The variation of cooking degree could be made greater or smaller by difference of experience or difference of skill of the person in charge of digesters (refer to Fig. 6-3-3).

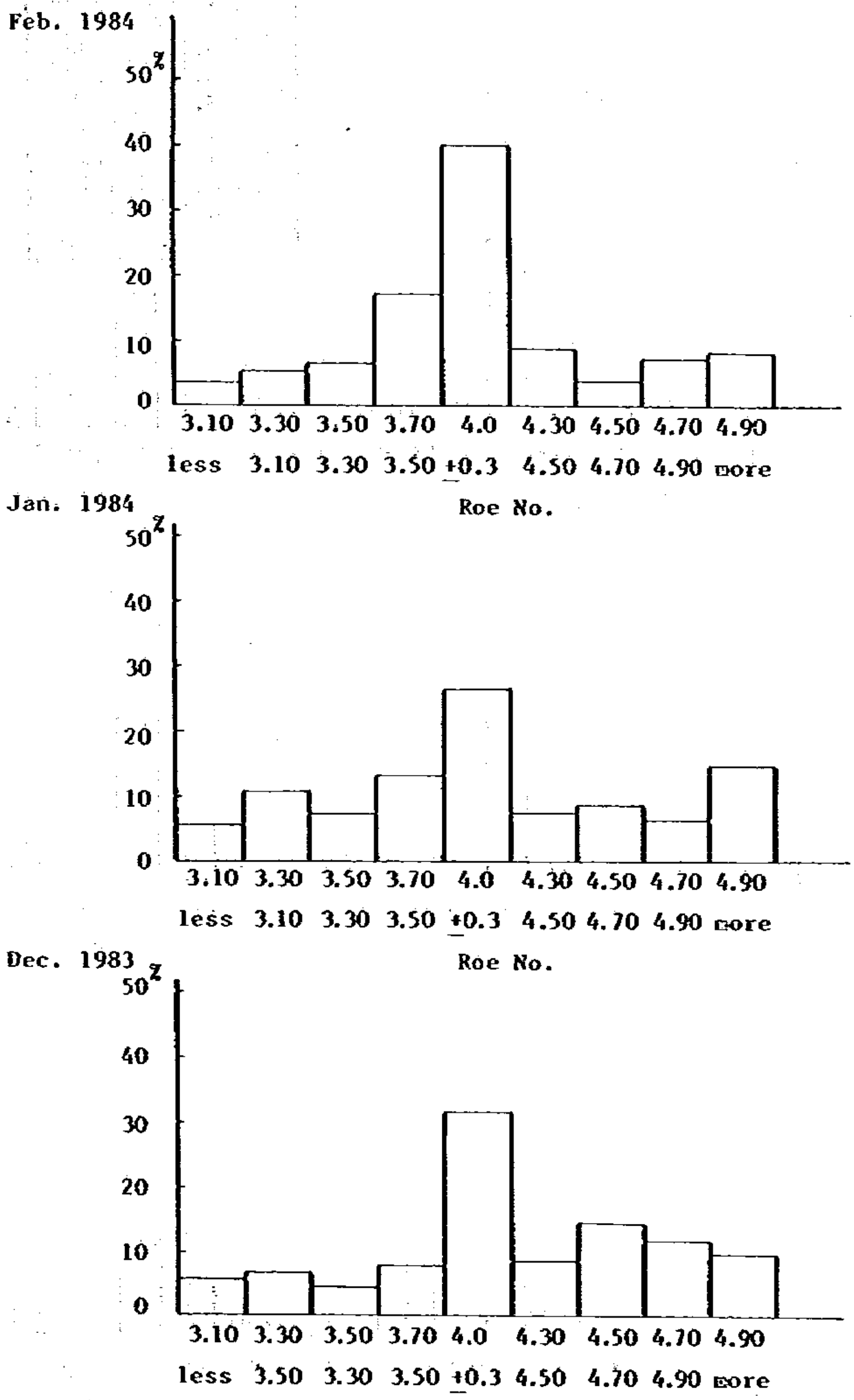


Fig. 6-3-2 Fluctuation of Roe No. of Unbleached Pulp

Feb. 1984

Target: 4.0 ±0.3

-4	Up to 3.10
-3	3.10 ∿ 3.30
-2	3.30 ∿ 3.50
-1	3.50 ∿ 3.70
0	4.0 ± 0.3
+1	4.30 ∿ 4.50
+2	4.50 ∿ 4.70
+3	4.70 ∿ 4.90
+4	4.90 or more

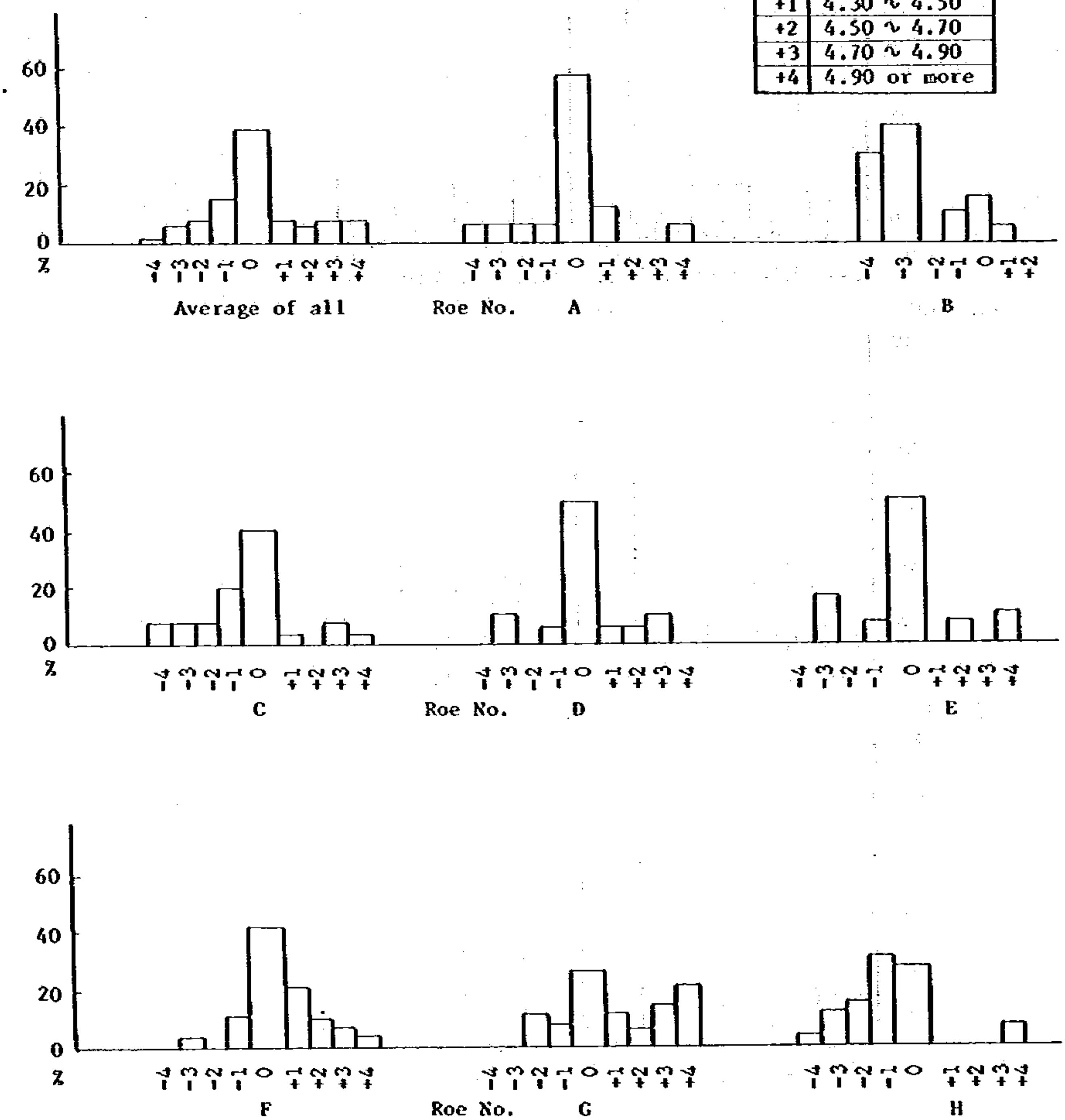


Fig. 6-3-3 Average Roe No. and Individual Difference

6-3-4 Quantity of Generated Black Liquor

(1) Current situation

During the months of December 1983 to February 1984, the quantity of black liquor was generated as following. (Refer to Table 6-3-5 and Table 6-3-6)

Table 6-3-5 Quantity of Generated Black Liquor

(Unit: kg/BDt. UKP)

	Solids eluted from chips	Inorganic solid in BL	Estimated loss of solids	Solids to unbleached pulp washer	Solids to evaporator
Dec. '83	1,315	644	Δ 11	1,948	1,205
Jan. '84	1,185	586	Δ 9	1,762	1,265
Feb. '84	1,258	611	Δ 10	1,859	1,343
Total	3,758	1,841	Δ 30	5,569	3,813
Average	1,253	613	Δ 10	1,856	1,271

Table 6-3-6 Actual Quantities of Generated and Received Black Liquor

	Unit	Designed capacity	Dec. '83	Jan. '84	Feb. '84	Average	Estimation of renovation
1) Pulp production		(31.5 BDt)	644,350 BDt	780.500 BDt	956.200 BDt		(29.35 BDt/d)
2) Generated black liquor	m^3/BDt-UKP		9.947	9.264	9,260	9.49	9.66
Weight	kg/BDt-UKP		10,733	9,949	10,000	10,226	10,406
Concentration	%		18.15	17.71	18.59	18.15	18.0
Weight of solid portion	kg/BDt-UKP		1.948	1.762	1.859	1.856	1.873
3) Received weak black liquor	m^3/BDt-UKP	6.92	6.15	6.65	6.69	6.50	9.37
Weight	kg/BDt-UKP	7,368	6,640	7,143	7,224	7,005	10,094
Concentration	%	18.50	18.15	17.7	18.59	18.15	18.0
Weight of solid portion	kg/BDt-UKP	1,400	1,205	1,265	1,343	1,271	1,817
4) Loss of other than black liquor	kg/BDt-UKP		743	497	516	585	56
5) Processed weak black liquor	m^3/BDt-UKP	6.92	6.13	6.56	6.69	6.46	9.37
Weight	kg/BDt-UKP	7,568	6,618	7,041	7,226	6,592	10,094
Concentration	%	18.50	18.15	17.71	18.57	18.15	18.0
Weight of solid portion	kg/BDt-UKP	1,400	1,201	1,247	1,343	1,264	1,817
6) Produced thick black liquor	m^3/BDt-UKP	2.08	2.18	2.19	2.25	2.20	3.120
Weight	kg/BDt-UKP	2,692	2,696	2,762	2,864	2,774	3,950
Concentration	%	52.0	44.65	45.14	46.91	45.33	46.0
Weight of solid portion	kg/BDt-UKP	1,400	1,201	1,247	1,343	1,264	1,817
7) Evaporated water	kg/BDt-UKP	4,876	3,922	4,279	4,362	4,188	6,144
8) Steam consumption	kg/BDt-UKP	1.327	1.29	1.27	1.14	1.23	1.76
9) Ratio of evaporation	kg/kg	3.675	3.04	3.38	3.83	3.41	3.50
10) Operating hours	h		43 h 25 min	558 h 10 min	735 h 45 min	553 h 26 min	24 h
11) Pulp material (Digestion)		Bamboo (Bamboo chips only)	Bamboo, N and L-wood (Mixed chips)	N and L-wood (Mixed chips)	N and L-wood (Mixed chips)		N and L-wood (Separated cooking)

6-3-5 Cooking Chemicals

(1) Quantities of chemicals added

In a kraft pulp plant, generally salt cake (Na_2SO_4) only is added for cooking and no other chemicals is added.

In most plants, salt cake is added at a rate of 55 to 60kg/BDt-BKP, but in the area where the control of water pollution is severe, the rate is 22kg/BDt-BKP.

The quantity of salt cake added by BRPP as an average of the three months of December 1983 to February 1984 is at a very high rate of 398kg/BDt-BKP. The quantity of salt cake to be added should be substantially reduced by renewing the washing facilities, replacing improper instruments and operating under an appropriate load through this renovation project.

The actual quantities of chemicals added in the three months of December 1983 to February 1984 and planned quantity of this renovation project are as follows. The quantities of chemicals to add are all indicated in values converted to 100% purity Na_2SO_4(refer to Table 6-3-8).

Table 6-3-7 Actual Consumption (Dec. '83 - Feb. '84) and Planning of Chemicals Consumption

		Dec. '83	Jan. '84	Feb. '84	Total	Quantity added kg/BDt-BKP	Planned quantity to add kg/BDt-BKP
Salt cake (Na_2SO_4)	kg 93%	51,700	84,300	88,000	224,000	107,862	76.1
Sodium sulfide (Na_2S)	kg 60%	47,720	17,032	25,850	90,602	43,627	0
Caustic soda (NaOH)	kg 100%	101,227	93,485.8	91,675.8	289,389	137,904	18.5
Pulp production	BDt-BKP	555,373	691.207	830,149	2,076,729	289,395	946

Table 6-3-8 Actual and Planning of Chemicals Consumption as 100% Sold and Rate of Na_2SO_4

		Dec. '83	Jan. '84	Feb. '84	Total	Quantity added kg/BDt-BKP	Planned quantity to add kg/BDt-BKP
Sale cake (Na_2SO_4)	kg	50,666	82,614	86,240	219,520	105.71	78.4
Sodium sulfide (Na_2S)	kg	52,125	18,604	28,236	98,965	47.65	0
Caustic soda (NaOH)	kg	179,679	165,937	162,725	508,341	244.78	35.5
Total		282,470	267,155	277,201	826,826	398.14	113.9
BKP production	BDt	555,373	691,207	830,149	2,076,729		—
Total salt cake BDt-BKP	kg/t	508.61	386.505	333.917	398.14	—	—

(2) Sulfidity

The average sulfidity in the three months of December 1983 to February 1984 is 24.77%, 24.96% and 24.88% respectively.

It is said that when the effective alkalinity is kept constant, 15 to 20% of sulfidity is the critical value to delignifying effect and that if the sulfidity increases to 25% or higher, the delignifying effect becomes smaller and the bleaching effect is also lowered.

Accordingly, the sulfidity must be kept at the level of 20 to 23%, only salt cake (Na_2SO_4) is used as the adding chemical and the use of costly sodium sulfide (Na_2S) should be stopped other than for really an abnormal case.

Ordinarily, salt cake only is used as the adding chemical for digestion in kraft pulp plants, and the operation is proceeding under the sulfidity is kept constant in a range of 20 to 25%.

Supposing that caustic soda (NaOH) only was used without using sodium sulfide (Na_2S) in the three months of December 1983 to February 1984, the sulfidity is calculated as follows. Except December 1983, the sulfidity is within a range of 20 to 23% even if the use of sodium sulfide was stopped as shown in Table 6-3-7 and 6-3-8.

Table 6-3-9 Sulfidity and Adding Chemicals

		Dec. '83	Jan. '84	Feb. '84
Salt cake to add (Na_2SO_4)	kg	22,122	36,071	37,654
Sodium sulfide to add (Na_2S)	kg	22,759	8,123	12,328
Total	kg	44,881	44,194	49,982
Consumption rate of Na_2S	%	50.71	18.38	24.66
NaOH in digestion solution	kg	193,987	219,344	274,839
Na_2S in digestion solution	kg	63,899	72,943	91,047
Total	kg	257,886	292,287	365,886
Sulfidity	%	24.78	24.96	24.88
Calculated value of sulfidity when NaOH is added instead of Na_2S		15.95	22.18	21.55
Chemical recovery rate	%	56.96	63.81	70.51

Note: The quantities of chemicals used are the total quantities used in one month. The values are shown after conversion into sodium oxide (Na_2O) basis.

6-3-6 Steam Consumption

(1) Actual steam consumption

The average actual consumption of steam in the three months of December 1983 to February 1984 is as shown below (Table 6-3-10).

The estimated steam consumption when N and L-wood is digested separately is also shown below (Table 6-3-11).

Table 6-3-10 Actual Consumption of Steam

	Steam pressure kg/cm²	Consumed steam t	Produced pulp BDt-UKP	Consumed steam/t pulp t/BDt-UKP	Operating hours hr-min	Average steam consumption t/hr
Dec. '83	9.1	1,571.53	644.35	2.44	469-00	3.35
Jan. '84	9.2	1,944.26	789.50	2.48	570-00	3.41
Feb. '84	9.5	2,179.62	956.20	2.28	593-20	3.67
Total	27.8	5,695.41	2,384.05	7.20	1,632-45	10.43
Average	9.3	1,898.47	794.68	2.39	544-15	3.49
Per batch	–	11.08	4.615	–	–	–

Table 6-3-11 Steam Consumption when Separate Cooking N and L-Wood is Made

			Actual consumption for mixed wood	Consumption for N-wood only	Consumption for L-wood only
Steam pressure		kg/cm²	9.3	9.5	9.5
Steam quantity	Average	t/h	3.49	3.67	3.67
	Peak	t/h	5.5	5.5	5.5
Consumption		t/BDt-UKP	2.39	2.30	2.30
Consumption		t/batch	11.08	10.6	10.6

(2) Inside temperature of digester body

The upper part of digester body is filled with steam during cooking, and the temperature is usually the same as the saturated stream temperature of applied pressure.

The record for March 1984 shows a fairly large difference between the two digesters. The instrument must be checked correctly. The pressure gauges as well as the thermometer need checking.

Table 6-3-12 Digester Temperature

	Pressure kg/cm²	Steam temperature °C	Indicated upper part temperature °C	Indicated lower part temperature °C
No. 1 digester	7.8	173.6	168	160
No. 2 digester	8.0	174.5	168	146

The following must be investigated.

1. Comparison of the pressure gauge with a standard pressure gauge.
2. Comparison of the thermometer with a mercury thermometer.
3. If the pressure gauge is normal, whether or not the gas is discharged sufficiently must be checked.
4. If the lower part temperature meter is normal, whether or not the black liquor circulates normally must be checked.

(3) Cooking curve

The average values of cooking curve in the three months of December 1983 to February 1984 and the estimated cooking curve after implementing this renovation project are shown in Fig. 6-3-4.

On the graph showing the actual cooking, the points of cooking start and arrival to the maximum pressure are connected by a straight line, but in actuality, this is a deformed curve. To make this deformed curve to as straight a line as possible is the key point to stabilize the quality.

If the cooking is proceeded along the cooking curve when the alkali adding rate and liquid ratio (water content of chips) are constant to the filling amount of chips, then Roe No. is kept within a certain range, and sample test during cooking by an experienced staff is no longer necessary.

When changing the cooking conditions, the change must be given to one factor only, and change other factor if the first result requires it. But do not make changes of two or more factors concurrently.

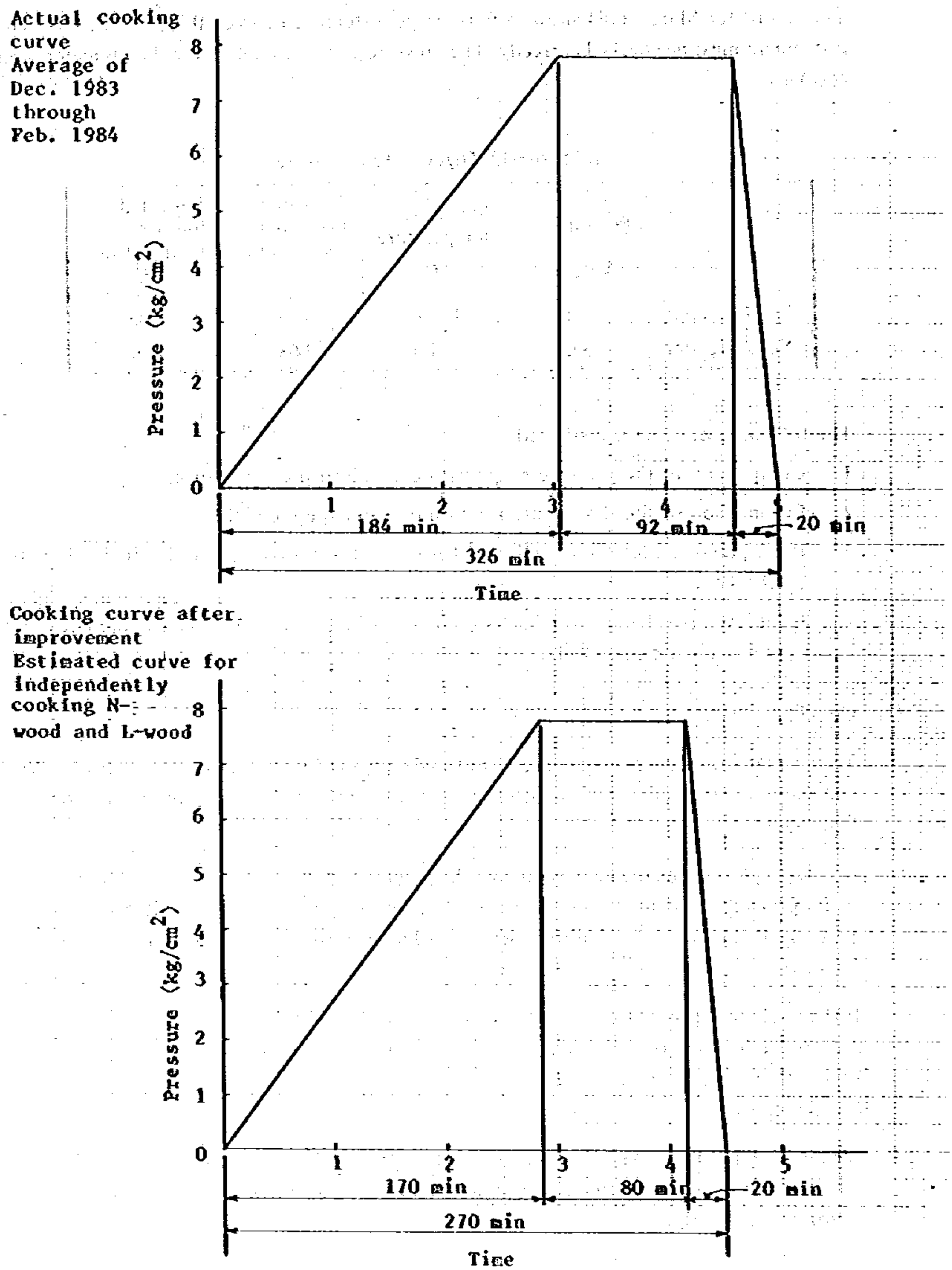


Fig. 6-3-4 Cooking Curve

6-3-7 Proposal for Improvements on Operation

(1) Change of the current mixed chip cooking to separate cooking of N and L-wood. The cooking conditions are shown in Table 6-3-15.

(2) The effects obtainanble from this change are estimated as follows.

Table 6-3-13 Comparison of Mixed and Separate Cooking

	Current	Improvement	
	Mixed cooking	Separate cooking	
		N	L
Barks	Contained	Not contained	Contained
Yield %	42.73	45	43
Steam consumption t/BDt-UKP	2.39	2.30	

Estimated data after the improvement is shown in Table 6-3-14.

Table 6-3-14 Estimated Yield of Pulp after Improvement

	Chip consumption BDt/d	Pulp production BDt-UKP/d	Number of digestion Batch/d	Yield %
N-pulp	29.356	13.21	2.9	45.0
L-Pulp	37.535	16.14	3.5	43.0
Total	66.891	29.35	6.4	43.88

Table 6-3-15 Estimated Cooking Conditions after Improvement

Item		Independent cooking plan by N and L-wood	
1)	Cooking method	Independent cooking kraft method	
		N-wood	L-wood
2)	Roe No.	5.5 ± 0.5	2.1 ± 0.4
3)	Activated alkali adding rate (as Na_2O)	17% BD chip	16% BD chip
4)	Sulfidity	20 - 29%	20 - 23%
5)	Liquid ratio	3.5	3.5
6)	Cooking yield	45%	43%
7)	Washing yield	92%	92%
8)	Bleaching yield		
9)	Total yield	41.4%	39.6%
10)	Cooking conditions of unbleached pulp		
	Unbleached pulp production	13.21 BDt/d	16.14 BDt/d
	Quantity of filling chips	10.2 BDt chip/batch	10.6 BDt chip/batch
	Pulp prod./batch	10.2 x 0.45 = 4.59 BDt-UKP/batch	10.6 x 0.43 = 4.56 BDt-UKP/batch
	Number of digestion/day	2.9 times	3.5 times
	Quantity of liquid necessary for cooking	10.2 x 3.5 = 35.700 t/batch	10.6 x 3.5 = 37.650 t/batch
	Quantity of WL required for cooking	10.2 x 0.17 x $\times \frac{1,000}{91.44} = 18.965$ m^3/batch	10.6 x 0.16 $\times \frac{1,000}{91.44} = 18.543$ m^3/batch
	Weights of WL and water	WL 18,963 x 1.1 = 20,859 kg	WL 18,548 x 1.1 = 20.403 kg
	Black liquor	Water in chips 5,492 kg Black liquor 9,349 kg Total 35,700 kg	Water in chips 5,708 kg Black liquor 10,789 kg Total 37,100 kg

Table 6-3-15 (Continuing)

B-2

	Item	N-wood	L-wood
11)	Solids in cooking solution (100% solid) (excl. solids in BL for liquid ratio adjustment)	From chips: $10.2^t - 4.59^t$ = 5,610 kg From digestion solution: $\frac{0.27}{0.17} \times 91.44$ $\times \frac{18,963}{1,000} = 2,754$ kg Total 8,364 kg	From chips: $10.6^t - 4.56^t$ = 6,040 kg From digestion solution: $\frac{0.27}{0.17} \times 91.44$ $\times \frac{18,548}{1,000} = 2,694$ kg Total 8,734 kg
12)	Filling content of digester	Chip 10,200 Moisture content in chips 5,492 White liquor 20,859 Black liquor 9,349 Vapor exhausting Δ5,000 Total 40,900 kg	Chip 10,600 Water in chips 5,708 White liquor 20,403 Black liquor 10,989 Vapor exhausting Δ5,000 Total 42,700 kg
13)	Stock consistency	$\frac{4,590}{40,900} \times 100 = 11.93\%$	$\frac{4,560}{42,700} \times 100 = 10.68\%$
14)	Solid content of BL in blow tank (excl. solids in BL for liquid ratio adjustment)	$\frac{8,364}{(40,900 - 4,590)}$ $\times 100 = 23.03\%$	$\frac{8,734}{(42,700 - 4,560)}$ $\times 100 = 22.90\%$
	Solid content of BL in blow tank (incl. solids in BL for liquid ratio adjustment)	9,349 x 0.2 = 1,870 kg $\frac{1,870 + 8,364}{(40,900 - 4,590)}$ $\times 100 = 28.18\%$	10,989 x 0.2 = 2,198 kg $\frac{2,198 + 8,934}{(42,000 - 4,560)}$ $\times 100 = 28.66\%$
15)	Generation of solids in BL (excl. solids in BL for liquid ratio adjustment)	$\frac{8,364}{4,590} = 1,869$ kg/BDt-UKP	$\frac{8,374}{4,560} = 1,915$ kg/BDt-UKP

6-3-8 Facility Improvements

(1) Study how to cope with anti-corrosion of digester

The wall thickness of digester body is 22mm, but there are places which have partially corroded (15.9mm) in recent several years. It also looks that the corrosion proceeds as the time goes by. The main cause for the corrosion is salt contained in the mangrove wood.

The internal pressure of digester during digestion is about 8kg/cm^2, and the digester is in a dangerous state because of the corrosion. SUS lining should be given as quickly as possible.

(2) Difference of indication between upper and lower thermometer of digester

There is a difference in the indicated temperature between the upper and lower meters on both of No. 1 and No. 2 digesters. The difference at the time of the highest temperature is 8°C on No. 1 digester and 22°C on No. 2 digester.

Since the temperature is a very important control item on the operation, the cause must be found out and countermeasures must be taken as quickly as possible.

(3) Black liquor heater

a) Black liquor heater tube

The tube for the black liquor heater (two heaters) is made of STB, the size is 34mm (outer diameter), 3.2mm (thickness), and 3,990mm (length). 148 tubes are used per heater.

When compared with a stainless steel tube, an STB tube has shortcomings of scales sticking quicker and the thermal conductivity degrading quicker.

Also, all these tubes have been used for a long time and have degraded. They must be replaced now, and if they are to be replaced, stainless tubes are recommendable.

b) Capacity of black liquor circulation pump

The black liquor circulation pump has a design capacity of 3.2m^3/min × 15m. The normal circulating rate of black liquor during digestion is 4.8 to 5.7 times/hr, but this pump has only 3.84 times/hr actually and that figure was too low. Accordingly, this pump should be replaced with a larger pump of 5m^3/min × 25m.

When this larger pump is installed, a circulating rate of 5.4 times/hr can be maintained even if the capacity down by no-maintenance is taken into consideration.

(4) Blow tank

Since this renovation project plans independent cooking of N and L-wood, there ought to be two blow tanks to separately store the unbleached stock of N and L by installing an additional blow tank having the same capacity (150m^3) as the existing one.

The unbleached stock stored in the two blow tanks is to be sent to the unbleached pulp washer by one stock pump at an appropriate furnish combination of N and L-pulp under proportionate control.

Our proposal is to separately digest N and L-wood. In order to do this, the line from the log preparation to the blow tank must be separated into two.

After the blow tank, the flow rate is controlled by FRCQ and CRC, therefore, one blow tank must be installed anew.

6-4 Unbleached Pulp Washing Equipment

6-4-1 Existing Washing Equipment

(1) State of washer

The existing washing machine is a leg type 3-stage washer. Its size is 2.25m diameter and 1m width. The filtration area is $7.1m^2$.

Judging from the installed washer height, the theoretical vacuum for washing is 9mAq, but we suppose actual operation is below 3mAq.

Since the air seal section to maintain the vacuum is improperly structured, the machine can not maintain the vacuum. A vacuum pump has been installed but it does not give much improvement, and the vacuum is extremely low as shown below.

First stage washer	0.85mAq
Second stage washer	1.7mAq
Third stage washer	2.0mAq

(2) Capacity of washer for unbleached pulp (N and L-mixed pulp)

The actual quantities of unbleached pulp processing in the three years of 1981 to 1983 and three months of December 1983 to February 1984 are shown in the following.

Table 6-4-1 Annual Processing Quantity of Unbleached Pulp

		1981	1982	1983
Processed unbleached pulp	BDt/y	10,682.23	10,619.46	10,122.58
Number of operating days	d/y	327.78	320.63	306.32
Processed unbleached pulp	BDt/y	32.99	33.12	33.05
Processing per filtration area	$BDt/m^2 d$	4.65	4.66	4.65

Table 6-4-2 Monthly Processing Quantity of Unbleached Pulp

		Dec. 1983	Jan. 1984	Feb. 1984
Processed unbleached pulp	BDt	634.35	789.50	948.20
Operating hours	hr-min	414-25	491-20	577-45
Processed unbleached pulp	BDt/d	28.83	27.22	32.70
Processing per filtration area	$BDt/d/m^2$	4.06	3.83	4.61

The largest processing on record, according to the above tables, is 4.6 $BDt/d/m^2$. The normal capacity is 2.7 to 3.6 $BDt/d/m^2$ on N-pulp and 3.5 to 4.5 $BDt/d/m^2$ on L-pulp. In the case of mixed pulp, 3 to 4 $BDt/d/m^2$ seems to be adequate, and values shown in the above tables exceed it by about 27%.

6-4-2 Dilution Factor and Actual State of Chemical Loss

(1) Significance of dilution factor

Large chemical loss means a large quantity of replenishing chemicals for cooking (cost increase). The main purpose of using a washer is to wash the pulp containing chemicals and recover the chemicals efficiently.

The efficiency of chemical recovery is determined by the dilution factor (using hot water), and normally it is 2 to 3.

This value is affected by the capacity of evaporator. The dilution factor is calculated as follows:

Dilution factor

$$= \frac{\text{Amount of washing warm water, t/h}}{\text{Amount of air-drying processed unbleached pulp, t/h}} - \frac{\text{Water content (\%) in pulp sheet}}{\text{Pulp content in pulp sheet}} \times 0.9$$

As a reference, a graph showing the relationship between washing factor and chemical loss is given below.

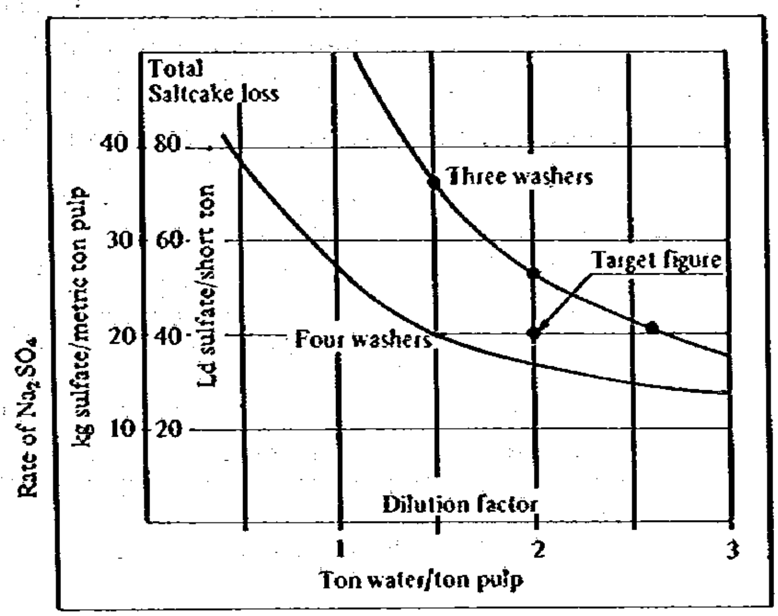


Fig. 6-4-1 Saltcake Loss and Dilution Factor Relationship

(2) Actual case of dilution factor

As shown in the table below, the actual values of dilution factor in recent three months are negative, indicating that the washing work of unbleached pulp is abnormal. This means the majority of cooking chemical loss occurs at the unbleached pulp washing facilities.

Table 6-4-3 Actual Values of Dilution Factor

		Dec. 1983		Jan. 1984		Feb. 1984	
		Total	hr	Total	hr	Total	hr
Amount of processed pulp	BDt	644.35	1.555	783.50	1.593	956.20	1.655
	ADt	715.94	1.728	870.56	1.771	1,062.44	1.839
Warm water consumption	t	3,386	8.17	3,884	7.90	4,536	7.85
Pulp concentration in pulp sheet	%	12		12		12	
Water content in pulp sheet	%	88		88		88	
Dilution factor		−1.87		−2.14		−2.33	
Working hour	h	414 h 25 min		491 h 40 min		577 h 45 min	

Note: The pulp content in pulp sheet is an estimated value.

Causes for abnormal dilution factor:

1) The vacuum of washer is poor and the pulp sheet contains excess water.
2) Water enters the system through other than the washer shower pipe.

(3) Relationship between quantity of unbleached pulp washing warm water and quantity of weak black liquor sent to evaporator

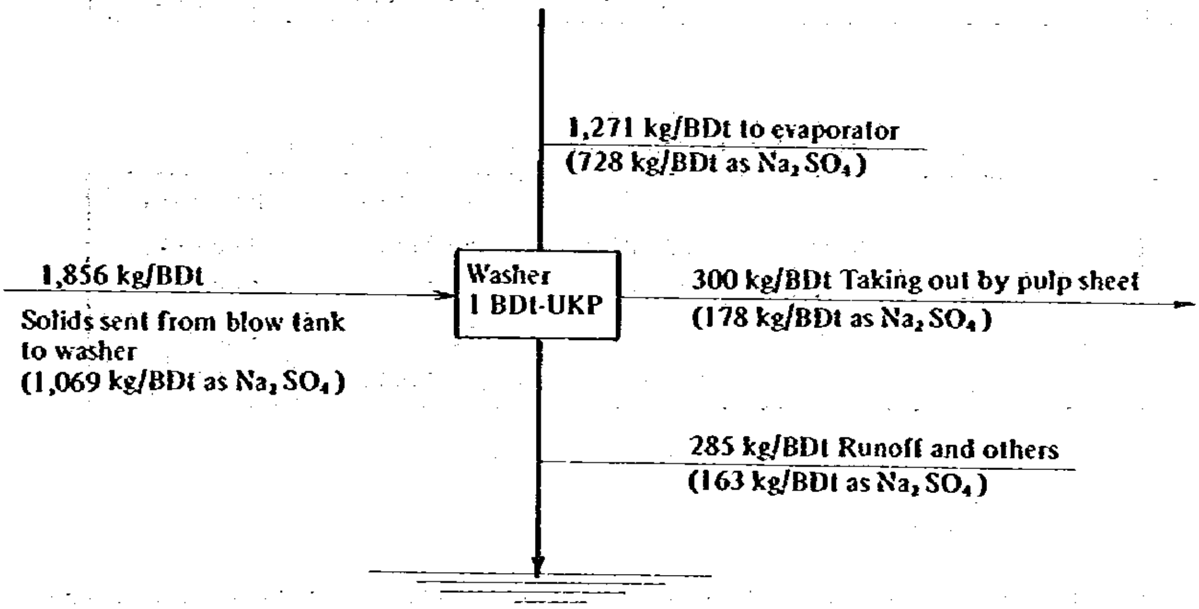
Normally, the quantity of weak black liquor sent from the washing section to the evaporator section is about 1.15 ± 0.05 times as much the warm water used for washing of unbleached pulp. Table 6-4-4 shows actual data related to this transaction.

Judging from this data, the operation in the washer section was abnormal and more water other than the warm washing water entered the line. This means that clean water other than the washing water (warm water) was injected into the washer without being used as washing water. The water used by the unbleached pulp washer must be used as cleaning water to raise the washing effect.

Table 6-4-4 Weak Black Liquor Sent from Washing Section to Evaporator Section

	Weak black liquor (m^3)	Solids in black liquor (kg)	Unbleached pulp production (BDt)	Solids/ton unbleached pulp (kg/BDt)	Warm water consumption (m^3)	Weak black liquor/warm water consumed
Dec. '83	3,919	776,442	644.35	1,205	3,386	1.16
Jan. '84	5,252	991,128	783.5	1,265	3,884	1.35
Feb. '84	6,344	1,284,177	962.5	1,343	4,536	1.40
Total	15,515	3,051,747	2,384.05	3,813	11,806	3.91
Average	5,171.7	1,017,249	794.7	1,271	3,935.3	1.30

The black liquor solid balance of washer is approximately as shown below.



6-4-3 Actual Values of Chemical Loss and Chemical Recovery Rate

(1) Actual values of chemical loss

The actual values of chemical loss on recent operation are shown below.

The table shows that the chemical loss amounts to 28 to 40%. The standard value of general plants is about 5.4% and BRPP's chemical loss is extremely high. This large loss must be reduced to the general level by all means.

Table 6-4-5 Total Alkali Quantity (as Na_2O) in Digesting Solution

Chemical	Dec. 1983	Jan. 1984	Feb. 1984
Caustic soda ($NaOH$)	193,987 kg	219,344 kg	274,839 kg
Sodium sulfide (Na_2S)	63,899	72,943	91,047
Sodium carbonate (Na_2CO_3)	28,654	30,007	44,451
Salt cake (Na_2SO_4)	13,789	16,081	20,224
Total	300,329 kg	338,375 kg	430,561 kg

Table 6-4-6 Total Alkali Quantity (as Na_2O) in Adding Chemicals

Chemical	Dec. 1983	Jan. 1984	Feb. 1984
Salt cake (Na_2SO_4)	22,122 kg	36,071 kg	37,654 kg
Sodium sulfide (Na_2S)	22,759	8,123	71,049
Caustic soda ($NaOH$)	78,451	72,451	12,020
Total	123,332 kg	116,645 kg	120,723 kg

<Rate of chemical loss>

The chemical loss in the three months is calculated as shown below from the values of Tables 6-4-5 and 6-4-6.

Table 6-4-7 Rate of Chemical Loss

	(1) Total alkali quantity (as Na_2O) in digesting solution, kg	(2) Total alkali quantity (as Na_2O) in make-up chemicals, kg	Rate of chemical loss $\frac{(2)}{(1)} \times 100$
Dec. 1983	300,329	123,332	41.07
Jan. 1984	338,375	116,645	34.47
Feb. 1984	430,561	120,723	28.04

(1): Total alkali quantity (as Na_2O) in cooking solution, kg
(2): Total alkali quantity (as Na_2O) in adding chemicals, kg
(2) ÷ (1) × 100: Rate of chemical loss

We have brought up samples of unbleached pulp sheet from the washer, sealing them tightly, and had them analyzed by the Central Research Laboratory of Honshu Paper Co. The following are the results.

Table 6-4-8 Sodium Oxide (Na_2O) in Pulp Sheet

Sample No.		Na_2O content (kg)/BDt UKP	
13-3-1984	1.2 t/h	47	
15-3-1984	1.0 t/h	82	Average 77 x 4 = 308 kg (Equivalent to solid)
15-3-1984	1.0 t/h	71	

[Measuring method]

Each sample is added with water, making one liter as a total, the water soluble soda portion is sufficiently transferred to the water layer, which is measured as natrium (Na) by an atomic photo absorption method (Hitachi Absorption Spectrometer), and the measured value is converted to Na_2O per BD pulp.

(2) Rate of chemical recovery

As shown in Table 6-4-9, the rate of actual chemical recovery is in a range of 65±6%.

Table 6-4-9 Rate of Actual Chemical Recovery

	Dec. 1983	Jan. 1984	Feb. 1984
Quantity of cooking solution used	2,757.85 m^3	3,216.19 m^3	4,044.72 m^3
Chemicals in cooking solution (as Na_2O)			
Caustic soda ($NaOH$)	193,987 kg	219,344 kg	274,839 kg
Sodium sulfide (Na_2S)	63,899	72,943	91,047
Sodium carbonate (Na_2CO_3)	28,654	30,007	44,452
Salt cake (Na_2SO_4)	13,789	16,081	20,224
Subtotal	300,329 kg	332,375 kg	430,562 kg
Added chemicals (as Na_2O)			
Salt cake (Na_2SO_4)	22,122 kg	36,071 kg	37,654 kg
Caustic soda ($NaOH$)	78,451	72,451	71,049
Sodium sulfide (Na_2S)	22,759	8,123	12,329
Subtotal	123,332 kg	116,645 kg	121,032 kg
Recovered quantity	176,997 kg	221,790 kg	309,530 kg
Rate of recovery	58.93%	65.53%	71.89%

Table 6-4-10 Estimation of Rate of Chemical Recovery after Renovation

Per BDt-UKP	$NaOH$ (kg)	Na_2S (kg)	Na_2CO_3 (kg)	Na_2SO_4 (kg)	Total (kg)	Recovery rate
Na_2O in cooking solution	307.20	81.92	40.96	20.48	450.56	90.29%
Added chemicals (as Na_2O)	13.18	–	–	30.56	43.74	

Calculation formula of rate of chemical recovery:

$$\text{Rate of chemical recovery} = \frac{\text{Total } Na_2O \text{ in cooking liquor} - \text{Total } Na_2O \text{ in added chemicals}}{\text{Total sodium oxide } (Na_2O) \text{ in cooking solution}} \times 100$$

Table 6-4-11 Chemical Recovery Cycle
(as kg-Na_2SO_4/t BDt-BKP)

Existing

Loss from brown pulp sheet 64 kg

Loss from others 194 kg

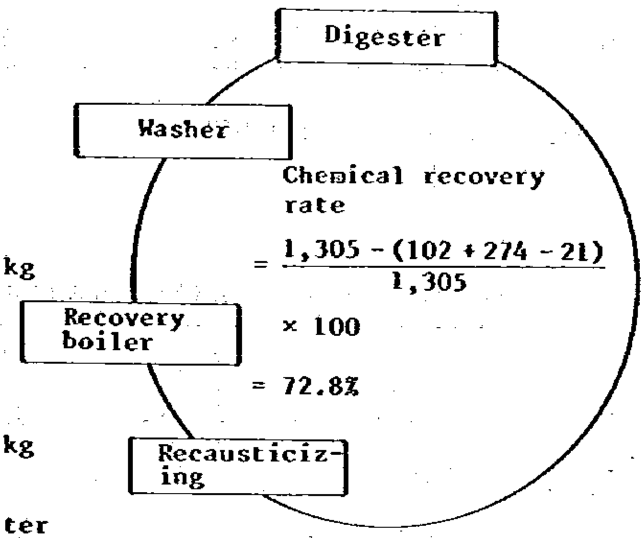
Add. chemical + 102 kg Na_2SO_4

Loss from Eva, R/B 85 kg

Add. chemical + 274 kg Na_2S, NaOH

Loss from Recus. filter 12 kg

Chemical in process + 21 kg



After Renovation

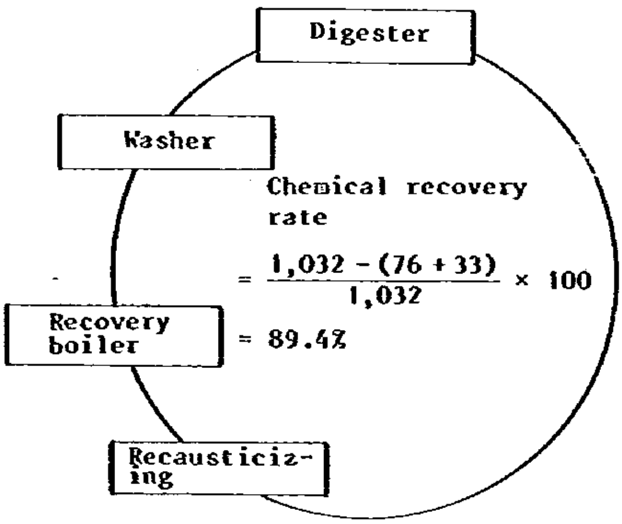
Loss from brown pulp sheet 22 kg

Loss from others 78 kg

Add. chemical 76 kg Na_2SO_4

Loss from cottrell 9 kg

Add. chemical 33 kg NaOH



Comparison of Chemical Loss (as Na_2SO_4)

	Loss from brown pulp sheet	Loss from cottrell	Loss from re-causticizing blow tank and others	Total
Existing	1,728 kg/d	567 kg/d	7,290 kg/d	9,585 kg/d
After renovation	594	243	2,106	2,943
Difference	1,134	324	5,184	6,642

Note: Case of production as 27 BDt-BKP/d.

Comparison Quantity of Chemical Added (as Na_2SO_4)

	Na_2SO_4	Na_2S	NaOH	Total
Existing	2,600 kg	1,300 kg	5,685 kg	9,585 kg
After renovation	2,055	0	888	2,943
Difference	545	1,300	4,797	6,642

Note: Case of production as 27 BDt-BKP/d.

6-4-4 Composition of Cooking Chemical Solution

The standard composition of cooking chemical solution and the average composition in the three months are as follows. The concentration of cooking solution should be kept at a level of about 100g/l active alkalinity since concentration becomes lower in the digester if liquid ratio is too high.

Table 6-4-12 Composition of Cooking Chemical Consumption (as Na_2O)

	Standard	Dec. 1983	Jan. 1983	Feb. 1983	Average
Caustic soda ($NaOH$)	g/l 68 – 75	g/l 70.34	g/l 68.20	g/l 67.95	g/l 68.69
Sodium sulfide (Na_2S)	20 – 25	23.17	22.68	22.51	22.75
Sodium carbonate (Na_2CO_3)	8 – 12	–	–	–	–
Salt cake (Na_2SO_4)	4 – 6	–	–	–	–
Active alkaline concentration g/l	88 – 100	93.51	90.88	90.46	91.44
Temperature °C	78	–	–	–	–
Specific weight	1.1	–	–	–	–

6-4-5 Study of How to Improve Washing Efficiency

(1) Since the existing washer is poor in the washing efficiency, the chemical loss is abnormally high ranging in 28 to 41% as described earlier. In order to improve the washing efficiency, a new washer must be installed.

(2) A newly installed washer should cope with the capacity of evaporator. Therefore, the washing factor will be about 2. The estimated effects of new washer are shown in Table 6-4-13.

Table 6-4-13 Comparison of Washer Efficiencies

	Existing washer	New washer
Dilution factor	(–)	+2.0
Chemical loss (as Na_2SO_4)	360 kg/BDt-UKP	100 kg/BDt-UKP
Rate of chemical recovery	65 ±6%	About 90%

6-5 Bleaching Equipments

6-5-1 Outline

BRPP has 5-stage continuous bleaching system for chlorine-alkali extraction – hypo-alkali extraction – hypo (C-E-H-E-H). The normal capacity of bleaching equipment is 30 ADt/d with the major specifications as listed in Table 6-5-1 below.

Table 6-5-1 Major Bleaching Facilities

Name	Size	Capacity	Material
Chlorine filter	2.5 mφ x 1.0 m (width)	7.85 m^2	Cylinder, Screen plate: made of stainless steel Vat: made of iron plates with hard rubber lining for liquor contacting part
Hypo filter	2.5 mφ x 1.0 m (width)	7.85 m^2	Same as above
Alkali filter	2.5 mφ x 1.0 m (width)	7.85 m^2	Cylinder: made of iron plates Screen plate: made of stainless steel Vat: made of iron plates
Chlorine tower	2.25 mφ x 14 m (height)	50 m^3	Made of iron plates with hard rubber lining
Alkali tower	2.35 mφ x 10.5 m (height)	40 m^3	Made of iron plates
Hypo tower	2.7 mφ x 10.5 m (height)	55 m^3	Made of iron plates with hard rubber lining

The operating conditions of bleaching pulp are shown in Table 6-5-2.

Table 6-5-2 Bleaching Conditions

		C	E	H	E	H
		Cl_2	Alkali	Ca-Hypo	Alkali	Ca-Hypo
Consistency	%	3	10	10	10	10
Retention time	min	60	120	180	120	180
Stock temp.	°C	35	50 – 70	40	50 – 70	40
Flow system	%	Up – flow	Down – F	Down – F	Down – F	Down – flow
Tower level	%	100	80	80	80	80
Chemical	kg/BDt	52 – 56	15	26	5	12 ($NaOH_2$)
Initial pH			11.0	10.5	11.0	10.5

6-5-2 Processing Capacity

(1) The quantity of actual processing is as shown below.

Table 6-5-3 Actual Processing
(December 1983 – February 1984)

	UKP processing			BKP production			Yield
	BDt	BDt/d	BDt/24 h	BDt	BDt/d	BDt/24 h	%
Dec. 1983	602.28	27.38	33.70	540.59	24.57	30.25	89.76
Jan. 1984	744.675	24.82	32.97	658.179	21.94	29.14	88.38
Feb. 1984	898.50	30.98	33.87	807.524	27.85	30.44	89.87
Total	2,245.455	83.18	100.54	2,006.293	74.36	89.83	268.01
Average	748.485	27.72	33.52	668.764	24.80	29.95	89.35

Table 6-5-4 Actual Processing (Average of 1983)

BKP processing		BKP production		Yield
BDt	BDt/d	BDt	BDt/d	%
9,920.13	32.38	8,862.64	28.933	89.34

Note: The number of working days used for this calculation is 306.32 days which is the number of days that the digester was operated.

(2) The maximum processing capacities of major equipments are as follows.

Table 6-5-5 Maximum Processing Capacities of Major Facilities

		Pulp consistency %	Tower effective capacity m^3	Retention time h	Processing capacity ADt/d	Mixer capacity ADt/d	Filter capacity ADt/d
Chlorine tower	NOR	3	50	1	40		
	MAX	5	50	1	67	40	43
No. 1 alkali tower	NOR	10	32	2	43		
	MAX	12	32	2	51	40	43
No. 1 Ca-hypo tower	NOR	10	44	3	39		
	MAX	12	44	3	47	40	43
No. 2 alkali tower	NOR	10	32	2	43		
	MAX	12	32	2	51	40	43
No. 2 Ca-hypo tower	NOR	10	44	3	39		
	MAX	12	44	3	47	–	–

Note: The capacities of mixer and others become short when the pulp consistency is becomes 12%.

(3) The actual consumption of washing water is as follows.

Table 6-5-6 Consumption of Bleached Pulp Washing Water

	Consumption m^3	BKP production BDt	Operating time hr-min	Consumption per t. pulp m^3/BDt-BKP	Consumption per hour m^3/h
Dec. 1983	13,305	602.28	428-55	22.09	31.02
Jan. 1984	16,635	744.675	542-00	22.33	30.09
Feb. 1984	19,330	898.500	654-45	21.51	29.52
Total	49,270	2,245.455	1,625-40	65.93	90.63
Average	16,423	748.485	541-53	21.98	30.21

Scheduled consumption of the original design

First through fourth stages 12 m^3/h

Fifth stage 18 m^3/h

$12 \times 4 + 18 = 66$ m^3/h = 1,584 m^3/24 hours

6-5-3 Quality

(1) Brightness and tearing strength

The monthly average values of brightness and tearing strength of bleached pulp in February 1984 are as follows.

Table 6-5-7 Brightness and Tearing Strength

		Max.	Min.	Average
Brightness	%Ht	81.70	79.23	80.50
Tearing strength	gr	106.60	76.80	89.60

The fluctuation of brightness and tearing strength in February 1984 is shown in Fig. 6-5-2. An example each of fluctuation on these with a Roe No. is shown in Fig. 6-5-1.

Since the quality of bleached pulp greatly depends on the quality of unbleached pulp, the quality of unbleached pulp must be stabilized.

The major reason for the fluctuation of tearing strength is non-uniform blending of chips, but additionally, efforts must be made to add chemicals properly and follow the retention time standard.

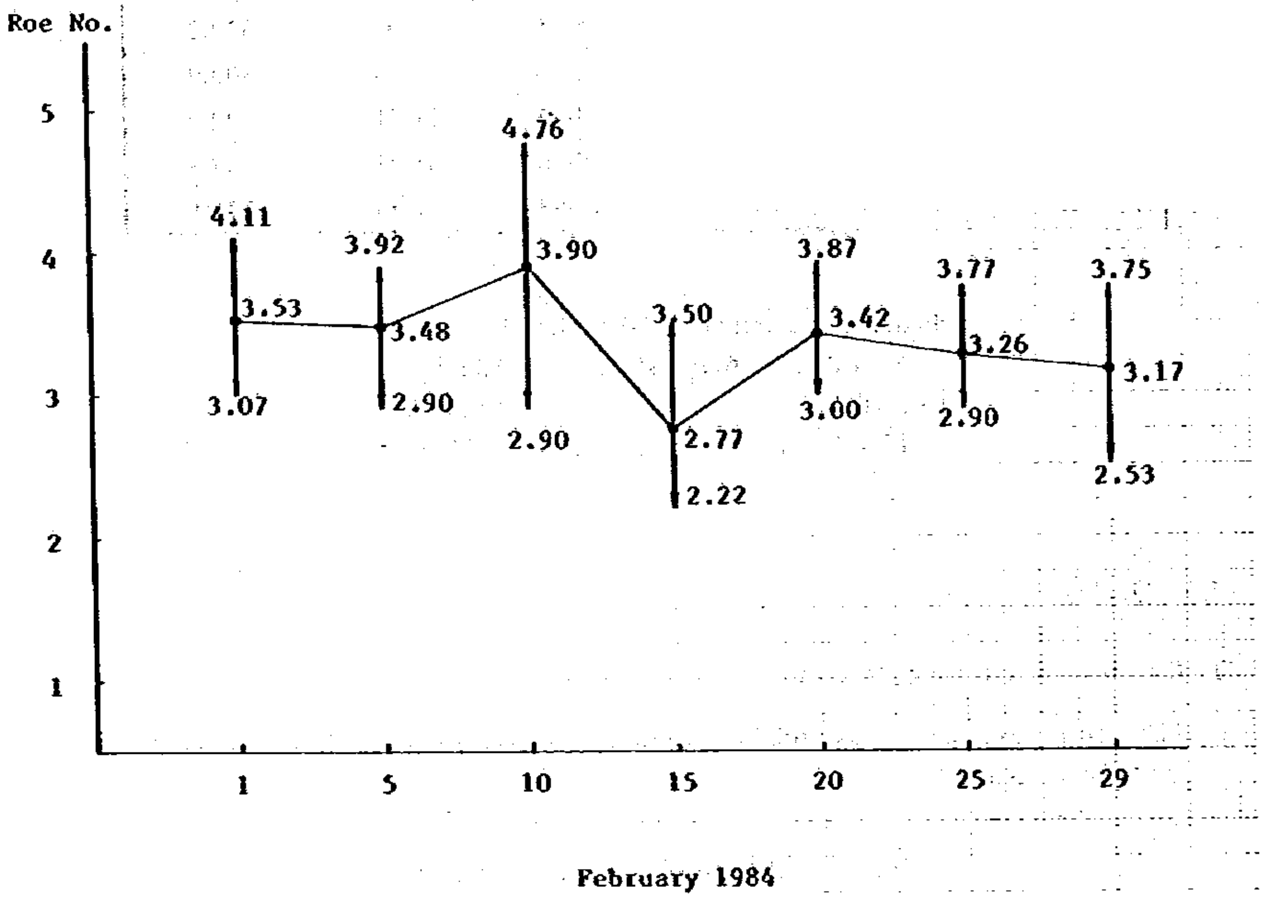


Fig. 6-5-1 Fluctuation of Roe No. of Received Pulp

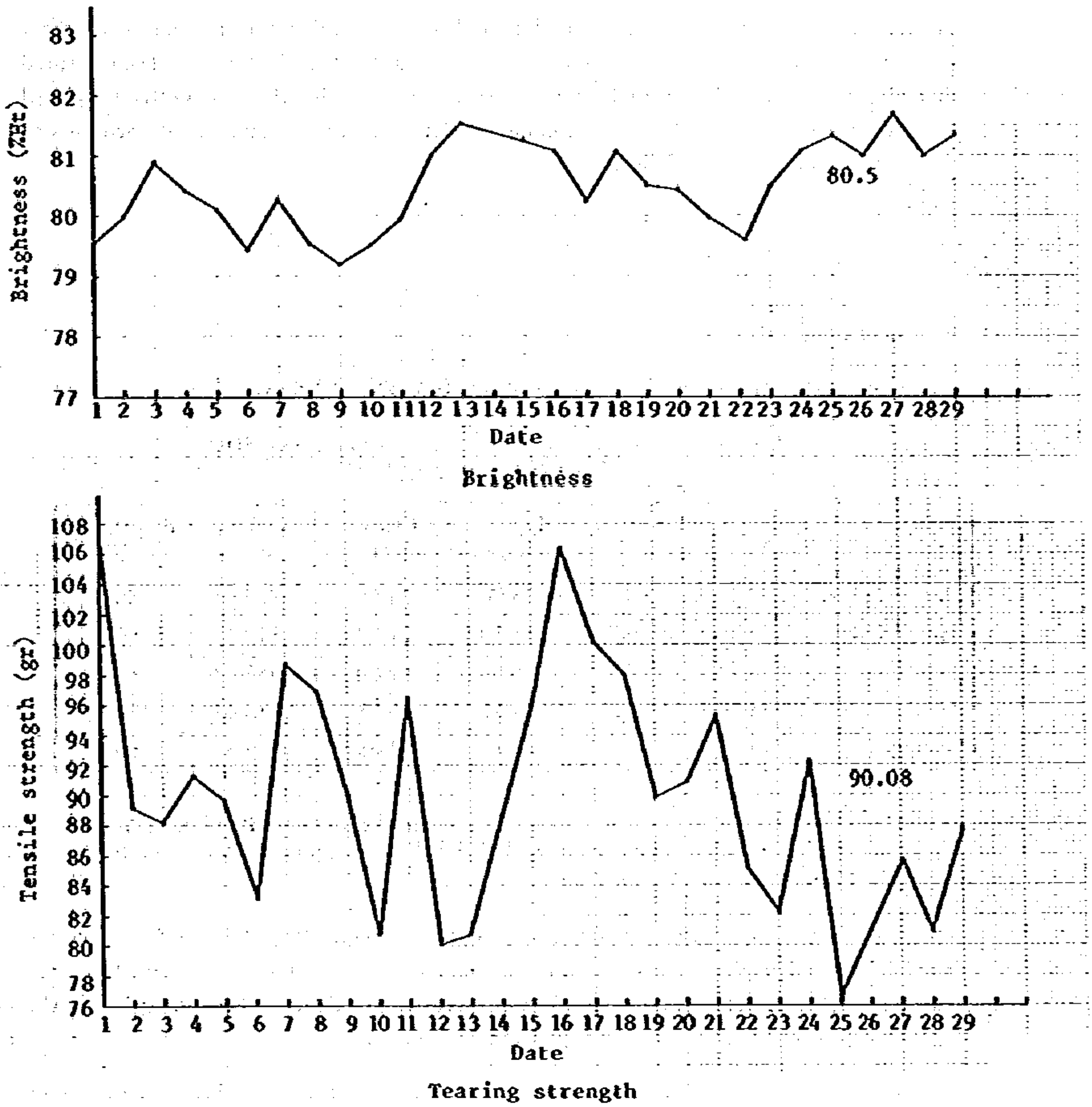


Fig. 6-5-2 Brightness and Tearing Strength at No. 5 Tower Outlet in February 1984

(2) Freeness

At present, the freeness of finished bleached pulp is not directly controlled at the production site.

However, since the freeness is necessary data to determine the degree of fluctuation of paper properties, we recommend that the freeness is measured at the production site. The measured data is to be immediately sent to the papermaking section, so that the data is effectively used to adjust the stock furnish combination and to determine proper amount of chemicals to add, thereby improving the paper quality.

6-5-4 Chemicals

(1) Bleaching chemicals

The actual consumption of bleaching chemicals is as shown below.

Table 6-5-8 Consumption of Bleaching Chemicals (kg/BDt)
(December 1983 - February 1984)

	Roe No.	Chlorine gas	Hypo solution	Caustic soda	Sulfamic acid	Brightness %Ht
Dec. 1983	3.52	53.99	33.06	24.90	865.05	80.3
Jan. 1984	3.45	52.32	35.50	21.73	819.15	80.6
Feb. 1984	3.38	56.31	40.58	19.60	953.81	80.5
Total	10.35	162.62	109.41	66.23	2,638.01	241.5
Average	3.45	54.21	36.38	22.08	879.34	80.5

Note: The consumption of sulfamic acid is expressed in the unit of g/BDt-UKP and others are expressed in the unit of kg/BDt-UKP. The hypo solution is converted to the effective chlorine value.

A proper use rate of chlorine gas to the pulp is generally considered 1.3 to 1.5 times of the Roe No. of received unbleached pulp. The actual consumption in the three months is high with an average of 1.57 times. It is difficult to reduce this close to the standard since the fluctuation of Roe No. of existing unbleached pulp is great.

On this project, we plan adopting separate cooking of N and L-chips and renewal of washer for unbleached pulp, and we believe these will greatly stabilize the Roe No. and reduction of the adding quantity of bleaching chemicals can be expected.

6-5-5 Screening Equipments

(1) Existing equipments

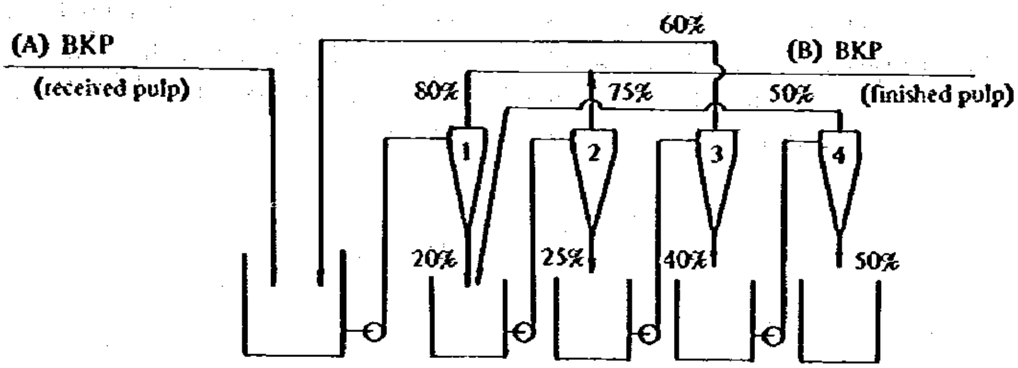
At present, dust is removed in a 4-stage system using No. 600 type centri cleaner. The details of cleaning capacity are as follows.

Table 6-5-9 Centri-cleaner

	Number of centri-cleaner	Inlet flow rate per cleaner l/m	Processing capacity BDt/d Consistency at inlet	
			0.5%	0.6%
1st stage	80	76	43,776	52,531
2nd stage	20	76	10,944	13,133
3rd stage	6	76	3,283	3,940
4th stage	2	76	1,094	1,313

<Flow sheet>

The flow sheet of centri-cleaner is shown below.



<Material balance>

The material balance for the case of inlet consistency being 0.5% and 0.6% is shown below.

Table 6-5-10 Material Balance of Centri-cleaners

	0.5% inlet consistency			0.6% inlet consistency		
	Inlet	Accept	Reject	Inlet	Accept	Reject
1st stage BDt/d	43.776	35.021	8.755	52.531	42.025	10.506
2nd stage BDt/d	9.216	6.912	2.304	11.059	8.294	2.764
3rd stage BDt/d	2.304	1.382	0.922	2.765	1.659	1.106
4th stage BDt/d	0.922	0.461	0.461	1.106	0.553	0.553
BKP received BDt/d	42.393			50.319		
BKP finished BDt/d	41.932			49.766		
CC yield %	98.91			98.90		

(CC: centri-cleaner)

(2) Problem on centri-cleaner

Although the nominal capacity is large enough on all existing pumps, the current pressure at the inlet of the first and second centri-cleaner is only 0.5kg/cm². The proper pressure value at the CC inlet is 3.0 to 3.5kg/cm².

Since the inlet pressure is low, dust cannot be removed well. As a matter of fact, the Honshu Laboratory's paper property measuring data indicates that BRPP samples had about four times as much dust as competitor's (Cibi Kemiya) samples. The capacity of centri-cleaner pumps must be made larger.

6-5-6 Recommendation on Improvement

(1) Ca-hypo solution

The quantity of effective chlorine in the Ca-hypo solution used as a bleaching chemical is generally 30 to 40g/liter.

The actual quantity of effective chlorine at BRPP was 54 to 56g/liter. Since the adding rate was proper. The quantity of chemical added at the mixer is about 36% less than that of typical case. So, the quantity of chemical to the mixer becomes smaller than case of liq. by typical consistency, so we are afraid that the chemical will not be uniformly mixed with the pulp.

We recommend that consistency of Ca-hypo should make 30 to 40g/liter as effective chlorine. As a result, it would become more effective bleaching because quantity of Ca-hypo to mixer should be more volume than existing.

Also, we found that the Ca-hypo solution was light pink in the color and it was opaque. This means that the solution contained impurities. When these impurities enter into the pulp, the bleached pulp color fades quicker.

If the existing Ca-hypo solution storage pit ($50m^3$, made of concrete) is divided into two and the pit is used alternately, there will be enough time for impurities contained in the solution settle down and thus clear hypo solution will become obtainable. This recommendation is illustrated in Fig. 6-5-3.

(2) Pulp washing shower pipes of filters

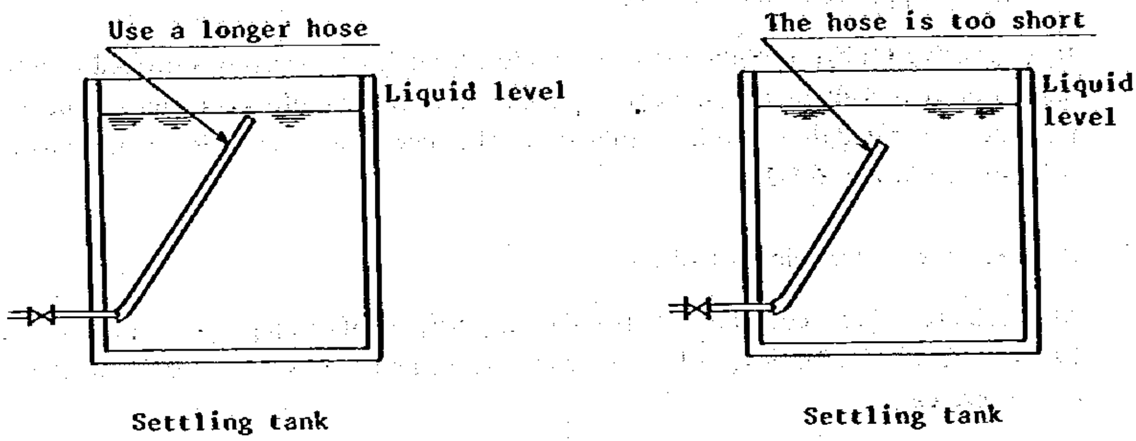
Although each filter is equipped with two shower pipes, use of one pipe was suspended since 1977 for the reason of shortage of warm water, and the pulp is washed with only one shower pipe at present.

Since only one shower pipe is used, the washing water is not applied to the whole surface of each pulp sheet, and washing is by no means sufficient.

The consumption of chemicals varies by the washing effect, and we recommend that the washing is conducted sufficiently.

Since the consumption of washing water at present is only 30 m^3/h against the scheduled 66 m^3/h, an additional pipe must be installed to do better washing.

1. Plan for improvement　　　　Existing



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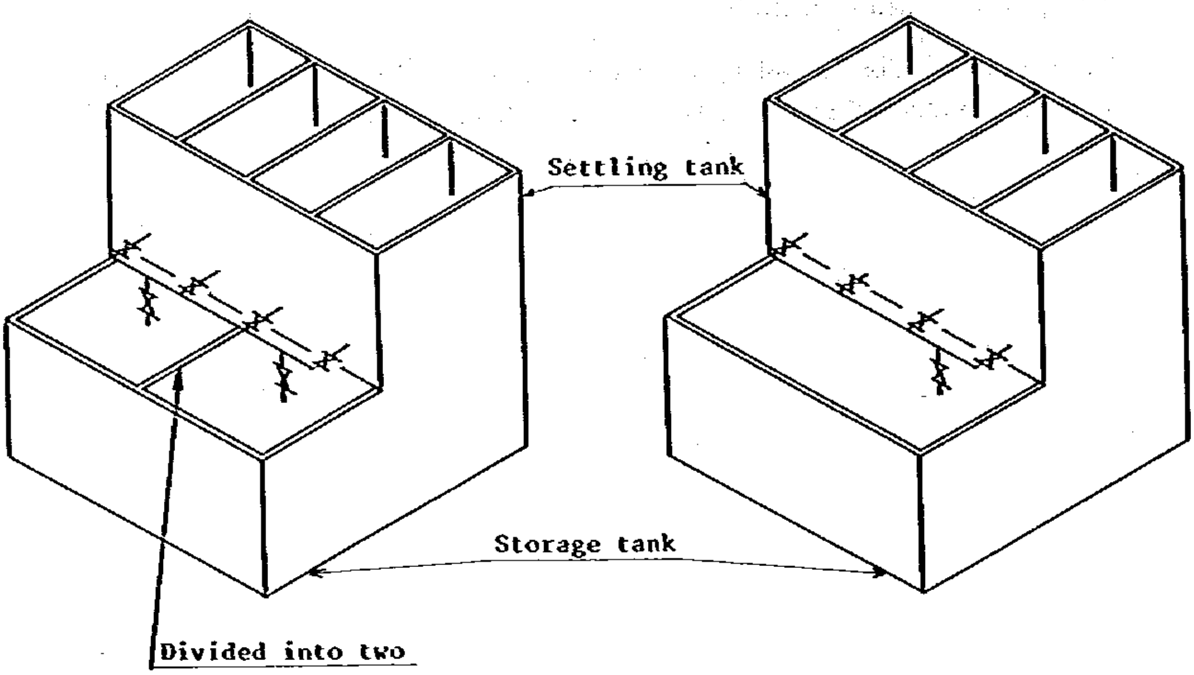


Fig. 6-5-3 Hypo Solution Settling Storage Tank

6-6 Evaporator

6-6-1 Existing Situation

The current evaporation facilities consist of five body five effects vertical long-tube type evaporator (L.T.V.) with a total thermal transfer area of 400m² (80cm² each evaporator).

The materials used for the tubes at the time of installation were SUS for No. 1 evaporator and SS for the other evaporators. Since then all SS tubes were replaced with SUS tube, No. 2 and No. 3 evaporator in 1980 and No. 4 and No. 5 evaporator in 1982.

6-6-2 Current Evaporator Capacity and Proposal

(1) Nominal capacity

The evaporation facilities were installed aiming at producing 30 ADt/d (maximum 35 ADt/d) of pulp and processing 44.1t/d of solids. The actual quantity of processing is shown in Table 6-6-1.

Table 6-6-1 Evaporator Capacity (Actual and Nominal)

	Total solids		Weak BL			Thick BL			Evaporating water		Used steam		Evaporating rate	Pulp production
	Weight		Concentration	Gross weight		Concentration	Gross weight		Gross weight		Gross weight			
	t/d	t/h	%	t/d	t/h	%	t/d	t/h	t/d	t/h	t/d	t/h		BDt-UKP/d
(1) Nominal capacity	44.09	1.84	18.5	238.3	9.93	52.0	84.8	3.53	153.5	6.40	41.8	1.74	3.675	27.0
(2) Dec. '83	41.91	1.75	18.15	230.91	9.62	44.55	94.07	3.92	136.84	5.70	45.01	1.88	3.04	28.83
(3) Jan. '84	40.17	1.67	17.71	226.82	9.45	45.14	88.99	3.71	137.83	5.74	41.14	1.71	3.35	27.22
(4) Feb. '84	48.08	2.00	18.59	258.63	10.78	46.91	102.49	4.27	156.14	6.51	40.77	1.70	3.83	32.70
(5) Average	43.39	1.81	18.15	238.79	9.95	45.53	95.18	3.97	143.60	5.98	42.31	1.76	3.41	29.58
(6) When condition is good in (4)	54.99	2.29	20.15	272.9	11.37	46.58	118.05	4.92	154.97	6.46	43.47	1.81	3.57	41.28 (Estimate)
(7) Renovation project	53.32	2.22	18.0	296.2	12.34	46.0	115.91	4.83	180.29	7.51	51.73	2.15	3.50	29.35

Solids received by evaporator: (1) Nominal capacity ; 1,400 kg/BDt-UKP
(2) Average, Dec. '83 – Feb. '84 ; 1,271 kg/BDt-UKP
(3) Renovation project ; 1,817 kg/BDt-UKP

(2) Actual processing

Table 6-6-1 shows the actual processing in the three months of December 1983 to February 1984.

The table indicates that the evaporator processed less in December and January, and this seems to be because the processing quantity in these months was not steady.

On the other hand, all values, except the consistency of thick black liquor, are good in February 1984 in which the pulp production was large and the quantity of processing was fairly steady.

Upon studying these figures, we think that if the thick black liquor consistency is set to about 46%, the nominal capacity of 16kg/m² per hour of evaporating water can be maintained.

(3) Estimation of processing capacity

The conditions to process the whole black liquor generated by the unbleached pulp washer by the evaporator after implementing this renovation project are calculated. The results of calculation, the designed capacities and a weekly average of February 17 to 23 of 1984; during which the processing was conducted to the highest are shown in Table 6-6-2.

Table 6-6-2 Evaporator Capacity

	Solids	Consistency of solids at evaporation inlet	Consistency of solids at evaporation outlet	Evaporating water	Used steam	Evaporation rate
	t/h	%	%	t/h	t/h	kg/kg
1. Nominal capacity	1.84	18.5	52.0	6.4	1.74	3.675
2. Actual processing in 16 - 22 of Feb. '84	2.29	20.15	46.6	6.45	1.89	3.57
3. Estimated processing after renovation	2.22	18.0	46.0	7.5	2.15	3.5

Thus, the estimated processing quantity is above the nominal capacity. Normally, the design capacity is 120% of the nominal capacity. Therefore, although the estimated quantity is almost reaching the upper limit, it is possible to process that much.

If operation with allowance is desired, the following measures can be taken.

a) Bark L-wood and reduce the quantity of generated black liquor.

b) Increase the consistency of weak black liquor.

Reduction of the dilution rate at unbleached pulp washer from 2.0 to about 1.5 and operation conducted on slight sacrifice of the chemical recovery.

When the consistency is increased from 18% to 20%, values that are about the same as the actual values of (2) in Table 6-6-2 are obtained, and the whole quantity can be processed.

c) Change of the existing 5 body, 5 effect system to a 5 body, 4 effect system for larger capacity.

When the existing 5 body, 5 effect system is changed to a 5 body, 4 effect system, the capacity increases by about 20%. Therefore, the evaporation capacity is 7.68t/h (6.4×1.2), which is greater than 7.5t/h, and all generated solids can be treated.

However, a 5 body, 4 effect system consumes more steam than a 5 body, 5 effect system does. The evaporation rate becomes about 2.8 from 3.5, which means a decrease of 25%. Therefore, the steam consumption is 2.69t/h (2.15×1.25), or increase of 0.54t/h.

In case the absolute quantity of steam is short for the reason of steam balance of the plant, the operation can be conducted by the steam compression method in the same performance as the 5 effect system if the recovery of drain is sacrified.

6-6-3 Measures on Scale Trouble

(1) Existing situation

All existing evaporators are the L.T.V. type, and scales are apt to be generated and stick to No. 1 evaporator which has the highest consistency of black liquor.

Under the existing operation conditions, the actual black liquor consistency is 46 to 47%, but because of lower thermal transfer performance of No. 1 evaporator caused by increased amount of scales sticking to it when the operation continues for ten days, the steam pressure rises and the processing rate drops.

It looks as if the operation cannot be continued longer than about a week if the black liquor consistency rises to about 50%.

The steam pressure of No. 1 evaporator is about 1kg/cm^2 immediately after cleaning the evaporator, but the steam pressure rises as the operation continues. The limit of this steam pressure is 2.0kg/cm^2, and once the pressure reaches it, the evaporator is stopped and the scales are removed.

(2) Scale removal

Scales which are generated when the black liquor consistency is at a low level of 46 to 47% are soft and they can be removed by jet water at a pressure of about 40kg/cm². The time needed to remove the scales is about seven hours.

Scales which are generated when the black liquor consistency is 50% or higher are hard scales and they cannot be removed by jet water of 40kg/cm² or thereabout. They must be removed by either a mechanical method of tube cleaner or chemical cleaning, and removal takes much longer time.

6-6-4 Black Liquor Consistency and Burning in Recovery Boiler

(1) Black liquor consistency and operability of recovery boiler

Even if the black liquor consistency is low (solids of jet consistency 57 to 58%), if the feed rate of black liquor to the recovery boiler is steady (black liquor in consistency of minimum 46% after the evaporator), the burning is conducted steadily.

The average black liquor consistency during February 1984 was rather low at 46.47%, and the feed was rather steady. As a result, the recovery boiler was operated by burning the black liquor only, without fuel oil for burning, for nine days during the month. (We were told that such good performance had never been had.)

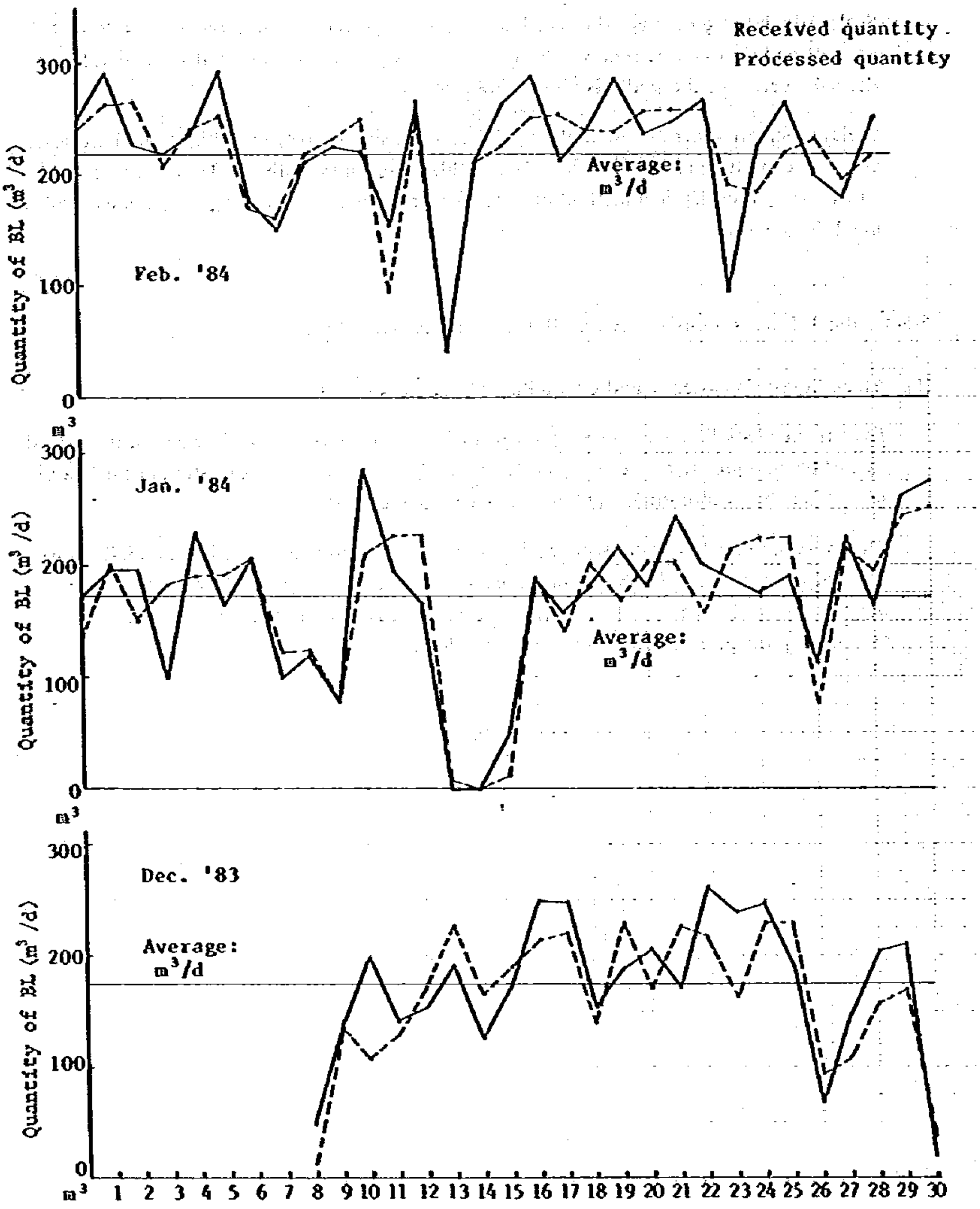


Fig. 6-6-1 Quantity of Black Liquor Received and Processed by Evaporator

6-6-5 Proposal on Improvements

(1) Installation of $200m^3$ tank of weak black liquor for stabilized operation

The quantity, consistency and temperature of the black liquor sent from the unbleached pulp washer must be steady and uniform in order to stabilize the evaporator operation.

In the three months of December 1983 to February 1984, the quantity of weak black liquor received and processed is not steady as shown in Fig. 6-6-1.

The existing weak black liquor storing capacity in the evaporator room is $150m^3$ ($75m^3 \times 2$). The quantity of weak black liquor from the cooking department in February 1984, when the pulp production was large, was average 229.7 m^3/d. The maximum was $297m^3/d$, and the minimum was $153m^3/d$, and this large fluctuation causes unstabilized operation of the evaporator.

The basic reason for the unsteady evaporator operation is its low absorption capacity (about 15 hours 30 minutes). Accordingly, we recommend installation of a weak black liquor tank of $200m^3$ (about 36 hours 30 minutes) to stabilize the evaporator operation.

(2) Removal of strainer in evaporator

A strainer was installed to the upper part of evaporation section of No. 1 to No. 5 evaporators to separate the black liquor and fiber, thereby reducing the alkali loss.

However, because of this strainer, each evaporator cannot avoid having pressure loss of 10 to 30mmHg. Since the alkali loss that can be saved by this strainer is very little, we recommended that the strainer is removed and the evaporator performance is improved.

(3) Alteration of vapor drain piping of surface condenser (Fig. 6-6-2)

Although the vertical pipe from the vapor drain discharge, pit of surface condenser to GL is about 10m long, the drain is not discharged smoothly. Therefore, we recommend connecting this drain pipe to the suction pipe of No. 5 evaporator drain pump, so as the drain is discharged by the pump.

A siphon tube should be installed to a middle part of the piping to maintain the vacuum balance.

These measures will improve the drain flow, raise the heat recovery efficiency and raise the temperature of warm water.

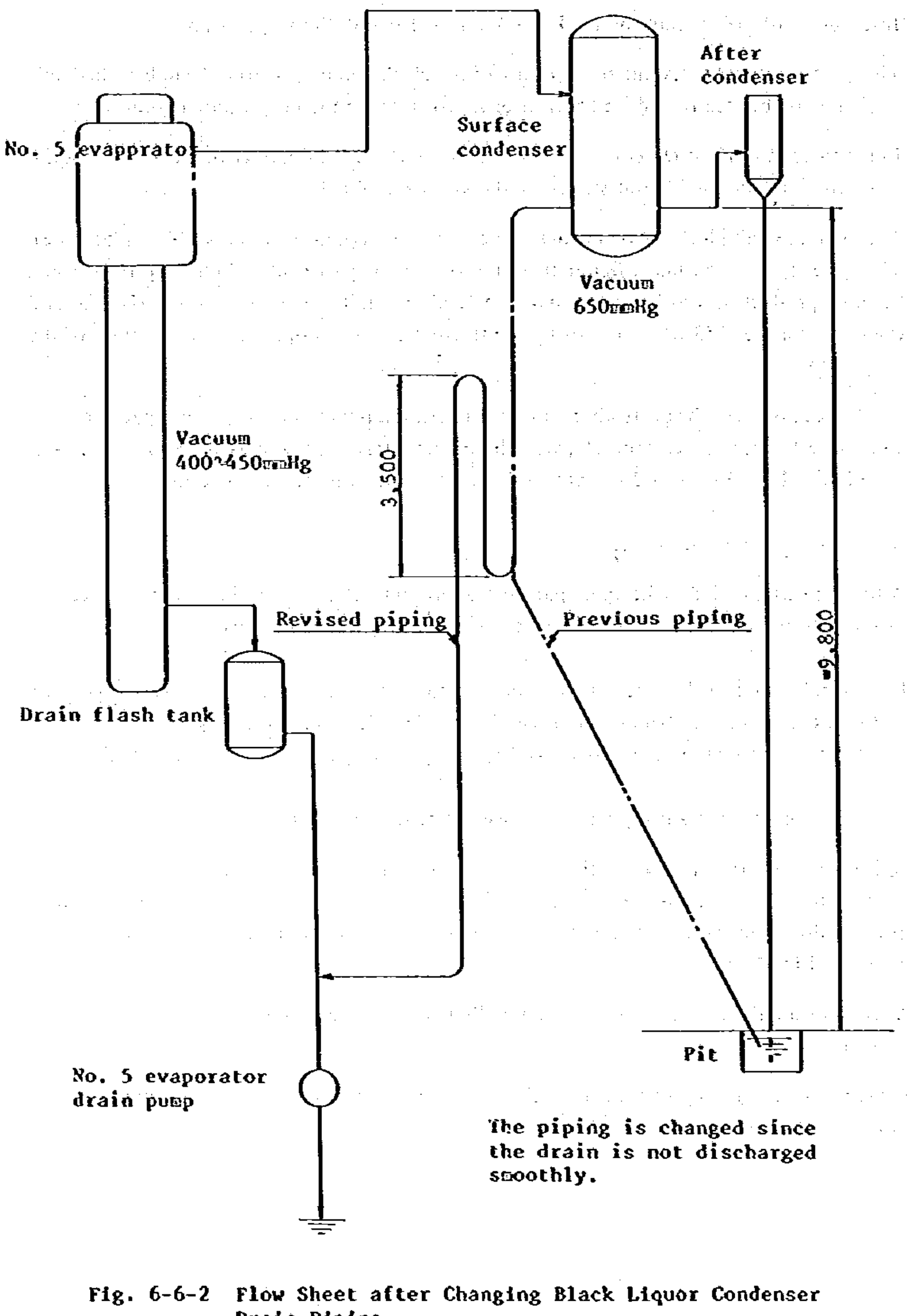


Fig. 6-6-2 Flow Sheet after Changing Black Liquor Condenser Drain Piping

6-7 Boilers

6-7-1 Outline

BRPP is equipped with one each of black liquor recovery boiler and fuel oil boiler.

The major specifications of these boilers are as follows.

Table 6-7-1 Outline of Boiler Specifications

		Recovery Boiler	Oil Boiler	
1) Number		1	1	
2) Pressure	Design	16 kg/cm²	16 kg/cm²	
	Operation	15 kg/cm²	15 kg/cm²	
3) Steam generation	Max.	6.5 t/h	12.0 t/h	
	Normal	6.0 t/h	10.0 t/h	
4) Fuel consumption				
Solids in BL		1,838 t/h		
Auxiliary fuel oil		86.3 kg/h		
Fuel oil			Max	870 kg/h
			Normal	718 kg/h
5) Calorific value of fuel				
Solids in BL		3,200 kcal/kg		
Fuel oil (low value)		10,000 kcal/kg	10,000 kcal/kg	
6) Furnace capacity		31 m³	23.4 m³	
7) Furnace thermal load		215,800 kcal/m³h	347,600 kcal/m³h	
8) Added Na_2SO_4		2,900 kg/d		

6-7-2 Consumption of Black Liquor

(1) Actual consumption

In the three months of December 1983 to February 1984, the recovery boiler consumed the black liquor as shown below.

Table 6-7-2 Actual Consumption of Black Liquor

	BL consistency %	Solids in BL kg	BL jet time hr-min	Consumed BL solids		Pulp production BDt-UKP
				kg/hr	kg/24 hr	
Dec. '83	42.19	760,920	445-30	1,710	41,000	634,350
Jan. '84	44.26	978,010	584-20	1,670	40,200	789,500
Feb. '84	44.55	1,276,320	651-30	1,960	47,000	948,200
Total	131.00	3,015,250	1681-20	5,340	128,200	2,372,050
Average	43.67	1,005,080	560-40	1,780	42,733	790,680

The pulp production in February 1984 was greater than that of other two months. Accordingly, the consumed black liquor was also the greatest in the three months, and the quantity of black liquor solids consumed in February was 106.6% of the nominal capacity.

Table 6-7-3 Actual Operation of Boiler (one week in Feb. '83 - Feb. '84), Nominal Capacity and Estimated Values after Renovation

Day	R/B evaporation		O/B evaporation		Total evaporation		O/B heavy oil consumption			R/B fuel oil consumption		Solids (TS) in R/B BL				R/B efficiency, %	R/B furnace load x 10³ kcal/m³h	Consistency of BL solids, %			Added salt cake
	t/d	t/h	t/d	t/h	t/d	t/h	l/d	l/h	Evaporation oil consumption	l/d	Converted in steam t/d	t/d	t/h	Generated steam t/d	Generated steam t / T.S t			After evaporator	R/B receive	R/B jet	t/d
(1) Nominal capacity	1,440	6.0(6.5)	240.0	10.0(12.0)	3,840	16.0	18,300	770	12.95	2,230	17.4	44.11	1.84	126.6	2.87	59.82	215.8	52.0	52.0		2.9
(2) Actual operation in Dec. 11 - Dec. 17, 1983																					
11	182.0	7.58	104.4	4.35	286.4	11.93	9,410	392.1	11.09	4,440	62.22	21,899	0.912	119.78	5.47	90.09	151.8	40.57	39.09	38.65	0
12	154.0	6.42	139.5	5.81	293.5	12.23	12,371	523.8	11.10	5,060	50.01	26,186	1.091	103.99	3.97	65.40	178.8	42.93	40.23	42.34	2.4
13	163.7	6.82	140.6	5.86	304.3	12.68	11,854	493.9	11.86	4,046	37.38	35,137	1.464	126.32	3.60	59.21	208.1	41.01	37.33	49.27	2.4
14	189.8	7.91	123.0	5.13	312.8	13.04	11,015	459.0	11.17	2,235	23.35	40,714	1.696	166.45	4.09	67.33	212.2	43.37	39.96	53.11	2.4
15	170.8	7.12	105.7	4.40	276.5	11.52	9,509	396.2	11.12	1,361	16.48	32,599	1.358	154.32	4.73	77.96	164.9	43.67	41.01	55.17	3.0
16	189.0	7.88	112.1	4.67	301.1	12.55	9,092	378.8	12.33	2,958	32.71	36,142	1.506	156.29	4.32	71.15	199.7	46.32	44.26	59.74	3.0
17	166.5	6.94	129.8	5.41	296.3	12.35	11,218	467.4	11.57	262	2.80	39,693	1.654	163.70	4.12	67.86	184.5	46.03	43.08	59.45	3.0
Total	1,215.8	50.67	855.1	35.63	2,070.9	86.3	74,669	3,111.2	80.24	20,362	224.95	232,37	9.681	990.85	30.3	498.95	1,300.0	303.90	284.98	357.73	16.2
Average	173.7	7.24	122.2	5.09	295.9	12.33	10,667	444.5	11.46	2,908.9	32.14	33,196	1.383	141.55	4.33	71.28	185.7	43.41	40.71	51.10	2.3
(3) Actual operation in Jan. 3 - Jun. 9, 1984																					
3	157.5	6.56	113.3	4.72	270.8	11.28	9,917	413.2	11.42	5,543	54.10	27,108	1.130	103.40	3.81	62.82	188.7	43.96	42.19	56.65	3.6
4	158.1	6.59	121.8	5.08	279.9	11.67	10,067	419.5	10.43	2,243	22.25	35,030	1.460	135.85	3.88	63.88	186.3	44.70	43.67	56.50	3.6
5	165.9	6.91	134.8	5.62	300.7	12.53	11,304	471.0	11.92	4,016	37.73	34,896	1.454	128.17	3.67	60.50	206.4	45.14	43.82	57.98	3.6
6	156.8	6.53	131.2	5.47	288.0	12.00	11,022	459.3	11.90	2,778	26.44	35,077	1.462	130.36	3.72	61.21	192.8	45.44	45.14	56.06	3.6
7	158.3	6.60	116.8	4.87	275.1	11.47	9,780	407.5	11.94	2,000	19.13	37,224	1.551	139.17	3.74	61.58	193.5	45.44	44.99	56.20	3.6
8	138.4	5.77	119.6	4.98	258.0	10.75	10,180	424.2	11.75	3,720	39.22	24,090	1.004	99.18	4.12	67.81	153.6	44.98	43.81	55.32	3.6
9	154.2	6.43	114.6	4.78	268.8	11.21	9,660	402.5	11.86	6,340	62.27	23,816	0.992	91.73	3.85	63.44	182.9	44.55	43.62	54.58	3.6
Total	1,089.2	45.39	852.1	35.52	1,941.3	80.90	71,930	2,997.2	81.22	26,640	261.13	217,241	9.053	827.86	26.79	441.24	1,304.2	314.22	307.25	393.29	25.2
Average	155.6	6.48	121.7	5.07	277.3	11.55	10,276	428.2	11.60	3,805	37.30	31,034	1.293	118.3	3.83	63.03	183.6	44.89	43.89	56.18	3.6
(4) Actual operation in Feb. 16 - Feb. 22, 1984																					
16	195.9	8.16	145.6	6.07	341.5	14.23	12,390	516.3	11.75	0	0	54,400	2.267	195.9	3.60	59.29	248.6	-	46.73	61.07	3.6
17	182.0	7.58	146.6	6.11	328.6	13.69	12,540	522.5	11.69	0	0	49,197	2.050	182	3.70	60.93	224.8	46.47	45.29	60.19	3.6
18	188.9	7.87	148.1	6.17	337.0	14.04	12,452	518.8	11.89	78	0.7	50,482	2.103	188.2	3.73	61.39	225.7	46.03	45.29	58.12	3.6
19	201.0	8.38	140.6	5.86	341.6	14.24	11,945	497.7	11.77	0	0	51,176	2.132	201.0	3.93	64.68	233.9	47.21	46.32	57.98	3.6
20	206.1	8.59	132.1	5.50	338.2	14.09	10,718	446.6	12.33	0	0	54,723	2.280	206.1	3.77	62.02	250.1	46.47	46.32	57.98	3.6
21	205.9	8.58	138.6	5.78	345.5	14.36	11,698	487.4	11.85	0	0	56,202	2.342	205.9	3.66	60.34	256.8	46.47	45.29	58.12	3.6
22	212.6	8.86	130.3	5.43	342.9	14.29	12,610	525.4	10.33	0	0	55,210	2.300	212.6	3.85	63.41	252.3	46.47	44.85	57.24	3.6
Total	1,392.4	58.02	981.9	40.92	2,374.3	98.94	84,353	3,614.7	81.61	78	0.7	371,390	15.474	1,391.7	26.24	432.06	1,692.2	279.12	320.09	410.70	25.2
Average	198.9	8.29	140.3	5.85	339.2	14.14	12,050	516.4	11.66	11.1	0.1	53,055	2.211	198.8	3.75	61.72	241.7	46.52	45.73	58.68	3.6
(5) Estimate after renovation	200.7	8.76	112.8	4.7	313.5	13.06	9,720	405.0	11.6	0	0	53,330	2.222	200.7	3.76	62.0	243.7	46.0	45.0	57.5	2.0

(2) Estimation of max. consumption of BL

The actual consumption per 24 hours in one week during the three months, described in Item (1), is shown in Table 6-7-3.

For quick review, the part of furnace thermal load of Table 6-7-3 is extracted below.

Table 6-7-4 Furnace Thermal Load

	Max. furnace load x 10^3 kcal/m³-Hr	Average furnace load x 10^3 kcal/m³-Hr	Min. furnace load x 10^3 kcal/m³-Hr	Remarks
(1) Nominal capacity	215.8	188.6	–	Average is for production of UKP at 27 BDt/d. Max. is for production of UKP at 31.5 BDt/d.
(2) Dec. 11-17 1983	212.2	185.7	151.8	
(3) Jan. 3-9 1984	206.4	183.6	153.6	
(4) Feb. 16-22 1984	256.8	241.7	224.8	Quantity of processedl solids with average furnace load: 53,055 kg/d
(5) Renovated	–	243.7	–	UKP production: 29.35 BDt/d Consumed solids: 53,330 kg/d

As shown in the above, the furnace load in one week of February 16 to 22, 1984 (Item (4)), is 112% and 119% of the nominal capacity at the average and max., respectively, indicating that the consumption shown in Item (4) is almost the max. quantity of consumption.

The furnace load after implementing this renovation project is 243.7 x 10^3kcal/h, as shown in the above table, which is about the same as that of Item (4). Therefore, the quantity of 53,330kg/d for black liquor solids after the renovation can be estimated as the maximum value for the average.

6-7-3 Fuel Oil Consumption of Recovery Boiler

The average monthly consumption of fuel oil by the recovery boiler in 1983 was 68.8kl/m, as shown in Table 6-7-5. Although this consumption includes the fuel oil burnt for start and stop, it is assumed that the majority was the fuel oil consumed as auxiliary oil.

In the actual consumption during one week in February 1984, referred to in Item (4) of Table 6-7-3, the quantity of consumed black liquor solids is 1.5 to 1.6 times (53.1d/d) as much as the average. During this week, the fuel oil was consumed only one day and it is a very small quantity of 7.8l/d. The quantity of black liquor solids to be consumed after implementing this renovation project is estimated average 53.3t/d, which is about the same quantity as that shown in Item (4).

If the black liquor can be steadily supplied, the consumption of auxiliary fuel oil can be reduced to about half. However, we think it better to plan reduction of fuel oil consumption by about one third of the 1983 consumption for the time being, with greater reduction to be realized later, and the target consumption of fuel oil for start and stop as well as for co-burning is set to about 10kl/m. It is estimated that the saving of fuel oil by the renovation is about one third (68.8×1/3=23kl/m) of the existing consumption.

Table 6-7-5 1983 Main Boiler/Recovery Boiler Actual Operation

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Burning BL.	m^3/M	2,214.4	2,093.3	2,302.8	2,273.4	2,523.2	1,942	2,623.5	2,252.4	2,305.5	2,447.9	2,095.1	1,388.6	2,205.17
R/B fuel oil	kl/M	80,960	67.539	49.793	61.093	48.144	91.303	44.092	65.846	61.083	105.113	89.657	61.035	68.804
R/B steam generation	t/M	5,821.2	5,563.8	5,535.4	5,181	5,471	5,256	5,951	5,337.5	5,262.3	5,615.2	5,108.65	3,348	5,289.25
	t/kl	71.90	82.37	111.16	84.80	113.63	57.56	134.96	81.36	86.14	53.42	56.97	54.85	82.42
M/B fuel oil	kl/M	279.244	264.701	293.157	288.127	340.396	269.447	290.778	283.764	302.465	287.657	253.863	283.565	286.430
M/B steam generation	t/M	3,943.3	3,677	4,072.3	3,405	4,138	3,323	3,553	3,422.7	3,672.2	3,432.1	3,065.47	3,482.33	3,598.86
	t/kl	14.12	13.89	13.89	11.81	12.15	12.33	12.21	12.06	12.74	11.93	12.07	12.28	12.57

6-7-4 Steam Generation

(1) Actual quantity of generated steam

The quantity of steam generated in the three months of December 1983 to February 1984 is shown in Table 6-7-6. The quantity generated per 24 hours during one week in these months is shown in Table 6-7-3.

The consumption of steam during 24-hour a day operation is 300 to 350t/d (12.5 to 14.6t/h). To this consumption, the recovery boiler generates 55 to 60% and oil boiler 40 to 45%.

The nominal capacity of steam generation is 144t/d (6.0t/h, and 6.5t/h at the peak) on the recovery boiler and 240t/d (10.0t/h, and 12t/h at the peak) on the oil boiler, which makes a total of 384t/d (16t/h, and 18.5t/h at the peak).

The actual quantity of steam generated by the recovery boiler is average 7.5t/h, or max. 8.3t/h. Since the quantity of steam generated by the oil boiler is about 6.3t/h, the load to the oil boiler is about 63%.

The capacity of steam generation at the time of starting the cooking (21.8t/h at the peak), the boiler cannot supply enough steam, and the steam supplied to the digester is limited.

The steam consumption by the digester is limited up to 5.0t/h basically, and the consumption is further limited each time the boiler pressure drops.

The actual approximate efficiency of both boilers is shown in Table 6-7-6. Since the standard used generally is 60% on recovery boiler and 88% on oil boiler, it can be said that the BRPP boilers are operated in good state.

Table 6-7-6 Actual Steam Generation (Dec. 1983 - Feb. 1984)

Black liquor recovery boiler (R/B)

	Steam generation	Feed water	Blow amount	Rate of blowing	Oil consumption	Consumed solids in BL	Approximate boiler effic.	Generated steam per ton of solids
	t	t	t	%	kl	t	%	t/t
Dec.'83	3,348.0	3,492.4	144.4	4.14	61.04	760.92	60.13	3.65
Jan.'84	4,329.0	4,495.7	166.7	3.70	95.76	978.01	58.30	3.54
Feb.'84	4,951.9	5,107.3	155.4	3.04	30.61	1,276.32	60.21	3.66
Total	12,628.9	13,095.4	466.5	10.88	187.41	3,015.25	178.64	10.85
Average	4,209.6	4,365.1	155.5	3.63	62.47	1,005.08	59.55	3.62

Oil boiler (O/B)

	Steam generation	Feed water	Blow amount	Rate of blowing	Oil consumption		Approximate boiler effic.	Steam generation per kl of fuel
	t	t	t	%	kl		%	t/kl
Dec.'83	3,382.3	3,778.1	395.8	10.48	283.57		85.95	11.93
Jan.'84	3,765.8	4,225.1	459.3	10.87	306.55		88.50	12.28
Feb.'84	3,784.0	4,236.8	452.8	10.69	308.96		88.38	12.25
Total	10,932.1	12,240.0	1,307.9	32.04	899.08		262.83	36.46
Average	3,644.0	4,080.0	436.0	10.68	299.69		87.61	12.15

(2) Estimation of steam generation after renovation

The estimated steam consumption after implementing this renovation project is average 313.5t/h.

Case of average steam consumption

(6.98t/t pulp × 27t/d) + (2.5t/t paper × 50ADt/d) = 313.5t/d steam

1) Case of max. steam consumption (Form paper)

(6.98t/t pulp × 27t/d) + (3.0t/t paper × 50ADt/d) = 338.5t/d steam

2) Peak at papermaking

(6.98t/t pulp × 27t/d) + (3 × 1.15t/t paper × 50ADt/d) = 360t/d steam

The normal boiler steam generation capacity is 388t/d as described earlier.

Recovery boiler + oil boiler

(6 × 24 = 144t/d) + (10 × 24 = 240t/d) = 384t/d

384 − 313.5 = 71.5t/d (3.0t/h)

$$\left(\frac{384}{313.5} - 1\right) \times 100 = 22.5\%$$

Thus, there is an allowance of 22.5% in the capacity of boiler steam generation.

Since the average of actual steam generation of the recovery boiler (one week in February 1984) is 198.9t/d, the allowance becomes even greater, or about 40% as shown below.

71.5 + (198.9 − 144) = 126.4t/d (about 5.3t/h)

$$\left(\frac{384 + (198.9 - 144)}{313.5} - 1\right) \times 100 = 40.0\%$$

Accordingly, there is no need of installing an additional boiler.
However, the steam consumption at the peak when the digester starts cooking must be restricted, as done at present.

6-7-5 Feed Water

(1) Condensate recovery rate

The condensate recovery rate in the three months of December 1983 to February 1984 is as follows.

Table 6-7-7 Condensate Recovery Rate

(Unit: ton)

	R/B steam generation	O/B steam generation	Total steam generation	Condensate recovery	Condensate recovery rate
Dec. '83	3,348.0	3,382.3	6,731.3	2,522.5	37.47 %
Jan. '84	4,329.0	3,765.8	8,094.8	4,293.9	53.05
Feb. '84	4,951.9	3,784.0	8,735.9	4,765.9	54.56
Total	12,628.9	10,932.1	23,561.0	11,582.3	145.08
Average	4,209.6	3,644.0	7,853.6	3,860.8	48.36

The reason for the lower condensate recovery rate in December 1983 is the leakage of condensate from the heater tube of digester.

The condensate recovery rate in general plants is at least 60%. Since this is about 50% and quite low in BRPP, how to raise it must be investigated.

(2) Soft water

a) Capacity of soft water making equipment

BRPP has a unit of soft water making equipment in a capacity of $12m^3/h$ flow rate, $435m^2$/cycle, $280m^3/d$.

b) Record of soft water making

In the three months of December 1983 to February 1984, soft water was made in the following quantity.

Table 6-7-8 Soft Water Production

(Unit: ton)

	Recovery boiler	Oil boiler	Total
Dec. '83	969.9	3,778.1	4,748.0
Jan. '84	201.8	4,225.1	4,426.9
Feb. '84	341.4	4,236.8	4,578.2
Total	1,513.1	12,240.0	13,753.1
Average	504.4	4,080.0	4,584.4

c) Necessary amount of soft water after renovation

As described in 6-7-4 (2), the steam generation after the renovation is 360t/d. Adding 7.5% of boiler blowing makes a total steam generation of 390t/d.

When the condensate recovery rate is set to 50%, the amount of condensate is 180t/d (360×0.5), and the amount of soft water required is $210m^3/d$ (390 – 180).

Since the equipment has a capacity of $280m^3/d$, there is enough allowance in the soft water making capacity.

(3) Quality of feed water and boiler water

The analyzed results of boiler water in the three months of December 1983 to February 1984 are as follows.

Table 6-7-9 Boiler Water Standards and Analysis Results

	PH value	Methyl orange alkalinity ($CaCO_3$) ppm	Phenol-phthalane alkalinity ($CaCO_3$) ppm	Phosphoric acid ion Po_4^{3-} ppm	Total Solids ppm
Standard	10.5 – 11.3	Up to 300	Up to 200	20 – 40	Up to 1,500
Recovery boiler					
Dec. '83	10.7	318.9	268.3	40.7	631
Jan. '84	10.7	281.6	223.7	38.5	575
Feb. '84	10.7	271.9	213.0	39.3	611
Total	32.1	872.4	705.0	118.5	1,817
Average	10.7	290.8	235.0	39.5	606
Oil boiler					
Dec. '83	10.6	417.8	364.4	35.5	609
Jan. '84	10.6	395.0	336.2	35.8	710
Feb. '84	10.7	432.0	365.8	39.4	703
Total	31.9	1,244.8	1,066.4	110.7	2,022
Average	10.6	414.9	355.5	36.9	674

The alkalinity and phophoric ion consistency are high on both boilers, and it is suggested that the adding quantity of the boiler cleaning agent is reduced and the trend of change is watched.

6-7-6 Equipment Improvement Plan

(1) Vagga scraping conveyor for Cottrell precipitator

Failures occur very frequently and the precipitator is stopping very long. While the Cottrell precipitator is stopping, chemicals fly at a rate of about 80 to 150kg/h, causing a large loss of the chemicals. The conveyor must be replaced with a new type.

For reference, the stopping time of the Cottrell precipitator in the three months of December 1983 to February 1984.

Table 6-7-10 Stopping Time of Cottrell Precipitator

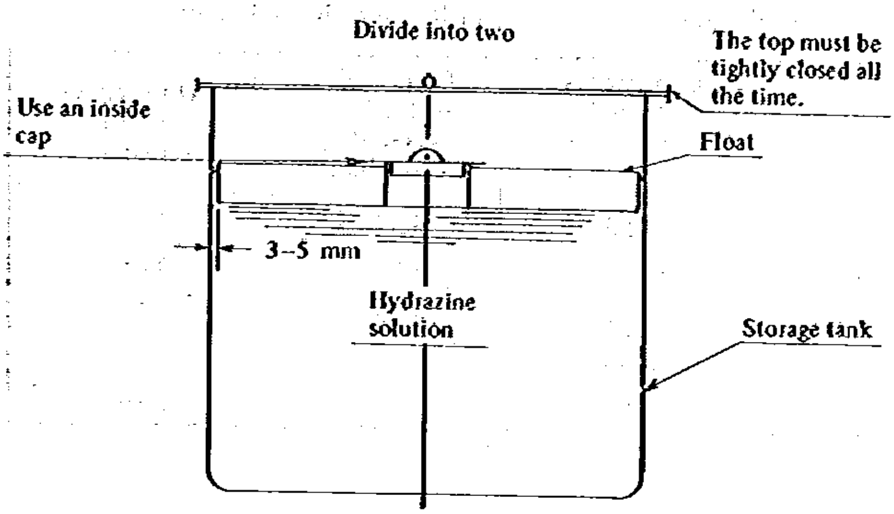
	Black liquor jet time	Cottrell operating time	C. operating time/BL jet time
Dec. '83	445 h 30 min	136 h 45 min	30.70 %
Jan. '84	584 20	440 30	75.39
Feb. '84	651 30	508 00	77.97
Total	1,690 20	1,085 15	64.20
Average	563 26	361 45	64.20

Although the cause of the Cottrell stopping is not a failure of the scrapping conveyor all the time, the failure occupies the majority of the cause.

(Note) The stopping time of Cottrell precipitator caused by a failure of the scrapping conveyor is average 129.5h/m, and during the period about 15t/m (10.4 to 19.4t/m) of salt cake (Na_2SO_4) scatters into the atmosphere.

(2) Boiler cleaning agent (Hydrazine) storage tank

Hydrazine (N_2H_2) solution is used as a deoxidizer, but the storage top is open. In this state, the solution contacts and reacts with the air, losing the effect. A float must be placed on the tank surface and the top must be covered tightly to avoid the solution contacting the air.



(3) Grand seal of black liquor pump

During the three months of December 1983 to February 1984, there was a difference of 1.86% on the consistency between the thick black liquor finished by the evaporator and thick black liquor received by the recovery boiler, with the consistency being lower at the recovery boiler receiving side. Since the average quantity of black liquor consumed in the three months is 42,700kg/d, the consistency difference of 1.86% indicates that about 4,000kg/d (166kg/h) pump seal water leaked in.

In order to avoid the consistency of black liquor becoming lower, the grand packing must be controlled tighter and the leakage must be reduced.

If it is difficult to reduce the leakage, the seal type must be reviewed and changed to other type like mechanical seal.

Table 6-7-11 Consistency of Received Black Liquor

	Consistency of thick BL finished by evaporator	Consistency of thick BL received by recov. boiler	Difference on the consistency
Dec. '83	44.55%	42.19%	2.36%
Jan. '84	45.14	44.26	0.88
Feb. '84	46.91	44.55	2.36
Total	136.60	131.00	5.60
Average	45.53	43.67	1.86

6-7-7 Proposal on Improvement of Operation

(1) Blowing pressure of air into recovery boiler for combustion

a) Standards of blowing pressure of air for combustion

i) The blowing pressure of air into the furnace for combustion should be kept within the following range:
Blowing pressure of primary air 40 – 60mmAq
Blowing pressure of secondary air 100 – 130mmAq

ii) Distribution of air for combustion
For primary air 50 to 60% of total
For secondary air 40 to 60% of total

iii) The total amount of air is 105 to 110% of the theoretical amount.

iv) Furnace inside
① When the blowing pressure of primary air is high, the charbed is not formed properly, causing more carry-over of dust.
② When the blowing pressure of secondary air is low, there is not enough jetting speed to penetrate through the gas flow, resulting in difficulty of complete combustion since the incomplete combustion gas that comes from the charbed is not mixed sufficiently.
③ Since the reduction of salt cake (Na_2SO_4) is conducted in an atmosphere of air shortage, complete combustion should not be conducted with the primary air only.

b) Record of blowing pressure of air for combustion

The blowing pressure of air for combustion of the recovery boiler in the three months of December 1983 to February 1984 is as follows.

Table 6-7-12 Blowing Pressure of Combustion Air

	Blowing pressure	
	Primary air mmAq	Secondary air mmAq
Dec.' 83	58.0	91.0
Jan. '84	55.4	90.7
Feb. '84	65.2	95.6
Total	178.5	278.2
Average	59.5	92.7

c) Proposal on operation

i) The secondary air blowing pressure is lower than the standard (100 to 130mmAq). Efforts must be made to get 120mmAq to stay within the standard.
The Laboratory analysis indicates CO_2: 13.6%, O_2: 3.6% and CO: 1.6%. This occurs when the blowing pressure of the secondary air is low and the amount of air is not enough.

ii) The average value of the blowing pressure of the primary air is within the standard range, but it tends to be on the higher side. Efforts must be made to obtain 50mmAq.

6-8 Recausticizing Equipment

6-8-1 Outline of Process

Recausticizing is a facility, recycling caustic soda (NaOH) that is produced by adding calcium oxide (CaO) to the sodium carbonate (Na_2CO_3) which contained in the green liquor, and the sodium sulfide (Na_2S) existing in the green liquor.

The following is the outlines of the equipment.

Table 6-8-1 Causticizing Facilities

No of set

	Size	Capacity	Quantity
Lime slaker tank	1.34 mφ (dia.) x 1.62 m (depth)	2.2 m^3	1
Classifier	5.04 m (length) x 0.44 m (depth)		1
Causticizer		4.2 m^3	3
White liquor clarifier	9.0 mφ (dia.) x 4.3 m (depth)	63.6 m^3	1
Lime mud washer	9.0 mφ (dia.) x 4.3 m (depth)	63.6 m^3	1
Lime mud filter	1.8 mφ (dia.) x 1 m (width)	20 t/d	1
Lime crusher	Hammer crusher	4.5 t/h	1

6-8-2 Processing Capacity

These facilities have a nominal capacity of producing 122m^3/d (5.08m^3/h) cooking white liquor (WL).

(1) Current processing capacity

In the three months from December 1983 to February 1984, the causticizing plant processed as following.

Table 6-8-2 Actual Quantity of Causticizing

	GL processing	WL production	WL/GL	Processing of black liquor solids	GL/solids
Dec. 1983	2,300 m^3	1,900 m^3	82.6%	762.0 t	3.02 m^3/t
Jan. 1984	2,960 m^3	2,382 m^3	80.5%	984.5 t	3.01 m^3/t
Feb. 1984	3,936.5 m^3	3,026 m^3	76.9%	1,273.7 t	3.09 m^3/t
Total	9,196.5 m^3	7,308 m^3	240.0%	3,020.2 t	9.12 m^3/t
Average	3,065.5 m^3	2,436 m^3	(79.5)	1,006.7 t	3.04 m^3/t

Table 6-8-3 Causticizing Quantity

	Operating hours hr-min	GL processing		WL processing	
		m^3/hr	$m^3/24$ hr	m^3/hr	$m^3/24$ hr
Dec. 1983	345-05	6.66	159.8	5.50	132.0
Jan. 1984	482-00	6.14	147.4	4.94	118.6
Feb. 1984	616-10	6.39	153.4	4.91	117.8
Total	1,443-15	19.19	460.6	15.35	368.4
Average	481-05	6.40	153.5	5.12	122.8

As shown in Table 6-8-3, the current operation is within the designed capacity.

(2) Estimate of green liquor (GL) generation

The quantities of generated green liquor (GL) and production of white liquor (WL) after implementing this renovation project are estimated as follows.

As shown in Table 6-6-1, the generated quantity of black liquor from solids is estimated at 53.32t/d in this renovation project.

In the three months of December 1983 to February 1984, green liquor of $3.04m^3$ was obtained from one ton of black liquor solids. Make use of this data calculation as follows.

Table 6-8-4 Estimation of Green Liquor Generation

	Pulp production BDt-UKP/d	GL generation		WL production	
		m^3/hr	m^3/d	m^3/hr	m^3/d
Renovation project	29.35	6.76	162.1	5.33	128

The processing quantity slightly increases after implementing this renovation project. The estimated increased quantity is about 5% of the designed capacity, and no problem would occur related with the capacity.

6-8-3 Calcium Oxide (CaO)

(1) Quantity of calcium oxide necessary for causticizing of green liquor.

Reaction form:

Sodium carbonate + (Calcium oxide + water)
= Caustic soda + Lime carbonate;

$Na_2CO_3 + (CaO + H_2O = Ca(OH)_2) = 2NaOH + CaCO_3$;

$106 + (56 + 18 = 74) = 80 + 100$

Quantity of calcium oxide theoretically needed for causticize sodium carbonate = 56/100 = 0.5283kg/kg.

Accordingly, the consumption of calcium oxide is: 0.5283 × 1.05 = 0.5547kg/kg

(2) Quantity of calcium oxide necessary to causticize green liquor

The quantity of calcium oxide needed to causticize green liquor in the three months of December 1983 to February 1984 is as follows.

Table 6-8-5 Quantity of CaO Necessary for Causticizing

	Processing quantity of GL (m^3)	Na_2CO_3 as Na_2O (kg/m^3)	Na_2CO_3 (kg)	Calcium oxide (CaO) Actual consumption (kg)	Proper consumption (kg)	Difference (%)
Dec. 1984	2,300	65.56	257,799	126,534	140,001	−11.5
Jan. 1984	2,960	64.88	328,335	166,475	182,127	− 8.6
Feb. 1984	3,936.5	69.20	465,726	229,527	258,338	−11.2
Total	9,196.5	199.64	1,051,860	522,536	583,466	—
Average	3,065.5	66.55	350,620	174,179	194,489	−10.4

The actual consumption of CaO is about 10% smaller than the proper amount of consumption.

6-8-4 Lime Mud

The designed capacity of lime mud is as follows:

Lime mud generation: About 14.0BDt/d
Processing capacity of lime mud filter: 20BDt/d (55% moisture content)

(1) Actual quantity of generated lime mud

In the three months of December 1983 to February 1984, lime mud was generated as following.

Tables 6-8-6 Quantity of Generated Lime Mud

(Unit: kg)

	100% CaO consumption	Generated $CaCO_3$	Impurities in CaO	Total generation	Generation	
					per hr	per 24 hr
Dec. 1983	126,533	225,951	44,507	270,450	784	18,816
Jan. 1984	166,475	297,277	65,805	363,082	753	18,072
Feb. 1984	229,527	409,870	92,333	502,203	815	19,561
Total	525,535	933,098	202,645	1,135,735	2,352	56,449
Average	174,178	311,033	67,548	378,578	784	18,816

The quantity of lime mud processed is under the designed capacity, so no problem at the present.

(2) Estimated quantity of generated lime mud

The estimated quantity of lime mud that would be generated after implementing this renovation project is as follows.

Table 6-8-7 Estimated Quantity of Lime Mud Generated

Pulp production BDt-UKPt/d	100% CaO consumption (kg)	$CaCO_3$ generation (kg)	Impurities in CaO (kg)	Total generation (kg)	Generation	
					per hr (kg)	per 24 hr (kg)
29.35	10,250	18,304	4,694	22,998	958	22,992

Although the generated quantity of lime mud is above the nominal capacity, but not large to create any problem.

6-8-5 Quantity of Cooking Chemicals Addition

Since the unbleached pulp washer does not perform satisfactory washing, much chemicals are lost and a large quantity of cooking chemicals must be added at the present.

After renewing the unbleached pulp washer by this renovation project, a substantial reduction of the quantity of adding chemicals can be expected.

(1) Quantity of chemicals actually added

The quantity of chemicals added in the three months of December 1983 to February 1984 is as follows.

Table 6-8-8 Quantity of Chemicals Actually Added

	Salt cake Na_2SO_4	Sodium sulfide Na_2S	Caustic soda NaOH
Dec. 1983	50,666 kg	28,632 kg	101,227 kg
Jan. 1984	82,614	10,219	93,486
Feb. 1984	86,240	15,510	91,676
Total	219,520 kg	54,361 kg	199,713 kg
Average	73,173 kg	18,120 kg	64,904 kg

Table 6-8-9 Quantity of Salt Cake (Na_2SO_4) Added

	Pulp production	Na_2SO_4 added	Na_2S added	NaOH added	Total Na_2SO_4 added	Na_2SO_4 consumption per/t pulp
	kg	Purity 100% kg	Converted to Na_2SO_4 100%, kg	Converted to Na_2SO_4 100%, kg	Purity 100% kg	kg/BDt-UPK
Dec. 1983	634,350	50,666	52,125	179,678	282,469	445.29
Jan. 1984	789,500	82,614	18,614	165,938	267,156	338.39
Feb. 1984	948,200	86,240	28,236	162,725	277,201	292.34
Total	2,372,050	219,520	98,965	508,341	826,826	1,076.02
Average	790,683	73,173	32,988	169,447	275,608	358.67

(2) Quantity of chemicals actually added

The quantity of chemicals added in general kraft plants is 55 to 60kg/BDt-UKP. As shown in Table 6-8-9, in BRPP, about 360kg/BDt-UKP was added in the three months. This is as high as about six times of the others.

The estimated quantity of chemicals to add after implementing this renovation project is 100kg/BDt-UKP, as described in the next paragraph, and we wish the project is started as quickly as possible.

(3) Estimation of chemical addition quantity

The quantity of chemical addition after implementing this project has already been discussed, but it is confirmed in the following.

Table 6-8-10 Estimated Quantity of Chemicals to Add

Pulp production	Salt cake to add	Caustic soda to add		Sodium sulfide	Total (Converted to salt cake)
		Caustic soda	Converted to salt cake		
29.35 BDt-UKP/d	2,055 kg/d	499 kg/d	886 kg/d	0	2,941 kg/d
1 BDt-UKP	70 kg	17 kg	30 kg	0	100 kg

6-8-6 Causticizing Efficiency

(1) Causticizing efficiency

The causticizing efficiency is expressed as a ratio of caustic soda (NaOH) against the caustic soda (NaOH) and sodium carbonate (Na_2CO_3) contained in the cooking white liquor.

$$\text{Causticizing efficiency} = \frac{NaOH}{NaOH + Na_2CO_3} \times 100$$

(NaOH and Na_2CO_3 are expressed as Na_2O.)

(2) Actual causticizing efficiency

The causticizing efficiency in the three months of December 1983 to February 1984 is as follows.

Table 6-8-11 Causticizing Efficiency

	Dec. 1983	Jan. 1984	Feb. 1984
Caustic soda (NaOH)	65.71 g/l	66.01 g/l	69.07 g/l
NaOH in green liquor	−10.01	−10.97	−11.87
Generated NaOH	55.70	55.04	57.20
Sodium carbonate	10.41	10.05	13.08
Total	66.11	65.09	70.28
Causticizing efficiency	84.25%	84.56%	81.39%

Note: Since much caustic soda is contained in the green liquor, soda in GL is deducted to calculate the causticizing efficiency.

(3) Standard causticizing efficiency

The general standard of causticizing is 80% ± 5.0. The BRPP's value is 81.39%, and shows normal situation.

6-8-7 Calcium Oxide

(1) Purity of calcium oxide

The purity of calcium oxide is usually 80% or higher, and calcium oxide of about 85% purity is generally used.

The purity of calcium oxide used by BRPP at present, based on the records of December 1983 to February 1984, is 72.29% as the average, with 86.75% as the highest and 42.45% as the lowest.
The variability of purity is shown in Fig. 6-8-1.

(2) Influence of fluctuation of purity

When the purity of calcium oxide greatly fluctuates, the chemical reaction becomes unsteady, resulting in fluctuation of the white liquor. This is proven by the data contained in Fig. 6-8-1.

If calcium oxide of a desirable purity is unobtainable, it may be lower than 80%, but at least the variability must be kept within ±2%, in order to stabilize the causticizing operation.

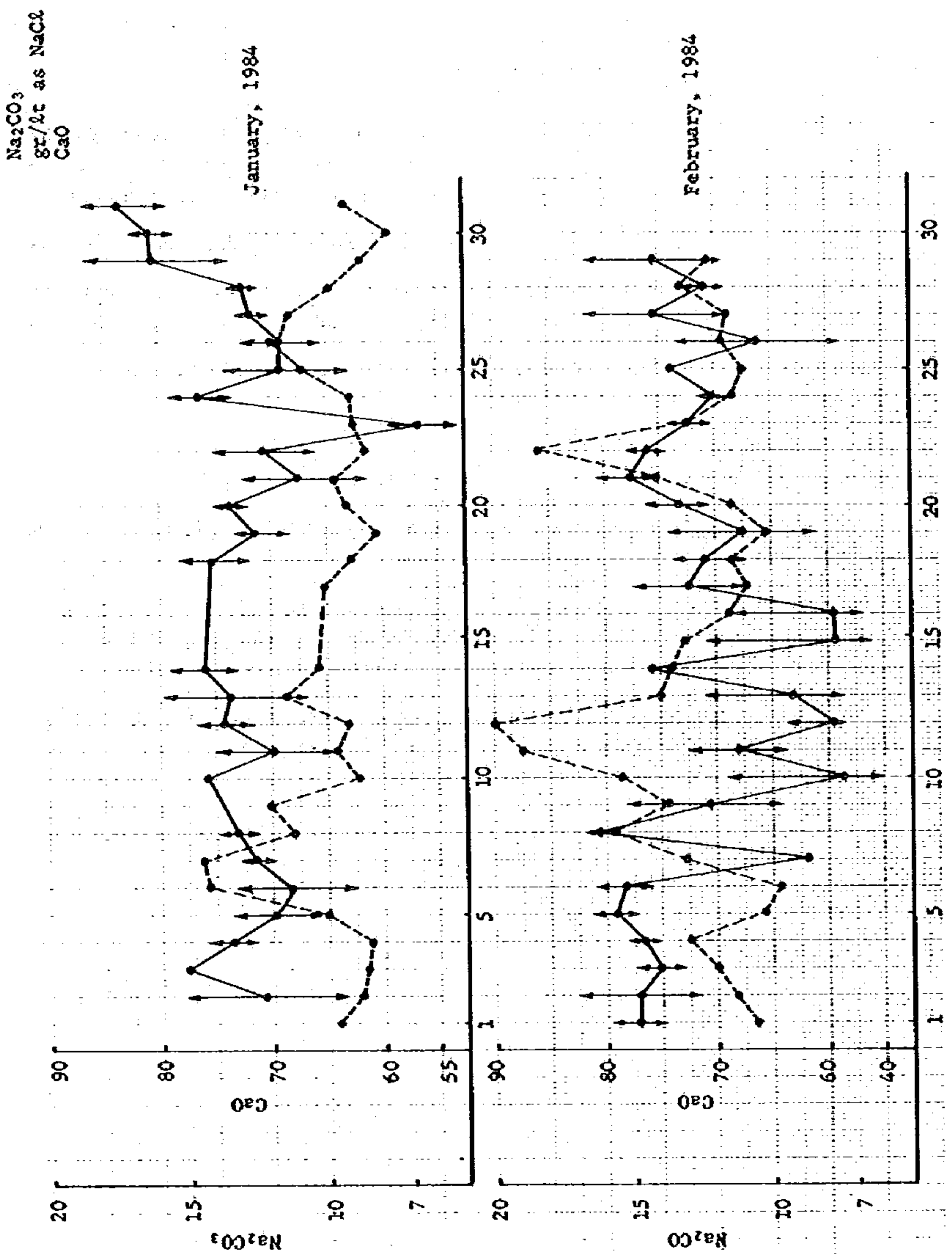


Fig. 6-8-1 Comparison of Data between Sodium Carbonate (Na_2CO_3) and Calcium Oxide (CaO) Contained in White Liquor

6-8-8 Improvement of Facilities

(1) Scale trouble of weak liquid transferring pipe

Disturbed by scale troubles on the piping for transfer of weak liquor to the recovery boiler, the recovery boiler is receiving only about half of the weak liquor. Since the scale cannot be removed by cleaning with steam or warm water, the piping must be replaced with a new one.

SUS pipes, rather than SGP pipes, are recommended since these allow depositing of less scales.

Ordinarily, no scale deposits in weak liquor piping. The reason why scales deposit is poor sludge settlement in the lime mud washer, resulting in the weak liquor containing much sludge.

The weak liquor must be analyzed and appropriate measures must be taken.

(2) Clogging of green liquor heater

Scales clog the heater and the heater is not used at present.

In order to expedite the causticizing reaction of green liquor, the green liquor temperature should be high.

When the temperature of calcium oxide is low, the temperature inside the slaker drops, and this slows the causticizing reaction. We recommend that the green liquor is heated so that the temperature in the slaker (currently about 85°C) is raised to 95 to 100°C.

When the temperature is high, the sludge settles down quicker. If the current green liquor heater cannot be repaired easily, we recommend use of a simple steam blowing type in-line heater which can be mounted very easily.

CHAPTER 7 OPERATION AND EQUIPMENT OF STOCK PREPARATION AND PAPER MACHINE

CHAPTER 7 OPERATION AND EQUIPMENT OF STOCK PREPARATION AND PAPER MACHINE

7-1 Operation and Facilities of Stock Preparation and Problems

7-1-1 General

The mission of stock preparation is to perform the following in order to assure the runnability in the next process, namely, paper machine process:

1) Uniformalization of pulp furnish combinations
2) Stabilization of stock consistency and freeness
3) Control of furnish ratios of chemicals

Especially, the control of freeness and quantity of chemical additives is a crucial point affecting the runnability of the machine and also from the viewpoint of quality control of products.

The major equipment for stock preparation are four super refiners (two are on actual use), three deluxe refiners (one is on actual use), stock mixing facilities and chemical adding facilities.

7-1-2 Record of Pulp Processing

Self-made pulp (N and L mixed pulp) and purchased pulp (NBKP, LBKP and CTMP) are mixed in the mixing tank, located in front of the stock preparation room, and sent into the room.

Table 7-1-1 (Comparison of pulp consumption) shows the actual record of pulp consumption in annual averages.

The daily average is 11171.09 BDt/341.65 days = 32.7 BDt/d for 1981, 11009.73 BDt/345.44 days = 31.87 BDt/d for 1982 and 10262.25 BDt/345.639 days = 29.70 BDt/d for 1983.

The processed quantity by grades is as follows:

Table 7-1-1 Comparison of Pulp Consumption

Description		1981		1982		1983	
		BDt/y	%	BDt/y	%	BDt/y	%
Self-made pulp	NBKP	4,205.23	45.0	3,761.96	41.46	4,006.31	45.2
	LBKP	5,147.45	55.0	5,535.72	59.54	4,856.33	54.8
	Sub total	9,352.68	100.0	9,297.68	100.00	8,862.64	100.00
Purchased pulp	NBKP	509.78		788.10		486.54	
	LBKP	1,129.90		816.0		819.96	
	CTMP	121.37		107.95		93.11	
	GP	57.41		-		-	
	Sub total	1,818.46		1,712.05		1,399.61	
	Total	11,171.09		11,009.73		10,262.25	

Kind of pulp		%		%		%
NBKP	4,715.01	42.2	4.550.06	41.3	4,492.85	43.8
LBKP	6,456.08	57.8	6,459.67	58.7	5,769.40	56.2

Table 7-1-2 Theoretical Quantity of Pulp Refined

	Theoretical quantity of paper produced ADt/24 hr	Theoretical quantity of pulp ADt/24 hr			
		Self-made pulp	NBKP	LBKP	Total
HVS 45	36.4	28.6	7.2	–	35.8
HVS 60	48.0	41.2	2.2	3.1	46.5
HVS/O 80	44.4	37.2	2.1	2.8	42.1
CS 70	45.32	37.2	–	CTMP 6.4	43.6

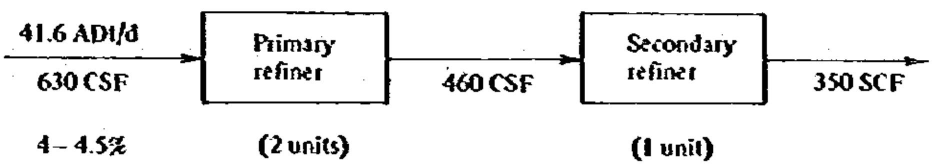
Note: Theoretical quantity of pulp
= (theoretical quantity of paper produced – clay retained) ÷ 0.95
Pulp yield = 95%

7-1-3 Refiner Capacity

The specifications of refiners that are currently used in the stock preparation room are as follows.

Use	Name	Horsepower (kW)	No. of refiners	No. of refiners at work
Primary refiner (Steel blade)	Type 150 Super Refiner	110	4	2
Secondary refiner (Stone)	Type 100 Delux Finer	95	3	1

The average freeness drop before and after the refiner for HVS 60g/m² is shown below.



Based on a papermaking efficiency of 89.4% as recently, the quantity of pulp consumed at this time is 41.6 ADt/d. This is compared with the capacity of refiners as shown below.

Table 7-1-3 Refiner Capacity

	Nominal kWh/100 cc ADt	Actual kWh/100 cc ADt
Super Refiner (Steel blade)	100 – 110	60 – 70
Delux Finer (Stone)	30 – 33	40 – 42

Based on the above data, it can be said that the refiners in the BRPP mill are used very efficiently.

When these refiners are used in series (4 Super Refiners and 3 Deluxe Finers), the production capacity is about 100 ADt/day.

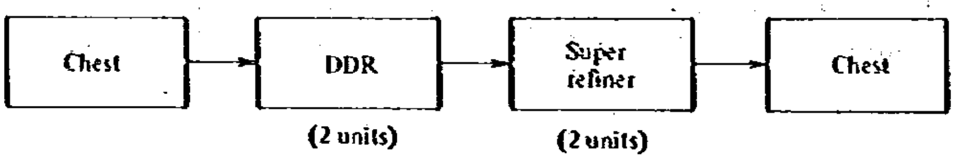
However, the steel blade type used for the Super Refiners is not suitable for improvement of the paper property if it is used for the primary refining.

Generally, DDR is used as the primary refiner. Based on CSF freeness 550ml, the following improvements can be expected by changing the super refiner to DDR:

Tear factor:	23% improvement
Breaking length:	17% improvement
Fiber length:	19% improvement

Accordingly, we recommend DDR (2 units) for the primary refining and Super Refiner (2 units out of which one is for standby) for the secondary refining.

The layout of the equipment in such a case is as follows:



7-1-4 Pulp Furnish Combination

The annual consumption of NBKP and LBKP is shown below.

Table 7-1-4 Annual Pulp Consumption

		1981		1982		1983	
Self-made pulp	BDt/y	9,352.68	83.7%	9,297.68	84.4%	8,862.64	86.4%
Purchased pulp	BDt/y	1,818.46	16.3%	1,712.05	15.6%	1,399.61	13.6%
Total	BDt/y	11,171.14	100%	11,009.73	100%	10,262.25	100%
NBKP	%	4,715.01	42.2%	4,550.06	41.3%	4,492.85	43.8%
LBKP	%	6,456.08	57.8%	6,459.67	58.7%	5,769.40	56.2%

Details of Table 7-1-4 are shown in Table 7-1-1.

[Furnish ratio of self-made pulp]

The breakdown of self-made pulp in the recent six months (August 1983 – January 1984) is shown in Table 7-1-6 and Table 7-1-7.

The ratio of NBKP to LBKP is 45% to 55% on the average, but the ratio greatly varies from month to month. The major reason is unstable supply of wood that is used for LBKP. In order to maintain as much uniformity in the paper quality as possible, the necessary species and quantity of wood for pulping must be secured and the pulp furnish combination must be maintained at a ratio optimum to produce the required quality.

Table 7-1-6 Ratio of Self-made Pulp (%)

	Aug.1983	Sep.1983	Oct.1983	Nov.1983	Dec.1983	Jan.1984	Average	1983 Avr.
LBKP	60.7	59.5	55.9	43.5	56.3	54.7	55.1	54.8
NBKP	39.3	40.5	44.1	56.5	43.7	45.3	44.9	45.2

Table 7-1-5 Freeness & Sheet Break Times

(Case of HVS 45 g/m^2)

	Freeness in head box			Sheet break times/shift
	Freeness	n	σx	
1	366.1	9	13	4
2	336.3	8	6.9	5
3	319.3	7	6.2	1
4	273.3	9	13.7	4
5	299.3	7	14.5	2
6	390.0	7	22.2	6
7	306.0	9	13.5	2
8	316.9	8	7.5	0
9	307.9	7	22.5	1
10	263.9	9	13.1	4
11	279.4	8	4.6	2
12	270.7	7	4.9	1
	$\bar{\bar{x}}$ 310.8	Total 95	37.0	$\bar{x}$ 2.67

Table 7-1-7 Breakdown of Actual Self-made Pulp Furnish Combination (%)

		Aug.1983	Sep.1983	Oct.1983	Nov.1983	Dec.1983	Jan.1984
LBKP	Turi	13.9	23.2	24.1	4.6	5.8	5.6
	Mangrove	4.0	4.8	6.0	12.2	6.2	1.8
	Albizia	3.6	4.3	7.2	2.4	6.2	9.5
	Lamtoro	35.8	24.2	12.0	21.0	36.4	37.8
	Bamboo x 1/2	3.4	3.0	6.6	3.3	1.7	1/2
NBKP	Bamboo x 1/2	3.4	3.0	6.7	3.4	1.8	–
	Pinus	35.9	37.5	37.4	53.1	41.9	45.3

7-1-5 Freeness

(1) The freeness in the stock preparation room is daily measured at five places, namely, Thickner, after Super Refiner, after Delux Finer, in Head box and in Flow box. The measurement in the flow box will become very effective in achieving good formation at the wire part and good runnability.

(2) Variation of freeness

Although the freeness control in the stock preparation room is standardized, the freeness itself has a large variation, and the current situation is R = 90 (including measurement errors and variation on processing). For example, variation of the freeness frequently occurs in the process of changing the weight from 80g/m^2 to 45g/m^2. The data of freeness variation is given in Fig. 7-1-1, 7-1-2 and 7-1-3.

The major cause for the freeness variations seems to be that the adjustment of refiners (especially primary refiners) is apt to delay (for manual and mechanical reasons) which is needed when the quantity of pulp to be treated changes, as well as the unstabilized quality of pulp referred to earlier.

If DDR is used as the primary refiner, this kind of trouble can be reduced to a remarkable extent.

The freeness control standard, actual state and improvement plan at BRPP is shown in Table 7-1-8.