Chapter 3 Paper & Pulp Sub-sector

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CASE STUDY P-01

Hoang Van Thu Paper Factory

Survey Date: 19 November 1999
6, 7 & 8 March 2000

1. General

1.1 Profile

Hoang Van Thu Paper Factory(HVT-PF) is a state-owned company which was established, at first, as a first paper production company in Viet Nam in 1913. The company profile of HVT-PF is summarized in Table 1.

Table 1 Enterprise Profile

Name of Company	Hoang Van Thu Paper Factory(HVT-PF)
Ownership	State-owned
Address	Quan Trieu Quarter Thai Nguyen City
Tel/Fax	02808444548 / 02808445481
Director	Mr. Nguyen Van Vui
Established	1913
Corporate Capital	
Number of Employees	400
Main Products	Paper, Cartons

1.2 Environmental protection department

The Quality Control and Technical Department is the section responsible for environmental protection, as well as the improvement of production technologies.

1.3 Business Status

Table 2 shows production and sales of HVT-PF.

Table 2 Production and Sales

Product	Production (ton)	Turnover (million VND)
Paper (gram mage 30-400g/m^2)	3,612	16,796
Carton from Waste Fibers	191	215
Black Liquor	103	51
Total		17,062

2. Production Technology

2.1 Process

Figure 1 shows a block flow diagram of the whole factory.

River water is used as process water, and the volume of water consumption is estimated at 900,000 to 1,000,000 ton/year. No flow meters are provided for river water intake and wastewater.

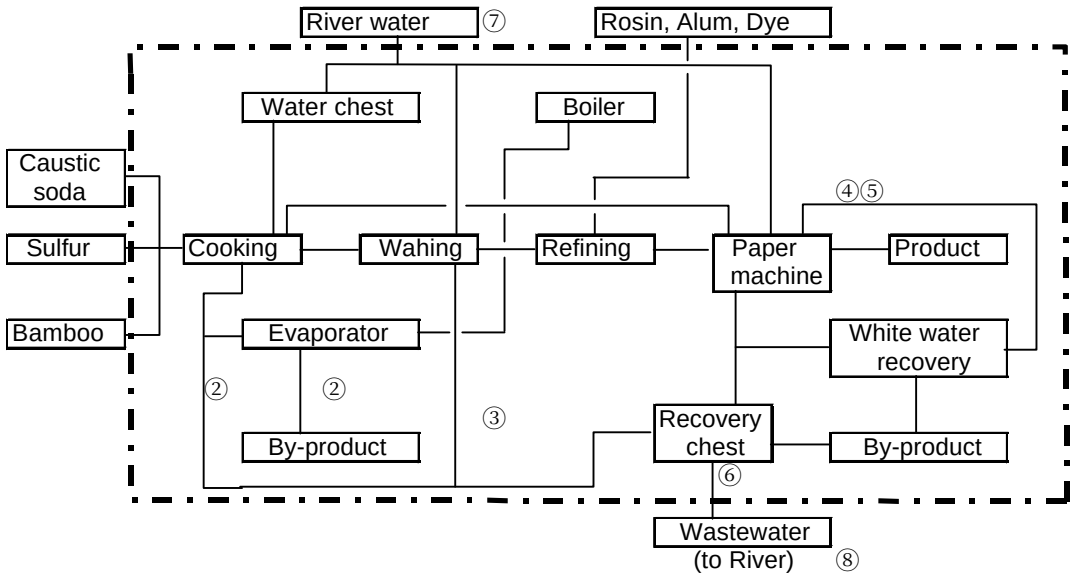


Figure 1 Block Flow Diagram of the Factory

2.1.1 Pulping Plant (Alkaline Pulp)

1) Bamboo Alkaline Pulp(AP) is cooked by a batch-type ball digester using NaOH and solid Sulfur(S).
2) Pulping is done using a beater, and then washing is done by the same beater.
3) Cooking liquor and washing wastewater, which contain very high COD levels, are discharged to the Cau river after removing only fiber material by settling tank, and a small volume of black liquor from the digester.

2.1.2 Recycle Fiber

Waste paper is pulped by beating only and then is washed in the same “beater” machine, which is utilized for AP. The factory has no equipment, except for Jonson screens, with two big holes, for removing dirt material etc.

2.1.3 Two Foudlineer Paper Machines

Each paper machine has a settling tank made of concrete. It is very effective to recover fiber material for re-use.

2.1.4 Two Cylinder Wire Machines

Both machines have no settling tank.

2.1.5 Black Liquor Evaporator

The factory produces black liquor for concrete use only in small amounts less than 1/30 of total black liquor. The evaporation process is carried out in a tank with a steam pipe in the bottom section. Therefore, the ratio of evaporation to steam consumption is less than 0.8.

2.2 Future Plans for Improvement

HVT-PF has the following future plans for process improvement:

1) If the factory is able to get funding from the state, the factory will increase the production capacity from 4,000 to 20,000 ton/year in the year 2000.
2) The factory has a plan to introduce a Refiner instead of using the Beater.

3. Management Technology

3.1 Yield of Bamboo Unbleached AP

The factory produces only 36.5 wt% of unbleached paper from BD chips weight.

In general, the yield of unbleached AP for bleached pulp is higher than 44wt%. Therefore, it is possible to raise the yield of unbleached bamboo pulp to more than 50 wt%. In this way it is possible to save more than 1/3 of chips and to reduce 1/2 of the effluent load.

The reasons for low yield are considered to be as follows;

(1) Pentosan, which is contained in BD chips of more than 25 wt%, does not remain due to the long cooking time.
(2) The outer side of the chips is over cooked before the inner part of the chips gets cooked, because steaming of the chips is not done and the remaining amount of NaOH is not sufficient. The steaming and/or saturation processes are very important for the inner part of the chip.

3.2 Unit Consumption and Cost

Table 3 shows consumption and costs of raw materials and utilities, and also turnover in 1998.

In spite of the very low cost of raw material bamboo, coal and labor, chemicals and waste paper costs are at the international price. So, the final total cost of paper, including fixed cost, is calculated to be the same as the average international price.

Table 3 Unit Consumption, Cost and Turnover in 1998

Used Material	Unit	Quantity	Expenses million VND	Unit Cost \/t	Note As 130 VND/\
I .For Paper Product	t/year	((3,612))		(\/kWh)	
1.Bamboo	t/year	9,887	3,322	2,585	＜＜1/5～1/6
2.Caustic soda	t/year	655	2,291	26,923	*Same as Inter. Price
3.Sulfur	t/year	24	72	23,077	*Same as Inter. Price
4.Waste Paper	t/year	1,338	1,773	10,192	*Same as Inter. Price
5.Rosin Size	t/year	52	364	53,615	*Same as Inter. Price
6.Alum	t/year	180	288	12,308	*Same as Inter. Price
7.Carbonate	t/year	11	21	15,391	*Same as Inter. Price
8.River Water	m^3/year	950,000			(4000～4500Kcal/Kg)
9.Coal	t/year	4,366	816	1,438	＜1/2 of Inter. Price
10.Electric Power	kWh/year	3,452,439	2,279	5.077	＞2 of Inter. Price
II .Carton	t/year	((190.5))			
1.Waste Paper	t/year	47	42	6,923	*Same as Inter. Price
2.Electric Power	kWh/year	37,000	24	5.077	＞2 of Inter. Price
III.Black Liquor	t/year	((103.4))			
1.Coal	t/year	136	25	1,436	＜1/2 of Inter. Price
Total Fiber	t/year	6,329	5,138		44.5% of Total Cost
Total Paper Product	t/year	((3,802))			60.0% of Raw Fiber
Total ((Energy Cost))			3,120		27.6% of Total Cost
Total Expenses	million VND		11,318	22,846	Running Cost of Paper
Fiber /Bamboo 0.45		Salary	3,600	7,284	
		Finance Cost	1,166	2,359	
		Total Cost	16,084	32,542	3/4 of Japan Price
		Turnover	17,062	34,520	
		Turnover-T.C	978	1,978	5.73%

4. Industrial Wastewater Treatment and Discharge

4.1 Industrial Wastewater

Wastewater from each plant is sent to an excavated sedimentation pond, then discharged to the river as shown in Figure 1. In this study, wastewater samples were taken at the points shown in Figure 1.

(1) Wastewater Samples Taken in November 1999

Samples were taken on 19 November 1999 as follows:

1. Mixed wastewater from the Chip cooker and evaporator;
2. Wastewater from the by-product recovery line;
3. Wastewater from the washing equipment;
4. Wastewater from the paper machine;
5. Wastewater from the paper machine;
6. Wastewater at the outlet of the wastewater recovery pit;
7. Supply water intake at the Cau river;
8. Wastewater at the final discharge point of the factory.

Table 4 and 5 show the analysis results of the samples mentioned above.

Table 4 Wastewater Quality (19 November 1999)

Item	Unit	Sample number and sampling time				
		①	②	③	④	⑤
Temperature	℃	21	20.8	20.5	25.8	27.9
pH	-	6.9	7.5	6.7	6.4	7.1
Electric conductivity	μS/cm	1270	1205	909	249	259
Turbidity	NTU	3096	37712	459	144	139
Oil & Grease	mg/l	0	0	0	0	0
BOD	mg/l	1010	973	985	175	181
COD	mg/l	58219	70320	16360	244	399
DO	mg/l				7.8	8.1
VSS	mg/l	1600	11020	210	58.5	60
TSS	mg/l	3160	37800	487	157	146
Total Nitrogen	mg/l					
Residual Chlorine	mg/l	T		336.8	11.3	T
SO_4^{2-}	mg/l					
S^{2-}	mg/l	0.14	0.21	0.19		0.02
Phenol	mg/l	4.0	4.0	0.35	0.06	0.05
Cyanogen	mg/l					
Na	mg/l	328	120	308	352	220
$CaCO_3$	mg/l	125	134	200	117	110
Cu	mg/l					
Pb	mg/l	0.34	0.053	0.296	0.035	0.05
Cd	mg/l	0.126	0.011	0.332	0.015	0.019
Hg	mg/l					
Cr(VI)	mg/l					
Zn	mg/l	0.246	0.033	0.428	0.045	T
Salt	%					0.01

Table 5 Wastewater Quality（19 November 1999）

Item	Unit	Sample number and sampling time ⑥	⑦	⑧		TCVN 5945
Temperature	℃	20.7	24.1	25		40
pH	-	8.0	8.3	9.95		5.5-9
Electric Conductivity	μS/cm	1341	166	1220		
Turbidity	NTU	359	22.5	271		
Oil & Grease	mg/l	T	0	T		10
BOD	mg/l	338	9.7	319		50
COD	mg/l	5160	15.8	5320		100
DO	mg/l		6.0	7.7		
VSS	mg/l	127	9.5	100		100
TSS	mg/l	385	26	289		
Total Nitrogen	mg/l	45.9	18.3	39.0		60
Residual Chlorine	mg/l	401	7.8	411.2		2
SO_4^{2-}	mg/l					
S^{2-}	mg/l	0.05	0	0.08		
Phenol	mg/l	0.50	0.018	0.28		0.001
Cyanogen	mg/l	T	T	T		
Na	mg/l	323	335	314		
$CaCO_3$	mg/l	232	66	250		
Cu	mg/l					
Pb	mg/l	0.057	0.048	0.02		
Cd	mg/l	0.024	0.025	0.024		
Hg	mg/l					
Cr(VI)	mg/l		0.01	T		
Zn	mg/l	0.017	0.007	0.007		
Salt	%		0	0.05		

(2) Wastewater Samples Taken in March 2000

Samples were taken on 6 March 2000 as follows:

1. Wastewater at the outlet of the wastewater recovery pit(sample point ⑥);
2. Supply water intake at the Cau River(sample point ⑦);
3. Wastewater at the final discharge point of the factory(sample point ⑧.)

Table 6 shows the analysis results of the wastewater samples taken.

Table 6 Wastewater Quality (16 March 2000)

Item	Unit	Sample number and sampling time ⑥	⑦	⑧		TCVN 5945(B)
Temperature	℃	20.9	20.9	20.6		40
PH	-	9.0	8.1	9.4		5.5-9
Electric Cnductivity	μS/cm	366	168	487		
Turbidity	NTU	139	10	168		
Oil & Grease	mg/l	T	0	T		10
BOD	mg/l	372	8.1	426		50
COD	mg/l	430	12.3	508		100
DO	mg/l	6.31	6.64	5.49		
VSS	mg/l	64	7.4	58.3		100
TSS	mg/l	159	19	142		
Total Nitrogen	mg/l	34.5	13.2	37.8		60
Residual Chlorine	mg/l	16.8	0	T		2
SO_4^{2-}	mg/l	61	34	48		
S^{2-}	mg/l	0.54	0	0.81		0.5
Phenol	mg/l	3.35	0.01	2.63		0.001
Cyanogen	mg/l	T	0	T		
Na	mg/l	286	48	345		
$CaCO_3$	mg/l	280	52	310		
Cu	mg/l	0.64	0.08	0.57		1
Pb	mg/l	0.03	0.001	0.04		0.5
Cd	mg/l	0.01	0.001	0.027		0.02
Hg	mg/l	0.002	0	T		0.005
Cr(VI)	mg/l	0.01	0.01	0.01		0.1
Zn	mg/l	0.1	0.093	0.21		2
Salt	%	0.01	0	0.02		
Ca^{2+}	mg/l	112				

Based on the analysis results, HVT-PF's wastewater is characterized as follows:

1) COD , BOD and sulfur content in the wastewater are exceeding Viet Nam wastewater standard (TCVN 5945 B);
2) VSS content is lower than the standard, but TSS is exceeding the 100 mg/l level. It is thought that useful material is leaking out of the processes.

4.2 Wastewater quality in major processes

In March, 2000, detailed analysis was done on the transition of SS content in

wastewater of major process as shown below;

(1) Blow pit overflow water and washing water from the digester

The transition of SS content in the digester, blow down liquid overflow from the blow pit, and washing water from the digester are shown in Table 7 and 8 respectively.

Table 7 SS Content in the Overflow from the Blow Pit（6 March 2000）

Item	Unit	Sample number and Sampling time(passing time)				
		BP1 00(min)	BP2 10	BP3 20	BP4 40	BP5 60
BOD	mg/l	1960				
COD	mg/l	58620				
VSS	mg/l	2733	2940	3755	4107	4984
TSS	mg/l	6165	6206	6282	6304	6313
TSS – VSS	mg/l	3432	3262	2527	2197	1328

Table 8 SS Content in Washing Water from the Digester（6 March 2000）

Item	Unit	Sample number and Sampling time (passing time)				
		W1 00(min)	W2 10	W3 30	W4 60	W5 120
BOD	mg/l					462
COD	mg/l					780
VSS	mg/l	356	476	443	409	388
TSS	mg/l	394	821	762	625	399
TSS – VSS	mg/l	38	345	319	216	11

Based on the above analysis results, separation efficiency of the blow pit and washing efficiency of the digester are not so good, so useful components for pulp leak out of the processes.

(2) Wastewater Quality of Paper Machines

Figure 2 shows a schematic drawing of the paper machines and sampling points. The factory has two paper machines, and samples were taken from each machine.

Analysis results are shown in Table 9.

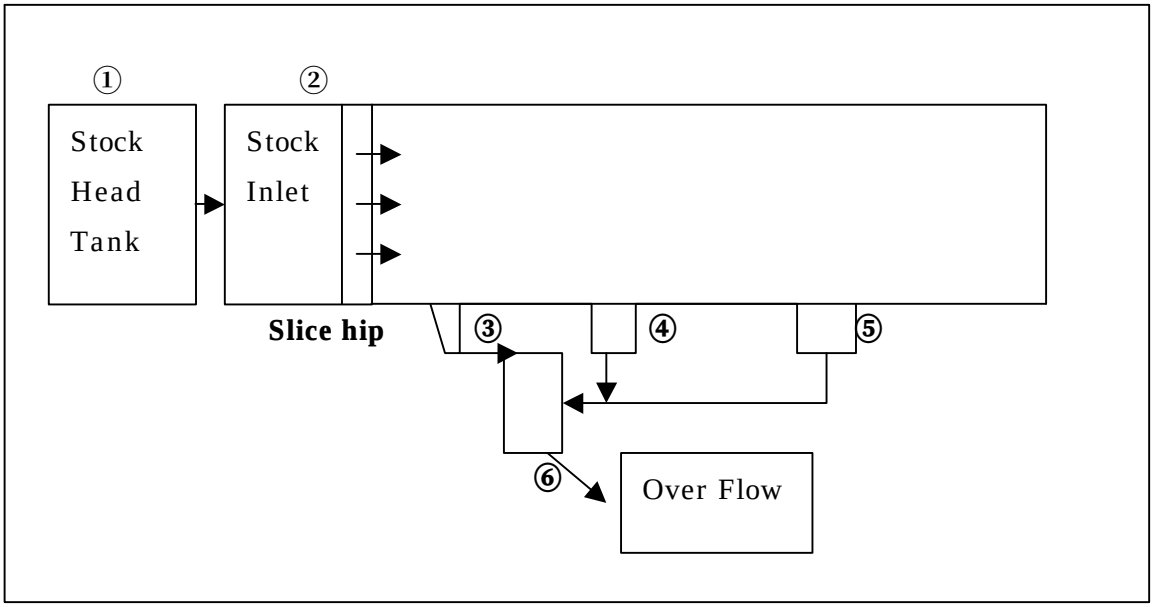


Figure 2 Paper Machine and Sampling Point Scheme

Table 9 Water Quality of the Paper Machine (7、March,2000)

Item	Unit	Sample number and Sampling point					
		① Head Tank.	② Stock inlet	③ White water	④ White water	⑤ White water	⑥ Over flow
No.1 Paper machine							
Ash	mg/l	185	950	417	382	56	214
TSS	mg/l	37530	42520	35780	44600	4125	39130
No.2 Paper machine							
Ash	mg/l	124	124	87	204	52	143
TSS	mg/l	20476	25760	19480	23715	13604	29713

Based on the above analysis results, wastewater containing high level of SS also comes from the paper machines.

5. Countermeasures for Industrial Pollution Prevention

5.1 Current Problems

Current issues in HVT-PF concerning wastewater are summarized as follows:

(1) Almost all of the cooking liquor which contains very high COD levels (roughly 60,000 mg/l) and all of the washing liquor are discharged to the river after receiving only sedimentation treatment at the pond;

(2) The yield of unbleached AP is very low, less than 40 %, so, it seems that the fiber and pentosan are effectively dissolved to cooking liquor;

(3) The wastewater volume is very high, as much as 263 times of product paper, so, it is reasonable to assume that fresh cold water is used for washing the pulping machine and the paper machine;

(4) Wastewater from the digester and paper machine contains very high volumes of SS, and environmental impact is very severe.

.

5.2 Production Technology Improvement

5.2.1 Recovery of Useful Components through Cleaner Production Techniques

It is possible to greatly improve the unit consumption of raw materials by recycling back useful material recovered from wastewater to the former process.

5.2.2 Apply a New Hot Water Washing Procedure

The washing efficiency will improve by using pressurized hot water (over 37℃ and 3.0kg/cm^{2}G), instead of fresh cold water. Therefore, it is possible to reduce the volume of washing water.

5.3 Wastewater Treatment

5.3.1 Design Basis

As for the design basis, total volume of wastewater to be treated is set at 3,300 m^3/day, and the qualities of wastewater to be treated are based on analysis results in this study of samples taken at the final discharge point.

5.3.2 Conceptual Design

Based on the above data, a conceptual design of a wastewater treatment system was constructed by the Study Team.

Summarizing the results of the conceptual design, the block flow diagram for the wastewater treatment system is shown in Figure 3.

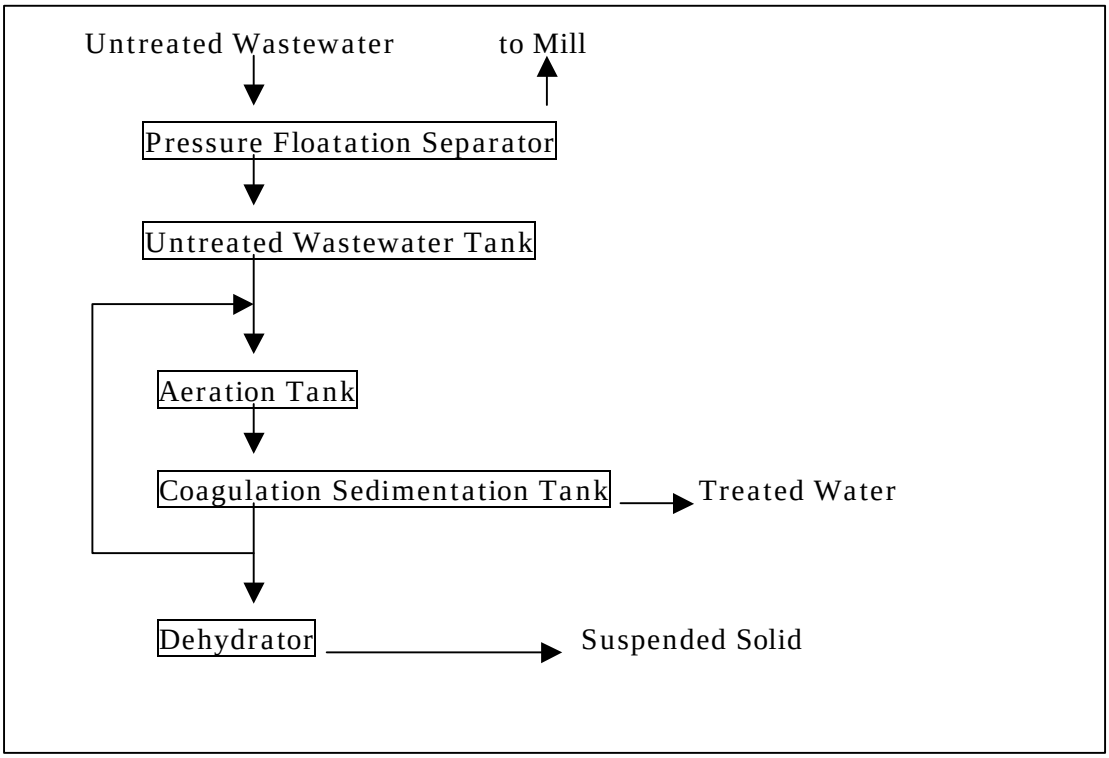


Figure 3 Block Flow Diagram of a Wastewater Treatment System

5.3.3 Factory Layout

The site area of the wastewater treatment system is estimated at 3,440 m^2.

The factory has no recent drawings of the factory lay out, because the factory was established in 1913. However, it was confirmed in this survey that the factory has enough space to install a wastewater treatment system, including sufficient space for future production expansion plans.

5.3.4 Required Cost

The required construction cost of the wastewater treatment system, based on the conceptual design, is estimated at 4.8 billion VND.

6. Recommendations

6.1 Short Term Recommendations

On a short term basis, it is recommended that the company take the following

preparatory actions which will serve as the basis for mid-term countermeasures:

(1) Strict Enforcement of 7S**;**

(2) Optimization of chip size;

(3) Set shower pipes to suppress floating stock and foam in the cylinder wire vat;

(4) Usage of low Hg content NaOH.

6.2 Mid-Term Basis Recommendations

On a mid-term basis, it is recommended that a wastewater treatment system be installed as discussed in Section 5.3. In order to minimize the construction cost of the wastewater treatment system, a reduction in the volume of wastewater and in the amount of contaminants in the wastewater is mandatory.

Process improvement projects such as;

(1) Usage of hot water for the cleaning shower

(2) Short cycle recovery of white water for each paper machine

should be implemented in parallel with the wastewater treatment project.

It is also recommended that wastewater treatment operation experts be invited to the company during the test operation stage in order to establish and optimize operating conditions, especially for the biological treatment system.

6.3 Long Term Basis Recommendations

On a long term basis, it is recommended that optimization of cooking liquor circulation, recovery and utilization of cooking steam and waste liquor, and increasing washing efficiency by using hot water be implemented.

In addition, it is most important to maintain stable operation of the wastewater treatment system.

6.4 Implementation Schedule

By an implementation schedule planned during this study, the test operation of the wastewater treatment system is expected to commence in the middle of 2003.

Case Study P-02

Dong Nai Paper Company

Survey date：30 November 1999
25, 28 & 29 March 2000

1. General

1.1 Company Profile

The Dong Nai Paper Company was established in 1959 and installed three world class level paper machines in the 60's. The company owns a 240,000 ㎡ site in the Bien Hoa Industrial Zone, they have co-generation power equipment that utilizes steam and handles the needs of the paper machines, and electrolysis equipment for salt. They also produce half the amount of bleached pulp they need, using the AP method.

The factory has high level technology and equipment, which includes a coating machine with the latest technology imported from Germany in 1990. Chemical collecting equipment for pulp waste was installed in 1997. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Name of the Company	Dongnai Paper Company (COGIDO)
Address	Bienhoa Industrial Zone-Dongnai Province
Tel	(061)-836201-836193
Fax	(061)-826231
Establishment	1959
Number of employees	950 (3shifts, 300 days operation/Y)
Ownership	State-owned

1.2 Environmental management

The technology department consists of managing sections in each production process, the production management section, and the pollution prevention section.

1.3 Business Status

This company produces bleached paper called “Cobo Pulp” from bamboo and eucalyptus using the AP method. Utilizing waste paper and imported pulp, they produce many kinds of paper and cardboard, such as Writing, Printing, Photocopy, Coating, Board, and Duplex paper.

The total production of this company was 23,823 tons in 1998, which ranked

fourth in Viet Nam. However, this company ranks second in Viet Nam overall, and is considered to be a high potential enterprise.

Table 2 shows the production and sales in 1998.

Table 2 Production and Sales in 1998

Product	Production/designed	Sales (VND)
Products	23,823/23,000	226,429,541,117
Bleached pulp	10,045/15,000	For Mill use
Caustic soda	1,610/2,400	For Mill use
Soda recovery	1,082/6,175	For Mill use

2. Production Technology

2.1 Production Process

Figure 1 shows a block flow diagram of the factory. The main production equipment is shown in Table 3.

3. Management Technology

3.1 Management of Business Targets

On a large bulletin board in the factory office shown are monthly budgets and results for production and each unit consumption in order. The basic purpose of this measure is to promote awareness of employees. Executives are very keen on production management.

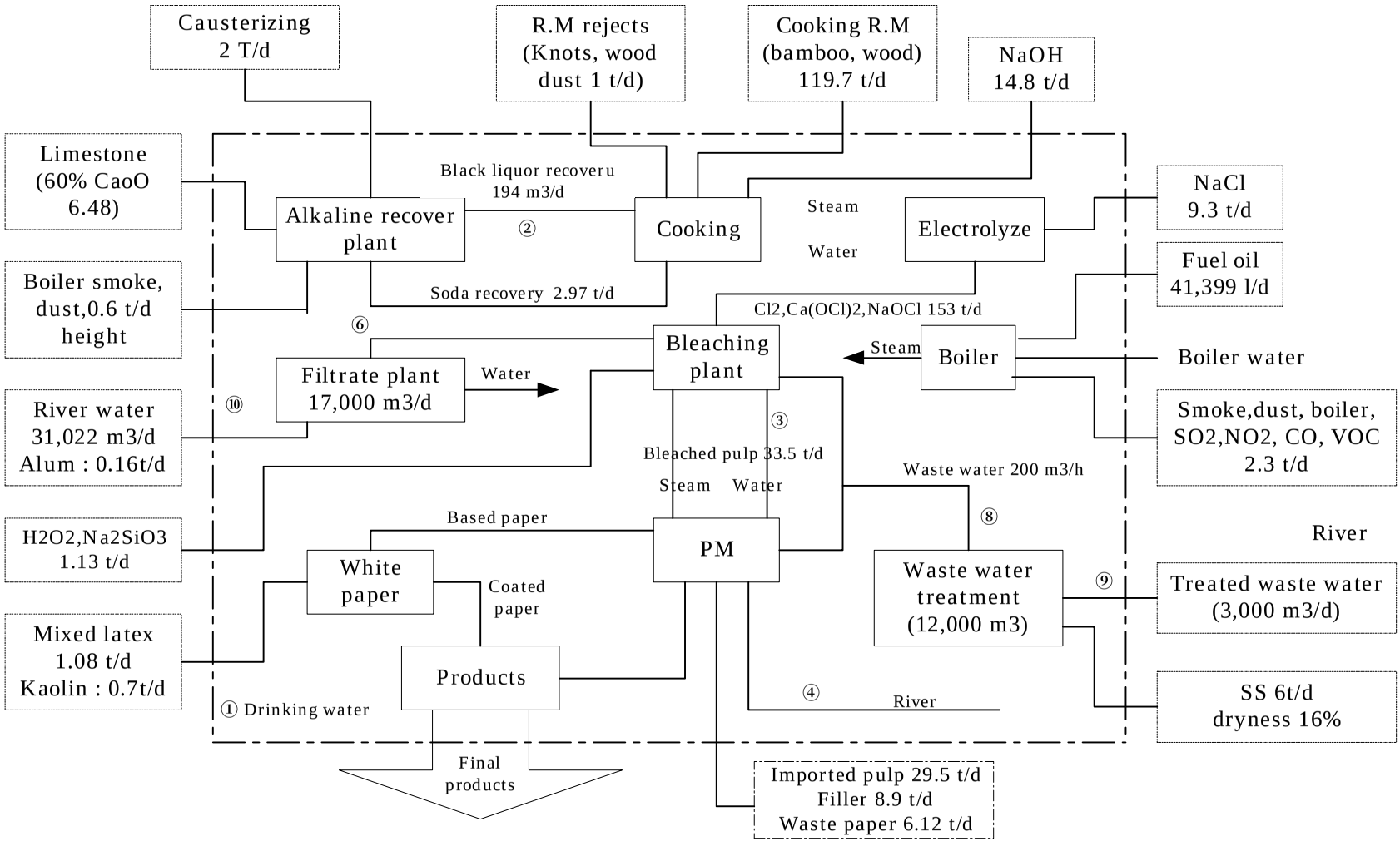


Figure 1 Block Flow Diagram of the Factory

Table 3 Main Equipment

Paper machine No. 1	DE PRETTO ESCHER WYSS – Italy –
Starting up	9 October 1961
Capacity	7,500 ton/year
Speed	150 m/min
Trim width	2.3 m
Paper Machine No. 2	KARHULA – AHLSTROM — Finland –
Starting up:	End of 1968
Capacity	9000 ton/year
Speed	240 m/min
Trim width	2.6 m
Paper Machine No. 3	TOMIOKA MACHINERY WORK – Japan
Starting up	10 May 1967
Capacity	4,500 ton/year
Speed	40 m/min
Trim width	1.65 m
Coating Machine	OFMANN—SCHWABE KREFELD— Germany
Starting up	1990
Capacity	2,000 ton/year
Speed	60 m/min
Trim width	1.6 m
Electrolysis Plant	Starting up： 1973
NaOH Capacity	2,400 ton/year
Chlorine Capacity	2,100 ton/year
Pulp Plant	Starting up: April 1967
Capacity	15,000 ton/year
Brightness	82 ° — 85 ° ISO
Raw material	Bamboo, Eucalyptus
Ball Digesters	7 kg/cm^2
Chemical Recovery	Starting up: December 1997
Capacity	4,000 ton/year
Black Liquor	8 ° Be, 500 m^3/day
Recovery Boiler	12.7 kg/ cm^2, 8 ton/hour
Stack Height	60 m — concrete
Electrical Generator	Starting up: 1961 – 1971
Diesel M.A N	1,000, kVA —2pcs
Turbine Escher Wyss	9,000kVA
Boiler Center	Starting up: 1971 – 1991
Boiler No. 4 Babcok	50 kg/cm^2 — 40 ton/hour
Boiler No. 6 — 7 DKB	9 kg/cm^2 — 25 ton/hour
Environmental System	Starting up: 1992
Sedimentation Basin	12,000 m^3 – Sweden –

3.2 Unit Consumption

Unit consumption is grasped and analyzed for each product as shown in Table 4.

Table 4 Unit Consumption and Expenses (1)

MATERIAL	UNIT	QUANTITY	EXPENSES (VND/UN)
I. Bleached pulp (Cobo pulp):			
1. Main raw material (wood, bamboo)	ton	43,705.3	420,103
2. NaOH	ton	5,406.011	4,154,000
3. $Ca(OCl)_2$+NaOCl	m^3	18,949	197,154
4. Cl_2	ton	532.123	6,027,000
5. Na_2SiO_3	ton	38.050	1,126,000
6. H_2O_2	ton	375.563	4,244,000
II. White writing paper			
2.1. Imported pulp	ton	300.358	6,494,197
2.2. Cobo pulp	ton	306.368	7,284,756
2.3. Waste paper	ton	60.3	3,800,000
2.4. Resin	ton	9	689,000
2.5. Anion starch	ton	9	8,075,000
2.6. Alum	ton	30	1,814,000
2.7. Na_2CO_3	ton	1.44	1,950,000
2.8. Talc	ton	60	1,595,000
III. White printing paper			
3.1. Imported pulp	ton	7,560.42	6,494,197
3.2. Cobo pulp	ton	9,329.88	7,284,756
3.3. Waste paper	ton	256	3,800,000
3.4. Resin	ton	193.2	6,890,000
3.5. Anion starch	ton	241.5	8,075,000
3.6 Alum	ton	805	1,814,000
3.7. Na_2CO_3	ton	38.6	1,950,000
3.8. Talc	ton	1,610	1,595,000
IV. Color board			
4.1. Imported pulp	ton	57.089	6,494,197
4.2. Cobo pulp	ton	98.781	7,284,756
4.3. Waste paper	ton	31.194	3,800,000
4.4. Resin	ton	2.04	6,890,000
4.5. Anion starch	ton	2.55	8,075,000
4.6 Alum	ton	8.5	1,814,000
4.7. Na_2CO_3	ton	4.08	1,950,000
4.8. Talc	ton	17	1,595,000
4.9. Mixed colors	ton	0.17	131,146,000
V. High quality printing paper			
5.1. Imported pulp	ton	550.683	6,496,197
5.2. Cobo pulp	ton	349.64	7,284,756
5.3. Resin	ton	10.64	6,890,000
5.4. Anion starch	ton	30.45	8,075,000
5.5 Alum	ton	43.5	1,814,000
5.6. Na_2CO_3	ton	2.01	1,950,000
5.7. Talc	ton	87	1,595,000
5.8. Tinopal	ton	2.61	160,769,000
5.9. Steward glue	ton	1.566	15,197,000

Table 4 Unit Consumption and Expenses (2)

MATERIAL	UNIT	QUANTITY	EXPENSES (VND/UN)
VI. White sized board:			
6.1. Imported pulp	ton	396.422	6,494,197
6.2. Waste Paper	ton	409.01	3,800,000
6.3. Resin	ton	5.04	6,890,000
6.4. Anion starch	ton	6.3	8,075,000
6.5 Alum	ton	12.6	1,814,000
6.6. Na_2CO_3	ton	1.008	1,950,000
6.7. Steward glue	ton	2.61	15,197,000
VII. Cartons made from bamboo			
7.1. Semi chemical pulp	ton	445.256	2,401,892
7.2. Resin	ton	1,478.886	1,670,405
7.3. Anion starch	ton	12.8	6,890,000
7.4. Alum	ton	32	1,814,000
7.5. Na_2CO_3	ton	2.56	1,950,000
VIII. Coated paper			
8.1. Based paper	ton	2,148.126	10,502,771
8.2. Mixed glue	ton	395.6	8,439,000
8.3. Kaolin	ton	239.8	2,768,000
IX. Water and energy			
9.1. Water	m^3	535	11,421,859
9.2. Fuel oil	litter	1,680	15,110,923
9.3. Energy	kWh	824	39,864,354

4. Industrial Wastewater Treatment and Discharge

4.1 Industrial Wastewater

The water consumption in the factory is about 430 times as high as the paper production. Wastewater is mostly discharged from the pulping process and the paper process. For wastewater from the paper process, SS is collected in a settler, and clean water is reused for the pulping process. Wastewater from pulping process, in which SS and COD values are usually major concern, is treated through the use of a 12,000 m^3 sized sedimentation tank and SS, filler and the like are removed and carried out of the factory at an amount of 6 tons per day. However, the removal of COD is not efficient.

4.1.1 Wastewater Analysis in November 1999

The analysis results of wastewater samples that were taken on 30 November 1999 are shown in Table 5.

Table 5 The Results of Wastewater Analysis

(30 November 1999)

Sampling No	Unit	1	2	3	4	6	8	9	10
Temp	℃	28.6	20.7	34.4		28.7		33.6	28.9
PH		6.63	9.18	4.62		6.95		6.49	7.11
Elec. Conductivity	μS/cm	65	5168	694		53		3140	68
Turbidity	NTU	10	68146	154		10		33	10
Oil content	mg/l	A*	A*			A*	8.7	8.5	0.9
BOD	mg/l	0	632			0	136	196	
COD	mg/l	5	141639	1102	1416	5	944	669	11
DO	mg/l	5.34	0.8	4.6		4.82		2.5	4.16
VSS	mg/l	0	5.86	1.142	570	2	316	160	5
TSS	mg/l	0	10680	1686	700	5	329	215	13
Total nitrogen	mg/l	2.5				11.5	82.1	48.6	21.4
Residual Chlorine	mg/l	0.29				A*	A*	0.05	. A*
SO_4^{2-}	mg/l	10		440	20	9	2	10	6
S^{2-}	mg/l								
Cyanogen	mg/l	0.01				0.06	0.02	A*	0.02
Phenol	mg/l	0.011				0.009	0.1	0.119	A*
Na	mg/l		197						
$CaCO_3$	mgeq/l			82	16				
Cu	mg/l	0.09				0.09	0	0.16	0.03
Pb	mg/l	0.027				0.017	0.034	0.011	0.032
Cd	mg/l	Trace				trace	Trace	trace	trace
Hg	mg/l	Trace				trace	0.45	2	A*
Cr(VI)	mg/l	A*				A*	0.42	0.21	trace
Zn	mg/l								
Salt	%	0		0.02		0		0.15	0

Note : A* : not detected.

4.1.2 Wastewater Analysis in February 2000

(1) Samples taken before and after wastewater treatment.

Samples were taken before and after wastewater treatment (sedimentation tank) on 29 February 2000 as was done in November 1999.

The analysis results are shown in Table 6. The mercury value, which was of concern, decreased by three decimal points, and this may be explained by a change in the type of caustic soda being used.

Table 6 Results of Wastewater Analysis

(29 February 2000)

Sample No	Unit	8	9
Temp	℃		
pH			
Elec. Conductivity	μS/cm		
Turbidity	NTU		
Oil content	mg/l	0.25	0.1
BOD	mg/l	510	756
COD	mg/l	956	1069
DO	mg/l	7.9	7.5
VSS	mg/l	212	76
TSS	mg/l	225	116
Total nitrogen	mg/l	2.8	3.55
Residual Chlorine	mg/l	not detect.	not detect.
SO_4^{2-}	mg/l	7	10
S^{2-}	mg/l		
Cyanogen	mg/l	0.07	0.4
Phenol	mg/l	0.2	0.45
Na	mg/l	8440	11
$CaCO_3$	mgeq/l	1785	2.5
Cu	mg/l	0.37	0.2
Pb	mg/l	2.15	<0.001
Cd	mg/l	<0.001	<0.001
Hg	mg/l	0.006	0.003
Cr(VI)	mg/l	0.049	<0.01
Zn	mg/l	7	0.1

(2) Wastewater from the washing process for bleached and unbleached pulp

A total of 11 samples from washing process for bleached and unbleached pulp were taken at the following points.

Black Liquor from the Brown Stock Washer
W1:Black Liquor from the No.1 Stage Washer
W2:Black Liquor from the No.2 Stage Washer
W3:Black Liquor from the No.3 Stage Washer
W4:Black Liquor from the No.4 Stage Washer
W5:Black Liquor going to the Evaporator
W5':Diluted Black Liquor

Wastewater from Bleaching Washer
B6:Wastewater from Cl2 Washer
B6:Wastewater from NaOH Washer
B6:Wastewater from No1 HYPO Washer
B6:Wastewater from No2 HYPO Washer
B6:Wastewater from H2O2 Washer

The results of analysis are shown in Table 7. Judging from the COD values, about 1/4 of the dissolving solid component is carried over to the bleaching process.

Table 7 Results of Wastewater Analysis

(Bleached and Unbleached Pulp Washing Process)

(3 March 2000)

Sample No	Unit	W1	W2	W3	W4	W5	W5'
BOD	mg/l	27,232(*)					
COD	mg/l	66,000(*)	67,885	42,240	15,085	120,685	47,14
DO	mg/l	7.5					
Na	mg/l	2750(*)					
SW (15℃)		1.0595	1.03	1.017	1.0038	0.9985	0.9977

Sample No	Unit	B6	B7	B8	B9	B10
BOD	mg/l	172	410	238	232	413
COD	mg/l	848	2,451	716	678	716
DO	mg/l	7.3	7.6	7.5	7.5	7.5
Na	mg/l	41.2	92.5	226	41.8	92.3
SW (15℃)		0.9967	0.999	1	0.9977	0.9952

Note: (*) - sample after paper filtration
W- Washing Plant
B- Bleaching Plant

(3) Black Liquor in the Evaporator

The Evaporator in the Dong Nai factory is equipped with a special feature in liquid supply. Samples were taken 29 February 2000 at the following points according to the designed sequence of the equipment.

No.1: Black Liquor feeding to #3V/E
No.2: Black Liquor feeding to #4V/E
No.3: Black Liquor feeding to #1V/E
No.4: Black Liquor feeding to #2PH
No.5: Black Liquor feeding to #1V/E
No.6: Black Liquor feeding to #2V/E
No.7: Black Liquor feeding to F. Cyclone
No.8: Black Liquor feeding to R. Boiler
N0.9: Wastewater from the Seal Pit

The results of analysis are shown in Table 8.

Table 8 Results of Black Liquor Analysis in the Evaporator

(29 February 2000)

Sampling No	Unit	1	2	3	4	5	6	7	8	9
BOD	mg/l	30								35
COD	mg/l	131.25								60
DO	mg/l	8								8.3
VSS	mg/l	717.16							29.906	
TSS	mg/l	1995	9180	6540	1240	15630	15240	22770	81570	
Phenol	mg/l	23.2								2.33
Na	mg/l								7360	
SW(31℃)	kg/l	1.0771	1.178	1.174	1.184	1.1893	1.2047	1.2605	1.2789	0.998
K	mg/l								110	
ash VS	mg/l	67210							309470	

The concentration of heavy black liquor is estimated to be 40 % from specific gravity, which is considered to be relatively low because samples were taken right after the equipment operation started.

5. Industrial Pollution Prevention Measures

5.1 Present Problems

The following 5 items are the major problematic issues at present:

(1) Large size of chip;
(2) Unbleached pulp washing;
(3) High consumption of chemicals used for the bleaching process;
(4) Evaporation rate of the evaporator;
(5) Power generation using the Co-generation system.

5.1.1 Large Size of Chips

The use of large chip produces unfavorable effects such as an increase in the consumption rate of chemicals and cooking time, or decrease in pulp yield.

5.1.2 Washing Process for Unbleached Pulp

There are four washers. However, they are not equipped with pumps or other spare equipment, and are not maintained well. Because of this, it is impossible to carry out a four drum- four stage circulating washing. At present, only a single stage, independent washing is being carried out for each of the four drums. Gland packing of pumps and agitators is also not maintained sufficiently, and a certain amount of black liquor leakage was observed.

The factory is using washers that can be used for a two stage one drum process. By installing a small pump for each, those washers can be remodeled and changed to four drum-seven stage type and the discharged amount of NaOH and COD can be reduced to 1/20 or less.

5.1.3 Consumption Amount of Chemicals in the Bleaching Process

1) As mentioned above, the consumption amount of chemicals is large because of the large size of chips being used. Therefore, consumption amount of Cl_2 can be reduced from 6 % to 4 % by changing the size of chips to a more suitable size, and improving the washing process.
2) Since the five stage bleaching system, CEHHP washers, utilizes only clean water for washing, in the end a large amount of wastewater is discharged as a

result. It is necessary to utilize all or part of the wastewater from the succeeding stage for the preceding stage washer. This will allow remaining chemicals from the preceding stage to be neutralized, resulting in the reduction of the wastewater amount, and can also decrease high quality fiber draining loss. Waste heat can also be reduced or recycled. Thus the amount of chemicals and steam consumed in succeeding stages can be reduced as well.

5.1.4 Evaporation Rate of the Four Drum Four Stage Multiple Effect Evaporator: E/S is about 1.

The E/S rate is usually around 3.2 and the amount of steam used should be 1/3 or less of the steam generated by the recovery boiler. However, the evaporator utilizes the entire amount of steam, at a rate of 7-8 t/h.

Figure 2 shows the concentration of supply liquid in each drum, and the following statements could explain the reasons for these results.

(1) Only the #3 and #2 drums work efficiently. The #4 and #1 drum are working inefficiently. The load for each drum should be proportionate.

(2) While the temperature of diluted black liquor is too low, that is 65 ℃, it is fed to the #3 drum. The diluted black liquor with this low temperature should be fed to the #4 drum.

(3) By utilizing three existing external heaters, the value of E/S decreases. Therefore, it is recommended not to use these external heaters under the present low load operations.

(4) It is possible that a large amount of gland sealing water from pumps for the evaporator flows into the black liquor because much gland liquid leakage has been observed.

Sampling	S.W	TSS
#3 Feed	1.0771	1995
#4 Feed	1.1777	9180
#1 Feed	1.1893	15630
#2 Feed	1.2047	15240
Feed to F/C	1.2605	22770
Feed to BLB	1.2789	81570

Figure 2 Supply Water and Black Liquor Ratio in Drums

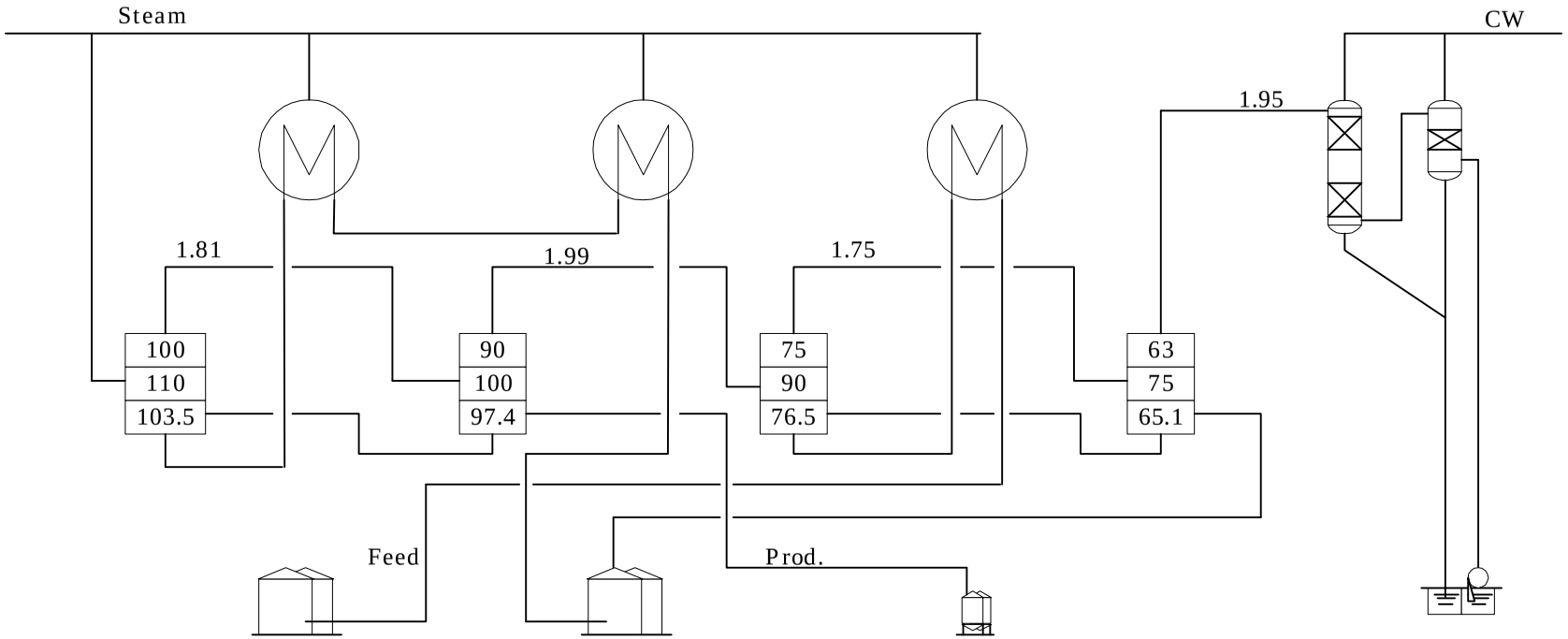
The heat balances around multiple effect evaporator before and after implementing countermeasures are shown in Figure 3 and 4 respectively.

5.1.5 Problems about the Co-generation Equipment

The factory used to sell excess electric power generated by two generators. However, a boiler, designed for operations at 50 kg/cm^2 pressure, can be operated only at 18 kg/cm^2 pressure. In addition, a turbine, with the capacity of 9,000kVA, is not operational at present. Since the unit cost for co-generation is 2 yen/kWh, or less compared to the unit buying price, 6 yen/kWh, they should start using co-generator to generate power by fixing the problems with the boiler and the turbine.

5.2 Countermeasures for Production Technology

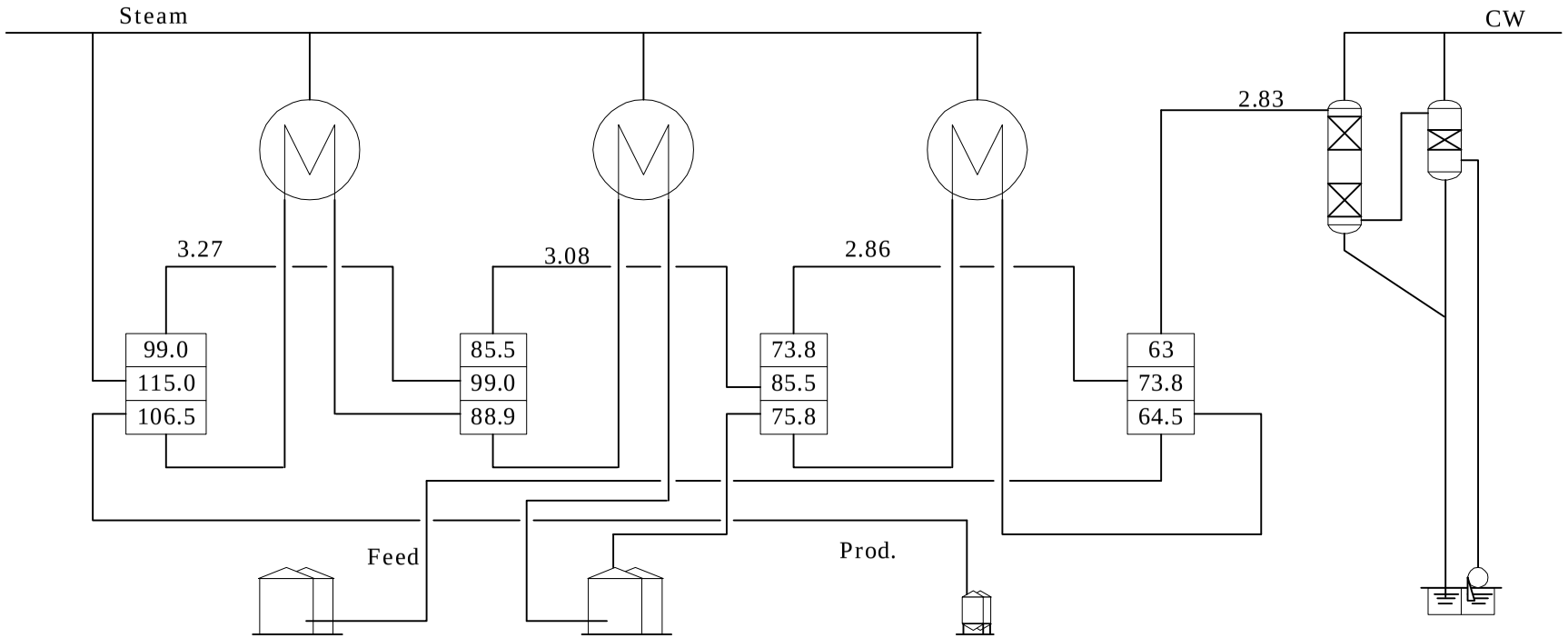
Countermeasures and estimated costs for the main problems in the factory are summarized as follows:



AREA [m2]	550	450	450	450	Feed 11.25t/h 15wt%60℃
△T [℃]	6.5	2.6	13.5	9.9	Prod. 3.75t/h 45wt%
BPR [℃]	3.5	7.4	1.5	2.1	Evap. 7.5 t/h
Conc. [wt%]	29.4	45.0	17.8	22.4	Steam 2.38 t/h at Heat
U [kcal/m2·hr℃]	350	850	190	230	E/S 3.15 Loss 0
					TS 1.69 BDt/h

(This balance is calculated under condition of excluding External 55 x 3 Heaters.)

Figure 3 Heat Balance of Multiple Effect Evaporator now in use



AREA [m2]	550	450	450	450	Feed 18.06t/h 15wt%60℃
△T [℃]	8.5	10.1	9.7	9.3	Prod. 6.02t/h 45wt%
BPR [℃]	7.5	3.4	2.0	1.5	Evap. 12.04 t/h
Conc. [wt%]	45	29.2	21.9	17.8	Steam 3.62 t/h at Heat
U [kcal/m2·hr℃]	400	400	400	400	E/S 3.32 Loss 0

(This balance is based upon : Liquor flow ; 4E →3E→2E→1E ; U value of each vessel and with no External Heaters.) TS 2.71 BDt/h

Figure 4 Improved Heat Balance of Multiple Effect Evaporator

5.2.1 Change the Chip Size to a More Suitable Size

It is easy to change the chip size by adjusting the length of the blade of the "chipper." However, by doing this the processing capacity will decrease, so operating hours should be extended. It is also necessary to install chip screens, and large size chips should be cut into smaller pieces by a crusher.

Estimated cost： 20 million yen＝2.6 billion VND

5.2.2 Washing Process for Unbleached Pulp

In order to use a four stage washing system, the following countermeasures for maintaining the entire washing process for unbleached pulp should be implemented:

(1) An adjustment and maintenance of four sets of valves on washing machines;

(2) Pump installation (30) and agitator maintenance;
Pumps currently used should be replaced with mechanical sealing types in order to avoid leakage of seal water into black liquor, and a sufficient amount of spares should be provided.

(3) Pipes and valves should be replaced and well maintained;

(4) Washing water temperature should be maintained at 60℃ or higher.

Estimated cost： 50 million yen＝6.5 billion VND

5.2.3 Counter-current Washing for the Bleaching Process

In order to enable counter-current washing in each stage of the bleaching process, the following item should be improved.

(1) Install pipings in order to reuse a part of the diluted white water, discharged from the outlet of the succeeding stage washer, as washing water for the preceding stage washer.

Estimated cost： 30 million yen＝3.9 billion VND

5.2.4 Remodeling of the Evaporator and Surrounding Equipment

The following items should be remodeled in order to improve the efficiency of the evaporator:

(1) The ＃1 drum should be changed to a falling film type;

(2) Because the evaporator has a large capacity, external heaters should be by-passed in order to increase the value of E/S;

(3) All pumps should be replaced with mechanical seal type. 10 sets of spare

pumps need to be arranged.

Estimated cost： 30 million yen＝3.9 billion VND

5.2.5 Maintenance of the Boiler and Turbine

For now, the boiler and turbine repair and maintenance issue needs to be studied in more detail. However, if it is implemented, profits will be returned to the company within a year for sure.

3,000 kWh×(6-2=4) Yen/kWh×8,000 hr=96 million Yen/year

5.3 Benefit by Improvement

5.3.1 Required Costs

The total costs required to implement the proposed improvement stated in 5.2.1 to 5.2.4, were estimated and shown below:

Estimated total costs： 130 million yen＝16.9 billion VND

5.3.2 Benefit Calculation

The following calculation can be made to estimate the merits of the reduction of NaOH consumption by black liquor recovery.

0.5 t/PT x 10,045 PT/year x @4,154,000 VND/t = 20.9 billion VND/y

About 16 million yen can be saved in NaOH costs, and other additional effects can be expected as follows:

a. The wastewater load will decrease in the unbleached and bleached pulp process;
b. A decrease in usable fiber drainage loss: 200 t/year, 1.5 billion VND;
c. An increase in the amount recovered and the concentration of BL(Black Liquor);
d. Conserve heavy oil used for steam generation by evaporating more steam in the BLB(Black Liquor Boiler), and decrease the amount of used steam in the Vacuum Evaporator;

   Reduce 4,000 kl/y or more: 6.7 billion VND

e. Reduce the amount of Cl_2 used in the bleaching process

   6% → 4%＝2% 200 t/year 1.2 billion VND

Total 20.9 ＋ 1.5＋ 6.7 ＋ 1.2 ＋ ＝ 26.3 billion VND 203 million yen/y

5.4 Wastewater Treatment

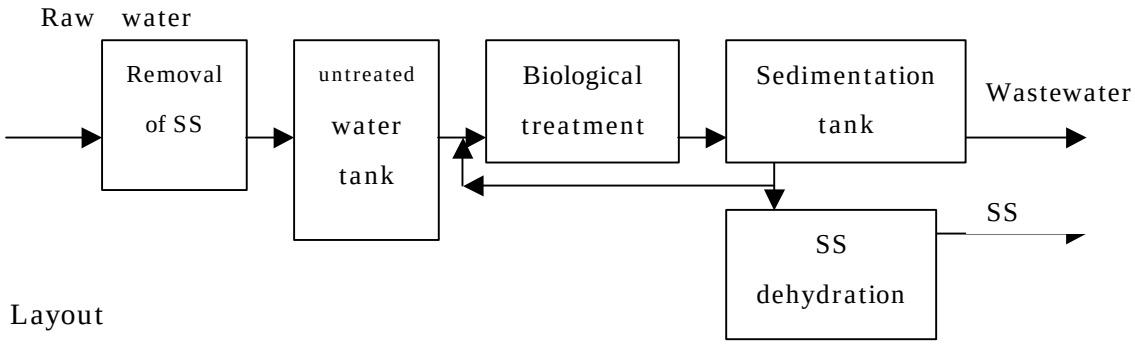
5.4.1 Design Basis

The total amount of wastewater that requires treatment is set at 4,800 m^3/day. The results of the wastewater analysis of samples taken at the final wastewater discharge point of the factory were used as the basis of the wastewater treatment design.

5.4.2 Conceptual Design

The wastewater treatment process and equipment layout chart is shown in Figure 5. This wastewater treatment equipment was designed only for the treatment of wastewater under its current conditions. If the CP measures stated above are implemented, the scale of equipment will be reduced to 1/3 of the designed size.

1. Flow Sheet



2. Layout

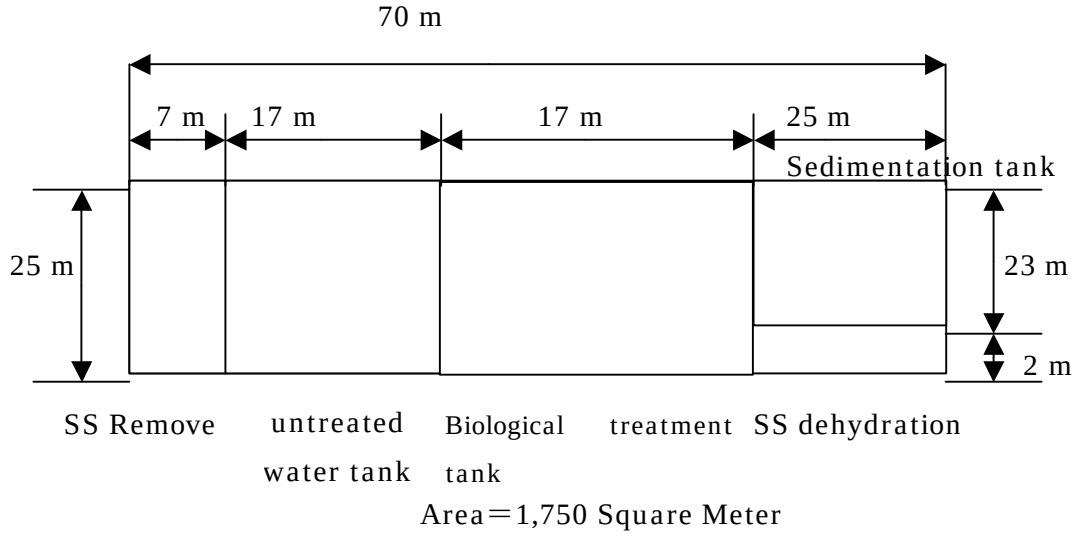


Figure 5 Wastewater Treatment Flow Sheet and Arrangement

6. Recommendations

6.1 Short Term Recommendations

The following items are recommended for short-term countermeasures:

(1) Promote 7S activities;

(2) Change the size of raw material chips to a more suitable size;

(3) Remove piled up raw material as well as bubbles from the wire cylinder by installing shower pipes;

(4) Use NaOH that contains a low concentration of mercury;

(5) Promote a realistic treatment for used paper and maintenance in the de-inking plant.

The total costs for short term countermeasures: 30 billion VND

6.2 Mid-term Recommendations

The following items are recommended as mid-term countermeasures:

(1) Strengthen the pollutant collection system;

(2) Establish a collection and recycle system of white water from each paper machine;

(3) Use heated water for the showering process;

(4) Heat rolled paper with steam;

(5) Promote the use of a realistic treatment for used paper and maintain and efficiently use the de-inking plant.

The total estimated costs for mid-term countermeasures： 12 billion VND

6.3 Long term Recommendation

The following items are recommended as long term countermeasures:

(1) Make the best use of the collection and recycling system for cooking liquor;

(2) Collect steam used for cooking;

(3) Collect and reuse wastewater from each process;

(4) Use heated water for the showering process;

(5) Establish a collection system for chemicals;

(6) Promote a realistic treatment for used paper and maintain and efficiently use the de-inking plant.

The total estimated costs for long term countermeasures：5.7 billion VND

The survey team proposes that profitable Cleaner Production countermeasures be implemented as much as possible, and that End of Pipe should be implemented to the minimum degree required.

6.4 Proposals for Implementation

At present, the company is in a situation where they cannot afford to repair or maintain broken equipment and machines. Once they have the necessary funds for investment, considering its necessity and validity, Cleaner Production measures should be implemented.

The followings are important items to be considered when selecting equipment:

1. Select equipment considering energy saving effects;
2. Select the best material considering the life cycle of the equipment;
3. Choose equipment that is easy to maintain;
4. Prepare the minimum amount of spare parts necessary;
5. Set budgets for new machines, including costs for following up after operation begins.

Case Study P-03

An Binh Paper Company

Survey Date：8 December 1999
1, 2 & 3 March 2000

1 General

1.1 Company Profile

The An Binh Paper Company was established in 1990, and began pulp manufacturing operations in 1992 in Bihn Duong Province. Since their first paper machine was constructed in 1993, they have been adding on to their number of paper machines gradually, as needed. At present, this private company has seven paper machines.

In November 1999, the Company was manufacturing bamboo pulp. However, as a pollution prevention measure, pulp manufacturing was stopped in January of 2000, and in its place, waste paper processing equipment was being constructed. The Company Outline is shown in Table 1.

Table 1 Enterprise Profile

Name	An Binh Ltd Company
Type	Private
Address	27/5A Kha Van Can, Di an, Binh Duong Province
TEL	Tel: 088 960 155／Fax: 088 960 700
Established	1992
Number ofEmployees	238 (3 shifts, 300 working days)
Main products	

1.2 Organization

There are only two managers responsible for technology at the Company. The Company has a domestic construction department, which has constructed paper machines in-house except for one imported pressurized dryer vessel from Taiwan.

1.3 Business Status

Bamboo pulp manufacturing equipment, which had been in operation since the Company was established, was shut down as an industrial pollution prevention measure in January of 2000. At present, raw materials for cartons and cardboard are being manufactured. The production capacity for each of these materials is 12,000 t/year and 5,000 t/year, respectively.

In addition, the company has 500 ha of eucalyptus afforested land, and in the near future, they have plans for constructing a pulp factory, which will be provided with complete industrial pollution prevention countermeasures, in another location.

Production and Sales in 1998 are shown in Table 2.

Table 2 Production and Sales

Product	Unit	Production	Sales (million VND)
Bamboo pulp	T	2,444	7,000
Carton	T	4,735	13,200
Packaging	T	1,648	8,240
Total			**28,440**

Also, as is shown in Table 3, production capacity is rapidly increasing.

Table 3 Enterprise Activities

(million VND)

Year	Activity	Production	Sales
1990	Established An Binh Paper Enterprise at 27/5A Kha Van Can, Thuan An, Binh Duong.	2,000 t chemical pulp/y	
1992	Changed from an Enterprise to Company Investment: 300,000,000 VND	4,000 t chemical pulp/y	8,000
1993	Installed a PM for carton package production. Installed equipment for 3 layer carton corrugated sheets. Investment: 4,000,000,000 VND	2,100 t pulp 188 t package 292 t carton	6,696
1994	Upgraded to their first PM and increased production to 10 t/d. Installed another PM with a capacity of 3 t/d. Installed PM 3&4 with a capacity of 6 t/d (total) Investment: 9,800,000,000 VND	2,310 t pulp 1,350 t package 441 t carton	15,123
1995	Installed PM 5 for packaging paper with a capacity of 3 t/d. Pulp production was reduced due to a shortage of raw material. Investment: 13,800,000,000 VND	987 t pulp 1,500 t package 593 t carton	12,444
1996	Installed PM 6&7 with a capacity of 6 t/d. Modified equipment for production of 5 layer carton corrugated sheets. Increased capacity to 1,000 t/y. Investment: 14,545,000,000 VND	259 t pulp 2,500 t package 1,235 t carton	20,443
1997	Improved product quality, increased packaging market, an upgraded to carton quality. (sold old equipment) Investment: 14,270,000,000 VND	886 t pulp 2,881 t package 1,124 t carton	23,000
1998	Built a new plant: 2,400 m^2 Built a new office: 1,120 m^2 Investment : 16,965,000,000 VND	2,444 T pulp 4,735 t package 1,648 t carton	27,307
1999	Installed PM 2 for duplex paper production with a capacity of 15 t/d. Installed equipment for making 3&5 layer carton packages with a capacity of 1,000 t/d. Built a new plant: 2,600 m^2. Constructed a wastewater treatment tank 300 m^3/d. Investment: 25,000,000,000 VND	2,000 t pulp 8,000 t package 2,200 carton	45,000

2 Production Technology

2.1 Production Process

There are three sets of waste paper processing systems, and seven paper machines which are used as production equipment to produce a total capacity of 12,000 tons of raw material carton and 5,000 tons of cardboard in a year.

Outline of main equipment is shown in Table 4.

Table 4 The Main Equipment

No	P.M	SPECIFICATIONS	PRODUCT PRODUCTION /d	NOTES
01	P.M 1	02 Dryer , 03 cylinder , 03 blanket 2500x1450	1m38 , 115 G/m^2 - 300 G/m^2 8000,00 Kg	02 SIDES
02	P.M 2	03 Dryer , 05 cylinder , 04 blanket Ø 2000x1950	1m82 , 115 G/m^2 - 400 G/m^2 10.000,00 Kg	02 SIDES
03	P.M 4	01 Dryer , 02 cylinder , 02 blanket Ø 1500x1350	1m25 , 120 G/m^2 - 200 G/m^2 3.500 ,00 Kg	01 SIDES
04	P.M 5	01 Dryer , 02 cylinder , 02 blanket Ø 1500x1530	1m44 , 120 G/m^2 - 200 G/m^2 4.250 ,00 Kg	01 SIDES
05	P.M 6	01 Dryer , 02 cylinder , 02 blanket Ø 1500x1530	1m44 , 120 G/m^2 - 200 G/m^2 4.250 ,00 Kg	01 SIDES
06	P.M 7	01 Dryer , 02 cylinder , 02 blanket Ø 1500x1530	1m44 , 120 G/m^2 - 200 G/m^2 4.250 ,00 Kg	01 SIDES
07	P.M 8	01 Dryer , 02 cylinder , 02 blanket Ø 1500x1530	1m44 , 120 G/m^2 - 200 G/m^2 4.250 ,00 Kg	01 SIDES

Designed capacity = 38.500,00 kg .

I- Refiner system:

1/ Hydro pulper 4pcs, 60 ^{Hp} - 100 ^{Hp} .
2/ Hollander 01pc, 60 ^{Hp} .
3/ Disc refiner 09pcs, 50 ^{Hp} .

II- Raw material treatment system:

1/ Vibrator 06pcs, 5 ^{Hp} x 06.
2/ Centric cleaner 02pcs, 7.50 ^{Hp} - 10 ^{Hp}, 02pcs/each .
3/ Sedimentation 03 sets .

III- Fine raw material treatment:

1/ Vibrator 04 sets, 5 ^{Hp} x 04.
2/ centric cleaner 05sets, 7.5 ^{Hp} x / 10 ^{Hp} x 03 .
3/ Sedimentation 09 sets .

* Rewinder with 1.82 m, Ø 1.05 m/reel, VS/5 ^{Hp} x 01.
* Sheet cutter width 1.45 m , VS/5 ^{Hp} x 01.
* Boiler 1000 $^{Kg\ steam}$/h x01.
* Boiler 3600 $^{Kg\ steam}$/h x01.

3 Management Technology

3.1 Self-management

Over the ten years since established, the Company has gradually increased its production capacity, and now has what can be considered to be a medium scale

production capacity. The number of employees is comparatively smaller than at other state-owned enterprises. The factory maintenance level and cleanliness of the facilities are also comparatively good.

From this aspect, it appears that the intentions of the Company president have been thoroughly communicated to employees.

3.2 Raw Material Consumption and Expenses

Materials unit consumption and costs are being analyzed by type of product as shown in Table 5.

Moreover, for every item, employee salaries are recorded, and the average yearly salary per employee obtained by dividing this figure by the total number of employee, 238, is around 7.9 million VND.

Table 5 Consumption of Raw Materials and Expenses in 1998

Product	Material used	Quantity	Expenses (VND)
Bamboo pulp 2,444 t	Bamboo	5,500 t	2,155,500,000
	Caustic soda	360 t	1,300,000,000
	Energy	665,000 kWh	710,000,000
	Employee's total salary		500,000,000
Carton paper 4,785 t	OCC	6,000 t	10,300,000,000
	Fuel oil	970,000 litter	3,000,000,000
	Energy	2 400,000 kWh	1,900,000,000
	Employee's total salary		880,000,000
Package paper 1,648 t		1,750 t	6,800,000,000
	Raw material		350,000,000
	Auxiliary (ink, glue)		450,000,000
	Energy	525,000 kWh	
	Employee's total salary		500,000,000

4 Industrial Wastewater Treatment and Discharge

4.1 Condition of Industrial Wastewater

At the An Binh Factory 1,320 t/day of water is used, and the water unit consumption is 45 times that of the product, which is a comparatively small figure. At present, the factory has a wastewater treatment facility for removing SS before discharge. The factory wastewater flow chart is shown in Figure 1.

The majority of wastewater in the factory is discharged from the waste paper

treatment equipment and from each paper machines. The concentration of useful fibers in this wastewater is high at over 1,000- 2,000 mg/l. Although the quality of the pulp is not universal depending on paper machine or products being produced, all the wastewater discharged from the paper machines is treated together. However, because only large particles of SS, or fillers are removed, and these are not reused, COD removal is not efficiently performed.

Since 1999, the construction of a 350 m^3 activated sludge treatment facility was planned and a treatment tank was constructed. However, an aeration tank or an activated sludge system have not yet been constructed, due to financial difficulty.

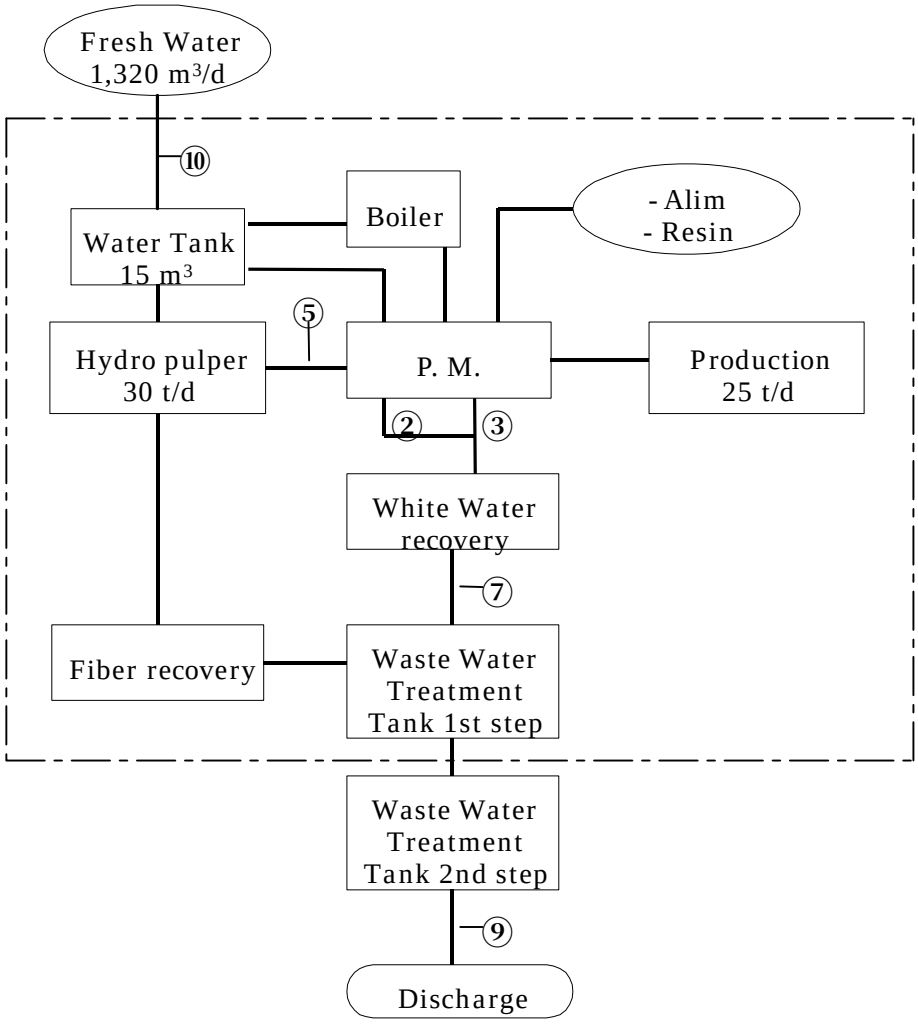


Figure 1 Wastewater Flow Diagram

4.2 Wastewater Analysis in December 1999

Sampling was carried out in six different locations on 8 December 1999, and the analysis results are shown in Table 6.

Table 6 Results of Wastewater Analysis

8 December 1999

Sampling No	Unit	2	3	5	7	9	10
Temperature	℃	32.1	32.8	20.8	27.4	32	29.8
pH		7.2	7.67	7.71	7.57	7.62	5.48
Elec. Conductivity	μS/cm	445	461	421	406	494	89
Turbidity	NTU	899	999	1019	221	675	10
Oil content	mg/l					16.4	Not detected
BOD	mg/l					460	0
COD	mg/l	1120	1520	10400	360	1200	2
DO	mg/l	5.25	4.3		1.24	3.21	2.95
VSS	mg/l	492	322.4	2014	64.3	361	0
TSS	mg/l					407	0
Total nitrogen	mg/l					39.7	0.1
Residual Chlorine	mg/l					Not detected	Not detected
SO_4^{2-}	mg/l	98	46	30	16	58	12
S^{2-}	mg/l						
Cyanogen	mg/l					0.05	Not detected
Phenol	mg/l					0.002	Not detected
Na	mg/l	311.8	390.1	271	298.2	284	230
$CaCO_3$	mgeq/l	176	200	429	104	216	8
Cu	mg/l					1.64	0.04
Pb	mg/l					0.021	0.5
Cd	mg/l					0.013	0.008
Hg	mg/l					Trace	trace
Cr(VI)	mg/l					0.081	not detec.
Zn	mg/l						
Salt	%	0.01	0.01		0.01	0.2	0

4.3 Wastewater Analysis in March 2000

In March 2000, a study to confirm the nature of wastewater conditions was executed with the paper machines as the main subject of the investigation.

(1) Sampling of Wastewater from the #2 Paper Machine

Sampling took place at the following ten points with the #2 paper Machine as the main subject on1 March 2000.

N.1-Inflow of WC#2
N.2-Over from Inlet Tank of WC#2
N.3-From Wire Cylinder WC#2
N.4-Inflow of WC#4
N.4-Overflow from Inlet Tank of WC#4
N.6-From Wire Cylinder WC#4
N.7-Inlet of #2 Paper Machine C/C
N.8-Recycling Over flow of C/C Reject
N.9-Outlet After W.W Treatment
N.9'-After White Water Recovery

The analysis results are shown in Table 7.

Table 7 Wastewater Analysis Results for Samples Taken in the Area Around the #2 Paper Machine

Sampling No	Unit	1	2	3	4	5	6	7	8	9	9'
Temperature	℃							32.8		32.8	33.1
PH								7.46		6.94	6.86
Electric Conductivity	μS/cm										0.602
Turbidity	NTU							99.9		6.34	99.9
Oil content	mg/l									52.29	83.73
BOD	mg/l									660	920
COD	mg/l							3,771		1,131	2,388
DO	mg/l							4.18		0.08	2.86
VSS	mg/l	6,020	5410	1610	6260	4890	1200	10160	11144	422	1390
TSS	mg/l	7740	6950	2635	7510	6010	1920	13040	15544	790	2260
Total nitrogen	mg/l									45.2	61
Residual Chlorine	mg/l									not detect.	not detect.
SO_4^{2-}	mg/l							29		124	66
Cyanogen	mg/l									1.02	0.74
Phenol	mg/l									0.04	0.06
Na	mg/l									209	314
Ca^{2+}	mgeq/l							122		84	80
Cu	mg/l									2.07	2.53
Pb	mg/l									0.02	0.032
Cd	mg/l									0.01	0.019
Hg	mg/l									trace	trace
Cr(VI)	mg/l									0.02	0.06
Salt	%							0.02		0.02	0.02

(2) Sampling Points of Wastewater from the #1 and #2 Paper Machines

Samples were taken at the following ten points with the paper machines as the main subjects on 2 March 2000.

N.1- After Sedimentation Centric Cleaner, PM#2
N.2- After Thickener, PM#2
N.4- After Beater, PM#2
N.5- After Disc Refiner, PM#2
N.6- After Sedimentation Centric Cleaner, PM#1
N.7- After Thickener, PM#1
N.10- After Disc Refiner, PM#1
W-1: Wastewater of #2 PM
W-2: Wastewater of #1 PM
W-3: Wastewater of #6,7,8PM

The analysis results are shown in Table 8.

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Table 8 Wastewater Analysis Results for Samples Taken from the Area Around the #1 and #2 Paper Machines

Sampling No	Unit	1	2	4	5	6	7	10	W-1	W-2	W-3
VSS	mg/l	10,710	14,230	55.4(*)	17,610	312	28.8(*)	33.7(*)	1,707	934	1,000
TSS	mg/l	15,000	19,840	59.9(*)	19,410	384	32.7(*)	38(*)	2,133	1,400	1,520

(*) - filtrated sample

(3) Sampling of wastewater from all paper machines and sampling before and after treatment

With all the paper machines as the subject, sampling was carried out at the following 10 points on 3 March 2000.

N.1- Cover Recovery Tank, Sheeting Machine #1
N.2- Bottom Recovery Tank, Sheeting Machine #2
N.3- Cover Recovery Tank, Sheeting Machine #1
N.4- Bottom Recovery Tank, Sheeting Machine #2
N.5- After PM#4-#6
N.6- After PM#6-#8
N.7- Overflow to Wastewater Reservoir
N.8- Overflow to Wastewater Reservoir
N.9- Inlet to Wastewater Treatment
N.10- Outlet After Wastewater Treatment

The analysis results are shown in Table 9.

Table 9 Wastewater Analysis Results of the Area Around All the Paper Machines

Sampling No	Unit	1	2	3	4	5	6	7	8	9	10
VSS	mg/l	350	286	721	830	930	900	1790	2030	1930	135
TSS	mg/l	360	293	733	850	1170	1130	2420	3000	2830	140
Ash of TSS)		10	7	12	20	240	230	630	970	900	5

5 Industrial Pollution Prevention Countermeasures

5.1 Present Problematic Issues

For the time being, the following four items are the major problematic issues the Company is facing:

(1) Dust remover is inadequate;

(2) Useful fibers are flowing out of the paper machine;

(3) Wastewater treatment facilities are incomplete;

(4) Low efficiency of pumps.

5.1.1 Inadequate Equipment for Pulper Dust Removal

While the quality of OCC, which is used as the raw material for carton manufacturing, is good, the amount of dust discharged from OCC is quite high. Because of this, useful fibers are being washed away. The present system consists of the separation and subsidence of heavy foreign substances by the riffler, Yanson Screens with large diameters and round holes, and large diameter centri-cleaners. Therefore, it is impossible to remove even big particle of dust causing the quality and the grade of the paper to fall.

5.1.2 Drainage Loss of Useful Fibers from the Paper Machine

Even though it is comparatively on the good side in Vietnam, the OCC yield is low as around 80% and a lot of raw material is washed out. Because the recovery of useful fibers in the water is not being carried out, the wastewater pollution load is high.

Ex. 1: If the left over rate is brought up to 80%-90%, the raw material wash out is 10/20=1/2 i.e. the SS pollution load is reduced by half.

Ex. 2: If the left over rate is brought up to between 80-95%, then the washout of raw materials is 5/20=1/4 i.e. the SS pollution load is 1/4

5.1.3 Unfinished Wastewater Treatment Facilities

As for the incomplete wastewater treatment facility, because wastewater flowing into a 3 m deep treatment tank for activated sludge treatment is not aerated, there is a possibility of methane gas generation caused by anaerobic bacteria in the high temperature season.

5.1.4 Low Efficiency Pumps

The efficiency of the domestic pumps now in use was estimated at less than 40 % based on the result of electricity measurement.

Because electricity cost in Viet Nam is almost twice that of the average international rate, low pump efficiency is one of the factors that make product costs relatively high.

5.2 Production Technology Countermeasures

5.2.1 Strengthen the Dust Removal Capacity

The following 2 items are recommended in order to strengthen the dust removal capacity:

(1) Change the Features of the Jonson Screens

Exchange Jonson Screens with round holes with slit type.

Ex.1 5-8H → 0.5-0.8S

Ex.2 2.5-3.5H → 0.35-0.45S

An estimated cost（10 machines） ：6 million Yen＝0.8 billion VND

(2) Centrifugal Cleaner

Since the cleaner in use only has a single stage, and the machine rejects a lot of staff, wastewater is sent through a junk box where dust settles. Therefore, the dust and dirt that are separated by a centrifugal cleaner are put back again into the raw material.

The Centrifugal cleaner should have a cascade system with more than 3 stages, and concentrated dust and dirt should be discarded.

Estimated cost(for 3 Paper Machines): 11million Yen＝1.4 billion VND

5.2.2 Install a Settler for Recovering Useful Fibers

In order to recover raw materials that drain out with water, useful fibers from the white water should be collected in each paper machine, or preferably for individual kinds of waste paper. The following types of settlers made of concrete should be installed for recovery.

Ex.1. PM #1 20 m^3

Ex.2. PM #2 25 m^3

Ex.3. PM #4-#8 50 m^3

Estimated costs(for 3 Paper Machines): 5 million Yen＝0.7 billion VND

5.2.3 Improvement of Equipment in Wastewater Treatment Facilities

Supplying a small amount of air can prevent anaerobic fermentation. In order to prevent methane gas generation, it is recommended that aerators be installed.

Estimated costs (5 Aerators): 18.5 million Yen＝2.4 billion VND

5.2.4 Use High Efficiency Pump

If high efficiency pumps from abroad are used, 1/3 to 1/2 of electricity costs can be saved. Once they have the needed resources, they should switch pumps to the high efficiency type.

5.3 Benefit of Countermeasures

5.3.1 The Total Required Investment

The proposed items stated in 5.2.1to 5.2.3 require the following budget:

Estimated cost ：40.5million Yen＝5.3 billion VND

The proposed items dealing with process improvement (5.2.1－5.2.2) require the following investment:

Estimated cost ：22 million Yen＝2.9 billion VND

5.3.2 Estimation of Economic Effects

(1) Merits for Collecting Useful Fibers

Assuming that about 1,000 mg/l of useful fibers can be collected, and the pulp price is 4,000 VND/kg,

55 m^3/hr×0.95×8,280 hr/y×1,000/(1000,000)×4,000,000 VND

=1.7 billion VND/y

This amount of raw material cost can be saved, and at the same time, the wastewater load can be decreased.

Furthermore, if this system is introduced, it is expected that it will have a big effect on paper quality, strength will improve, electricity consumption will decrease, and paper will not cut easily.

5.4 Wastewater Treatment

5.4.1 Design Basis

The total amount of wastewater that requires treatment is 1,300 m^3/day. A conceptual design was carried out for wastewater treatment using the results of

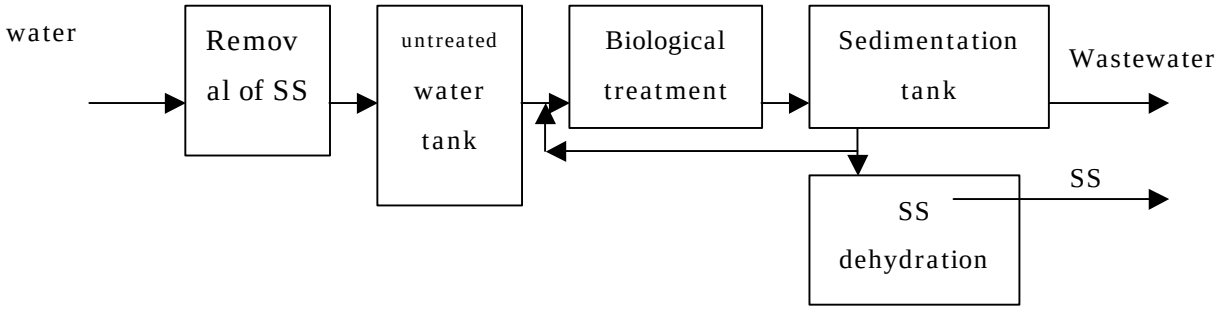
the wastewater analysis of samples taken at the wastewater outlet points.

5.4.2 Conceptual Design

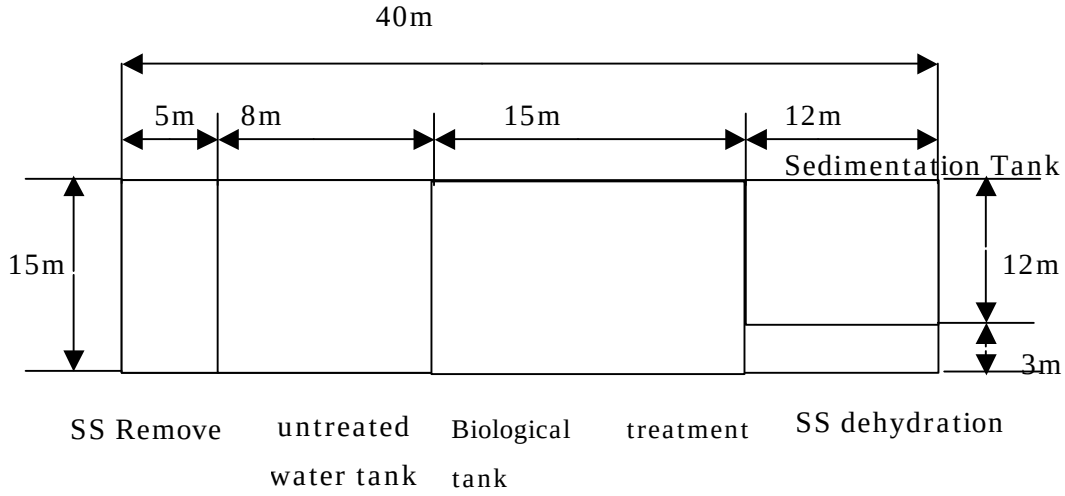
Figure 2 shows the wastewater treatment process and equipment layout.

This facility can use the activated sludge tank that was installed in 1999. Equipment is designed only for treatment that incorporates the End of Pipe methods under present conditions. If Cleaner Production stated above is implemented, the pretreatment stage for SS removal will not be needed, and the capacity of SS dehydration equipment can be reduced.

1. Flow Sheet



2. Layout



Area = 600 m²

Figure 2 Wastewater Treatment

6 Recommendations

6.1 Short Term Countermeasures

The following items are recommended for short term countermeasures:

(1) Promote 7 S activities;

(2) Remove piled up raw material, as well as bubbles from the wire cylinder, by installing shower pipes;

(3) Strengthen dust removal measures;

(4) Install a white water collection machine for each paper machine;

(5) Install activated sludge treatment equipment;

(6) Promote a realistic treatment for used paper, and maintain and efficiently use the de-inking plant.

The total estimated costs for the above recommendations: 7.5 billion VND

6.2 Mid- term Countermeasures

The following items are recommended for mid-term countermeasures:

(1) Use heated water for the showering process;

(2) Heat up wet paper with steam;

(3) Promote a realistic treatment for used paper, and maintain and efficiently use the de-inking plant.

The total estimated costs for mid-term countermeasures: 1.5 billion VND

6.3 Long-term Countermeasures

The items stated above and the following profitable countermeasures should be implemented using Cleaner Production as much as possible. End of Pipe should be implemented to the minimum degree required:

(1) Change to high efficiency pumps;

(2) Promote good maintenance and efficiency for realistic treatment facilities for used paper.

The total estimated costs for long term countermeasures：1.5 billion VND

Case Study P-04

Bac Giang Exporting Paper Company

Survey Date：13 December 1999
9 & 10 March 2000

1 General

1.1 Company Profile

This factory used to belong to the Ha Bac Factory. When Ha Bac Province was divided into Bac Ninh and Bac Giang Provinces, it was re-established as the Bac Giang Exporting Paper Company in 1997. Besides a paper mill, this company has a printing factory and a bamboo chopstick factory, and the total number of employees is 171. These two factories account for 61 out of the 171 employees.

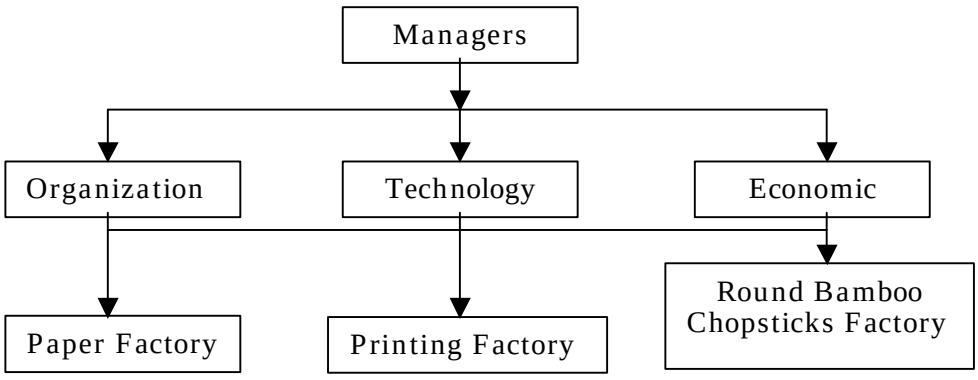
The company profile is shown in Table 1.

Table 1 Company Profile

Company Name	Bac Giang Exporting Paper Company
Ownership	Local Government（Bac Giang province）
Address	My Do- Bac Giang Province
Telephone	
Establishment	1997
Number of Employees	110 (3 shifts, 365 working days)
Main Products	

1.2 Environmental Management

As shown in Figure 1, the technology department controls all three factories, including quality and environmental management.



Number of staff: 171 people/shift.
Includes: Staff 9 (4 of 9 have Bachelor degrees)
Mechanical workers: 6
Female workers: 63

Figure 1 Organization

1.3 Business Outline

Using bamboo chips as raw material, special high quality, yellowish pulp with a high KN value is produced by using a cold soda method. Using this pulp, thick and porous special paper is produced through a paper machine, and the paper is processed to Buddhist ceremonial bill after being printed and cut. The final products are exported to Taiwan. Table 2 shows the company's production and sales in 1998.

Table 2 Production and Sales (1998)

PRODUCTS (1998)	**PRODUCTION** (ton/year)	**TURNOVER** (million VND)
Ceremonial Offering Paper		
Designed capacity	1,350	
Real production	1,000	**4,200**

2 Production Technology

2.1 Production Process

The production flow is shown in Figure 2. The factory is a small scale factory that consist of five chemical dipping tanks, one beater which is used as a washer, and one paper machine.

2.1.1 Pulping Process

(1) Soaking

For pulping, 35 tons of bamboo chips are put into a 100 m^3 chemical dipping tank, which is made of concrete, and then soaked in caustic soda liquid. The pulping cycle is set at 7 days as follows:

- Chip：1day
- Soaking in caustic soda liquid：4days
- Washing：2days

It was noticed that some tanks had been left for 3 or more days. Because chips are soaked in highly alkaline liquid for long time at a normal temperature, water-soluble chemicals such as pentosan and hemicellulose dissolve. Consequently, this causes low pulp yield less than 50 %, although the KN is high. Caustic soda is added at the ratio of 8.0 %. Washing using water at a normal temperature is being carried out for two cycles, which take an entire day for each complete cycle.

(2) Crushing Process

The factory uses a simple shredder and beater for the crushing process.

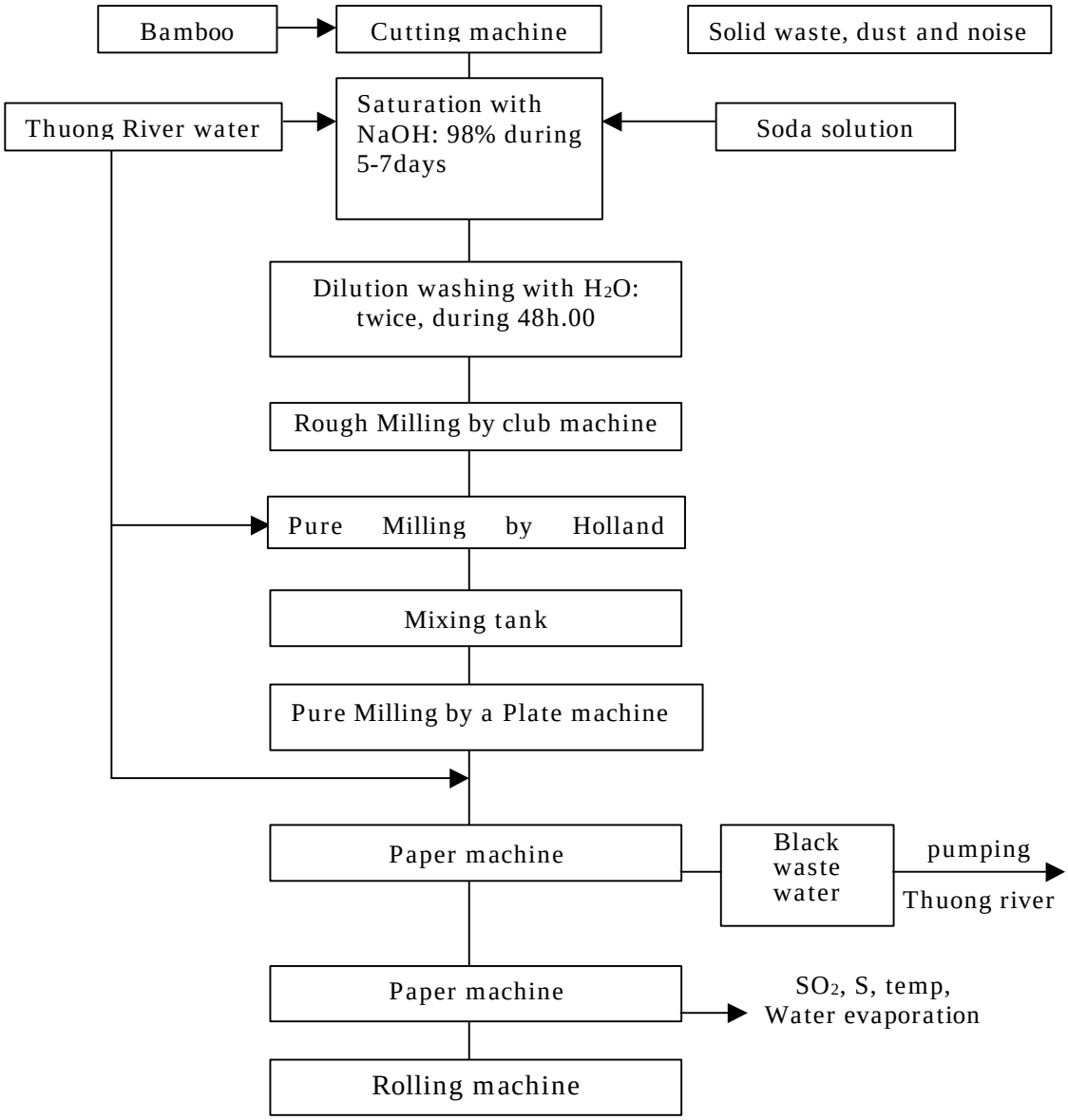


Figure 2 Production Flow

2.1.2 Paper Production Process

A hot blast from the cylinder mold and oil burner is blown into the dryer furnace directly, and SO_2 gas, created by burning sulfur powder, is blown into as well at the secondary stage. There were big holes in the paper because the speed adjustment of a drive role was not steady.

2.1.3 Printing, Cutting, and Packing

The cutting and packing processes are manually operated.

2.2 Production Equipment

Table 3 shows the main production equipment.

Table-3 The Main Equipment(1)

No	*Equipment No*	*Remark*	*Date of production made*	*Date of production use*	*Made from country*	*Capacity or special technological remark*	*Main technological*	*Technological speed (v/p)*	*Use Y/N*
1	Water supplied pump 1		1995	1996	Japan	37 m3/b for 7.2 HP	Average	380-2900	Y
2	Water supplied pump 2		1995	1996	Japan	25 m3/b for 5.5 HP	Average	380-2900	Y
3	Waste Water pump 1	SM:9523	1987	1996	Vietnam	50 m3/b for PH high 25 and 15 kW	Average	380-1450	Y
4	Waste Water pump 2	SM:9549	1996	1996	Vietnam	45 m3/b for PH high 31 and 7.5 kW	Average	380-2970	Y
5	Bamboo cut machine		1994	1996	Taiwan	3.5 ton/hr, 600 v/p and 50HP	Average	380-1460	Y
6	Small butcher		1994	1996	Vietnam	200 to 250 kg; N = 2.8 kW	Average	380-1450	Y
7	Rough milling		1995	1996	Taiwan	1 to 3 t/hr	Average	40 HP-1460	Y
8	Holland milling		1995	1996	Taiwan	DxRxC = 5080mmx1040mmx1040 mm	Average	40 HP-1460	Y
9	Mixing machine		1994	1996	China	5t/hr	Average	3HP-1460	Y
10	Washing machine		1996	1996	China	Psi = 50 kg/cm3	Average	1HP	Y
11	Material pump 1		1995	1996	Taiwan	5 HP	Average	220 V/380-1430	Y
12	Material pump 2		1995	1996	Taiwan	5 HP	Average	220 V/380-1430	Y
13	Presser pump		1995	1996	Taiwan	HZ = 50 to 60 mm	Average	1200-120 1500-150	Y
14	Paper machine		1995	1996	Taiwan	R=1000 mm; φ=1100 mm	Average	N=29 HP-220/380	Y
15	Plate milling machine		1995	1996	Taiwan	L=275 mm, R=1000 mm and H=1150 mm	Average		Y
16	Heater		1995	1996	Taiwan	Heater with 5 levels; R=1040 mm, T=15.875 mm	Average	N=16 HP	
17	Cutting machine		1995	1996	Taiwan		Average	380-1 HP.1390	N
18	Parking machine		1994	1996	Taiwan	Psi=150 kg/cm3	Average	380-1 hP1500	N

Table-3 The Main Equipment(2)

No	*Equipment No*	*Remark*	*Date of production made*	*Date of production use*	*Made from country*	*Capacity or special technological remark*	*Main technological*	*Technological speed (v/p)*	*Use Y/N*
19	Rolling machine		1996	1996	Vietnam	φ=920 mm, R=870 mm	Average	50-60 Hz 500 to 150	Y
20	Energy		1995	1996	Vietnam	400 kVA-3 Fa-50 Hz	Average		Y
21	Printed factory						Average		
22			1997	1999	Taiwan	N=2.2 HP	Average	380-1460	Y
23	Printer machine		1997	1999	Taiwan	N=5 HP	Average	380-1450	Y
24	Parking machine		1995	1999	Taiwan	N=1/3 HP	Average	220-1420	Y
25	Parking machine		1995	1999	Taiwan	N=1/3 HP	Average	220-1450	Y

3 Management Technology

3.1 Management of Business Targets

It is assumed that budgets and business goals are set and managed in the company. However, no program was recognized to promote a thorough understanding of employees on the management goals.

3.2 Unit Consumption and Expenses

Table 4 shows unit consumption and expenses in 1998.

Table 4 Unit Consumption and Expenses

USED MATERIAL (ton)	QUANTITY	EXPENSES (VND)
1. Bamboo	2,620 t/year	838,400,000
2. NaOH concentration	210 t/year	735,000,000
3. Oil	1,000 /year	9,000,000
4. Sulfur	13,500 t/year	32,400,000
5. Water	23,000 m^3/year	23,000,000
6. FO oil	264 t/year	475,200,000
7. Electric power (kWh)	400,000 kWh	320,000,000
Total		

3.3 Financial Status

Investment:	300,000 US$
Bank Loans:	200,000 US$
National Loans:	100,000 US$

4 Industrial Wastewater Treatment and Discharge

Wastewater is discharged in the nighttime because the factory switched its operation mode in 2000 to a night operation that utilizes electricity of a cheaper nighttime rate.

Black wastewater from the pulping process is discharged to an excavated pond, and then discharged without treatment to a river at night. The specific gravity of wastewater sometimes reaches around 1.05. Since residents in the vicinity use well water for drinking, it is worried that this drinking water may be contaminated with the wastewater. Moreover, a settler made of concrete should be installed because the wastewater contains mercury.

A large amount of excess water containing a lot of high quality fine fiber is discharged from the paper machine.

Figure 3 shows the wastewater system of the factory.

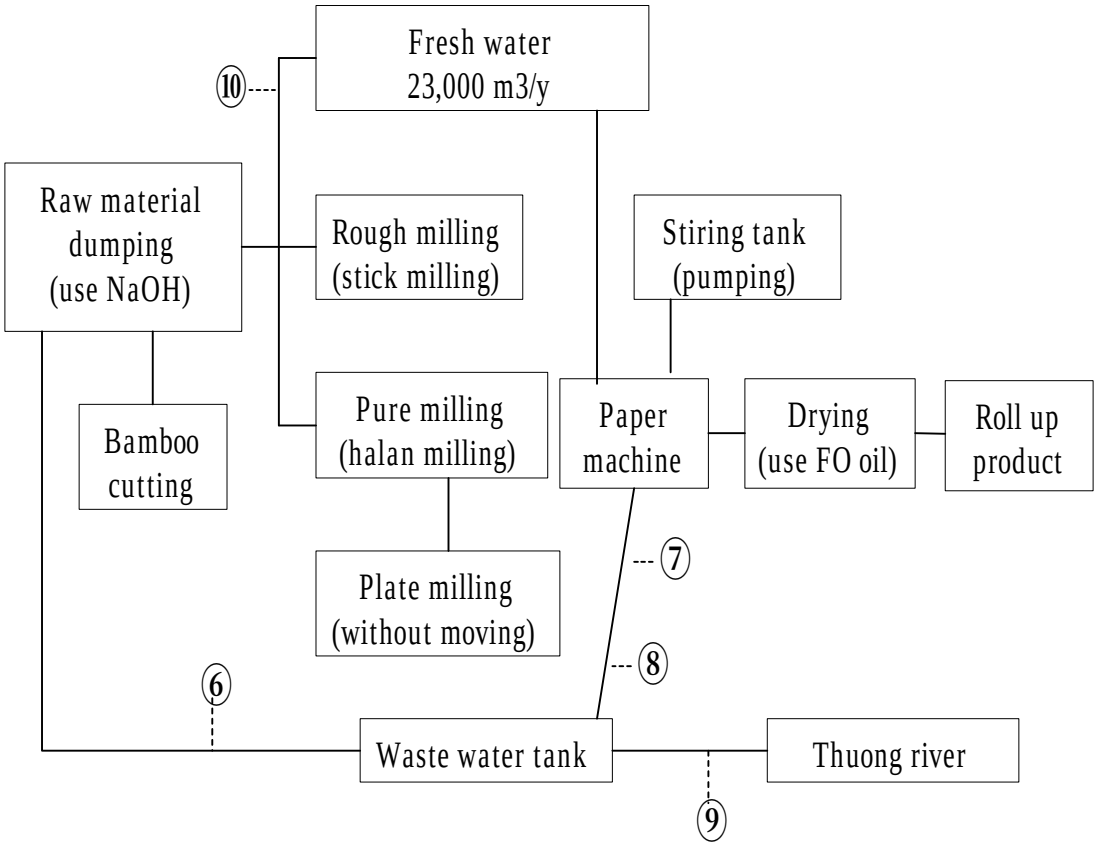


Figure 3 Wastewater System

4.1 Wastewater Analysis in December 1999

Samples were taken on 13 December 1999 at sampling points shown in Figure 3, and the analysis results are shown in Table 5.

Table 5 Results of Wastewater Analysis

13 December 1999

Sampling No	Unit	6	7	8	9	10
Temp	℃	22.5	22.3	22	20.1	19.1
PH		10.6	11.42	11.43	7.73	8.55
Elec. Conductivity	μS/cm	24500	462	487	239.8	4784
Turbidity	NTU		444	216	132	9.6
Oil content	mg/l				0	Trace
BOD	mg/l					58.96
COD	mg/l	21020	12135	10780	5120	120
DO	mg/l		5.1	5.2	1.01	4.75
VSS	mg/l	1084	553.5	167	119.6	8
TSS	mg/l				148.5	11.4
Total nitrogen	mg/l				21.72	3.54
Residual Chlorine	mg/l	2.14	trace	trace	Trace	1.07
SO_4^{2-}	mg/l	6286	114.8	92.6	47.6	22
Cyanogen	mg/l				0.02	Trace
Phenol	mg/l				0.32	0.05
Na	mg/l	292	241	246	297	229
$CaCO_3$	mg/l	123	112	248	161	89
Cu	mg/l				0.26	0.14
Pb	mg/l				0.027	trace
Cd	mg/l				0.007	0.002
Ni	mg/l				0.623	trace
Cr(VI)	mg/l				0.086	trace
Zn	mg/l					
Salt	%		0.1	0.09	0.21	0

4.2 Wastewater Analysis in March 2000

4.2.1 Samples taken before and after wastewater discharge

Samples were taken on 9 March 2000 at the same points as in December 1999, except for sampling point ⑦, and the analysis results are shown in Table 6.

Table 6 Results of Wastewater Analysis in March 2000

Sample No	Unit	6	8	9	10
Temp	℃	22.7	24.2	22.6	21.9
PH		12.35	8.93	8.2	7.66
Elec. Conductivity	μS/cm	15.4	0.431	4.99	0.219
Turbidity	NTU	78	613	100	22
Oil content	mg/l	0.12	trace	trace	0
BOD	mg/l			1340	129
COD	mg/l	18120	11010	5320	358
DO	mg/l	0.18	5.12	0.05	3.05
VSS	mg/l	168	407	164	4.9
TSS	mg/l	223	648	218	8.2
Total nitrogen	mg/l	32.7	21.4	37.4	2.89
Residual Chlorine	mg/l	1.86	trace	0.25	trace
SO_4^{2-}	mg/l	100	80	140	34
Cyanogen	mg/l	0.045	0.031	0.02	not detec.
Phenol	mg/l	0.38	0.72	0.51	0.05
Na	mg/l	262	218	3520	39
$CaCO_3$	mgeq/l	128	263	5	
Pb	mg/l	<0.001	0.041	0.04	<.0001
Cd	mg/l	<0.001	<0.001	0.003	0.001
Hg	mg/l	<0.001	<0.001	**0.58**	trace
Cr(VI)	mg/l	<0.01	<0.01	0.02	trace
Zn	mg/l	0.3	0.2	0.47	0.21
Ni	mg/l	<0.01	<0.01	0.019	trace

0.58 mg/l of Mercury was detected in the wastewater in March 2000. It is assumed that caustic soda contains mercury.

4.2.2 Sampling at the Alkaline Penetration Process and Paper Machine

Samples were taken at the following 9 points for wastewater discharged from the chipping process and paper process. Caustic soda was analyzed in order to find out if it contains mercury or not. The analysis results are shown in Table 7.

Sampling Points

N1- 7 days Chiping
N2- 4 days Chiping
N3- 7 days Chiping
N4- 10 days Chiping
N5- Wastewater Pit
N6- Before Pulp Chest
N7- After Mixing Chest
N8- To Mixing Chest
N9- From Wire Cylinder
NaOH- Caustic Soda

Table 7 Analysis Results of Wastewater from the Chipping Process and Paper Machines

10 March 2000

Sample No	Unit	1	2	3	4	5	6
Ash	mg/l	40	120	280	250	46;14*	176
TSS	mg/l	155	590	910	655	155;39*	900
Phenol	mg/l					0.33	
Pb	mg/kg						
Cd	mg/kg						
Hg	*m*g/kg						
Cr(total)	mg/kg						
Zn	mg/l						
SW		1.03	1.1	1.07	1.06	1.02	1.005
t	℃	23.3	23.2	23.2	23.2	23.2	23.2
K	mg/l						
NaOH	mg/l	3080	20590	14520	15500	0	
Cl-							
Al	mg/l						

Sample No	Unit	7	7*	8	9	9*	10	NaOH
Ash	mg/l	250	87*	140	260	95*	28;16*	
TSS	mg/l	450	181*	475	650	196*	150;28*	0
Phenol	mg/l						not det.	
Pb	mg/kg							5.56
Cd	mg/kg							0.988
Hg	*m*g/kg							29
Cr(total)	mg/kg							2.04
Zn	mg/l							119g/T
SW		1.01		1.01	1.01		1	
t	℃	23.2		23.2	23.2		23.2	
K	mg/l							372g/T
NaOH	mg/l		0*			0*	0	76.80%
Cl-								1.58%
Al	mg/l							<0.01

5 Countermeasures for Industrial Pollution Prevention

5.1 Present Problems

The following 5 items are the main problems the company is facing at present:

(1) Size of chips;

(2) Piping for chemicals at the penetration tanks;

(3) Wastewater from the pulping process and paper process;

(4) Drive of paper machines;

(5) Wastewater containing Mercury;

(6) Use of SO_2 gas.

5.1.1 Chip size

The utilization of large size chips brings about bad effects such as high chemicals consumption, long cooking time, and low pulp yield.

5.1.2 Chemical Spraying Hoses for the Impregnation Tank

Although the tank capacity is large, about 100 m^3, it is not equipped with piping for chemical spraying. Chemicals do not penetrate through chips evenly and effectively because at present they are sprayed with hoses.

5.1.3 Discharged Wastewater from the Pulping Process

It is usual practice for a paper factory to recover chemicals from wastewater from the pulping process. However, the factory currently discharges wastewater without treatment. The factory will have to stop operation in the near future due to violation of environmental regulations in Viet Nam, unless they adopt wastewater treatment methods, even very simple ones.

5.1.4 Wastewater from the Paper Machine

Wastewater from the paper machine contains a large amount of high quality fine fiber, which is not recovered at present.

5.1.5 Operation Adjustment of the Paper Machine

Because the paper machine operation is not adjusted well, paper becomes loose around the roller causing the machine bit to make holes in the paper.

5.1.6 Mercury in NaOH

The mercury concentration in wastewater was 0,.58 mg/l, 116 times higher than the regulation standard. This is due to the fact that NaOH purchased contains 29 mg/l of mercury. It is possible that mercury is flowing into drinking water for the residents in the neighborhood through wastewater.

5.1.7 Use of SO_2 Gas

SO_2 gas is created by burning sulfur powder and blown into a dryer hood. It is assumed that SO_2 blowing is adopted for color fixing purpose. However, it may cause health problems for human beings and the environment.

5.2 Countermeasures for Production Technology

5.2.1 Changing Chip Size and Piping for Chemical Spraying

If the chip size is controlled adequately and a piping system is installed for sufficiently spraying chemicals, the smearing time will be made shorter, and the wastewater load will decrease because the yield will be improved.

5.2.2 Collection of Pulp Wastewater Using Simple Equipment

Because the scale of the factory is not so large, the company should study such measures that the company, after concentrating its wastewater, request an outside large scaled factory to treat it to recover chemicals.

There are cases like this in Japan, and it can be managed as wastewater contains NaOH and energy resources, sell the wastewater more than shipping cost, or bring back NaOH with return car for the black liquor.

5.2.3 Install Corn Shaped Settlers Made of Concrete

In order to recover raw materials lost in wastewater, it is recommended that the company install settlers made of concrete for the excess white water and black liquor from the paper machine. Figure 4 shows a conceptual flow around a settler.

Two settlers for excess white water and black liquor: 30 m^3 each

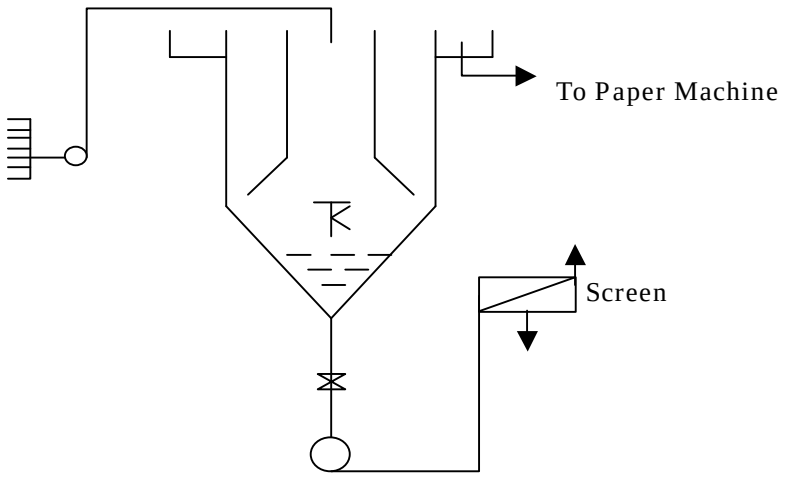


Figure 4 View of the Settler

5.2.4 Change to an SO_2 Liquid Solution with a Dryer

Install an absorber and change SO_2 gas to SO_2 liquid. In this case, it is important to prevent SO_3 from being generated.

5.3 Wastewater Treatment System

5.3.1 Design Basis

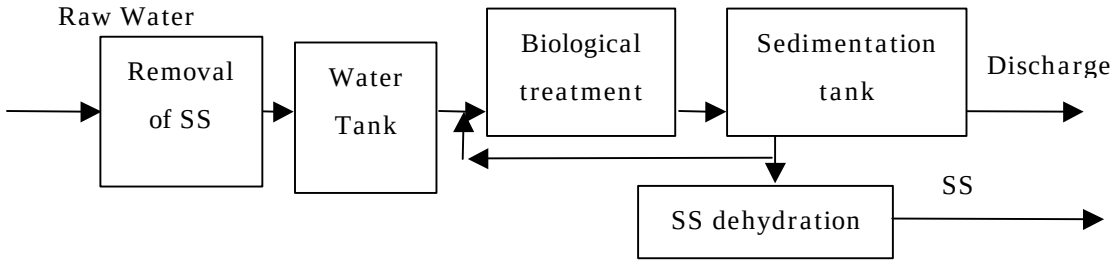
The total amount of water used in the factory is 23,000 m^3/year, so the factory should treat the corresponding amount of wastewater. A conceptual design of a wastewater treatment system was carried out using the results of the wastewater analysis of samples taken at the wastewater discharge points.

5.3.2 Conceptual Design

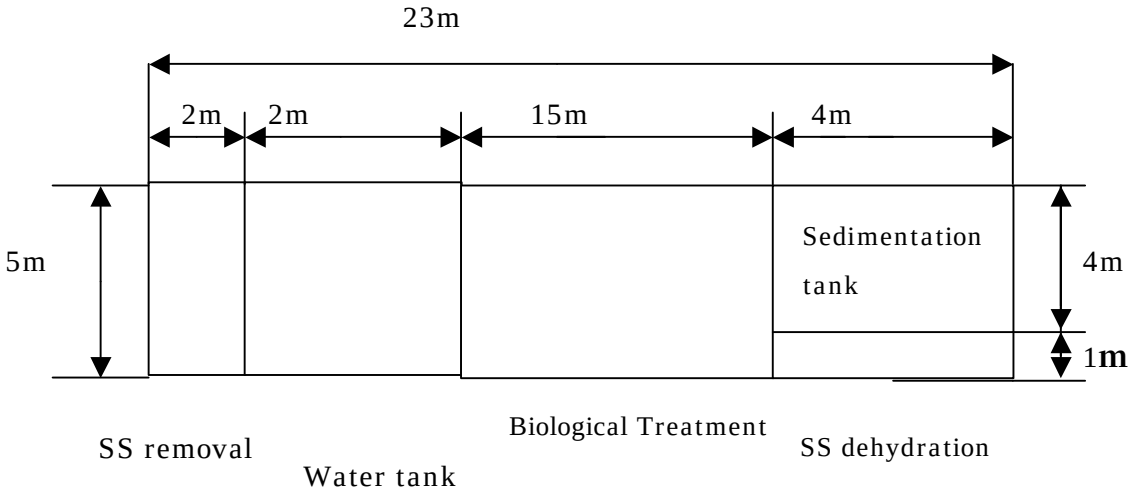
Figure 5 shows the wastewater treatment process and equipment layout.

This equipment is designed only for treatment that incorporates End of Pipe methods under present conditions. If the Cleaner Production stated above is implemented, the scale will be reduced to one third of this design.

1. Flow sheet



2. Layout



Area＝115m^2

Figure 5 Wastewater Treatment

6 Recommendations

6.1 Short Term Countermeasures

The following items are recommended for short term countermeasures:

(1) Promote 7S activities;

(2) Change the size of raw material chips to a more suitable size;

(3) Remove piled up raw material, as well as bubbles from the wire cylinder, by installing a shower piping system;

(4) Use NaOH that contains a low concentration of mercury;

(5) Install an absorber in order to use SO_2 liquid instead of SO_2 gas.

The total estimated costs for the countermeasures: 0.8 billion VND

6.2 Mid-term Countermeasures

The following are recommended for mid term countermeasures:

(1) Strengthen the pollutant collection system;

(2) Establish a collection and recycle system of white water for each paper machine;

(3) Use warm water for the showering process;

(4) Dry wet paper with superheated steam.

The total estimated costs for mid-term countermeasures: 1.5 billion VND

6.3 Long-term Countermeasures

The following items are recommended as long term countermeasures:

(1) Make the best use of the collection and recycling system for cooking liquor;

(2) Collect steam used for cooking;

(3) Collect and reuse wastewater from each process;

(4) Use heated water for the showering process;

(5) Establish a collection system for chemicals;

(6) Promote a realistic treatment for used paper, and maintain and efficiently use the de-inking plant.

The total estimated costs for long term countermeasures: 3.3 billion VND

The Survey Team proposes that profitable Cleaner Production countermeasures be implemented as much as possible, and that End of Pipe be implemented to the minimum degree required.

6.4 Proposals for Implementation

At present, the company is in a situation where they cannot afford to repair or maintain broken equipment and machines. Once they have the necessary funds for investment, considering its necessity and validity, Cleaner Production should be implemented.

The following are important items to consider when selecting equipment:

(1) Select equipment taking into consideration energy saving effects;
(2) Select the best material taking into consideration the life cycle of the equipment;
(3) Choose equipment that is easy to maintain;
(4) Prepare the minimum amount of spare parts necessary;
(5) Set a budget for the new machines and include costs for follow up measures after operations begin.

Furthermore, because this factory is a small-scale factory which produces about 1,000 t /year, it is difficult to install a recovery boiler and caustification equipment. In stead of installing this equipment, they should start implementing measures only for collecting wastewater and concentrating the black liquor, and make a deal with a nearby factory that has equipment for treatment.

Case Study P-05

Hai Phong Joint Stock Paper Company

Survey Date：14 December 1999
13 & 14 March 2000

1 General

1.1 Company Profile

This factory was established in 1960, and was privatized on 1 November 1999. The company has 2 other factories in Yen bai and Lao cai, and one more factory will be built in 2001.

The company profile is shown in Table 1.

Table 1 Company Profile

Name of the Company	Hai Phong Joint Stock Paper Company
Ownership	Private
Address	44A Ton Duc Thang Road Hai Phong
Telephone	Tel: 0311835369／Fax: 0311835462
Establishment	1960
Number of employees	603 (3 shifts, 7 days operation／week)
The main Products	

1.2 Environmental Management

The environmental management department is composed of one manager and nine staffs. Actually, the president of the company, a doctor of economics, also manages the technology.

1.3 Business Status

The factory possesses 10 paper machines and produces 15,000 tons/year of paper, which is exported to Taiwan for Buddhist religious ceremony use, and 1,000 tons/year of toilet paper.

Table 2 shows production and sales.

Table 2 Production and Sales

PRODUCTS	PRODUCTION (ton/year)	TURNOVER (million VND)
Ceremonial Paper	14,000	55,000
Toilet Paper	1,000	8,000
Total	15,000	63,000

2 Production Technology

2.1 Production Process

Figure 1 shows a block flow diagram of the entire factory.

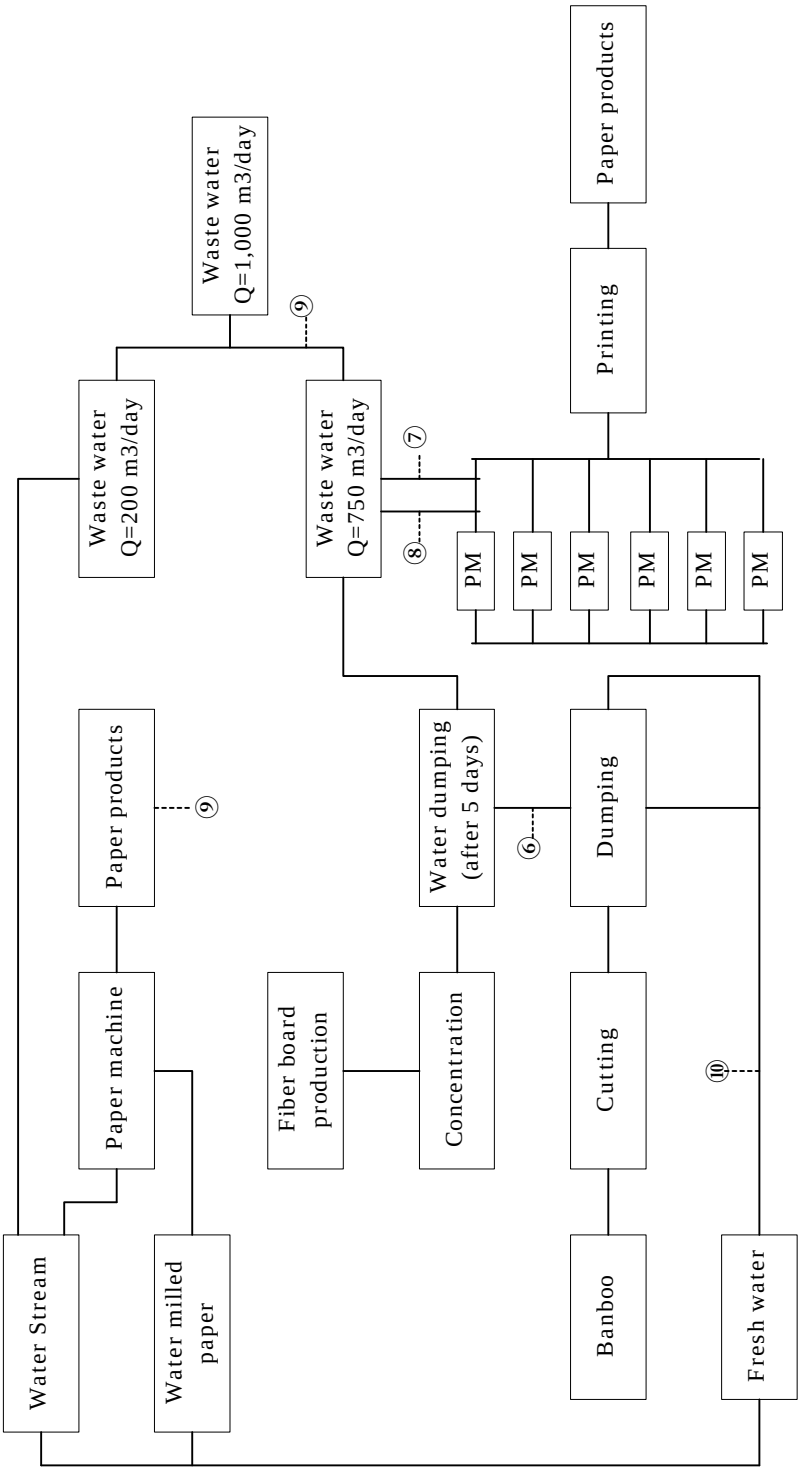


Figure 1 Block Flow Diagram of the Factory

2.1.1 Bamboo Pulp Production Process

There are 12 NaOH saturation tanks which are 80 m^3 and 100 m^3 in size, and each tank has the following 7 day impregnation cycle:

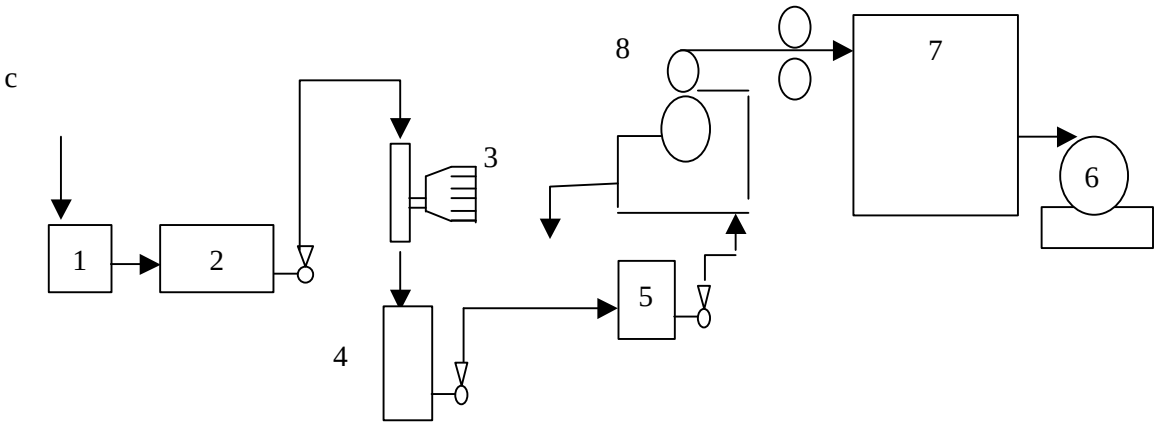
SATURATION CYCLE OR THE NUMBER OF DAYS REQUIRED FOR SATURATION AFTER THE CHIPS ARE FILLED IN TANKS

1. Chip feed
   40 tons of raw material (or 32 t/tank) is filled into the 100 m^3 tank (or 80m^3.) This process takes 1 day.
2. NaOH feed: NaOH of an amount equal to 75% of raw materials is used.
   That means 3 t (or 2.4 t NaOH/tank)
   The volume of H_2O added: 20 m^3: This process takes about 7 days
3. Removal
   After 7 days, black liquid of soda solution is removed and transferred to a collection tank.
   12 evaporation tanks are used to concentrate this solution from 7 be' to 18 be'. The temperature is always maintained at 78℃ or lower.
4. Washing
   About 40 m^3 of fresh water is filled into the saturation tank and is maintained for about 1 day because the washing process is carried out two times.
5. Washing water is pumped to the river

2.1.2 Paper Production Process

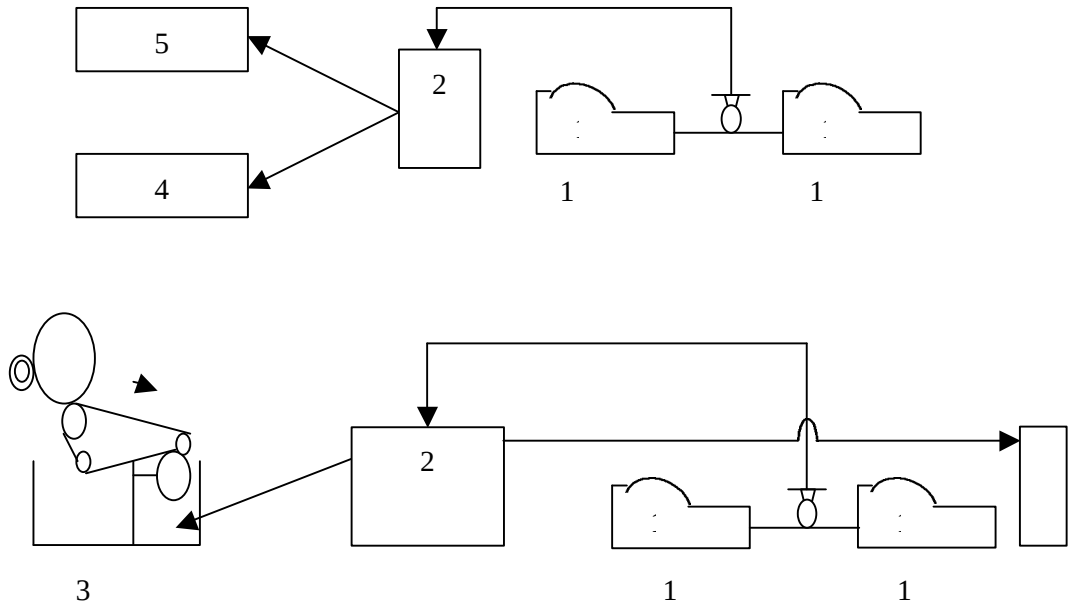
Bamboo pulp, used to make ceremonial paper for export to Taiwan, is produced by seven paper machines, and the process is shown in Figure 2.

Tissue paper, which is made from high quality waste paper that is dissolved by milling, is produced with three paper machines as is shown in Figure 3.



1. Rough milling
2. Holland style milling
3. Plate milling
4. Pulp tank
5. Diluted tanks
6. Paper machine
7. Heater machine
8. Parking machine

Figure 2 Paper Production Process Flow from Bamboo Pulp



1. Holland style milling (Made in Vietnam)
2. Pulp tank
3. Paper machine (Made in China)
4, 5. Paper machine (Made in Vietnam)

Figure 3 Process Flow for Tissue Paper Production

3 Management Technology

3.1 Management of Business Targets

The factory was privatized in November 1999. Maintenance and cleanliness of the factory had improved by March 2000 compared to the conditions observed in November 1999. It is assumed that employees understand the management policy.

3.2 Unit Consumption and Expenses

Unit consumption and expenses for each product were analyzed as shown in Table 3.

Expenses include salaries, and by dividing the total expense for salaries by 238, the number of employees, gives the average annual salary, which is about 7.9 million VND.

Table 3 Unit Consumption and Expenses

USED MATERIAL	QUANTITY (ton/year)	Cost (VN Dong)	EXPENSES (VN Dong)
I-Ceremonial paper production	20,000	300,000 VND/t	6,000,000
Bamboo	4,000	3500,000 VND/t	14,000,000
NaOH	4,500	1850,000 VND/t	83,250,000
Sulfur	50	2000,000 VND/t	100,000,000
FO oil			
II- Toilet paper			
1. Waste paper (ton)	1,300	5000,000 VND/t	6,500,000
2. Coal	900	350,000 VND/t	315,000,000
III- General use			
River water (m^3)	301,000m^3	500 VND/m^3	150,500,000
Electric power (kWh)	342,000 kWh	930 VND/t	318,060,000
Total			

3.3 Financial Status

Investment: 3 million US$

Bank Loans: none

4 Industrial Wastewater Treatment and Discharge

4.1 Industrial Wastewater

The unit consumption amount of water is about 20 times higher than that of the paper production, which is relatively small, and part of the black liquor is concentrated and sold.

Most of the factory wastewater is wastewater from the pulping process and surplus wastewater from each paper machine. The concentration of useful fiber in wastewater is less than 500 mg/l, a relatively small figure. After the final treatment, where SS is removed in a sedimentation pond, wastewater is discharged. The value of COD in wastewater sometimes measures less than 3,000 mg/l, and sometimes measures more than 6,000 mg/l, even after treatment. While Mercury was not found in wastewater in December 1999, high mercury values, 0.65 and 0.68 mg/l, were recorded in March 2000. This means the factory should switch caustic soda they are using now back to the previous type they used that contains a low concentration of mercury.

4.1.1 Wastewater Investigation in December 1999

Sampling was carried out on 14 December 1999 at sampling points shown in Figure 1, and the results of analysis are shown in Table 4.

Table 4 Wastewater Analysis Results in December 1999

14 December 1999

Sampling No	Unit	6	7	8	9	10
Temp	℃		20	19.6	20.1	19
pH		10.94	9.13	7.68	8.91	7.63
Elec. Conductivity	*M*S/cm	30500	1519.7	1766.7	1459.8	1824.8
Turbidity	NTU		191	237	232	16
Oil content	mg/l				0	Trace
BOD	mg/l				355.1	43.35
COD	mg/l	31208	6130	3050	2680	51.5
DO	mg/l	2.1	4.53	4.73	4.3	1.21
Ash content	mg/l	28760	60	100	120	10
TSS	mg/l				257	19.5
Total nitrogen	mg/l			19.8		12.7
Residual Chlorine	mg/l	3.55	Trace	Trace	Trace	Trace
SO_4^{2-}	mg/l	4823	306	354.8	416.2	48
S^{2-}	mg/l					
Cyanogen	mg/l				0.01	Trace
Phenol	mg/l				0.28	0.042
Na	mg/l	282	130	238	284	217
$CaCO_3$	mg/l	116	106	158	151	76
Cu	mg/l				0.23	0.11
Pb	mg/l				trace	trace
Cd	mg/l				trace	trace
Hg	*m*g/l				trace	trace
Cr(VI)	mg/l				0.021	trace
Zn	mg/l					
Salt	%		0.02	0.02	0.02	0.02

4.1.2 Wastewater Analysis in March 2000

(1) Wastewater Sampling before and after Treatment

Wastewater samples were taken on 13 March 2000 at the same points as in December 1999. The results of analysis are shown in Table 5.

Table 5 Wastewater Analysis Results in March 2000

13 March 2000

Sampling No		8	9	10
Temp	℃	22.7	22.1	20.6
PH		8.42	10.51	8.4
Elec. Conductivity	μS/cm	723	131	669
Turbidity	NTU	216	333	10
Oil content	mg/l	trace	trace	not detec.
BOD	mg/l	476	906	192
COD	mg/l	926	2850	465
DO	mg/l	4.91	5.09	0.06
Ash	mg/l	113	201	13.5
TSS	mg/l	246	392	29
Total nitrogen	mg/l	31.4	38.5	16.7
Residual Chlorine	mg/l	0.92	2	trace
SO_4^{2-}	mg/l	83.25	4.34	52
S^{2-}	mg/l			
Cyanogen	mg/l	0.01	0.015	0.01
Phenol	mg/l	0.12	0.3	0.03
Na	mg/l	282	318	146
$CaCO_3$	mgeq/l	185	177	64
Cu	mg/l	0.62	0.31	0.12
Pb	mg/l	0.08	0.04	trace
Cd	mg/l	0.009	0.004	trace
Hg	mg/l	0.31	0.65	0.002
Cr(VI)	mg/l	0.03	0.02	trace
Zn	mg/l	1.28	0.33	0.1
Salt	%			

(2) Sampling of Black Liquor

The following samples were taken on 13 March 2000 at the following points. The results of Black Liquor analysis are shown in Table 6.

N.1- #5Pit 1 Day Saturation
N.2- #1Pit 2 Days Saturation
N.3- #7Pit 3 Days Saturation
N.4- #2Pit 4 Days Saturation
N.5- #4Pit 5 Days Saturation
N.6- Wastewater Tank
N.7- After evaporation
(*) - Filtrated sample

Table 6 Results of Black Liquor Analysis

13 March 2000

Sampling No	Day	1	2	3	4	5	6	7
Ash	mg/l	160	190	140	140	90	130	250
Ash filtrated	mg/l	120 *	130 *	80 *	70 *	20 *	60 *	140 *
TSS	mg/l	800	845	760	592	300	560	1350
TSS filtrated	mg/l	575 *	582 *	456*	381*	220*	384*	1020*
Phenol	mg/l					1.12*	8*	8.2*
Na	mg/l					282*	291*	298*
SW		1.1	1.1	1.1	1.1	1.01	1.08	1.09
t	℃	23.6	23.8	23.7	23.6	23.4	23.4	23.4
K	mg/l					1.1*	1.22*	1.25*
NaOH	mg/l					0	23940	26310
Cl-	mg/l					1,420	5,325	5,751
Mg	mg/l					44	225	240
$C_2H_2O_4$	mg/l					2.46+/-0.1	28.86+/-0.1	29.75+/-0.1

The values of each sample of TSS and Ash differed as is shown in Figure 4.

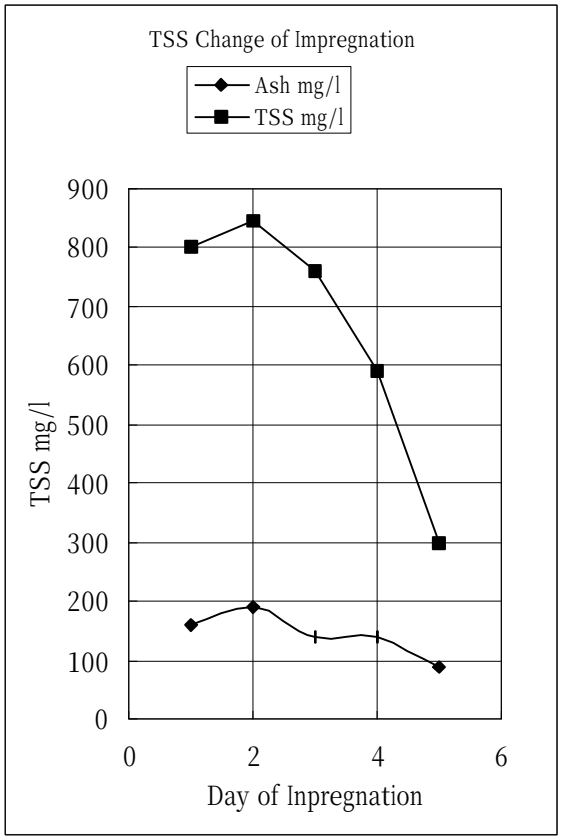


Figure 4 TSS and Ash Values

(3) Sampling of Wastewater from the Washer and the Paper Machines

Sampling was carried out on 13 March 2000 at the following points. The results of analysis are shown in Table 7.

Samples numbered 10,11,12,13, and 14, were analyzed in order to verify the time dependency of wastewater quality from the washer. At the same time, NaOH analysis was also conducted.

N10- Sampled at 10.00, Beater Washing
N11- Sampled at 11.00, Beater Washing
N12- Sampled at 12.00, Beater Washing
N13- Sampled at 13.00, Beater Washing
N14- Sampled at 14.00, Beater Washing
N15- Stock to Wire Clinder
N16- Stock of Inlet
N17- Over Flow from Wire Clinder
N18- White Water from Press
N19- Outlet After Wastewater Treatment
(*) – filtrated water sample

Table 7 Analysis Results for Wastewater from the Washer and Paper Mashines

14 March 2000

	Unit	10	11	12	13	14	15	16	17	18	19	NaOH
BOD	mg/l									3940	3160	
COD	mg/l									6,920	6,460	
Ash	mg/l	180	60	120	90	110	120	90	140	80	120	
TSS	mg/l	475	173	500	325	400	575	275	500	275	400	
Phenol	mg/l									2.7	2.16	
Pb	mg/l										0.035	13.11*
Cd	mg/l										trace	0.875*
Hg	mg/l										0.68	45*
Cr(total)	mg/l										0.01	2.04*
Zn	mg/l										0.02	158g/T
SW		1.005	1.005	1.005	1.005	1.01	1.005	1.005	1.005	1.005	1.005	
Temp.	℃	23.3	23.4	23.3	23.3	23.3	23.3	23.4	23.4	23.4	23.4	
K											0.82	117g/T
CHCl3										0.00623 +/-0.003	0.00656 +/-0.003	
NaOH		0	0	0	0	0	0	0	0	0	0	87.66%
Cl-											350.5	1.21%

The results of analysis of samples numbered 10,11,12,13, and 14 are summarized in Figure 5. Although a large amount of cold, clean water is used in the four hour washing process, as shown in Figure 5, washing efficiency is low and a large amount of useful fiber is lost, due to change in the specific gravity of wastewater.

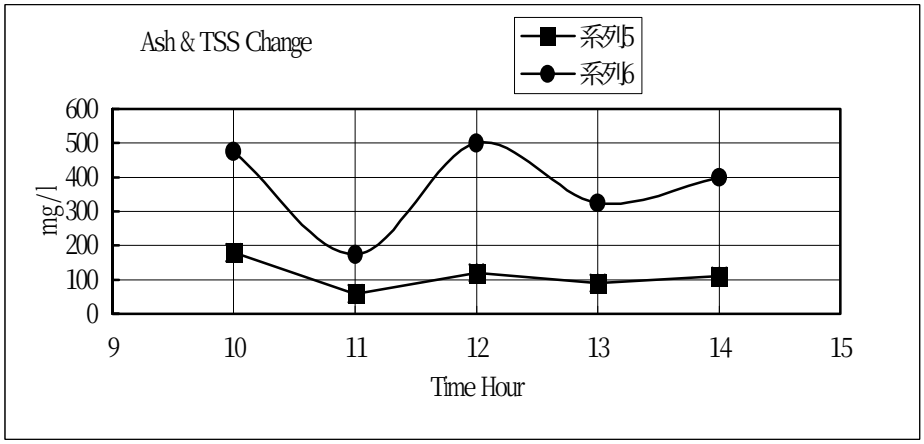


Figure 5 Change of SS in Wastewater during Washing

5 Industrial Pollution Prevention

5.1 Present Problems

For the time being, the following seven items are the major problematic issues the company is facing:

(1) Wastewater contains mercury, of which the concentration value is more than a hundred times that of the regulation standard;

(2) The size of bamboo chips is relatively large and saturation process is carried out at a normal temperature. The chips are saturated in caustic soda solution for five days, but 43.5% of chips do not get saturated;

(3) The majority of wastewater from the pulping process that shows high COD concentration values, several thousand mg/l, is being discharged into the general wastewater flow;

(4) Surplus white water from paper machines contains useful fibers, 1/2 concentration of raw material in Stock Inlet. However, it is discharged after going through a sedimentation tank;

(5) Poor management of the paper machine driver causes damage to products;

(6) Although the quality of waste paper, which is the raw material for tissue paper, is high, the products are covered with a lot of dust, and dirt, and have pinholes in them;

(7) The factory generates SO_2 gas by burning sulfur. From prospective of the working environment and high cost of raw materials, the company should consider stopping this method.

5.2 Countermeasures for Production Technology

5.2.1 Use NaOH of Low Mercury Content

It seems that NaOH quality has changed because mercury was not detected in December 1999.

5.2.2 Use Appropriate Sized Chips, and Install a Piping System for Chemical Spraying

If the chip size is changed and a piping system is installed around the pit, it is expected that chips can be saturated evenly, the saturation time will be shortened, more fiber will remain in the wastewater, and the wastewater load will decrease.

The wastewater should be reused in the next production cycle because the amount of alkali remaining is at level of 2.5 %. If the wastewater is reused the amount of NaOH can be decreased.

If the yield of pulp is improved from 43.5 % to 60 %, the COD in the discharged wastewater will decrease by half as shown in the following calculation:

(56.5/43.5-40/60)/(56.5/43.5)=0.513

The total estimated costs for equipment（12 machines）:

10 million Yen＝1.3 billion VND

5.2.3 Install Settlers for Recovering White Liquor from Paper Machines

It is recommended to install settlers made of concrete in order to recover white liquor from paper machines.

For the ceremonial paper production line: 150 m^3

For the toilet paper production line: 20 m^3

The total estimated costs of the equipment（4 sets）

：5 million Yen＝0.6 billion VND

5.2.4 Equip Ceremonial Paper Machine Drivers with a Speed Control and Adjustment Function

Drivers of Ceremonial Paper Machines should be equipped with a function for controlling and adjusting their speed.

The total estimated costs for the equipment (7 machines)

：4 million Yen＝0.5 billion VND

5.2.5 Strengthen the Dust Removal Capacity of the Waste Paper Equipment for Tissue Paper

There is no dust removal feature in OCC equipment at present. It is recommended that a Jonson Screen and a Centrifugal Cleaner be installed.

The total estimated costs for the equipment(2 lines)

：5 million Yen＝0.7 billion VND

5.2.6 Change SO_2 gas to SO_2 Liquid

A total of 1,408 tons of sulfur was burned at the factory in 1999. If SO_2 liquid is used instead of gas, and assuming that the concentration of SO_2 liquid is 2%, it is found that only 141 tons of Sulfur is required and that a total of 1,267 t (SO_2 Gas=2,534 t) of sulfur can be saved.

Profits made by saving sulfur＝1,267*1,850,000 VND = 2.3 billion VND

The total estimated costs for the equipment (1 line: newly established)

：10 million Yen＝1.3 billion VND

5.3 Benefit of Countermeasures

5.3.1 Necessary Costs

The total necessary costs for the implementation of items stated in 5.2.2 to 5.2.6 are as follows:

Estimated total costs: 34 million Yen＝4.4 billion VND

5.4 Wastewater Treatment

5.4.1 Design Basis

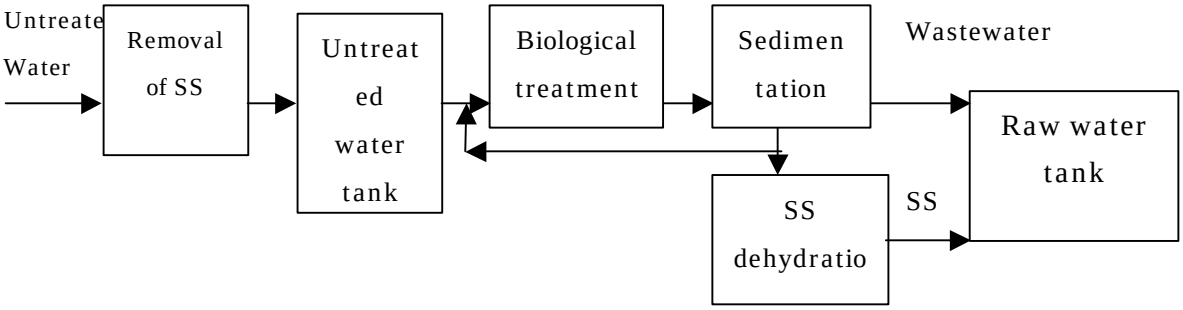
The total amount of wastewater that requires treatment is 1,000 m^3/day. The analysis results of the wastewater samples taken at the final wastewater discharge point of the factory were used as the design basis for a wastewater treatment system.

5.4.2 Conceptual Design

Figure 6 shows wastewater treatment process and equipment layout chart.

This wastewater treatment equipment was designed only for the treatment of wastewater under its current conditions. If the CP measures stated above are implemented, the scale of equipment will shrink to about 1/3 of the designed.

1. Flow chart



2. Layout

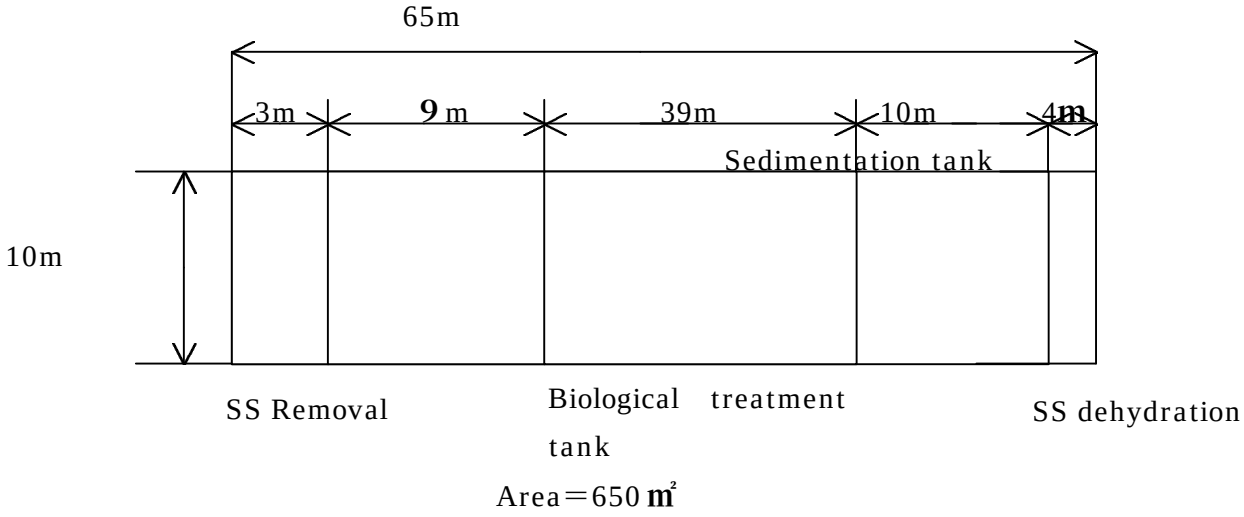


Figure 6 Wastewater Treatment System

6 Recommendations

6.1 Short Term Recommendations

The following items are recommended as short-term countermeasures:

(1) Promote 7S activities;

(2) Change the size of raw material chips to a more suitable size;

(3) Remove piled up raw material, as well as bubbles from the wire cylinder, by installing shower pipes;

(4) Use NaOH that contains a low concentration of mercury;

(5) Promote a realistic treatment for used paper and maintenance in the de-inking plant.

The total costs for short term countermeasures: 4.4 billion VND

6.2 Mid-term Recommendations

The following items are recommended for mid-term countermeasures:

(1) Strengthen the pollutant collection system;

(2) Establish a collection and recycling system of white water from each paper machine;

(3) Use heated water for the showering process;

(4) Heat rolled paper with steam;

(5) Promote the use of a realistic treatment for used paper and efficiently use the de-inking plant.

The total estimated costs for mid-term countermeasures: 8.3 billion VND

6.3 Long- term Recommendations

The following items are recommended as long-term countermeasures:

(1) Make the best use of the collection and recycling system for cooking liquor;

(2) Collect steam used for cooking;

(3) Collect and reuse wastewater from each process;

(4) Use heated water for the showering process;

(5) Establish a collection system for chemicals;

(6) Promote a realistic treatment and efficiently use of waste paper.

The total estimated costs for long-term countermeasures: 11.7 billion VND

The study team proposes that profitable Cleaner Production countermeasures be implemented as much as possible, and that End of Pipe should be implemented to the minimum degree required.

6.4 Proposals for Implementation

At present, the company is in a situation where they cannot afford to repair or maintain broken equipment and machines. Once they have the necessary funds for investment, considering its necessity and validity, CP should be implemented. The following are important items to be considered for selecting equipment:

(1) Select equipment considering energy saving effects;

(2) Select the best material considering the life cycle of the equipment;

(3) Choose equipment that is easy to maintain;

(4) Prepare the minimum amount of spare parts necessary;

(5) Set budgets for new machines, including costs for following up after operation begins.

Case Study P-06

Van Diem Paper Factory

Survey date：22 November 1999

1. General

1.1 Company Profile

The Van Diem Paper Factory is a State-owned paper company. The Company profile is shown in Table 1.

Table 1 Company Profile

Name	Van Diem Paper Factory
Ownership	State-owned
Address	Phu Minh Phu Xuyen Ha Tay
TEL	Tel:034854251-034854210／Fax: 034854251
Established	
Number of employees	300 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

Production and sales figures of the Company in 1998 are shown in Table 2. The production capacity of the Company is now 3,400 ton/year, and the Company has plans to raise production capacity by 40-50 tons/day in the year 2000.

Table 2 Production and Sales in 1998

Product	Production (ton/y)	Turnover (VND)
Normal cartons	2,002	7,621,220,913
Bi-layered cartons	405	1,984,226,466
Colored cartons	415	2,103,847,700
Corrugated cartons	530	1,939,803,608
Packaging paper	48	97,278,000
Total	3,800	13,746,376,687

2. Production Technology

2.1 Process

The factory process flow chart is shown in Figure 1.

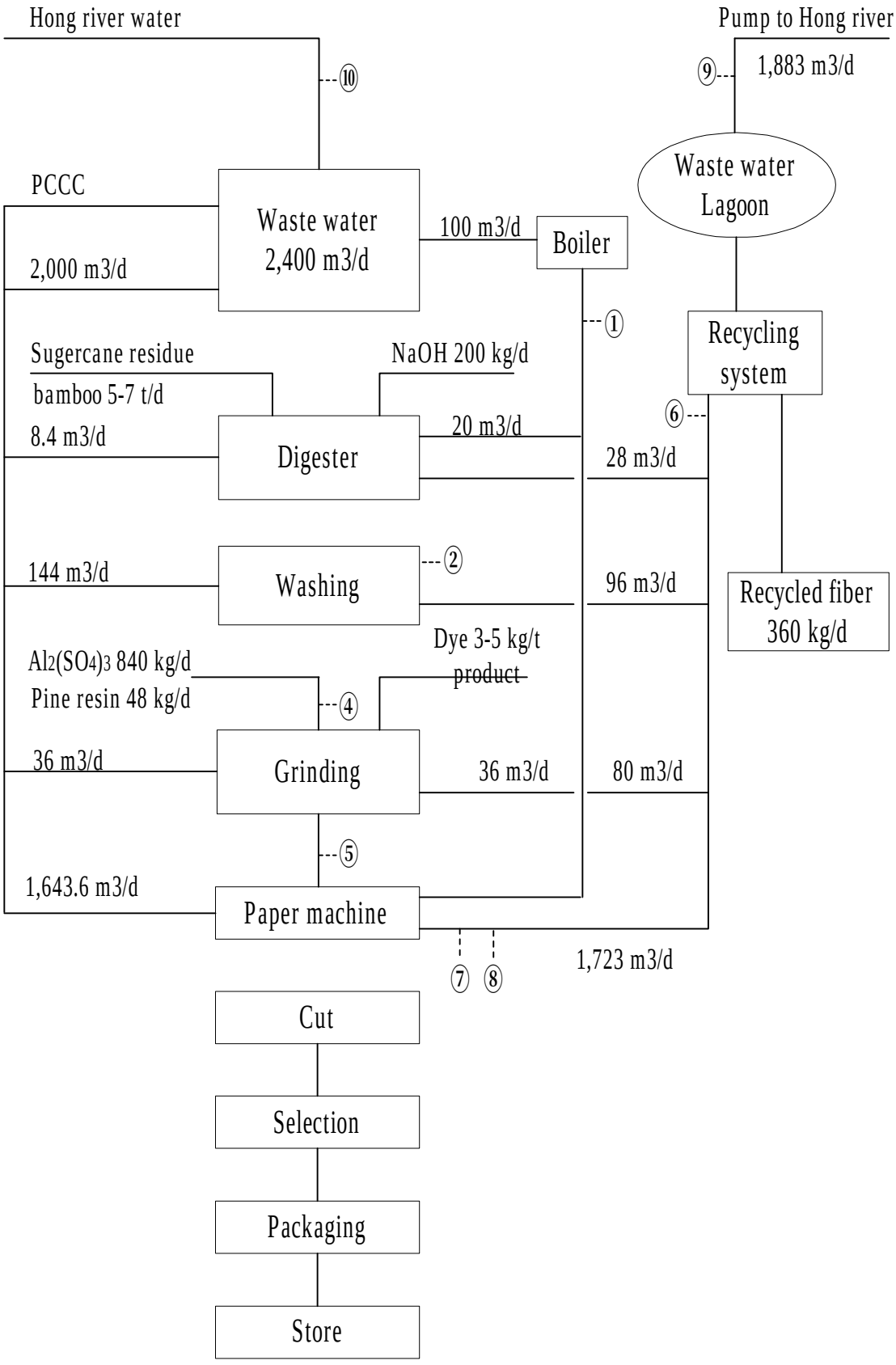


Figure 1 Process Flow Chart

2.2 Unit Cost of Raw Materials

Unit cost of raw materials and utilities are shown in Table 3.

Table 3 Unit Cost of Raw Materials and Utilities

Raw material	Unit	Quantity	Unit price (VND)	Expenses million VND
Black waste paper	ton	2,800	1,300,000	3,640
White waste paper		44	5,200,000	228.8
White pulp		33	7,000,000	231
Bamboo chips		349	390,000	136
Bamboo powder		176	2,200,000	387.2
Bamboo flakes		222	330,000	73.26
Sugar cane		2,900	170,000	493
$Al_3(SO4)_3$		240	1,671,000	401
Pine resin		15	7,000,000	105
Carbonate ($Na_2 CO_3$)		2.2		
Dye		1.547	75,000,000	116.025
Water	m3	668,000	450	300.6
Coal	ton	2,600	290,000	754
Electricity	KWH/h	2,720,000	830	2,257.6
Total				**9,123.485**

3. Industrial Wastewater

Wastewater is generated at a rate of 668,000 t/day. The results of wastewater analysis are shown in Table 4 (Sampling date: 22 November 1999).

4. Financial Status

Bank loan: 1,255,013,099 VND （as of 31 October 1999）

5. Recommendations

(1) The size of chips should be less than the size of a pack of cigarette, and they should all be arranged in the same size.

(2) It would be better to install de-inking apparatus and use floatator, screens, and cleaner on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent the product quality deterioration and paper break.

(3) It is necessary to prevent sticky compounds from attaching on the surface of the dryer.

(4) It is necessary to adjust the angle of the “Doctor” and maintain it at about 30 ° .

(5) It is better to wash off sticky compounds from wire, rolls etc. using high-pressure water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be used. Also to reduce the consumption of water, fiber should be recover from each paper machine and the sticky compounds should be removed. In order to collect fiber a concrete settler should be installed, and also clean water should be re-covered.

(6) The diameter of the roll of the press should be enlarged in order to reduce the content of water in the paper.

Table 4 The Results of Wastewater Analysis

Sampling No	Unit	1	2	3	4	5	6	7	8	9	10
Temp	℃	25.7	25.2				25.8	25	24.4	25.2	23.9
pH			8.29				8.28	6.5	7.32	7.17	8.4
Electric Conductivity	μS/cm	1408	556		1120	906	256	513	496	394	167
Turbidity	NTU	3696	1521		3893	2215	826	195	345	185	4.2
Oil content	mg/l	0	0		0.07	0.03	0	0	0.01	trace	0
BOD	mg/l	663.5	579.9		427.6	457.6	3846	219.6	264.8	165.9	205
COD	mg/l	68320	15180		15420	15020	8160	638	716	430	980
DO	mg/l		6.88				5.5	5.84	5.18	3.01	6.65
VSS	mg/l	540	500		1320	650	315	89	121	115	2.5
TSS	mg/l	36780	1560		3950	2250	850	215	369	229	5.3
Total Nitrogen	mg/l										
Residual Chlorine	mg/l	1024	9.217		trace	trace	18.43	46.89	24.1	43.95	40.41
SO_4^{2-}	mg/l	326.2	182.4		387.1	401.2	86.4	128.3	173.6	134.7	71
S^{2-}	mg/l	0.13	0.68		0.09	0.15	0.9	0	0	0	0
Cyanogen	mg/l									trace	trace
Phenol	mg/l	0.495	0.365		0.33	0.31	0.263	0.083	0.068	0.052	0.035
Na	mg/l	146	70							292	358
$CaCO_3$	mgeq/l	134	125		117	200	117	250	355	164	83
Cu	mg/l										
Pb	mg/l									0.025	0.037
Cd	mg/l									trace	trace
Hg	mg/l										
Cr(VI)	mg/l									0.12	trace
Zn	mg/l									0.36	0.32
Salt	%		0.02				0.01	0.02	0.02	0.01	0

Case Study P-07

Hoa Binh Paper Factory

Survey Date：23 November 1999

1. General

1.1 Company Profile

Hoa Binh Paper Factory is a State owned paper company. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Name	Hoa Binh paper factory
Type	State-owned
Address	Dan Hoa village ,Ky Son district,Hoa Binh province
TEL	Tel:018842195
Established	
Number of employees	180 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

Production and sales figures of the company in 1998 are shown in Table 2.

The production capacity of the Company is now 1,667 tons a year (2 line.) The company has plans to raise production capacity by 2,000 tons more in the year 2000.

Table 2 Production and Sales in 1998

Product	Production (tons)	Turn over (VND)
Paper	1,667	7,878,573,000

2. Production Technology

2.1 Process

A block flow diagram of the factory process is show in Figure 1.

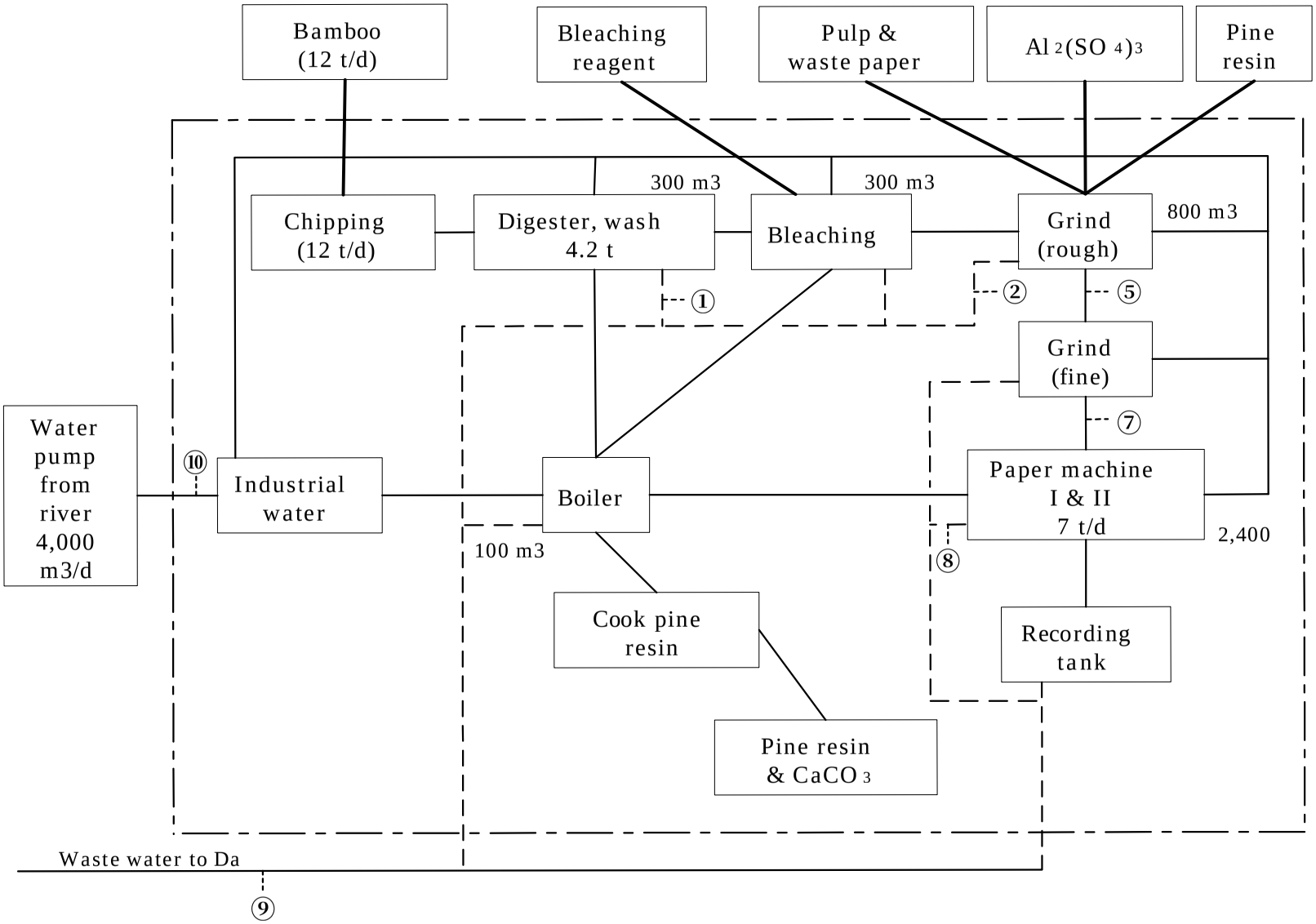


Figure 1 Block Flow Diagram of the Factory

2.2 Unit cost of Raw Materials

Unit consumption of raw materials and utilities are shown in Table 3.

Table 3 Unit Cost of Raw Materials and Utilities

Number	Material	Total consumption	Total cost (VND)
1	Bamboo	2,101 t	559,007,000
2	NaOH	100,510 kg	356,264,000
3	Waste paper	1,324 T	1,764,450,000
4	$Al_2(SO_4)_3$	52,790 kg	87,778,795
5	Pine Resin	14,173.5 kg	94,967,113
6	$CaCO_3$	2,150 kg	4,265,100
7	Coal	1,418 m^3	617,053,000
8	Electricity		1,193,610,000
9	Water	1,200,000 m^3	

3. Wastewater Treatment

The total amount of discharged wastewater from the factory is 1,200,000 t/year. The factory use water from the river that they discharge wastewater. Table 4 shows the results of wastewater sample analysis.

4. Financial Status

Bank loan: 1,404,757,973 VND

5. Recommendations

① It would be better to install de-inking apparatus and use floatator, screens, and cleaner on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent product quality deterioration and paper break.

② It is necessary to prevent sticky compound from attaching on the surface of the dryer. Otherwise, it will cause the paper to break.

③ It is necessary to adjust the angle of the “Doctor” and maintain it at about 30 degrees.

④ It is better to wash off sticky compounds from wire, rolls etc. using high pressure water. In order to conserve hot water, it is recommended that a sliding apparatus for the showering head be installed. Also to cut back on the consumption of water, fiber should be recovered from each paper machine and

the sticky compounds should be removed. In order to recover fiber, a concrete settler should be installed, and also clean water should be recovered.

⑤ For globe-type digesters it is still possible to recollect steam and black liquor, so it is better to collect steam and wastewater and to save chemicals and energy.

Table 4 The Results of Wastewater Analysis

Hoa Binh Paper Company (23/11/1999)

Samp. No.	Unit	1	2	5	7	8	9	10
Temp	℃	20.7	25.2		25.4	25.4	26.5	24.4
pH		8.42	8.29		7.74	7.96	6.94	8.15
Elec. Cond.	μS/cm	3602	556		359	293	243	139
Turbidity	NTU	3,020	2,860	1,866	455	348	26	56
Oil.	mg/l	0.02	0.03	0.02	0.03	0.02	0.02	0.03
BOD	mg/l	1,420.30	525.4	459.4	271.9	182.2	272.8	257.8
COD	mg/l	71,220	16,350	16,290	7,220	6,110	420	620
DO	mg/l	0.2	6.88		5.54	5.7	2.43	6.03
VSS	mg/l	795	620	675	280	128	23	41
TSS	mg/l	3,140	2,940	1,945	735	366	66	75
Total Nitrogen	mg/l							
Resid. Chlorine	mg/l	Trace	Trace	Trace	Trace	Trace	3.19	2.84
SO_4^{2-}	mg/l						91.2	28.1
S^{2-}	mg/l	0.27	1	0.29	0	0	0	0
Cyanogen	mg/l						0.091	0.088
Phenol	mg/l	0.415	0.395	0.35	0.068	0.052	0.047	0.022
Na	mg/l						297	310
$CaCO_3$	mg/l	125	117	134	200	250	164	72
Cu	mg/l						0.96	0.08
Pb	mg/l						0.045	0.024
Cd	mg/l						trace	trace
Hg	mg/l							
Cr(VI)	mg/l						trace	trace
Zn	mg/l						0.39	0.36
Salt	%		0.02		0.01	0.01	0	0

Case Study P-08

Bai Bang Company

Survey Date：24 November 1999

1. General

1.1 Company Profile

Bai Bang Company is a State owned paper company. The company profile is shown in Table 1.

Table 1 Company Profile

Name	Bai Bang Company
Type	State owned
Address	Phong Chau Town Phu ninh District Phu Tho
TEL	Tel: 0210829755／Fax: (84)210829177
Established	
Number of Employees	3200 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

Production and sales figures of the company in 1998/1999 are shown in Table 2.

The production capacity of the Company is now 55,000 tons a year. The company has plans to raise production capacity to 100,000 tons by the year 2001, and to 200,000 tons by the year 2005.

Table 2 Production and Sales

(1998; 1st and 2nd quarter of 1999)

Product	Design capacity (t/year)	1998 (t)	1st quarter 1999 (t)	2nd quarter 1999 (t)
Printing paper	55,000	60,000	14,000	14.000

2. Production Technology

2.1 Process

The main production lines of the factory are shown in Table 3.

Table 3 Main Production lines

	Name	Function
1	Pulp factory	Producing bleached pulp
2	Paper factory	Producing Printing paper
3	Electric factory	Generating steam, electricity, water supply
4	Chemical factory	producing chemicals for bleaching

Table 4 shows main equipment of the factory.

Table 4 Main Equipment

	Production line	Country of manus futurity	Exploit ation from	Description	Capacity
1	Raw material treatment -Debarking -Wood chopper -Bamboo chopper	 Finland Sweden Germany	1982	Produce wood and bamboo chips	 400 m^3 wood/day 40 t/h 25 t/h
2	Pulp factory	Sweden		Sulfate type digester, 4 step bleaching	165 t/day (Bleached pulp)
3	Chemical recovering			-Burn black liquor -Add alkaline	80 t/day
4	Paper Machine	Sweden		Paper is produced with addition of alkaline colloid	240 t/day
5	Steam and electric Power Generator	France		Thermoelectricity	28 MW
6	Chemical factory line	Italy		NaCl electrolysis	21 t-Cl/day
7	Water treatment	Sweden			72000 m^3/day
8	Wastewater treatment	Sweden		Wastewater is treated by using physical and chemical methods	18,000 m^3/day

Process flow of the paper factory is shown in Figure 1.

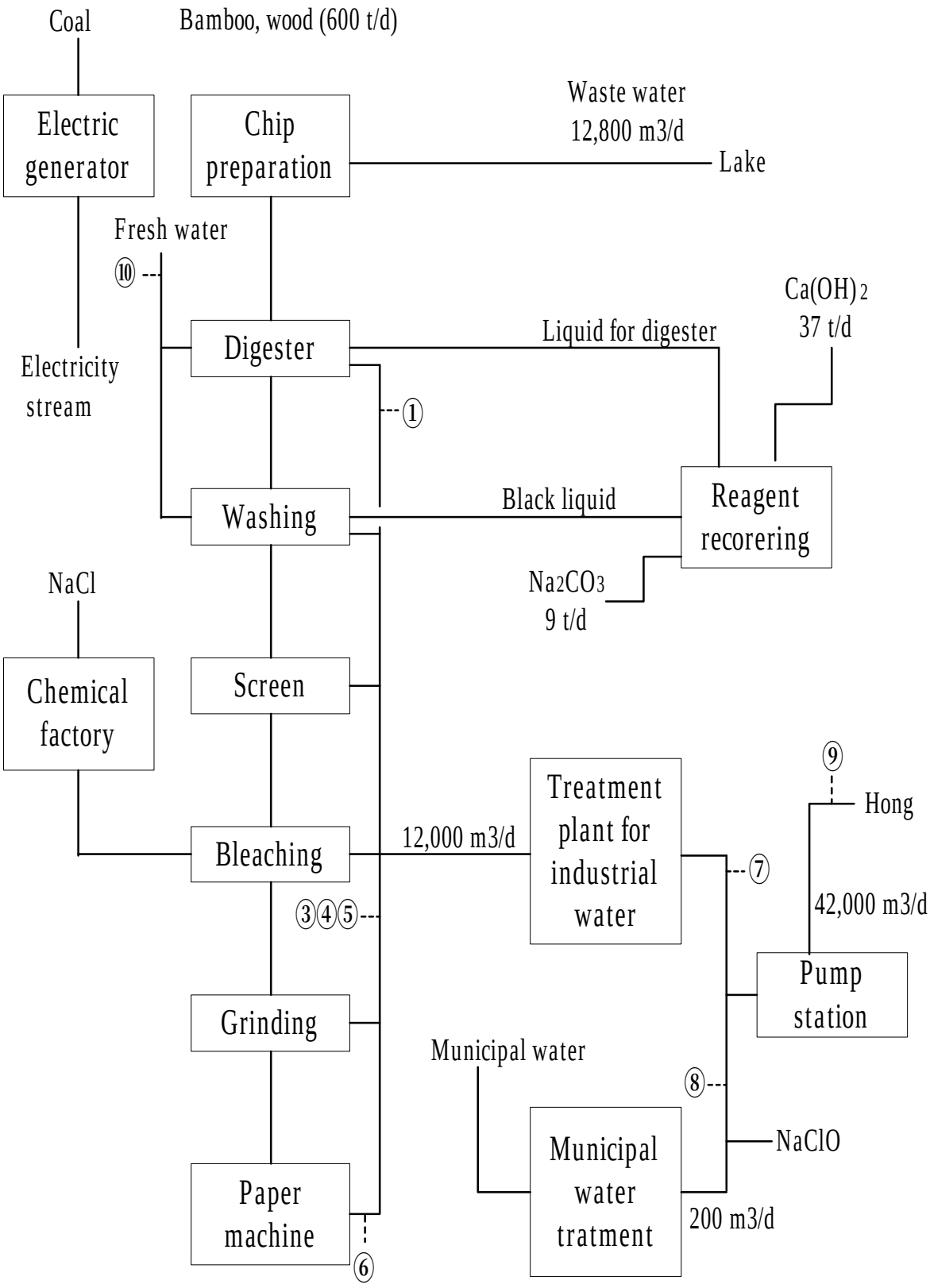


Figure 1 Process Flow Chart

2.2 Unit Consumption

Unit consumption of raw materials and utilities are shown in Table 5.

Table 5 Unit Consumption

Material	Amount consumed for 1 ton product	Cost	Total consumption(1998)
1)Bamboo, wood	3.3 tons/product	470,000 d/ton	200,000 tons
2)Imported pulp	250 kg/t	7,000,000 D/t	15,000 tons
3) NaCl	140 kg/t	630,000D/t	9,700 tons
4)Na_2SO_4			2800 tons
5)CaO			11,000 tons
6)$CaCO_3$			5,500 tons
7)Coal			180,000tons
8)$AL_2(SO_4)_3$	Wastewater	1,900,000 t	800 t (400 t for waste treatment)
9)Electricity	Supply water	800,000 t	127,900 MWh
10) Fo oil		1,800,000 t	1,060 tons
11) Water	280.0 m^3/t	800d/m^3	17,000,000 m^3
In 1998 28% pulp was imported			

For each ton of pulp 5.03 tons of material were consumed.

3. Industrial Wastewater

The total volume of discharged wastewater from the factory is 2,300 tons per day. Table 6 shows the results of wastewater analysis.

Moreover, solid and liquid waste conditions are shown in Table 7 and 8 respectively.

Table 6 Result of the Wastewater Analysis

(24 November 1999)

Samp.	Unit	1	3	4	5	6	7	8	9	10
Temperature	℃	20.8	20.6	21	20.8	20.6	32	27.6	29	24.8
pH		8.63	9.02	8.86	9.12	9.1	9.16	7.75	9.63	8.41
Elec.Cond.	μS/cm	890	362	1248	213	761	457	515	2020	183.2
Turbidity	NTU	2,912	326	102	131	36	198	4.5	758	35
Oil content	mg/l	0.01	0.03	0.01	0.01	0.02	0.03	0.02	0.01	Trace
BOD	mg/l	1222.3	210.3	902.9	231.4	306.2	1224.9	167.2	860.6	166.3
COD	mg/l	43,250	246	12,120	301	512	3,240	282.5	9,340	195
DO	mg/l						2.6	3.19	3.33	6.02
VSS	mg/l	1,250	55.1	18.9	30	15.1	100	3	240	18.5
TSS	mg/l	2,986	347	112	148	45	207	5	773	54
Total Nitrogen	mg/l									
Resd. Chlorine		A*	Trace	51.4	3.55	1.42	35.45	2.13	1.77	4.25
SO_4^{2-}	mg/l								372	64.8
S^{2-}	mg/l	0.27	0	0.01	0	0	0.13	0	0.09	0
Cyanogen	mg/l								0.069	0.067
Phenol	mg/l	0.068	0.02	0.055	0.031	0.13	0.263	0.018	0.34	0.014
Na	mg/l			618					317	328
$CaCO_3$	mgeq/l	268	110	47	96	72	117	96	134	66
Cu	mg/l								0.52	0.03
Pb	mg/l								0.045	0.085
Cd	mg/l								0.001	trace
Hg	mg/l									
Cr(VI)	mg/l								0.08	A*
Zn	mg/l								0.35	0.32
Salt	%						0.01	0.02	0.09	0

Note : A* : not detected

Table 7 Solid Waste

	Equipment of production line	Pollutant	Pollution rate	Migration of pollutant	Treatment
1	When alkaline is added	lime	18,000 t/ year	Diluted and pumped to resevior	Accumulated in the resevior
2	Raw material treatment	Bark sawdust	21,000 t/ year	Accumulated	Sold cut
3	Electric generator	Stag	51,000 t/ year		Sold out

Table 8 Liquid Waste

Source	Current (rate)m^3/day	PH	SS mg/l	COD mg/l	BOD Mg/l	S^2 mg/l	color mg/l
From material processing section	12,800	7.2	121.5		70		
From stag sedimentation tank to canal	1,800	7.2	16.7				50
From pump station to river	35,000	7.8	73	280	90	2,7	345

4. Financial Status

Bank loan	22,000,000,000 VND
Employee bond	22,000,000,000 VND

5. Recommendations

① The size of chips should be less than that of a cigarette pack, and they should all be arranged in the same size.

② It is necessary to adjust the angle of the “Doctor” and maintain it at about 30 degrees.

③ It recommended that fiber be recovered and a settler be installed because COD level is very high as 9,340 mg/l, and VSS is 240 mg/l.

Case Study P-09

Viet Tri Paper Factory

Survey date：25 November 1999

1. General

1.1 Company Profile

Viet Tri Paper Factory, established in 1961, is a state-owned paper company. The Company profile is shown in Table 1.

Table 1 Enterprise Profile

Name:	Viet Tri Paper Factory
Ownership:	State-owned
Address:	Thanh Mieu – Viet Tri - Phu Tho
TEL/FAX:	Tel: 0210 – 846702／Fax: 0210 - 846702
Established:	1961
Number of Employees:	700 (3 shifts, 300 working days)
Main products:	

1.2 Business Status

Production and sales figures of the Company in 1998 are shown in Table 2.

The total production capacity of the Company is 7,285 tons/year.

Table 2 Production and Sales in 1998

Product	Production (ton)	Turnover (million VND)
Print paper	5,945	57,000
Cover paper	260	2,000
Tissue paper	250	2,050
Packaging paper	690	2,890
Others paper	140	410
Total	7,285	64,350

2. Production Technology

2.1 Process

The Company process flow chart is shown in Figure 1.

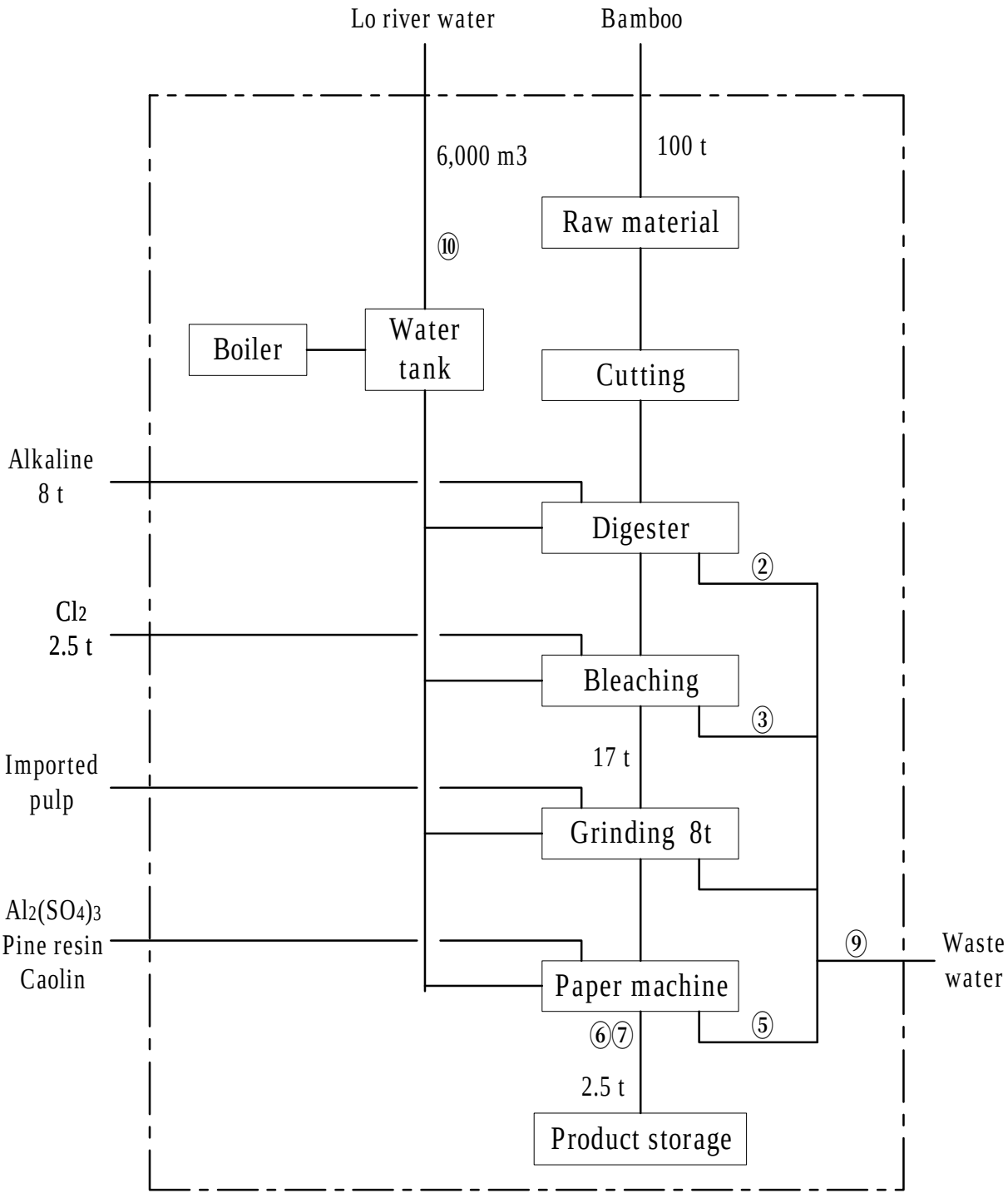


Figure 1 Process Flow Chart

2.2 Unit Cost of Raw Materials

The Unit Cost of raw materials and utilities are shown in Table 3 and 4.

Table 3 Unit Cost of Raw Materials and Utilities

Raw material	Average for 1 ton of product		Expenses (1000 VND)
	Net for 1 ton (kg/t)	Expenses (VND/ ton)	
I- Paper print			
1. Imported powder	356	2,349,600	13,968,372
2. Waste paper	46	234,600	1,394,697
3. Bamboo	3,950	1,354,850	8,054,583
4. NaOH	302	996,600	5,924,787
5. ClO	100	340,000	2,021,300
6. $Al_2(SO_4)_3$	36	62,280	370,255
7. Pine resin	8.5	52,700	313,302
8. Caolin	85	62,900	373,941
9. Water			
10. Coal	1,593	549,585	3,267,283
11. Electricity	1,006	734,380	4,365,889
II- Colored paper - cover paper			
1. Imported powder	234	1,544,400	401,544
2. Waste paper	39	198,900	51,714
3. Bamboo	4,653	1,595,979	414,955
4. NaOH	371	1,224,300	318,318
5. Cl_2	119	404,600	105,196
6. $Al_2(SO_4)_3$	38	65,740	17,092
7. Pine resin	8.7	53,940	14,024
8. Caolin	80	59,200	15,392
9. Water			
10. Coal	1,724	594,780	154,643
11. Electricity	1,057	771,610	200,619
III- Tissue paper			
1. Waste paper	770	2,541,000	635,250
2. Bamboo	2,374	814,282	203,571
3. NaOH	173	570,900	142,725
4. Cl_2	55	187,000	46,750
5. $Al_2(SO_4)_3$	6.1	10,553	2,638
6. Water			
7. Coal	1,348	465,060	116,265
8. Electricity	949	692,770	173,193
IV- Packaging paper			
1- Pulp from packaging paper	500	1,425,000	983,250
2. Waste paper	643	707,300	488,037
3. $Al_2(SO_4)_3$	37	64,010	44,167
4. Pine resin	8.7	53,940	37,219
5. Water			
6. Coal	1,005	346,725	239,240
7. Electricity	822	600,060	414,041

Table 4 Unit Consumption of Raw Materials and Utilities

Raw material	Norm for 1 ton product		Expenses (1000 VND)
	Net for 1 ton (kg/t)	Expenses (VND/ ton)	
III- Tissue paper			
1.Waste paper	770	2,541,000	635,250
2. Bamboo	2,374	814,282	203,571
3. NaOH	173	570,900	142,725
4. Clo	55	187,000	46,750
5. $Al_2(SO_4)_3$	6.1	10,553	2,638
6. Water			
7. Coal	1,348	465,060	116,265
8. Electricity	949	692,770	173,193
IV- Packaging paper			
1- Pulp from packaging paper	500	1,425,000	983,250
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4. Pine resin	8.7	53,940	37,219
5. Water			
6. Coal	1,005	346,725	239,240
7. Electricity	822	600,060	414,041

3. Industrial Wastewater

Wastewater is generated in the factory at 6,000 ton/day. The results of wastewater analysis are shown in Table 5.

Table 5 Results of Wastewater Analysis

(25 November 1999)

Samp. No.	Unit	2	3	5	6	7	9	10
Temp	℃	20.8	20.7	28.4	26.1	26.5	26.8	24.1
PH		9.14	9.7	5.81	7.2	7.23	9.12	7.95
Elec.Cond.	μS/cm	1530	900.5	1030	291	356	1050	186
Turbidity	NTU	598	417	535	234	1329	288	68
Oil.	mg/l	0	0	0	0	0	0	0
BOD	mg/l	1698.6	963.6	330	371.4	185.7	280.7	10.56
COD	mg/l	21320	15840	5325	894	5460	525	48.5
DO	mg/l	0.2	0.3	5.12	6.01	6.72	7.14	6.01
VSS	mg/l	210	152	564	301	500	90	48.5
TSS	mg/l	620	440	1595	1005	1605	158	98
Total Nitrogen	mg/l							
Resid. Chlorine	mg/l	3.61	173.71	2.84	1.06	0.71	trace	1.42
SO_4^{2-}	mg/l	472.2	284.1	316.3	92.7	43.4	100.8	30.4
S^{2-}	mg/l	0.15	trace	0	0	0	0	0

Samp. No.	Unit	2	3	5	6	7	9	10
Cyanogen	mg/l						0.071	0.069
Phenol	mg/l	0.13	0.11	0.026	0.024	0.028	0.161	0.016
Na	mg/l						346	330
$CaCO_3$	mgeq/l	250	134	110	117	0.6	125.00	66
Cu	mg/l						0.88	0.09
Pb	mg/l						0.04	trace
Cd	mg/l						trace	0.008
Hg	mg/l						trace	not detec.
Cr(VI)	mg/l						0.85	not detec.
Zn	mg/l						0.37	0.34
Salt	%			0.04	0.01	0.01	0.03	0

4. Financial Status

State bank loan: 3.7 billion VND

5. Proposed Countermeasures

① The size of chips should be less than that of a cigarette pack, and be arranged in the same size.

② It is better to install de-inking apparatus and, using floatator, screens, and cleaner of this apparatus, to eliminate ink and sticky compounds. By this method it will be possible to prevent product quality deterioration and paper break.

③ It is necessary to prevent sticky compounds from attaching on the surface of dryer. If not, it makes break of paper.

④ It is necessary to adjust angle of doctor and keep about 30 degrees.

⑤ It is better to wash sticky compounds from wire, rolls and etc. by high pressure water. It is better to wash by hot water and in order to save hot water, and the use of vibration apparatus on the showering head is recommendable. Also to reduce water consumption it is better to collect fiber from each paper machine and remove sticky compounds. To recover fiber it is better to install settler made of concrete, and also recollect clean water.

⑥ Increase diameter of the roll because diameter of roll in press process is short and paper contains high humidity.

⑦ Collect chemicals and heart energy from a glove digester in order to prevent wastewater pollution and increase productivity since steam and waste liquid can be reused in it.

⑧ Change caustic soda quality if the quality doesn't meet requirement because

chromium is contained in discharged water.

Case Study P-10

Thuan Thanh Paper Factory (TTPF)

Survey date：26 November 1999

1. General

1.1 Company Profile

The Thuan Thanh Paper Factory (TTPF), established in 1961, is a state-owned paper company. Although the company produced refined sugar in the past, they only produce paper at present.

The Company profile of TTPF is shown in Table 1.

Table 1 Enterprise Profile

Name	Thuan Thanh Paper Factory (TTPF)
Ownership	Local Government-owned.
Address	Ho Town, Thuan Thanh - Bac Ninh Province
TEL	Tel: 0241.865269 - 0241.865285
Established	1961
Number of Employees	100 (3 shifts, 340 working days)
Main Products	

1.2 Business Status

Production and sales figures of the Company in 1998 are shown in Table 2.

The Company's six production lines have a total production capacity of 483 ton/year.

Table 2 Production and Sales in 1998

Product	Unit	Production	Turn over (VND)
Packaging paper	ton	300	840,000,000
Color	"	83	298,800,000
Tissue paper	"	100	650,000,000
Total	"	483	1,788,800,000

2. Production Technology

2.1 Process

The process flow chart is shown in Figure 1.

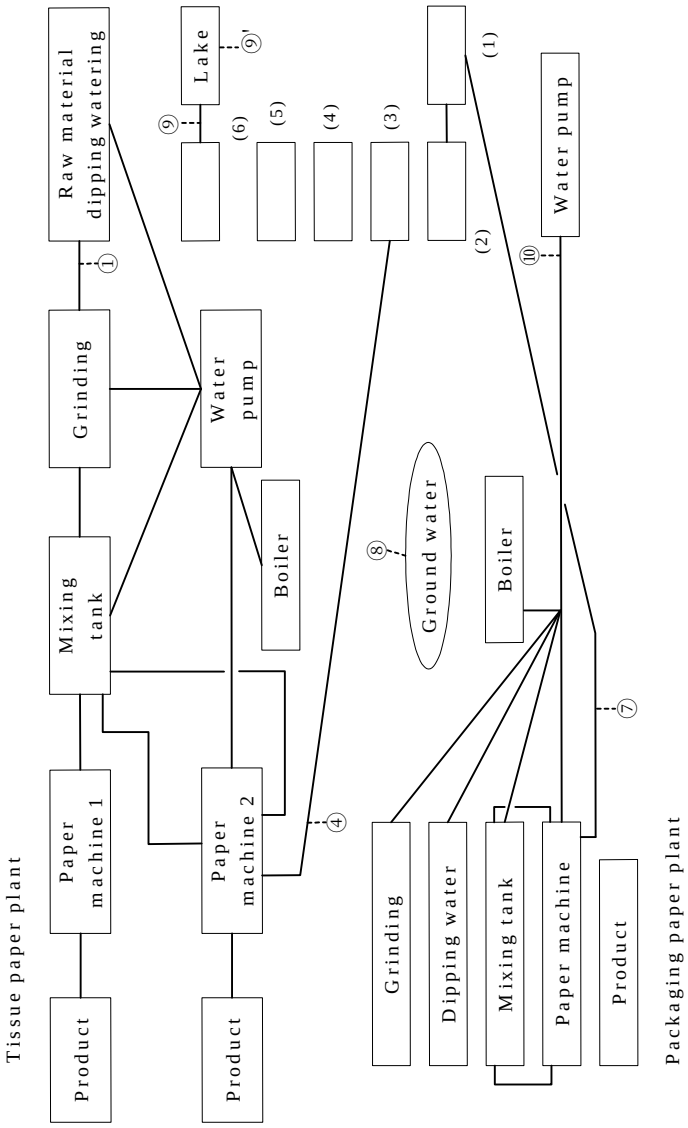

Figure 1- Process Flow Chart

2.2 Unit Cost

The unit cost of raw materials and utilities are shown in Table 3

Table 3 Unit Cost of Raw Materials and Utilities

Material	Unit	Consumption	Cost (VND)
1- Waste paper	ton	819	999,423,600
2- $Al_2(SO_4)_3$	ton	15	32,319,000
3- Pine resin	ton	5	25,589,000
4- Soda	ton	1	2,600,000
5- Alkaline	ton	6	30,000,000
6-Taven water	ton	15	12,000,000
7- Coal	ton	550	121,000,000
8- Electricity	KWh	350,000	271,645,342
9- Water	m^3	244,000	36,000,000

3. Wastewater Treatment

The amount of water used in the factory is 244,000 tons/year. The results of wastewater analysis are shown in Table 4.

4. Financial Status

5. Proposed Countermeasures

① It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, it will cause paper product to break.

② It is necessary to adjust the angle of the “doctor” and maintain it at about 30 degrees.

③ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with warm water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be installed. Also, in order to reduce water consumption, fiber should be collected from each paper machine and the sticky compounds should be removed. In order to collect fiber a concrete settler should be installed, and also clean water should be recollected.

④ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑤ For globe-type digesters, it is still possible to recollect steam and black liquor, so it is better to recover steam and wastewater then to save chemicals and energy.

Table 4 Results of Wastewater Analysis

(26 November 1999)

No	Unit	1	4	7	8	9	9'	10
Temperature	℃	24.9	25.6	25.9	25.8	25.4	27	28
pH		7.47	7.65	7.82	5.62	7.48	7.53	7.46
Elec. Conductivity	μS/cm	847	769	800	1362	769	1180	1086
Turbidity	NTU	73	692	2309	6.5	250	256	140
Oil content	mg/l	0.02	0.03	0.03	0.01	0.04	0.02	0.04
BOD	mg/l	1079.8	884.4	1048.7	316.8	1005.8	826	1420.3
COD	mg/l	5120	4898	12080	413.8	4210	2893	1820
DO	mg/l	1.76	3.95	4.43	1.31	0.97	1.53	1.17
VSS	mg/l	40	210.5	660	3.5	101	69	105
TSS	mg/l	82	708	2420	7.8	277	83	157
Total Nitrogen	mg/l							
Residual Chlorine	mg/l	trace	trace	trace	2.13	trace	trace	trace
SO_4^{2-}	mg/l	162	334	281	137	254.4	289.3	153.6
S^{2-}	mg/l	0.81	0.72	0.29	0	0.68	0.51	0.13
Cyanogen	mg/l					0.11	0.06	0.1
Phenol	mg/l	0.021	0.026	trace	0	0.024	trace	0.009
Na	mg/l					315	190	292
$CaCO_3$	mg/l	250	72	96	117	110	81	66
Cu	mg/l					0.52	0.31	0.07
Pb	mg/l					0.013	0.007	0.006
Cd	mg/l					0.006	0.006	trace
Hg	mg/l							
Cr(VI)	mg/l					0.13	0.09	not detect.
Zn	mg/l					0.36		0.33
Salt	%	0.05	0.05	0.05	0.03	0.05	0.05	0.05

Case Study P-11

Binh An Paper Company (COGIMEKO)

Survey date：1 December 1999

1. General

1.1 Company Profile

The Binh An Paper Company (COGIMEKO), established in 1965, is a state-owned paper company. The company profile of COGIMEKO is shown in Table 1.

Table 1 Enterprise Profile

Name	Binh an Paper Company (COGIMEKO)
Type	State-owned
Address	Binh an, Thuan an, Binh Duong Province
TEL	Tel: 065 851635／Fax: 065 850389
Established	1965
Number of employees	253 (3 shifts, 300 working days)
Main Products	

1.2 Business status

Production and sales figures of the Company in 1998 are shown in Table 2.

The Company is planning to expand its production capacity to 7,000 tons/year by the year of 2000.

Table 2 Production and Sales in 1998

Product	Production (t)	Sales (billion VND)
1. Carton paper	3,494.67	17.355
2. Wrapping paper	539.34	3.887
3. Typing and white wrapping paper	345.63	3.853
4. Toilet paper	280.32	3.064
Total	4,659.96	28.159

1. Production technology

2.1 Process

The process flow chart is shown in Figure 1

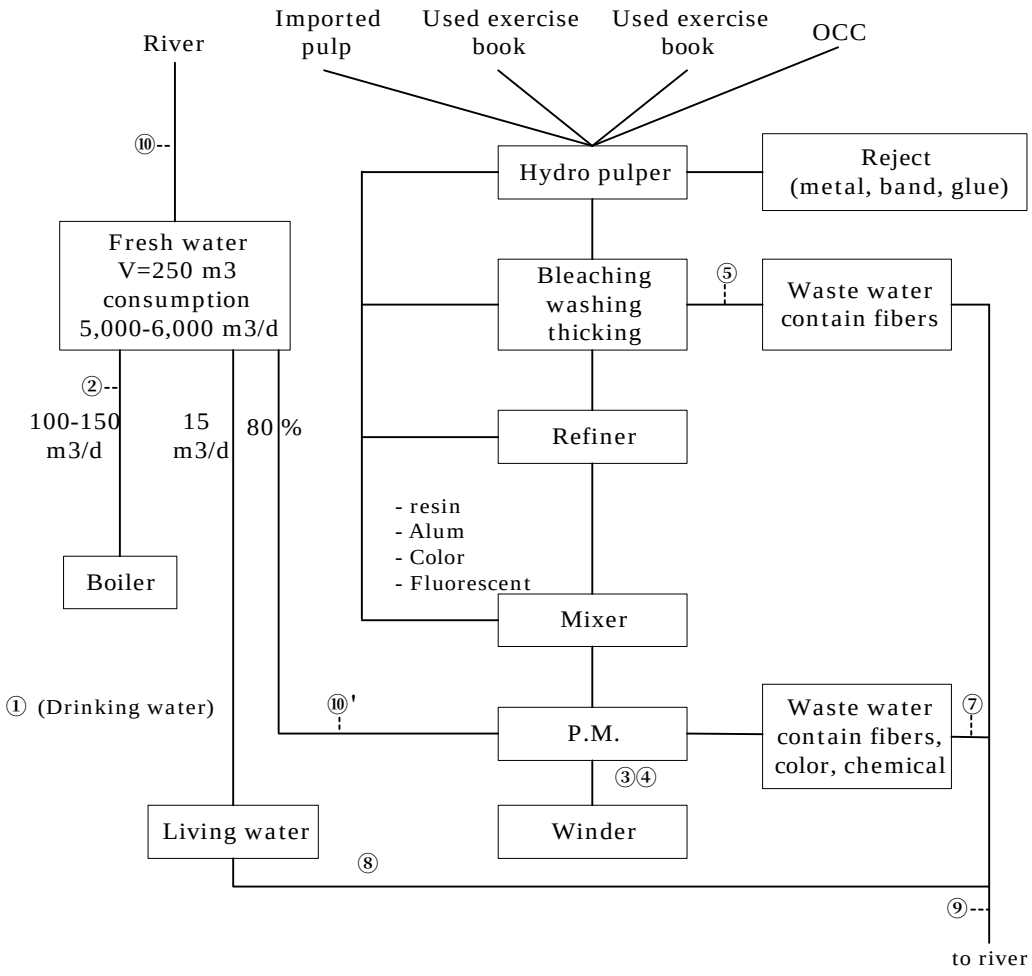

Figure 1 Process Flow Chart

1.1. Unit Cost and Consumption of Raw Materials

The unit cost and consumption of raw materials and utilities are shown in Table 3 and 4.

Table 3(1) Unit Cost and Consumption of Raw Materials and Utilities

Material used (1)	Quantity (2)	Expenses (3) VND/t
1. Carton paper:	3494.67 t	
Semi mechanical pulp	1104.125 t	2,500,000
OCC	3242.632 t	1,300,000
Used cement paper	141.234 t	2,250,000
H_2SO_4	1.058 t	1,790,000
Color	2.659 t	48,000,000
Resin	35.775 t	7,130,000
Alum	177958 t	1,750,000
Energy 821VND/kWh	3108016 kWh	821 VND/kWh
Fuel oil	1033.689 t	1,576,00.

Table 3(2) Unit Cost and Consumption of Raw Materials and Utilities

Material used (1)	Quantity (2)	Expenses (3) VND/t
2. Wrapping paper:	**539.34 t**	
Semi mechanical pulp	158.392 t	2,500,000
OCC	307.148 t	1,300,000
Used cement paper	240.689 t	2,250,000
H_2SO_4	0.157 t	1,790,000
Color	0.385 t	48,000,000
Resin	7.172 t	7,130,000
Alum	36.787 t	1,750,000
Energy 821VND/kWh	727646 kWh	821 VND/kWh
Fuel oil	200.180 t	1,576,000
3.Typing+white wrapping paper:	**345.63 t**	
Long fiber	61.935 t	7,600,000
Short fiber	285.424 t	6,200,000
White edge trimmings	55.836 t	5,200,000
Fluorescent	0.481 t	120,000,000
Resin	3.973 t	7,130,000
Alum	13.480 t	1,750,000
Energy 821VND/kWh	574450 kWh	821 VND/kWh
Fuel oil	154.269 t	1,576,000
4. Toilet paper:	**280.32 t**	
Long fiber	11.918 t	7,600,000
Short fiber	241.665 t	6,200,000
White edge trimmings	98.358 t	5,200,000
Fluorescent	0.378 t	120,000,000
Dispersing agent	0.461 t	87,530,000
Energy 821VND/kWh	450431 kWh	
Fuel oil	129.187 t	1,576,000 VND/T

Table 4 Unit Cost of Raw Materials and Utilities

Total material used 1998:

Order	Material used	Quantity (t)
1	Semi-mechanical pulp	1,262.517
2	OCC	3,549.780
3	Waste cement paper	381.923
4	White edge trimmings	154.194
5	Long fiber	73.853
6	Short fiber	527.089
7	Resin	46.920
8	Alum	228.226
9	H_2SO_4	1.215
10	Fluorescent	0.859
11	Dispersing agent	0.461
12	Color	3.045
13	Fuel oil	1,517.326
14	Energy 821 VND/kWh	4,860,543 kWh
15	Water	m^3

2.3 Industrial Wastewater

The amount of wastewater generated in the factory is 4,500 t/day. The capacity of a wastewater treatment system, where only SS is being removed, is 1,200 t/hour. The results of wastewater analysis are shown in Table 5.

Table 5 Wastewater Analysis Results

(1 December 1999)

Sampling No	Unit	1	2	3	4	5	7	8	9	10	10'
Temp	℃	27.8	29.1	29	29	28	30	28	28.9	28	28.2
pH		7.54	7.07	7.2	6.9	7.3	7.8	7.6	7.67	7.72	6.71
Elec. Conductivity	μS/cm	53	60	176	130	451	86	89	221	61	62
Turbidity	NTU	10	10	154	113	790	76	10	134	10	10
Oil content	mg/l	A*	A*						5.2	0.4	A*
BOD	mg/l	0	0						32	0	0
COD	mg/l	0.5	2	144		480	53	16	128	16	10
DO	mg/l	5.47	5.44	5.3	4.5	5	4.5	4.5	4.76	4.36	4.95
VSS	mg/l	0.5	0.5	70	100	130	28	16	8	11	5
TSS	mg/l	1	1	110	108	327	76	27	100	19	7
Total nitrogen	mg/l	1.9	1.6						3.5	2.1	
Residual Chlorine	mg/l	A*							A*		A*
SO_4^{2-}	mg/l	11	13	68	53	100	16	13	86	12	15
S^{2-}	mg/l										
Cyanogen	mg/l	0.03	0.02						0.02	0.02	0.02
Phenol	mg/l	A*	A*						0.002	0	0.008
Na	mg/l								402	169	153
$CaCO_3$	mgeq/l	14	9	60	20	16	26	16	78	10	11
Cu	mg/l	0	0.01						0.44	0.06	0.02
Pb	mg/l	0.018	0.025						0.029	0.04	0.043
Cd	mg/l	Trace	trace						trace	trace	0.008
Hg	mg/l	A*	trace						trace	trace	trace
Cr(VI)	mg/l	Trace	trace						0.28	0.01	0.02
Zn	mg/l										
Salt	%	0	0	0	0	0	0	0	0	0	0

Note : A* : not detect.

3. Financial Status

4. Proposed Countermeasures

① It would be better to install de-inking apparatus and to use floatater, screen, and cleaner on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent product quality deterioration and paper break.

② It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, it causes the paper break.

③ It is necessary to adjust the angle of the "doctor" and maintain it at about 30 degrees.

④ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be used. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber, a concrete settler should be installed, and also clean water should be re-collected.

⑤ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑥ The quality of caustic soda should be checked because Chromium is contained in the wastewater. If the quality of caustic soda is insufficient, it would be better to change to another source.

Case Study P-12

Tan Mai Paper Company

Survey date：29 November 1999

1. General

1.1 Company Profile

The Tan Mai Paper Company, established in 1958, is a State-owned paper company. The Company profile is shown in Table 1.

Table 1 Company Profile

Name	Tanmai Paper Company
Ownership	State-owned
Address	Thongnhat,Town: Bienhoa Industrial Zone, Province: Dongnai
TEL	Tel:(061) 822257／Fax:(061) 824915
Established	1958
Number of employees	950 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

The Company's production and sales figures in 1998 are shown in Table 2.

The production capacity of three production lines is roughly 60,619 t/year.

Table 2 Production and Sales in 1998

Products:	Production (t)	Sales (VND)
Newsprint paper	26,102.732	221,361,634,556
Printing paper	13,306.376	127,159,622,776
White printing paper	16,817.338	209,026,296,602
Wrapping and others	4,392.292	28,813,648,510
Total	**60,618.738**	**586,361,202,443**

2. Production Technology

2.1 Process

The process flow chart is shown in Figure 1.

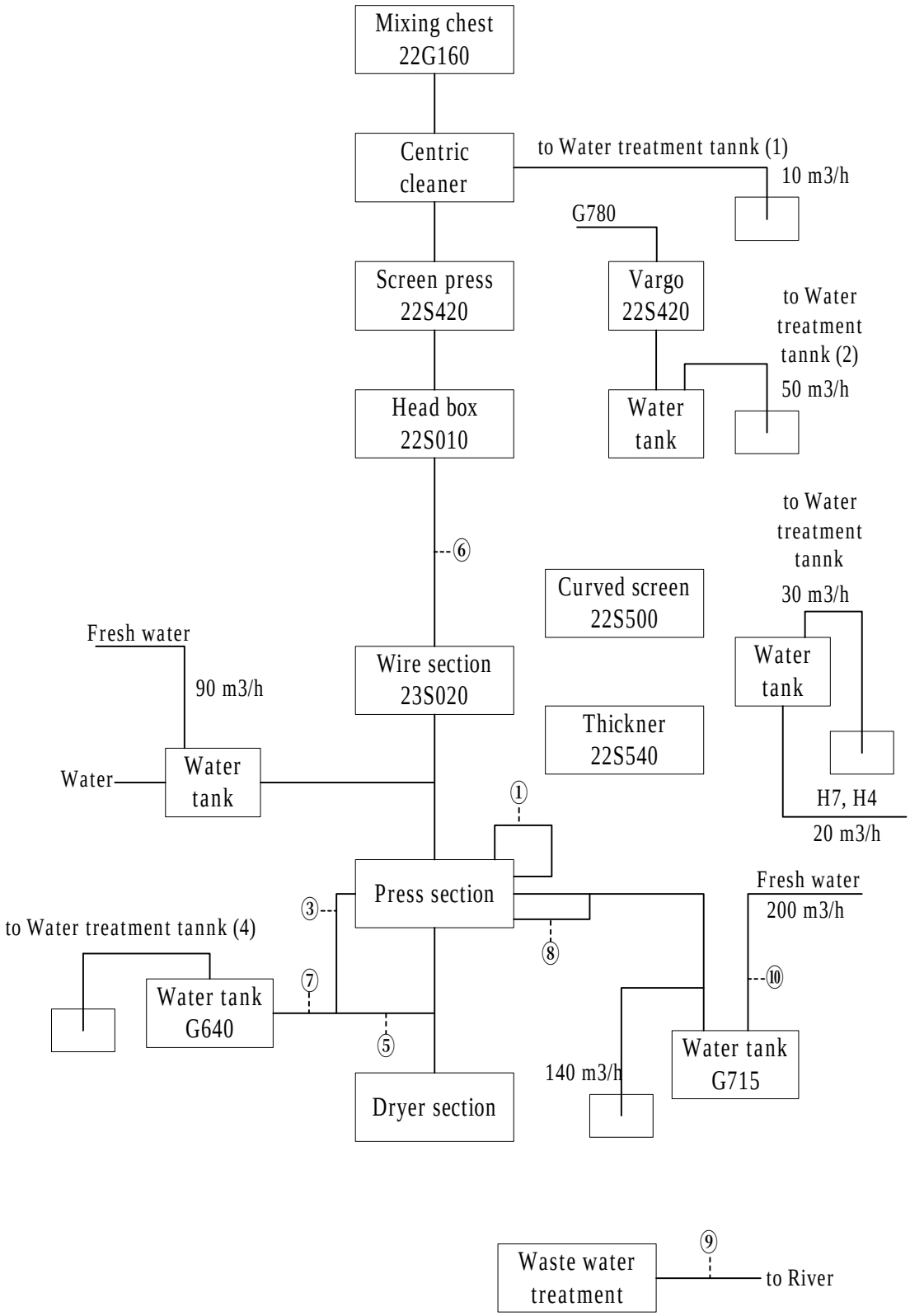

Figure 1 Process Flow Chart

2.2 Consumption of Raw Materials and Utilities

Consumption and cost of raw materials and utilities are shown in Tables 3 and 4.

Table 3 Raw Material and Utility Consumption and Costs(1)

Material	Weight (ton)	Costs(VND)
1. Newsprint		
Pulp		
1. Imported Pulp	28,182.459	143,485,270,000
2. Local Pulp		
Chemical		
Alum	416.634	749,941,200
Resin	26.227	281,643,718
NaOH	2.423	9,304,922
Retention chemical	4.634	522,117,414
Chemical to increase wet strength	117.021	2,048,335,584
Talc	788.733	1,160,277,787
Fluorescent	0.120	15,214,920
H_2SO_4	0.719	1,403,488
TiO_2	1.781	42,715,504
Colors	0.557	44,879,105
Energy and water		
Water, m^3	1,752,092	1,310,564,816
Fuel Oil, liter	6,359,970	9,845,233,560
Energy, kWh	20,339,369	14,725,703,156
Total		**174,242,605,174**
2. Printing paper		
Pulp		
1. Imported Pulp	15,626.962	79,415,610,192
2. Local Pulp	2,880.975	496,679,274
Chemical		
Alum	328.460	591,228,000
Resin	123.916	1,330,107,059
NaOH	5.686	22,187,551
Retention chemical	1.535	144,180,764
Chemical to increase wet strength	7.892	136,996,871
Talc	475.555	676,567,855
Fluorescent	1.511	85,962,193
H_2SO_4	0.434	849,459
TiO_2	5.440	125,327,360
Colors	0.159	14,942,853
Energy and water		
Water, m^3	1,041,442	778,998,616
Fuel Oil, litter	3,416,373	5,281,654,737
Energy, kWh	10,892,113	7,829,796,813
Total		**96,931,089,597**

Table 4 Raw Material and Utility Consumption and Costs (2)

3. White printing paper	**Weight (ton)**	**Costs (VND)**
Pulp		
1. Imported Pulp	18,144.155	131,419,875,053
2. Local Pulp	13.300	130,379,067
Chemical		
Alum	391.482	704,652,275
Resin	200.107	2,186,106,704
NaOH	28.132	110,497,489
Retention chemical	2.491	253,838,913
Chemical to increase wet strength	3.487	57,985,567
Talc	652.171	952,461,125
Fluorescent	25.694	3,522,108,967
H_2SO_4	0.492	958,822
TiO_2	79.779	1,976,546,767
Colors	0.286	22,666,535
Energy and water		
Water, m^3	1,319,556	987,027,888
Fuel Oil, litter	4,444,535	6,865,452,867
Energy, kWh	14,262,907	10,364,070,829
Total		**159,554,628,868**

4. Wrapping paper	Weight(ton)	Costs (VND)
Pulp		
1. Imported Pulp	554.983	2,915,383,374.734
2. Local Pulp	3,942.852	11,375,649,420
Chemical		
Alum	101.173	182,111,400
Resin	47.484	512,590,440
NaOH	1.167	4,583,976
Retention chemical		
Chemical for increase wet strength		
Talc		
Fluorescent		
H_2SO_4	0.157	306,464
TiO_2		
Colors	0.586	87,900,000
Energy and water		
Water, m^3	336,333	251,577,084
Fuel Oil, liter	1,075,423	1,664,754,804
Energy, kWh	3,616,154	2,685,767,415
Total		19,680,624,378

3. Industrial Wastewater Treatment and Discharge

The Company has a wastewater treatment facility and 4,449 t/year of wastewater is discharged from the factory. The results of wastewater analysis are shown in Table 5.

Table 5 Results of Wastewater Sample Analysis

29 November 1999

Sampling No	Unit	1	3	5	6	7	8	9	10
Temp	℃	32.5	35.1	34.9	29.5	35.1	35.6	30.8	29.3
PH		4.65	4.45	5.06	7.78	6.94	5.98	6.53	7.36
Elec. Conductivity	μS/cm	201	375	382	195	394	328	179	60
Turbidity	NTU	53	249	799	10	11	999	44	7
Oil content	mg/l				Not detect.	12.8	24.4	10.7	5.19
BOD	mg/l				6	189	920	141	4
COD	mg/l	400	360	1,920	12	400	2,080	360	11
DO	mg/l	4.93	4.72	4.44	3.6	1.52	4.32	3.88	3.5
VSS	mg/l	318	272	1,210	7	7	1,575	67	44
TSS	mg/l	344	455	1,322	7	7	2,320	105	60
Total nitrogen	mg/l								
Residual Chlorine	mg/l				Not detect.	not detect.	not detect.	not detect.	not detect.
SO_4^{2-}	mg/l	101	233	185	17	139	142	46	5
S^{2-}	mg/l							0.021	0.016
Cyanogen	mg/l				Not detect.	0.02	0.04	0.02	0.01
Phenol	mg/l				0.004	0.016	0.004	<0.001	0.016
Na	mg/l								
$CaCO_3$	mgeq/l	32	19	48	24	39	50	40	20
Cu	mg/l								
Pb	mg/l							0.008	0.043
Cd	mg/l							0.001	0.001
Hg	mg/l							not detect.	0.65
Cr(VI)	mg/l							0.02	not detect.
Zn	mg/l							0.23	0.19
Salt	%	0	0.01	0.01	0	0.01	0.01	0	0

4. Financial Status

5. Proposed Countermeasures

① It is necessary to prevent sticky compounds from attaching on the surface of the dryer. If this is not done, it causes the paper to break.

② It is necessary to adjust the angle of the “doctor” and maintain it at about 30 degrees.

③ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be used. Also to cut-back on the consumption of water, fiber should be recovered from each paper machines and the sticky compounds should be removed. In order to collect fiber a concrete settler should be installed, and also clean water should be re-collected.

④ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑤ Since raw material is changed to imported pulp from domestic one, it is recommended to study in the future the location of factory to close to a sea-port instead of inland.

Case Study P-13

Vien Dong Paper Company

Survey Date：2 December 1999

1. General

1.1 Company Profile

Vien Dong Paper Company, established in 1960, is a state owned company. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name	Vien dong Paper Company
Ownership	State Owned
Address	129 Au Co Street, ward 13, Tan Binh district, HCMC
Phone	Tel: (848) 8496056／Fax: (848) 8425880
Established	1960
Number of Employees	145 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

Table 2 shows production and sales of the company in 1998. The total production capacity is 1,237 tons per year and equipment used in the factory is made in Taiwan and China.

Table 2 Production and Sales in 1998

Products	Production (t)	Sales 1998 (VND)
Unbleached banknote pulp	94.619	
Bleached banknote pulp	270.411	
Bleached practice test book pulp	116.366	
Total	481.396	
White toilet paper	343.869	
Woman band, white facial paper	57.809	
Colored toilet paper	352.550	
Woman band, colored facial paper	2.016	
Total	**756.244**	**12,042,797,414**

2. Production Technology

2.1 Process

The process flow of this factory is shown in Figure 1.

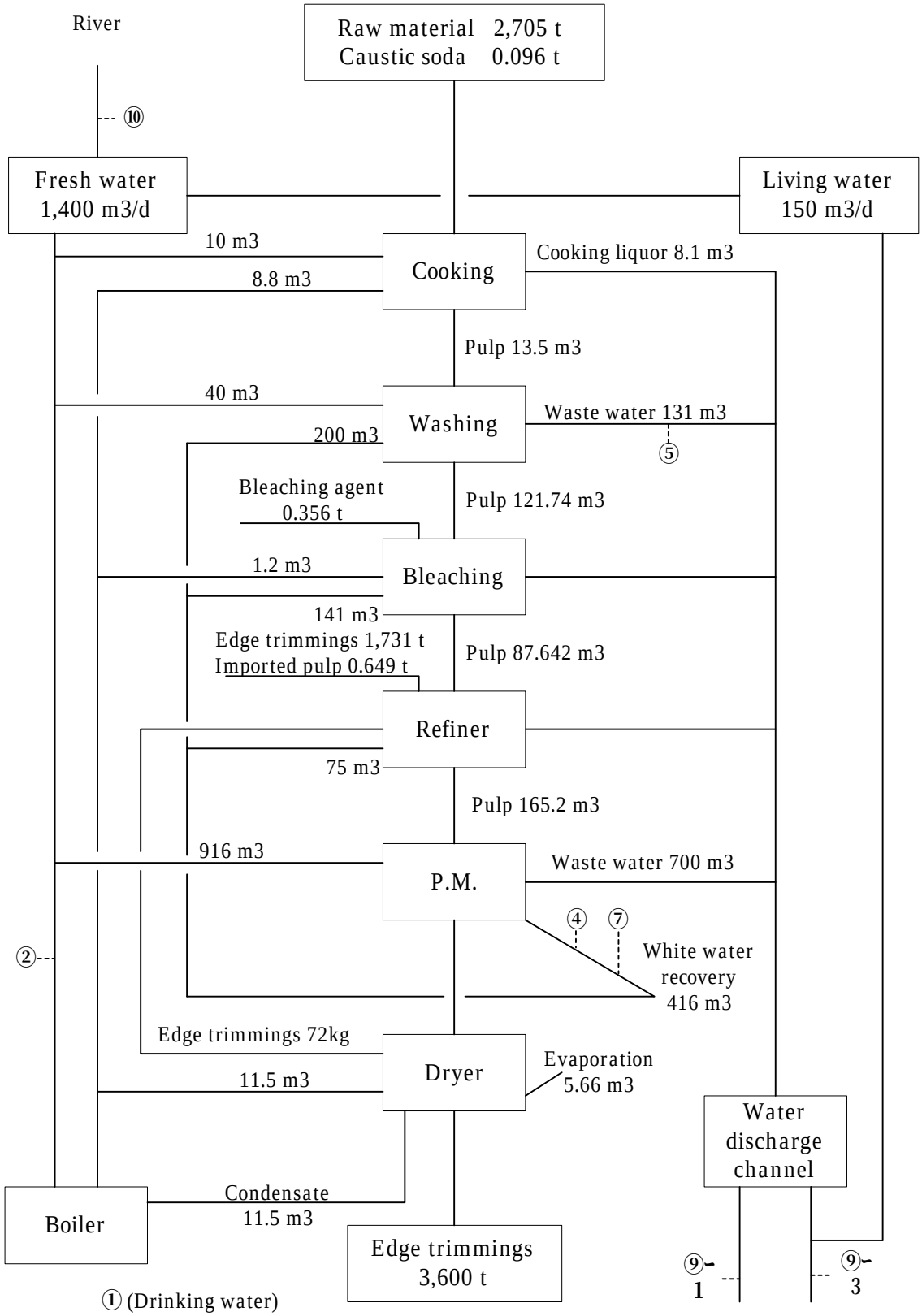

Figure 1 Process Flow of the Factory

2.2 Unit Consumption

Unit consumption of raw materials and utilities is shown in Table 3.

Table 3(1) Unit Consumption of Raw Materials and Utilities (1)

Production t	Material used	Consumption		Unit price VND	Expenses VND
		Unit	Product		
I Unbleached banknote pulp					
96.616	Banknote paper	kg	125,291	1,160	145,337,560
	Soda	kg	4,587	2,000	9,174,000
	Fuel oil	liter	29,358	1,620	47,559,960
	Energy	kWh	46,082	845	38,939,290
				Total	**241,010,810**
II. Bleached banknote pulp					
270.411	Banknote paper	kg	375,958	1,160	436,111,280
	Soda	kg	14,353	2,000	28,706,000
	Silicate	kg	18,388	1,100	20,226,800
	H_2O_2 (50%)	kg	8,383	5,040	42,250,320
	Fuel oil	litre	97,348	1,620	157,703,760
	Energy	kWh	143,318	845	121,103,710
				Total	**806,101,870**
III Bleached exercise book pulp					
116.366	Book	kg	124,171	3,800	47,849,800
	Silicate	kg	4,993	1,100	5,492,300
	H_2O_2 (50%)	kg	2,211	5,040	11,143,440
	Fuel oil	litre	4,655	1,620	7,541,100
	Energy	kWh	19,666	845	16,617,770
				Total	**512,664,410**
IV White toilet paper **401.678**					
1 White toilet paper					
343.869	Bleached banknote pulp	kg	230,347	2,981	686,664,407
	Imported pulp	kg	43,294	5,600	242,446,400
	Edge trimmings	kg	23,709	4,000	94,836,000
	Bleached practicebook pulp	kg	100,612	4,405	443,195,860
	Tinopal	kg	422.96	145,653	61,605,393
	Color	kg	7.460	61,300	457,298
	Carton paper	kg	39.870	5,624	224,228,880
	Silicate	kg	4,028	1,125	4,531,500
	P.E cover	kg	9,491	23,000	218,293,000
	Fuel oil	litre	197,381	1,620	319,757,220
	Energy	kWh	563,073	845	475,796,685
				Total	**2,771,812,643**

Table 3 (2) Unit Consumption of Raw Materials and Utilities(2)

Production T	Material used	Consumption		Unit price VND	Expenses VND
		Unit	Product		
2 Woman band paper+white facial paper					
57.809	Bleached banknote pulp	kg	40,427	2,981	120,512,887
	Imported pulp	kg	7,525	5,600	42,140,000
	Bleached practicebook pulp	kg	19,467	4,405	85,752,135
	Edges	kg	4,566	4,500	20,547,000
	Tinopal	kg	72.26	145,453	10,510,434
	Pattern paper	kg	3,137	3,600	11,293,200
	Color	kg	1.270	61,300	77,851
	P.E. cover	kg	5,261	12,000	63,132,000
	Fuel oil	litre	37,693	1,620	61,062,660
	Energy	kWh	98,212	845	82,989,140
				Total	**498,017,307**
VI Colored toilet paper **354.566**					
1 Colored toilet paper					
352.550	Unbleached banknote pulp				
	Edge trimmings	kg	84,259	2,494	210,141,946
	Color	kg	327,872	2,935	962,304,320
	Carton paper	kg	60.86	90,328	5,497,362
	P.E. cover	kg	45,875	6,583	301,995,125
	Fuel oil	kg	9,730	23,000	223,790,000
	Energy	litre	201,659	1,620	326,687,580
		kWh	576,725	845	487,332,625
				Total	**2,517,748,958**
2 Color band paper					
2,016	Unbleached banknote pulp				
	Edges	kg	595	2,494	1,483,930
	Color	kg	1781	2,943	5,241,483
	Pattern paper	kg	11.39	90,328	1,028,836
	P.E. cover	kg	103.0	9,612	990,036
	Fuel oil	kg	183	12,000	2,196,000
	Energy	litre	1,237	1,620	2,003,940
		kwh	3,400	845	2,873,000
				Total	**15,817,225**

3. Industrial Wastewater

The factory discharges 1,400 tons of wastewater per day. The analysis results of wastewater samples taken on 2 December 1999 are shown in Table 4.

Table 4 Results of Wastewater Analysis

Sampling No		1	2	4	5	7	9-1	9-3	10
Temperature	℃	29.4	40.2	31.4	30.7	30.1	31	30.4	29.9
PH		7.49	6.46	6.75	6.32	6.55	6.76	6.4	5.45
Electric Conductivity	μS/cm	286	119	403	412	395	524	408	326
Turbidity	NTU	10	10	375	694	392	425	401	10
Oil content	mg/l	not detect	not detect	8	28.6	7.2	8.6	6.8	not detect
BOD	mg/l	0	0				60	72	0
COD	mg/l	0	2	272	503	298	334	392	3
DO	mg/l	5.48	3.42	4.66	3.04	4.64	3.71	4.35	3.16
VSS	mg/l	3	5	208	131	150	348	432	18
TSS	mg/l	7	7	407	208	188	456	500	19
Total nitrogen	mg/l	4.7	68.1				52.5	46.6	12
Residual Chlorine	mg/l	0.3	not detect				not detect	not detect	not detect
SO_4^{2-}	mg/l	10	10	25	24	19	23	20	21
S^{2-}	mg/l	not detect	not detect				0.007	0.005	not detect
Cyanogen	mg/l	0.02	0.01				0.71	0.05	0.02
Phenol	mg/l	0.012	0.005				0.003	0.013	not detect
Na	mg/l								
$CaCO_3$	Mgeq/l	46	2	38	31	6	32	48	3
Cu	mg/l						0.4	0.38	0.02
Pb	mg/l						0.016		0.015
Cd	mg/l						0.001		0.007
Hg	mg/l						trace		trace
Cr(VI)	mg/l						0.13	0.09	0.02
Zn	mg/l								
Salt	%	0.01	0	0.01	0.01	0.01	0.02	0.01	0.01

4. Finance

5. Recommendations

① It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, paper break will occur.

② It is necessary to adjust the angle of the "doctor" and maintain it at about 30 degrees.

③ The level of volatile SS in waste water is too high (432 mg/l) and fiber is missing.

④ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done using warm water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be used. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber, a settler made of concrete should be installed, and also, clean water should be recovered.

⑤ The diameter of the roll of the press should be enlarged to reduce the water content of the paper.

⑥ In order to improve product quality, it is necessary to install 4 more thickeners so that each paper machine can use one independently.

⑦ It is necessary to install small wire cylinders for fiber recovery for each paper machine.

Case Study P-14

Linh Xuan Paper Company

Survey Date：3 December 1999

1. General

1.1 Company Profile

Linh Xuan Paper Company, established in 1972, is a state-owned paper company. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Company Name	Linh Xuan Paper Company
Owned	State-owned
Address	61/6 High Way N0 1, Linh xuan, Thu duc District, HCMC
Tel	Tel:(84) 8966784 / Fax: (84) 8961540
Established	1972
Number of Employees	214 (3 shifts, 330 working days)
Main Products	

1.2 Business Status

Table 2 shows production and sales of the company in 1998.

The total production capacity is 4,275 tons per year with 4 production lines. 60% of the raw material is waste paper from China. The width of the paper is 1.2-1.5 m, and the their machine speed is 50 m/min.

Table 2 Production and Sales (1998)

Product	Production (t)	Sales (VND)
Toilet paper	1,551	
Other grades	234	
Pulp of different kinds	4,755	
Votive paper	2,490	
Total	4,275	29,000,000,000

2. Production Technology

2.1 Process

The process flow of the factory is shown in Figure 1.

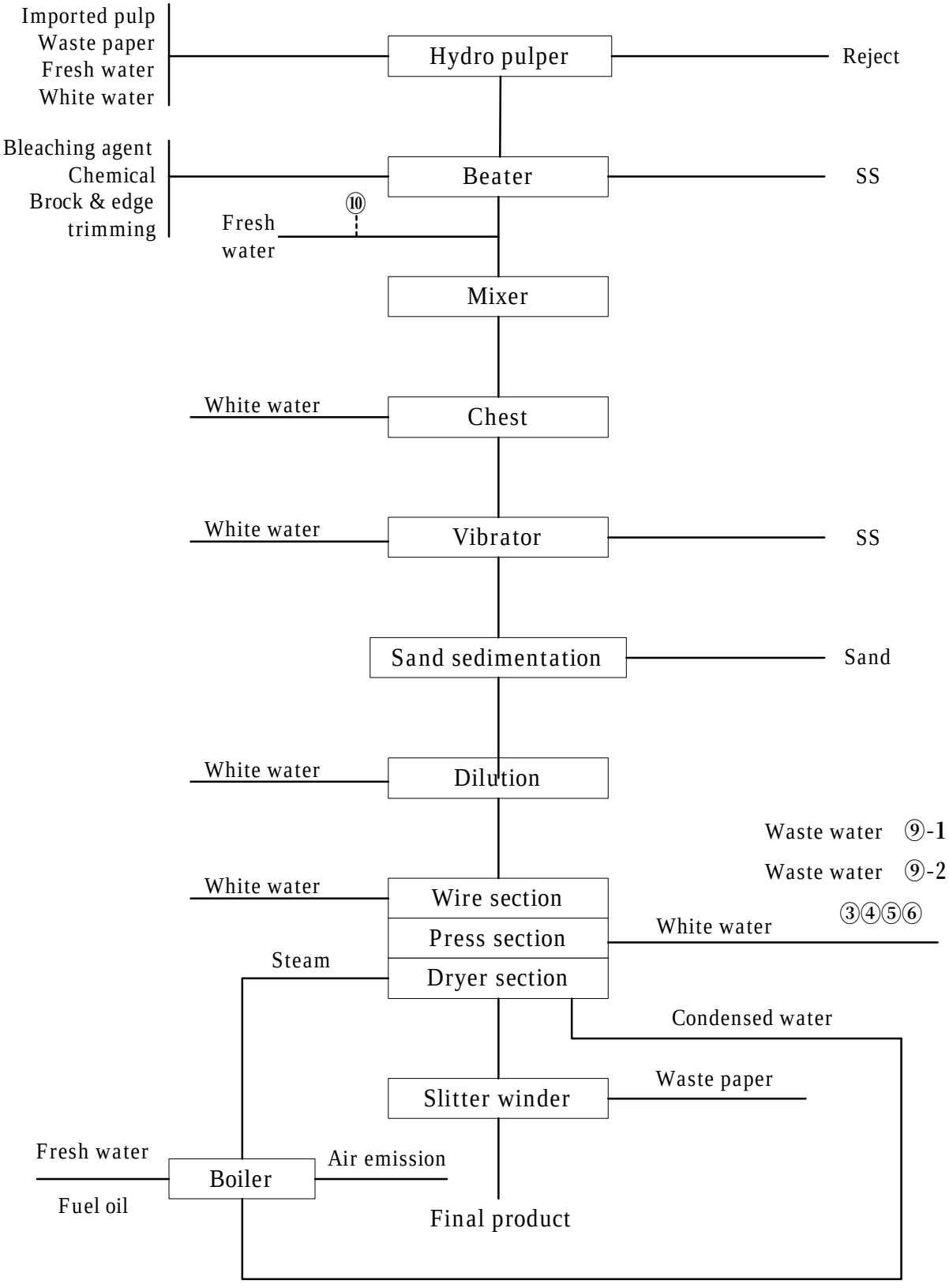

Figure 1 Process Flow of the Factory

2.2 Unit Consumption

The unit consumption of raw materials and utilities are shown in Table 3.

Table 3 Unit Consumption of Raw Materials and Utilities

Material Used	Unit	Quantity	Unit price (VND/t)	Expenses (VND)
Waste paper	kg	1,735.813	5,000,000	8,679,065,000
Imported pulp	kg	311.195	5,500,000	1,711,572,500
OCC	kg	197.149	1,700,000	335,153,300
Waste bamboo	kg	6,067.032	320	1,941,540,000
From chopstick production				
Water	m^3	864,000	1,200	1,036,800,000
Fuel oil	litter	1,661,261	1,550	2,574,954,500
Energy	kWh	5,369,457	850	4,564,038,450

3. Industrial Wastewater Treatment

The factory discharges 864,000 tons of wastewater per year, has an SS treatment system, and a wastewater treatment facility. The results of wastewater analysis are shown in Table 4.

Table 4 Results of Wastewater Analysis

Sampling No		3	4	5	6	9_1	9_2	10	
Sampling Date		10 December 1999							3/12/99
Temp	℃	28.7	28.7	30.4	29.3	29.7	28.7	26.5	26.5
pH		7.7	7.84	7.77	7.27	7.45	7.66	7.01	7.01
Elec. Conductivity	μS/cm	40	301	157	145	269	141	0.37	370
Turbidity	NTU	8	687	999	732	999	642	10	10
Oil content	mg/l					23	3.2		0.2
BOD	mg/l					193	63		5
COD	mg/l	102	1098	675	337	489	259		21
DO	mg/l	5.01	5.69	4.42	4.96	5.01	4.52	5.16	5.16
VSS	mg/l								0.5
TSS	mg/l					3213	350	1	1
Total nitrogen	mg/l					30.6	27.3	8	8
Residual Chlorine	mg/l					*A	*A	*A	*A
SO_4^{2-}	mg/l	10	12	12	10	10	8	7	7
S^{2-}	mg/l								0.002
Cyanogen	mg/l					0.28	0.02	*A	*A
Phenol	mg/l	0.001	0.001	*A	*A	0.005	*A	0.005	0.005
Na	mg/l					289	312	197	197
$CaCO_3$	mgeq/l	5	134	76	70	112	44	5	5
Cu	mg/l							0.62	0.62
Pb	mg/l							*A	*A
Cd	mg/l							trace	trace
Hg	mg/l							*A	*A
Cr(VI)	mg/l							*A	*A
Zn	mg/l							2.2	22
Salt	%	0	0.01	0	0	0.01	0	0	0

Note :*A : not detected

4. Finance

5. Recommendations

① It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, paper break will occur.

② It is necessary to adjust the angle of the "doctor" and maintain it at about 30^0.

③ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done using warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be installed. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber, a settler made of concrete should be installed, and also, clean water should be recovered.

④ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑤ Linh xuan is utilizing Johnson hole vibrators at present, but it is recommended that they replace those with slit type ones for reducing fiber consumption and improving product quality.

Case Study P-15

Hanh Linh Paper LTD. Company

Survey Date：6 December 1999

1. General

1.1 Company Profile

Hanh Linh Paper LTD. Company, established in 1994, is a private paper producing company. The Company Profile is shown in Table 1.

Table 1 Company Profile

Company name	Hanh linh Paper LTD. Company
Owner	Private
Address	Zone N0 9 - Dong hoa, Di an, Binh Duong Province
Phen#	Tel: 065851826 ／ Fax: 065850713
Established	1994
Number of Employees	176 (3 shifts, 300 working days)
Main Products	

1.2 Business Status

Table 2 shows production and sales of the company in 1998.

Production capacity is 2,000 ton per year with 6 production lines.

Table 2 Production and Sales in1998

Product	Production	Sales
Votive paper	2,000 t/y	90,000 US$

2. Production Technology

2.1 Process

The process flow of the factory is shown in Figure 1.

2.2 Unit Consumption

Unit consumption of raw materials and utilities are shown in Table 3.

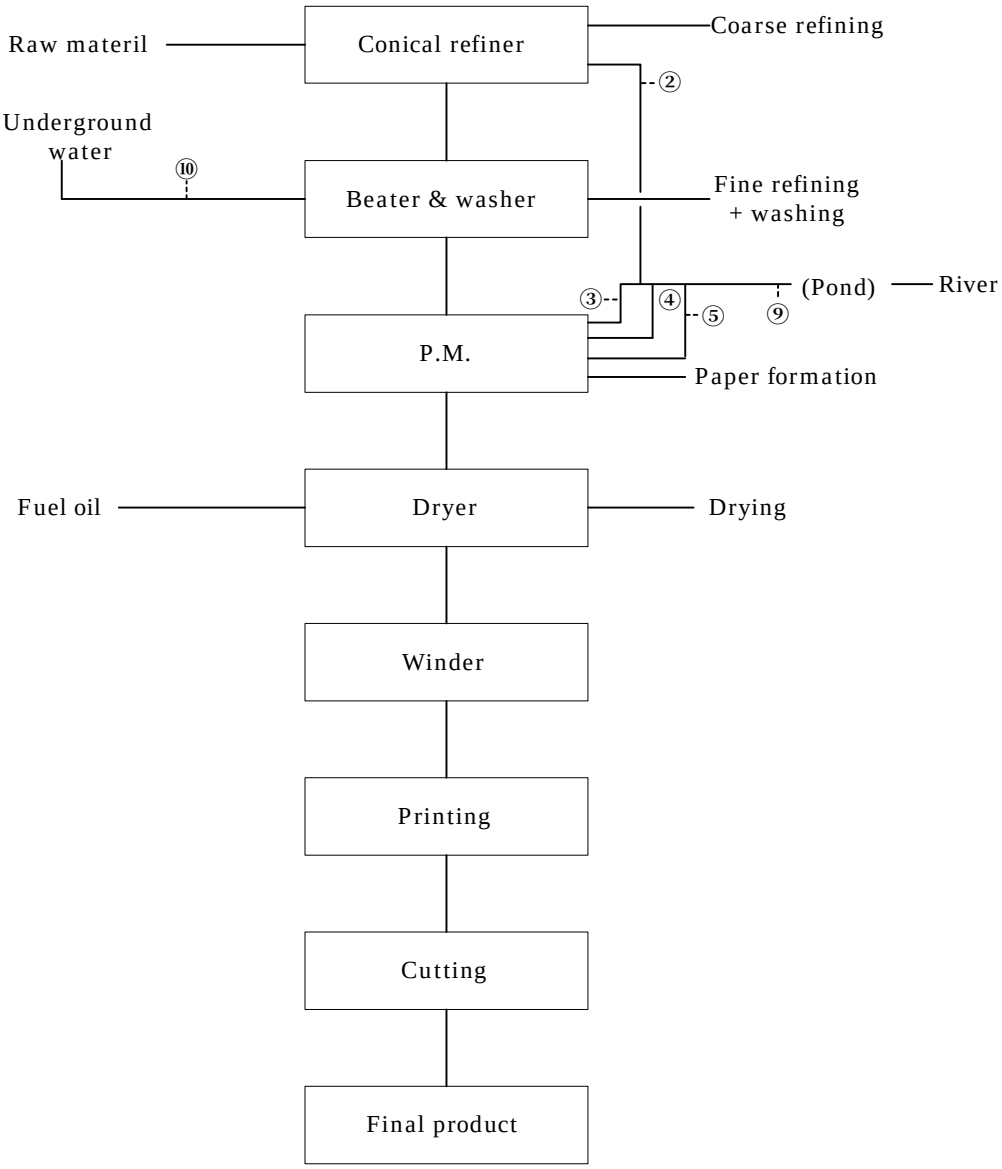

Figure 1 Process Flow

Table 3 Unit Comsumption of Raw Materials and Utilities

Material used	Unit	Quantity	Unit Price (VND)	Expenses(VND)
Bamboo pulp	t	2,400	2,000,000	4,800,000,000
Water	m^3	40,000	1,000	40,000,000
Fuel oil	litter	700,000	1,720	1,204,000,000
Energy	kWh	1,120,000	770	862,400
TOTAL				**6,906,400,000**

3. Industrial Wastewater Treatment

This factory discharges 500 tons of wastewater per day, has SS treatment equipment and a wastewater treatment facility. Wastewater is discharged to a river after going through this treatment system. The results of wastewater analysis are shown in Table 4.

Table 4 Results of Wastewater Analysis

Sampling No		1	2	3	4	5	9	10
Temp	℃	29.7	31.2	30.9	30.2	29.8	30.2	29.7
PH		4.7	9.3	10.29	7.6	10.21	10.17	4.88
Elec. Conductivity	μS/cm	670	1700	2750	693	950	1740	70
Turbidity	NTU	10	555	788	253	245	193	10
Oil content	mg/l	*A					3.8	*A
BOD	mg/l	2					910	1
COD	mg/l	11	4645	1301	1425	2555	2230	5
DO	mg/l	3.9	5.49	4.85	6.12	4.4	4.11	3.65
VSS	mg/l	3	46	178	225	197	84	0
TSS	mg/l	7					250	1
Total Nitrogen	mg/l	1.2					34	0.1
Residual Chlorine	mg/l	*A					1.2	*A
SO_4^{2-}	mg/l	5	37	42	20	25	24	5
S^{2-}	mg/l	0.001					0.375	*A
Cyanogen	mg/l	0.02					0.03	*A
Phenol	mg/l	*A					0.025	0.001
Na	mg/l	117.8	202	386.1	406.1	317.2	287	207.6
$CaCO_3$	mgeq/l	2	30	5	40	20	18	1
Cu	mg/l	0.09					0.97	0.05
Pb	mg/l	trace					trace	trace
Cd	mg/l	0.005					0.007	0.003
Hg	mg/l	trace					trace	trace
Cr(VI)	mg/l	trace					0.02	*A
Zn	mg/l							
Salt	%	0	0.07	0.13	0.02	0.04	0.08	0

Note :*A : not detected

Sampling date : 6/12/99

4. Finance

5. Recommendations

① It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, the paper break will occur.

② It is necessary to adjust the angle of the "doctor" and maintain it at about 30^0.

③ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done using warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be installed. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber, a settler made of concrete should be installed, and also, clean water should be recovered.

④ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

Case Study P-16

Hoa Phuong Industrial-Construction and Trading Ltd Company

Survey Date：7 December 1999

1. General

1.1 Company Profile

Hoa Phuong Industrial-Construction and Trading Ltd. Company, established in 1997, is a private company. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Company Name	Hoa Phuong Industrial-Construction and Trading Ltd Company
Ownership	Private
Address	19/2 Binh Dang, Binh Hoa, Thuan An, Binh Duong Province
Tel / Fax	Tel: 0650 743158 ／ Fax: 0650 743158
Established	1997
Number of Employees	28 (3 shifts, 300 working days)
Main products	

1.2 Business Status

Table 2 shows production and sales of the company in 1998. Production capacity is 2,000 ton per year using 2 production lines.

Table 2 Production and Sales in 1998

Product	Production (t)	Sales (million VND)
Corrugated carton paper (reel)	865/2000 (9months/12months)	2,795

2. Production Technology

2.1 Process

Figure 1 shows the process flow of the factory.

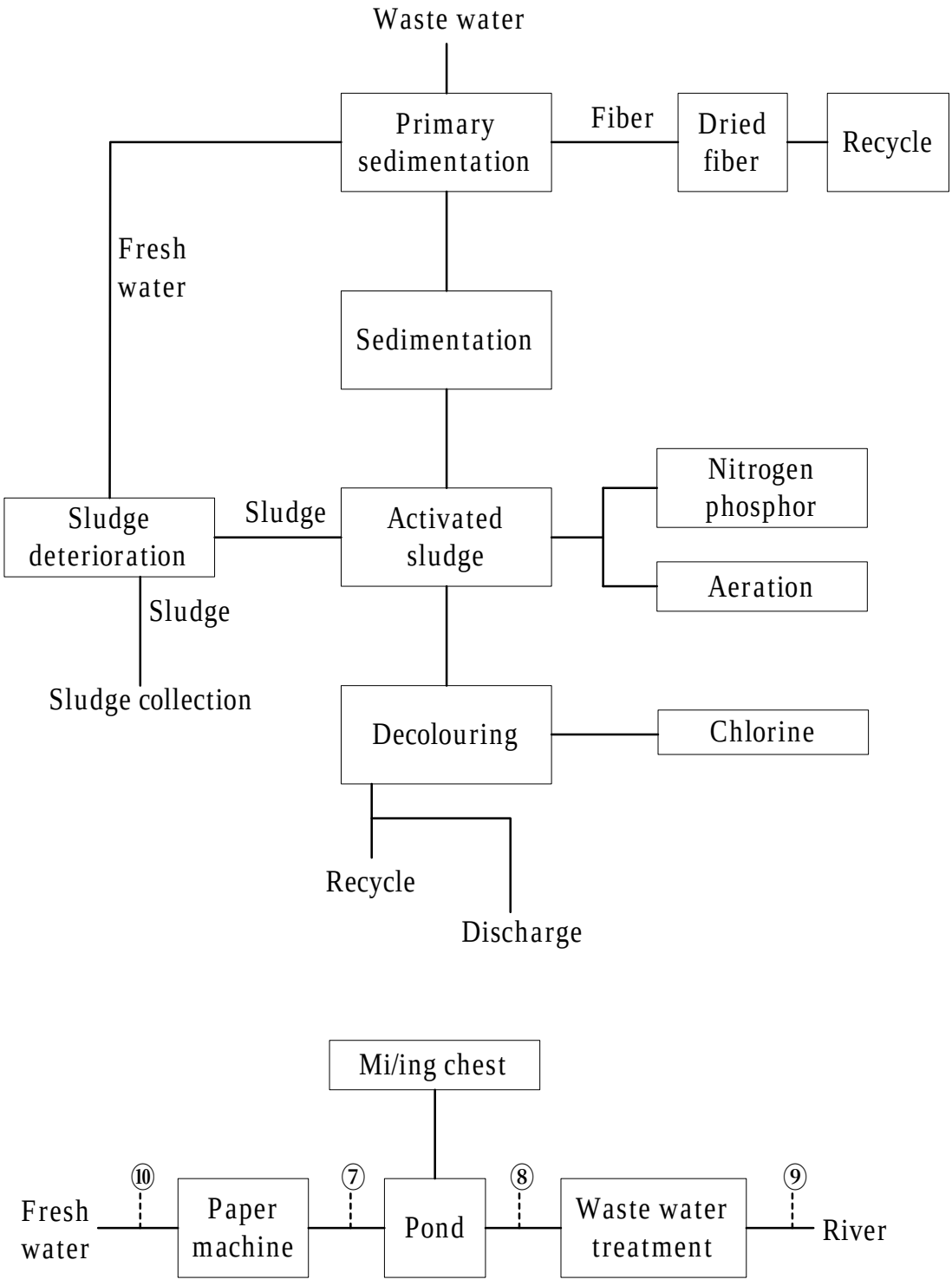

Figure 1 Process Flow of the Factory

2.2 Unit Consumption

The unit consumption of raw materials and utilities is shown in Table 3.

Table 3 Unit Consumption of Raw Materials and Utilities

Material used	Unit	Quantity	Expenses (million VND)
OCC	t	1,202	1,894
Auxiliary			15
Fuel oil	Liter	166,746	265
Energy	KWh	359	313
Total			2,487

3. Wastewater Treatment

The factory utilizes 85 tons of water per day, and discharges 34 tons of wastewater per day. Although the factory has a biological wastewater treatment system, the system removes only SS, and the concentration of COD discharged is 1,200-2,882 mg/l, which is considered very high. The results of wastewater analysis are shown in Table 4.

4. Financial Condition

5. Recommendations

① It is better to install a de-inking apparatus and use floataters, screens, and cleaners on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent the product quality deterioration and paper break.

② It is necessary to prevent sticky compounds from attaching on the surface of the dryer. Otherwise, it causes the paper to break.

③ It is necessary to adjust the angle of the "doctor" and maintain it at about 30^0.

④ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done using warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be installed. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber a settler made of concrete should be

installed, and also clean water should be recovered.

⑤ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑥ Because the raw material will be changed to imported pulp from domestic type, it is necessary in the future to study re-locating the factory closer to a sea-port.

⑦ Since the wastewater contains Mercury, caustic soda should be checked and another supplier should be selected.

⑧ It is more economical to recover fiber in the process than to recover from the pond as fuel for bricks.

Table 4 Results of Wastewater Analysis

7 December 1999

Sampling No	Unit	7	8	9	10
Temp	℃	31	31.3	29.8	29.8
pH		6.82	7.03	7.75	4.42
Electric Conductivity	μS/cm	1490	1530	1300	72
Turbidity	NTU	999	999	10	10
Oil content	mg/l		57	3	Not detected
BOD	mg/l		1215	10	0
COD	mg/l	1792	2635	61	0.8
DO	mg/l	3.25	3.15	1.52	4.63
VSS	mg/l	364	315.4	7.1	1.6
TSS	mg/l		1055	13	6
Total Nitrogen	mg/l		58.2	1.8	0.27
Residual Chlorine	mg/l		not detected	not detected	not detected
SO_4^{2-}	mg/l		265	285	7
S^{2-}	mg/l	2.08			
Cyanogen	mg/l		0.03	0.02	not detected
Phenol	mg/l		0.009	not detected	not detected
Na	mg/l		325	299	136.2
$CaCO_3$	mgeq/l	630	620	324	2
Cu	mg/l		1.97	1.54	0.03
Pb	mg/l		0.045	0.042	0.042
Cd	mg/l		0.005	0.01	0.011
Hg	*m* g/l		0.67	0.88	0.43
Cr(VI)	mg/l		0.09	0.08	not detec.
Zn	mg/l				
Salt	%	0.06	0.07	0.06	0

CASE STUDY P－17

Mai lan Paper Enterprise

Survey date: 9 December 1999

1. General

1.1 Company Profile

Mai Lan Paper Enterprise, established in 1969, is a state owned company. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Name of the Company	Mai lan Paper Enterprise
Address	129 Au co Street, Tan binh District, HCMC
Tel	8495453
Fax	8425594
Establishment	1969
Number of employees	190 (3shifts, 312days operation／Y)
Owneship	State-owned

1.2 Business Status

Table 2 shows production and sales of this company. Production capacity of the factory is 3.8 tons per day, and their main products are toilet paper and napkins.

Table 2 Production and Sales in 1998

Product	Production (T)	Sales (mill. DVN)
Various kinds of toilet paper	1,194	16,479

2. Production Technology

2.1 Process

The process flow chart of this factory is shown in Figure 1.

2.2 Unit Consumption of Raw Materials and Utilities

Table 3 shows unit consumption of raw materials and utilities of this factory.

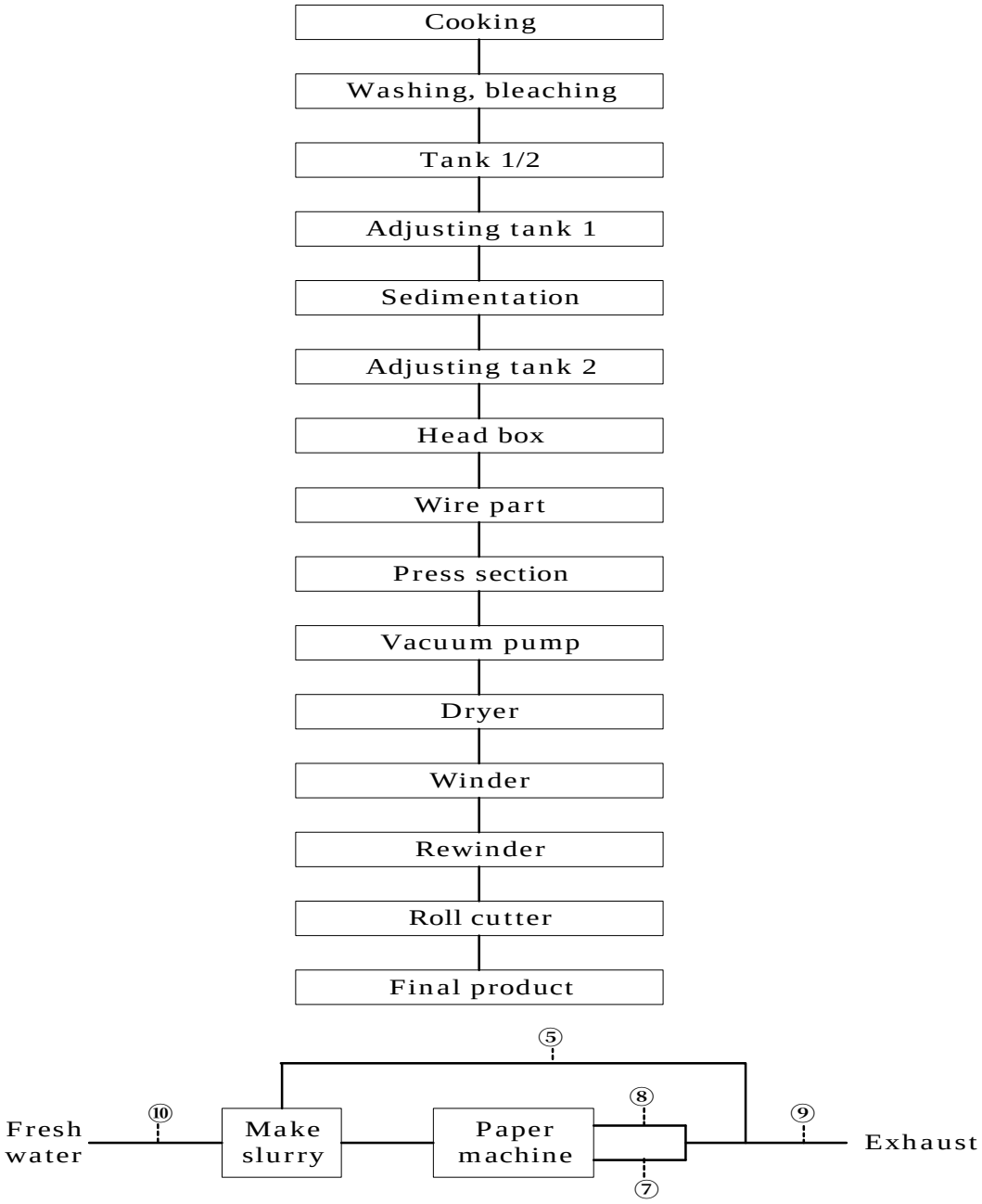

Figure 1 Process Flow Chart

Table 3 Unit Consumption of Raw Materials and Utilities

Material used	Unit	Quantity	Unit price (VDN)	Expenses (VDN)
Waste cotton	t	296.43	3,170,000	939,683,100
Waste paper	t	1,782.47	3,488,000	6,217,255,360
Imported pulp	t	86.234	5,374,000	463,421,516
Water	m^3	655,200		
Fuel oil	litter	728,787	1,550	1,129,619,850
Energy	kWh	3,010,800	830	2,498,964,000
				11,248,943,826

3. Wastewater Treatment

The factory utilizes 2,100 tons of water per day. The result of wastewater analysis are shown in Table 4.

Table 4 Results of Wastewater Analysis

Sampling No	Unit	5	7	8	9	10
Temperature	℃	35	29.6	30.2	31.9	29.2
pH		9.85	6.28	7.04	9.11	5.77
Elec. Conductivity	µs/cm	631	149	162	254	145
Turbidity	NTU	999	162	999	611	10
Oil content	mg/l					not detec.
BOD	mg/l				57	0
COD	mg/l	3796	180	722	71	0
DO	mg/l	11.93	4.89	5.21	8.02	1.8
VSS	mg/l	618	50.2	114	356	1.8
TSS	mg/l				424	9
Total Nitrogen	mg/l					1.44
Residual Chlorine	mg/l				notdetected	notdetected
SO_4^{2-}	mg/l	18	8	8	11	7
S^{2-}	mg/l					
Cyanogen	mg/l				0.02	0.14
Phenol	mg/l				0.022	0.004
Na	mg/l	498.1	346	307.3	350	322
$CaCO_3$	mgeq/l	17	57	29	59	3
Cu	mg/l				1.85	0.05
Pb	mg/l				0.025	0.024
Cd	mg/l				0.003	0.009
Hg	mg/l				trace	trace
Cr(VI)	mg/l				0.088	not detec.
Zn	mg/l					
Salt	%	0.03	0	0	0	0

Note:Sampling date : 9/12/99

4. Finance

5.Recommendations

① It is better to install a de-inking apparatus and use a “flotater”, screen, and cleaner on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent quality loss and paper break.

② It is necessary to prevent sticky compounds from attaching on the surface of the dryer. If this is not done, it causes the paper break will occur.

③ It is necessary to adjust the angle of the "doctor" and maintain it at about 30^0.

④ The level of burning SS in the waste water is too high of 356 mg/l and fiber is missing.

⑤ Sticky compounds should be washed off from wire and rolls etc. using high-pressure water. Washing should be done with hot water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be used. Also, to cutback on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to collect fiber, a concrete settler should be installed, and also clean water should be re-collected.

⑥ It is more economical to recover fiber in the process than to collect it from the pond and use it as fuel for bricks.

⑦ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑧ Raw material will be changed to imported pulp from domestic pulp, so in the future it is better to re-locate the factory closer to a seaport.

⑨ It is better to install one more stage of centric cleaning. The pressure of the wire cleaning water should be increased.

⑩ In order to solve the streaking problems on the paper sheet, the wire joint must be welded and the sewing operation that is being used now should be eliminated.

CASE STUDY P-18

Xuan duc Company

Survey date : 10 December 1999

1. General

1.1 Company Profile

The Xuan Duc Company, established in 1975, is a state owned paper company. The company profile is shown in Table 1.

Table 1 Enterprise Profile

Name of the Company	Xuan duc
Ownership	State-owned
Establishment	1975
Number of employees	191 (3shifts 350days／Y)
Main Product	

1.2 Business Status

Production capacity of this company is 14.5 t/day, using 4 production lines.

2. Production Technology

2.1 Process

The block flow diagram of the factory, including wastewater flow, is shown in Figure 1.

3. Industrial Wastewater

The factory uses 2,400 tons per day of water and discharges 50 ton per hour of wastewater. The results of wastewater analysis are shown in Table 2.

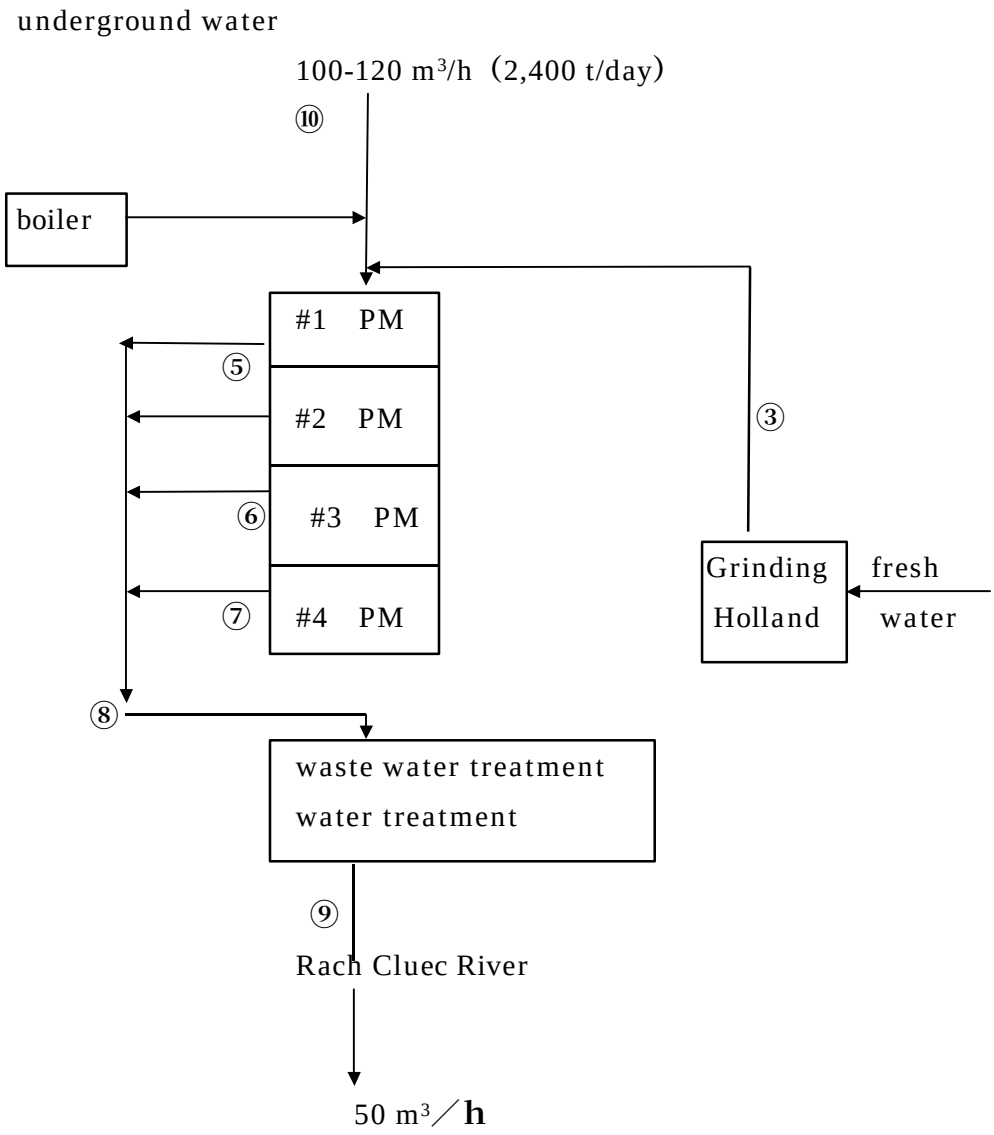

Figure 1 Process Flow

Table 2 Results of Wastewater Analysis

Sampling No		3	5	6	7	8	9	10
Temp	℃	30.5	29.9	30.1	28.6	29.4	29.7	28.5
PH		7.65	7.25	7.14	7.33	7.27	7.22	5.91
Elec. Conductivity	μS/cm	334	435	488	266	265	276	37
Turbidity	NTU	999	454	533	450	460	222	10
Oil content	mg/l						9.4	not detected
BOD	mg/l						121	0
COD	mg/l	1380	329	278	570	298	345	2
DO	mg/l	4.73	4.63	4.84	4.97	4.43	2.85	4.38
VSS	mg/l	217	312	356	324	341	26	0
TSS	mg/l						127	0
Total Nitrogen	mg/l						12.4	0.21
Residual Chlorine	mg/l						not detected	not detected
SO_4^{2-}	mg/l	50	132	18	60	40	44	10
S^{2-}	mg/l							
Cyanogen	mg/l						0.05	0.03
Phenol	mg/l						0.003	not detected
Na	mg/l						289	236
$CaCO_3$	mgeq/l	100	112	88	30	80	6	130
Cu	mg/l						0.84	0.07
Pb	mg/l						trace	trace
Cd	mg/l						trace	trace
Hg	*m*g/l						trace	trace
Cr(VI)	mg/l						0.03	not detected
Zn	mg/l							
Salt	%	0.01	0.01	0	0.01	0.01	0.01	0

Note：Sampling date : 10/12/99

4. Recommendations

There are problems with the treatment of SS, so it may be better for the company to adopt a high pressure floating method.

CASE STUDY P-19

Viet Dai Private Enterprise

Survey date : 11 December 1999

1. General

1.1 Company Profile

The Viet Dai Private Enterprise was established in 1996, and is one of the private enterprises surveyed for this study.

The Company profile is shown in Table 1.

Table 1 Enterprise Profile

Name of the Company	Viet dai Private Enterprise
Ownership	private-owned
Address	Loc tien, Bao loc, Lam dong
Tel	063.862390
Fax	063.860267
Establishment	1996
Number of employees	120(3shifts, 300 days operation/y)

1.2 Business Status

Table 2 shows production and sales of this company in 1998.

Production capacity is 1,750 tonn a year.

Table 2 Production Capacity (1998)

Product	Production(T)	Sales (mill. VND)
Votive paper	1,750	7,527

2. Production Technology

2.1 Process

A block flow diagram of the factory is shown in Figure 1.

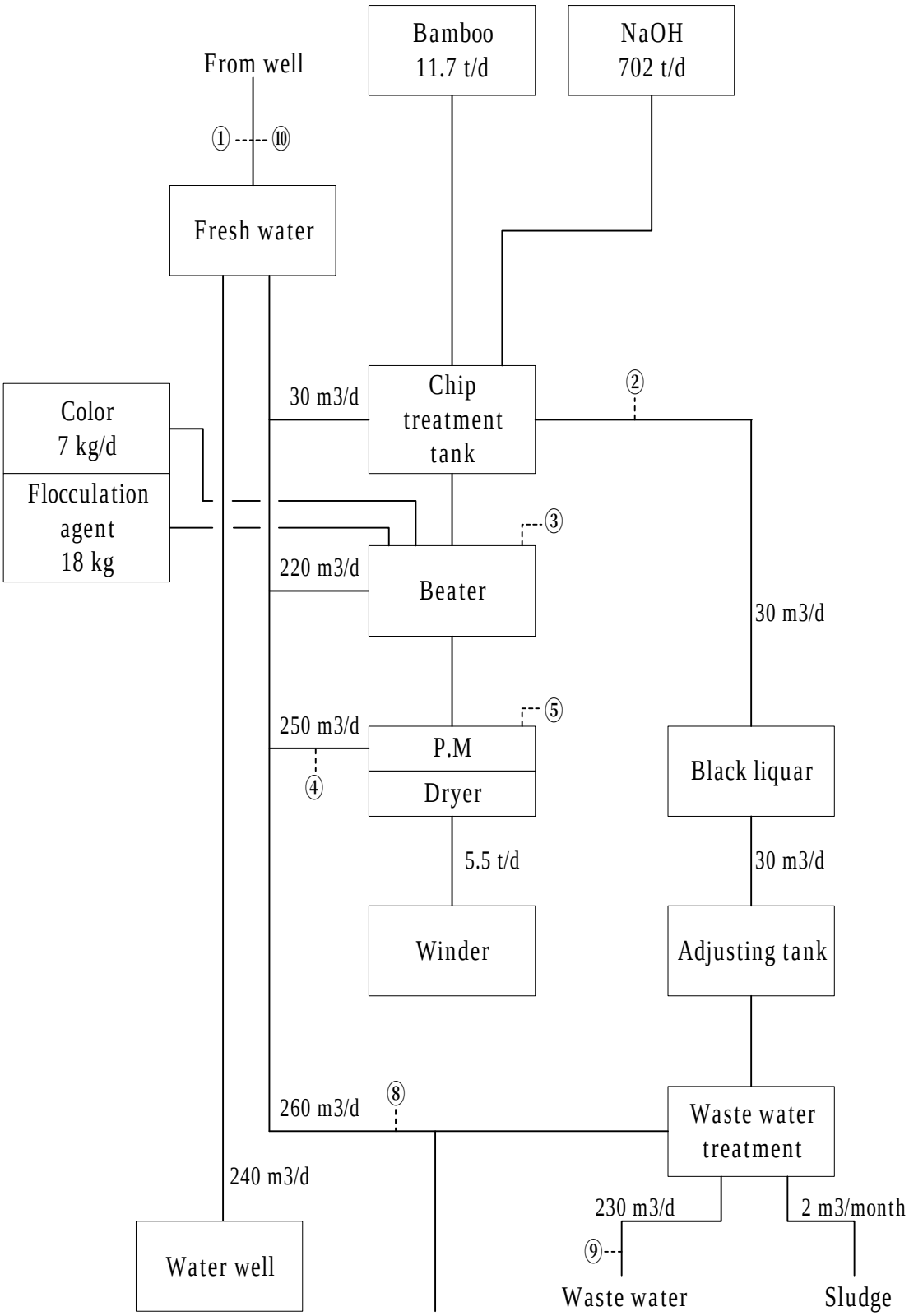

Figure 1 Block Flow Diagram

2.2 Unit Consumption

Unit consumption of raw materials and utilities are shown in Table 3.

Table 3 Unit Consumption of Raw Materials and Utilities

Material used	Consumption		Expenses	Total quantity
I. Semi finished products				
1.bamboo	2.1	t	300,000 VND/t	3,675 t
2.Caustic soda	0.126	t	3,900,000 VND/t	220.5 t
3.Water	90.9	m^3	2,000 VND/m^3	159,075 m^3
4.Fuel oil	445	l	1,800 VND/l	718,750 l
5.Energy	757	kWh	810 VND/kWh	1,324,750 kWh
II. Finished products				
1.Reel paper	1.0	t	3,200,000 VND/t	1,750 t
2.Methanol	22.2	kg	5,600 VND/kg	38,850 kg
3.Acetate	7.4	kg	13,000 VND/kg	12,950 kg
4.Polivinyl	8.8	kg	15,600 VND/kg	15,400 kg
5.Printing color	1.4	kg	60,000 VND/kg	2,450 kg
6.Soft silver	2.2	kg	70,000 VND/kg	3,850 kg

3. Industrial Wastewater Treatment

The factory uses 240 tons of water per day, and has a biological wastewater treatment system of a 240 t/day capacity. The results of wastewater analysis are shown in Table 4.

4. Finance

Table 4 Result of Wastewater Analysis

Sampling date : 11 December 1999

Sampling No		2	3	4	5	6	7	8	9	10
Temperature	℃	19.6	22.7	22.5	23	23.8	22.8	23.2	22.1	21.5
pH		9.14	7.75	7.66	9.23	9	8.74	7.2	7.78	6.5
Elec. Conductivity	MS/cm									
Turbidity	NTU	12250	1180	1170	2180	1830	1920	1970	1990	
Oil content	mg/l								23	*A
BOD	mg/l					429	498	49	89	0
COD	mg/l	14464	461	477	2098	1621	1971	938	922	0
DO	mg/l	0.65	3.45	3.53	6.21	4.9	0.29	1.32	0.49	6.03
VSS	mg/l	96.4	19.2	27	327.5	198.4	252.1	157.3	14.4	3.17
TSS	mg/l	210	24	94	426	180	300	173	98	8
Total Nitrogen	mg/l								21.4	0.04
Residual Chlorine	mg/l								0.02	*A.
SO_4^{2-}	mg/l	28.6	108.4	120.6	358	342.4	251.8	427	418.2	12.2
S^{2-}	mg/l									
Cyanogen	mg/l								0.18	0.07
Phenol	mg/l								0.047	*A
Na	mg/l	623.5	532.7	361	243	293	248	443	386	184.3
$CaCO_3$	mgeq/l	80	40	15	63	20	24	25	24	58
Cu	mg/l								1.58	0.09
Pb	mg/l								trace	trace
Cd	mg/l								trace	trace
Hg	mg/l								trace	trace
Cr(VI)	mg/l								0.107	0.02
Zn	mg/l									
Salt	%									

Note :*A : not detected

5. Recommendations

① It is necessary to spray caustic soda all the way to the portion of chips accumulated at the edge of the pit. This is because if caustic soda is sprayed only to the center of the pit, chips in the center will over-dissolve and chips on the edge will remain undissolved. It is better to use a PVC piping system for spraying equally.

② The size of the chips should be less than that of a pack of cigarettes, and be arranged in the same size.

③ It is necessary to prevent sticky compounds from attaching on the surface of the dryer. If this is not done, paper break will occur.

④ It is necessary to adjust the angle of the "doctor" and maintain it at about 30 degrees.

⑤ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with warm water. In order to conserve warm water, it is recommended that a vibration apparatus for showering be used. Also to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to recover fiber, a settler made of concrete should be installed, and also clean water should be recovered.

⑥ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑦ The wire of the cylinder is scarred and must be repaired by welding.

⑧ It is necessary to equip a digester (may be purchased from a HCMC mill) and a black liquor recovery system for the reduction of caustic soda consumption.

⑨ It is suggested that the doctor blade be installed on the opposite side of its present location to prevent fiber from dropping on to paper sheets.

CASE STUDY P-20

Thanh long Paper Factory

Survey date : 15 December 1999

1. General

1.1 Company Profile

Thanh Long Paper Factory, established in 1996, is private paper company.

Table 1 shows the company profile.

Table 1 Company Profile

Name of the Company	Thanh long Paper Factory
Ownership	Local state government
Address	Thanh long, Hien Nam, Hung yen Province
Establishment	1971
Number of employees	120 (3 shifts, 300 days operation/y)

1.2 Business Status

Table 2 shows production and sales of this company in 1971.

Production capacity of this company for Kraft pulp is 1800 ton/year.

Table 2 Production and Sales in 1998

PRODUCTS	PRODUCTION (ton/year)	SALES (VND)
Kraft Paper	1,800	3,200,000VND/T

2. Production Technology

2.1 Process

Figure 1 shows the process flow of this factory.

2.2 Unit consumption

The unit consumption of raw material and utilities are shown in Table 3.

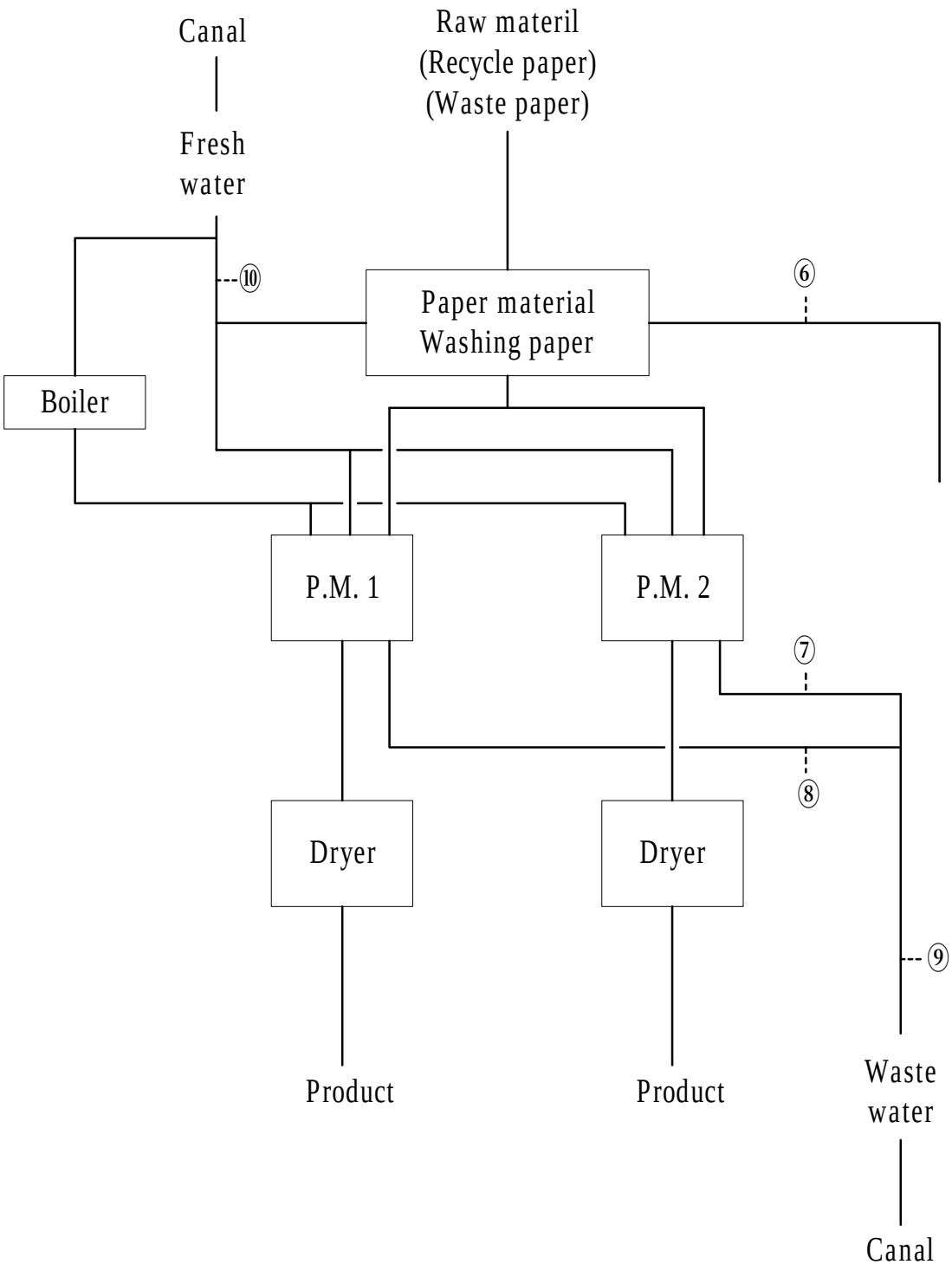

Figure 1 Block Flow Diagram of the Factory

Table 3 Unit Consumption of Raw Materials and Utility

MATERIAL USED	QUANTITY (ton/year)	EXPENSES (VND)
Paper Products:	1,800 t/year	5,000,000 VND/t
1. Recycle paper	2,250 t/year	1,400,000 VND/t
2. River Water	110,000 m^3/year	850 VND/m^3
3. Electric power (kWh)	1,680,000 kWh	770 VND/kWh
4. Coal	1,500 t/year	300,000 VND/t
5. NaOH	3 t/year	4,000,000 VND/t
Total		

3. Industrial Wastewater Treatment

Table 4 shows the results of wastewater sample analysis.

4. Finance

Investment: government

The company currently has no bank loans.

5. Recommendation

① A de-inking apparatus should be installed and a flotater, screen, and cleaner should be used on this apparatus to eliminate ink and sticky compounds. Through the use of this method it will be possible to prevent product quality deterioration and paper break.

② It is necessary to prevent sticky compounds from attaching on the surface of the dryer. If this is not done, paper break will occur.

③ It is necessary to adjust the angle of the "doctor" and maintain it at about 30 degrees.

④ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with hot water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be used. Also, to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to collect fiber, a concrete settler should be installed, and also, clean water should be recovered.

⑤ The diameter of the roll of the press should be enlarged to reduce the content of

water in the paper.

⑥ It is necessary to prevent heavy material and colors from sticking on the paper sheet surfaces. This facility needs a system which can help it pump finer water and reduce deposits. Not only will the process be faster and quicker, but the paper sheet surface will also be smoother. According to the capacity of this factory, it is necessary that each machine have 3 cyclones.

Table 4 Results of Wastewater Analysis

(15 December 1999)

Sampling No	Unit	6	7	8	9	10
Temp	℃	21.4	20.3	20.1	20	19.8
pH		8.44	8.03	7.94	7.94	7.91
Elec. Conductivity	μS/cm	1798.5	2717.3	2645.5	2717	3937
Turbidity	NTU	590	225	174	187	67
Oil content	mg/l				0.02	0.01
BOD	mg/l					26.9
COD	mg/l	13250	8110	7360	8320	81.5
DO	mg/l	5.7	5.14	5.07	4.68	4.92
VSS	mg/l					
TSS	mg/l				204	72
Total Nitrogen	mg/l				10.3	3.9
Residual Chlorine	mg/l				Trace	1.06
SO_4^{2-}	mg/l				261.4	23.4
S^{2-}	mg/l					
Cyanogen	mg/l				0.02	Trace
Phenol	mg/l				0.268	0.036
Na	mg/l	261	238	232	283	210
$CaCO_3$	mg/l	216	110	135	139	84
Cu	mg/l	0.24	0.21	0.17	0.18	0.1
Pb	mg/l				trace	trace
Cd	mg/l				0.002	trace
Hg	mg/l				trace	trace
Cr(VI)	mg/l				0.102	0.07
Zn	mg/l					
Salt	%	0.02	0.01	0.01	0.01	0

CASE STUDY P-21

Muc Son Paper Factory

Survey date: 16 December 1999

1. General

1.1 Enterprise Profile

The Muc Son Paper Factory was, established in 1969, as a state owned paper company. The company profile is shown in Table.1

Table 1 Company Profile

Name of the Company	Muc Son Paper Factory
Ownership	State-owned
Address	Lam son, Tho Xuan, Thanh Hoa Province
Tel / Fax	037 834 074 / 037 834 099
Establishment	1969
Number of employees	(3 shifts, 7 days operation／week)
Main Products	

1.2 Business Status

Table 2 shows production and sales of the company in 1998. Production capacity for Kraft Pulp is 6,000 tons/year using 3 sets of equipment made in China.

Table 2 Production and Sales in 1998

PRODUCTS (1998)	PRODUCTION (ton/year)	TURNOVER (1000 VND)
Kraft Paper	4,000	**20,000,000**

2 Production Technology

2.1 Process

Figure 1 shows the process flow of this company.

2.2 Unit consumption

The unit consumption of raw materials and utilities are shown in Table 3.

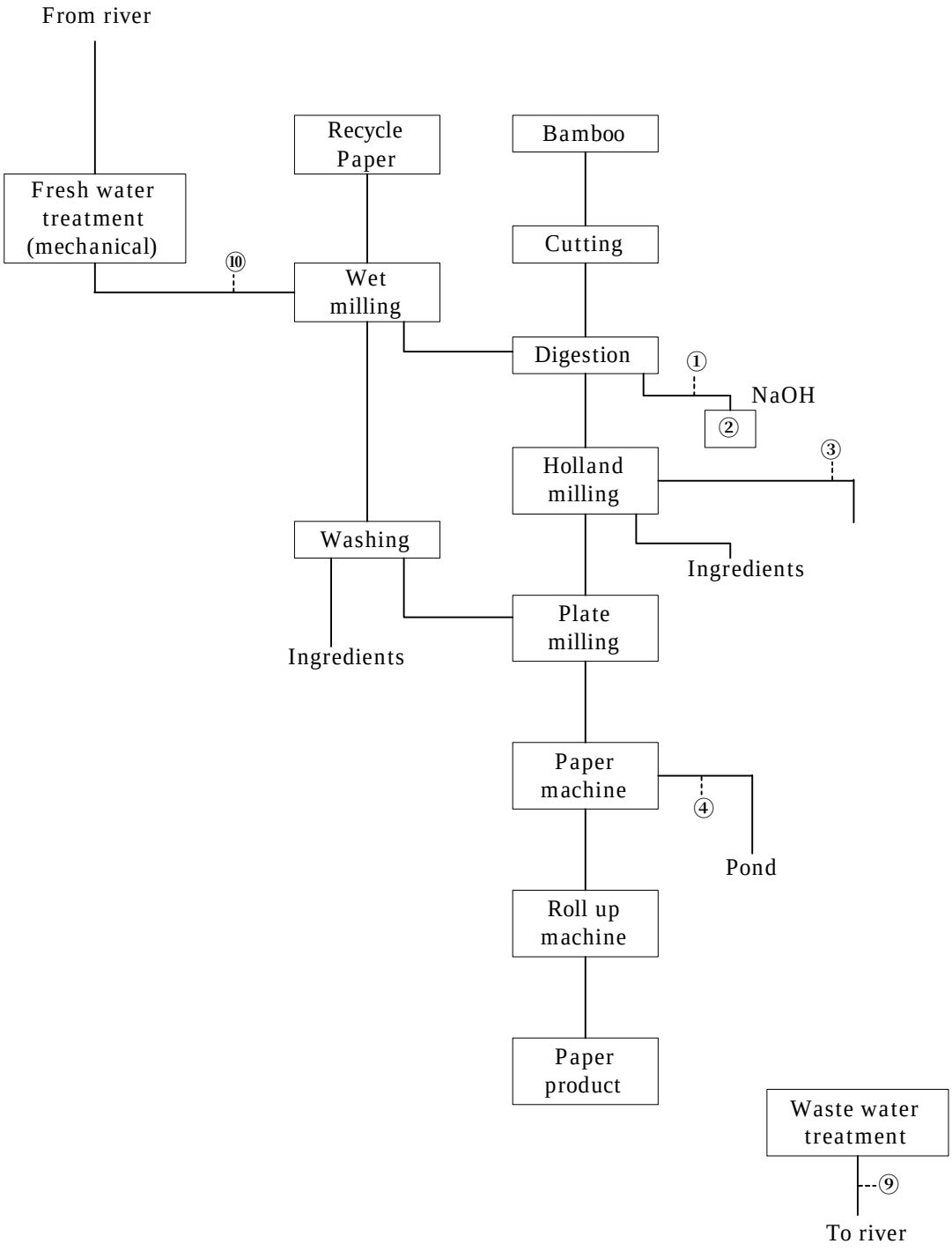

Figure 1 Block Flow Diagram

Table 3. Consumption of Material and Expenses

MATERIAL USED	QUANTITY	EXPENSES (VND)
For paper production	**4,000 (t/year)**	
1. Bamboo (70%)	7,000 t/year	300,000 VND/t
2. Recycle paper	1,700 t/year	1,400,000 VND/t
3. NaOH	280 t/year	4,000,000 VND/t
4. Coal	3,500 t/year	300,000 VND/t
5. Water	320,000 m^3/year	850 VND/m^3
6. Electricity	4,000,000 kWh	770 VND/kWh
Total		

3. Industrial Wastewater

Table 4 shows the results of wastewater sample analysis.

Table 4 Results of Wastewater Analysis

(16 December 1999)

Sampling No	Unit	1	2	3	4	10	10'
Temp	℃		20.8		21.6	20.2	20.6
pH		10.7	7.56	9.32	7.11	7.35	
Elec. Conductivity	μS/cm	65200	370	2210	210	90	150
Turbidity	NTU	27800	64	98	1120	24	38
Oil content	mg/l		0.3		0.02	Trace	Trace
BOD	mg/l			768		16.2	29.7
COD	mg/l	63820	6930	-	8990	86	89.6
DO	mg/l	0.11	0.76	0.45	0.36	1.81	0.84
VSS	mg/l					22	34
TSS	mg/l	31220	84	176	1190	28	41
Total Nitrogen	mg/l					18.8	14.2
Residual Chlorine	mg/l					Trace	Trace
SO_4^{2-}	mg/l					12.2	14.8
S^{2-}	mg/l						
Cyanogen	mg/l						
Phenol	mg/l					0.024	0.014
Na	mg/l					312	294
$CaCO_3$	mg/l		21.4	78	208	12	14
Cu	mg/l					0.03	0.02
Pb	mg/l					0.01	trace
Cd	mg/l					trace	trace
Hg	mg/l					0.217	trace
Cr(VI)	mg/l					0.009	0.017
Zn	mg/l					0.35	0.37

4. Finance

Investment: 5,000,000,000VND (from bank)

Profit: 3.5% (700,000,000VND/20,000,000,000VND expenses)

5. Recommendations

① It is necessary to spray caustic soda all the way to the portion of chips accumulated at the edge of the pit. This is because if caustic soda is sprayed only to the center of the pit, chips in the center will over-dissolve and chips on the edge will remain undissolved. It is better to use vinyl pipes for spraying equally.

② The size of chips should be less than the size of a cigarette pack, and they should all be arranged in the same size.

③ It is necessary to prevent sticky compounds from attaching on the surface of dryer. If not, it causes a break in the paper.

④ It is necessary to adjust the angle of the "doctor" and maintain it at about 30 °.

⑤ Sticky compounds should be washed off from wire, rolls etc. using high pressure water. Washing should be done with hot water. In order to conserve hot water, it is recommended that a vibration apparatus for showering be used. Also, to cut-back on the consumption of water, fiber should be recovered from each paper machine and the sticky compounds should be removed. In order to collect fiber, a concrete settler should be installed, and also, clean water should be re-collected.

⑥ The diameter of the roll of the press should be enlarged to reduce the content of water in the paper.

⑦ For globe-type digesters, it is still possible to recollect steam and black liquor. Therefore, it is better to collect steam and wastewater then to save chemicals and energy.