A REPORT WITH REGARD TO THE BASLAH PAPER MILL

PART I
EVALUATION OF THE BASLAH EXTENSION PLAN

PART II
REPORT ON VISITING TO THE BASLAH PAPER MILL

June, 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

REPORT PART I

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EVALUATION OF THE BASLAH EXTENTION PLAN

Contents

1. Preface

This report was written before visiting the Baslah Mill, and without seeing any drawings of the mill layout, although I had looked through a part of two specification documents about Baslah Mill II.

The construction of Baslah Mill II is almost finished now, and this report will be of no value for this work.

However, it would be very gratifying if this report serves to help in the future planning of Misan.

Reports on the paper machine, stock preparation, electrolysis plant and the reed cutting plant have been omitted due to lack of time.

Haruto OKUMURA

An expert dispatched from J.I.C.A. to IRAQ

Fig. 1. Flow Diagram according to Original Design

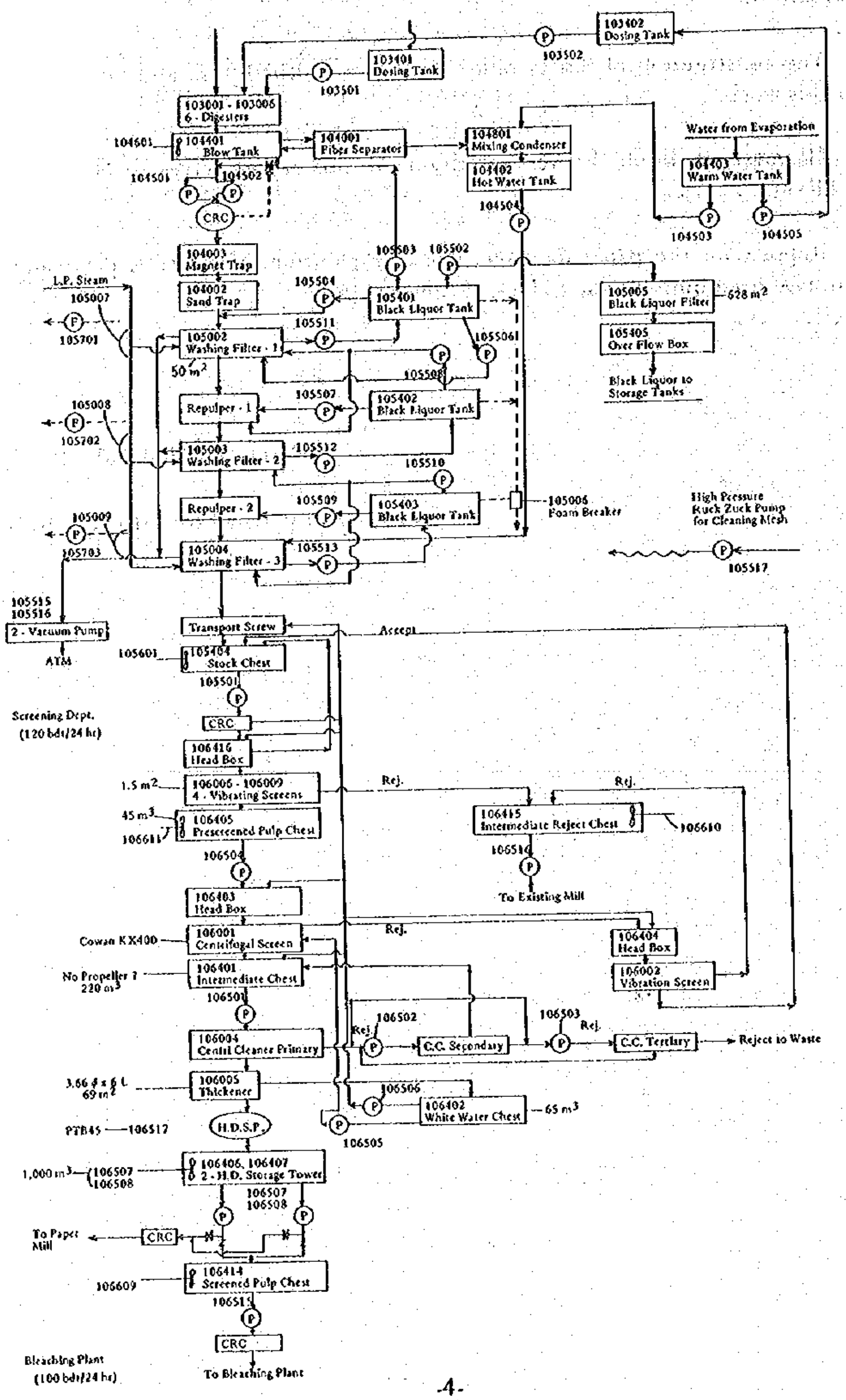
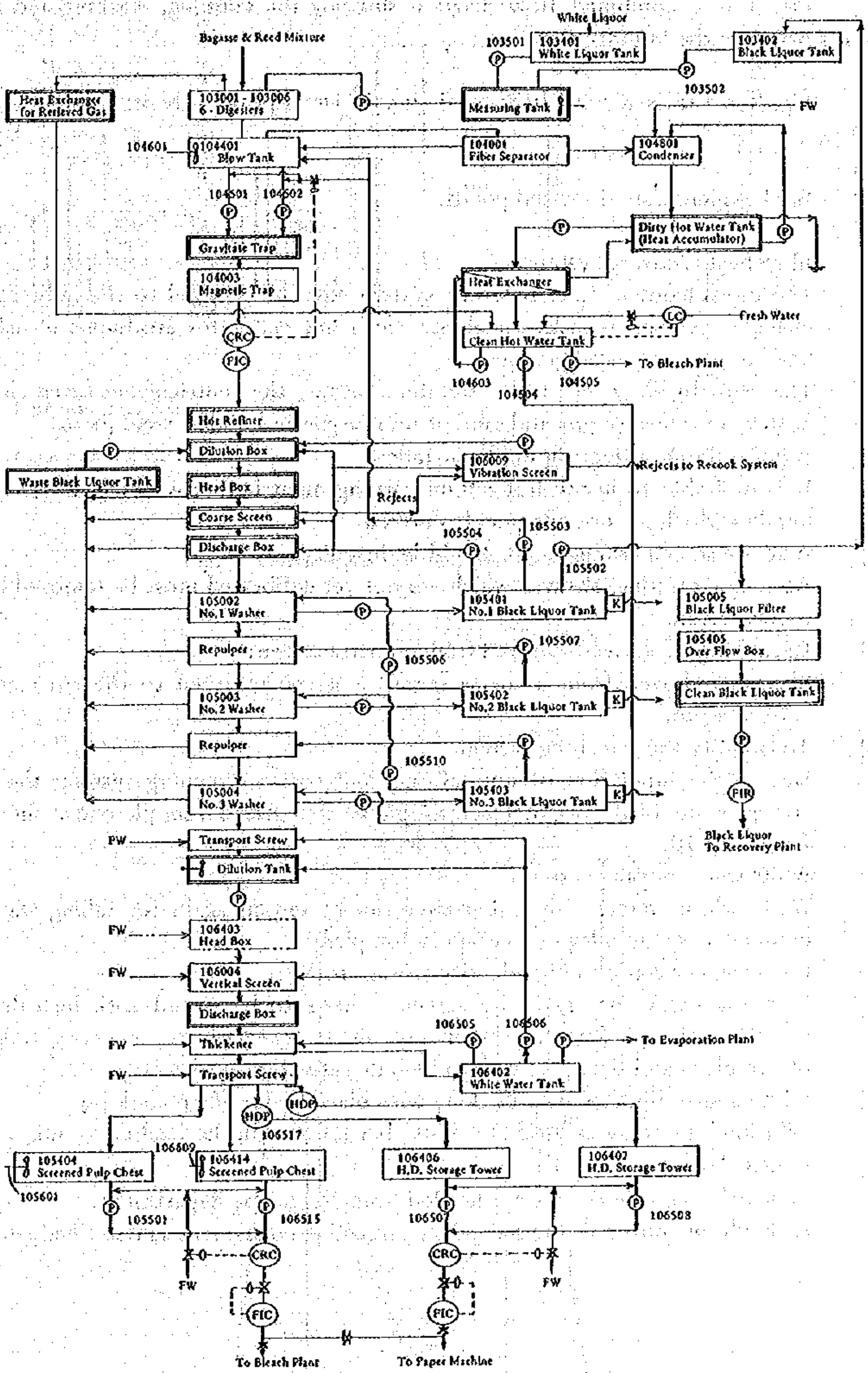


Fig. 2. Recommended Flow Chart



2. Cooking, Washing and Screening Departments

Fig. 1 is a combined flow diagram showing the cooking, washing and screening departments based on the original plan.

Fig. 2 is a revised flow diagram of Fig. 1. Description of revised points and reasons are as follows;

Brief explanation of revised points.

1) Blow heat recovery system:
The direct contact heat recovery system must be changed to the indirect heat exchanging system in order to obtain clean hot water for producing bleached pulp.

2) Sand or iron trap arrangments:
The centrifugal system is not suitable, because the centricleaner often clogs at the bottom nozzle with grit and sand or non-magnetic stainless steel pieces.

3) A hot refining system should be installed:
It is desirable to install hot refining arrangement before washing to defibrate fiber bundles which are not adequately cooked.

4) A coarse screen arrangement should be installed:
After hot refining, sheaves which are not yet defibrated must be removed by using a coarse screen.

5) Recooking of sheaves removed from a coarse screen:
Sheaves removed from a coarse screen must be returned to the cut reed silo and cooked again.

6) To simplify the screening system:
Due to the intallation of hot refining and coarse screening systems the screening arrangements of the original plan should be changed to a simple one as shown in Fig. 2 and Fig. 10.

7) White water reusing system:
Waste white water from a thickener can be reused again for falling water of the barometric vacuum leg in an evaporation plant.

8) Changing the route to high density storage towers:
It is not always necessary for screened stock to be stored with high density and therefore, there are two alternatives for the screened stock--, one goes straight to the bleach plant and the other goes to high density storage towers.

9) White liquor dilution must be done with black liquor when cooking:
Dilution by hot water produces dilute black liquor in the washing room.

10) Centri-cleaners:
Centri-cleaners are not always needed in the screening department.
It should be moved to the secondary screening department as described later.

Fig. 3 Digester Arrangement

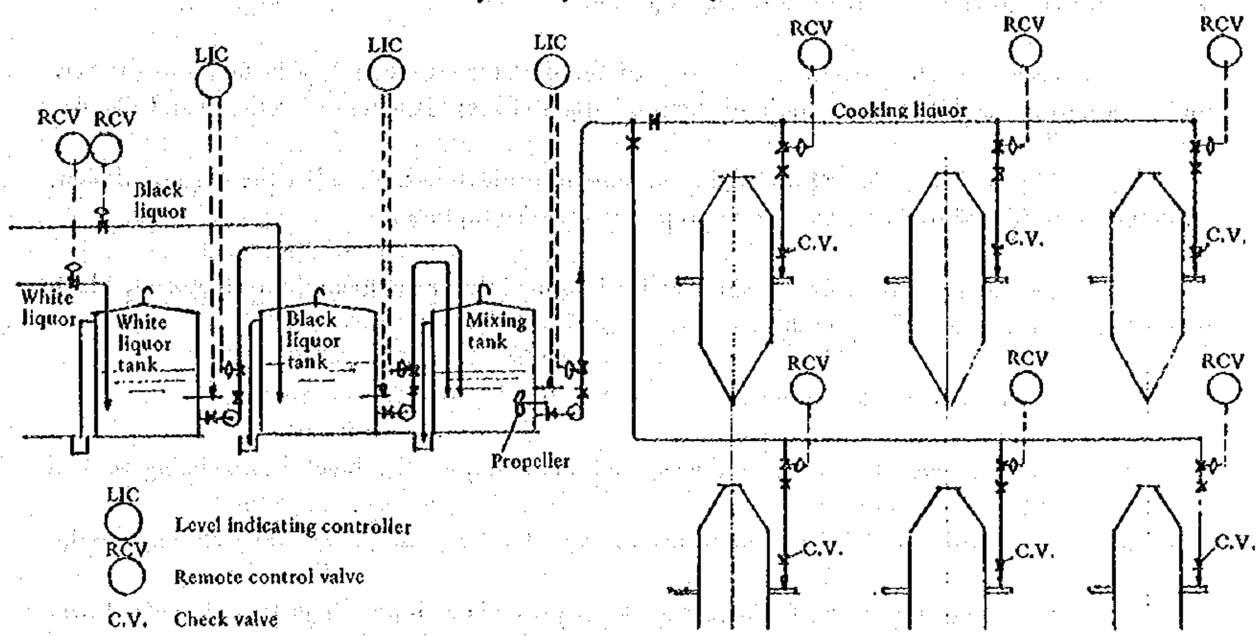
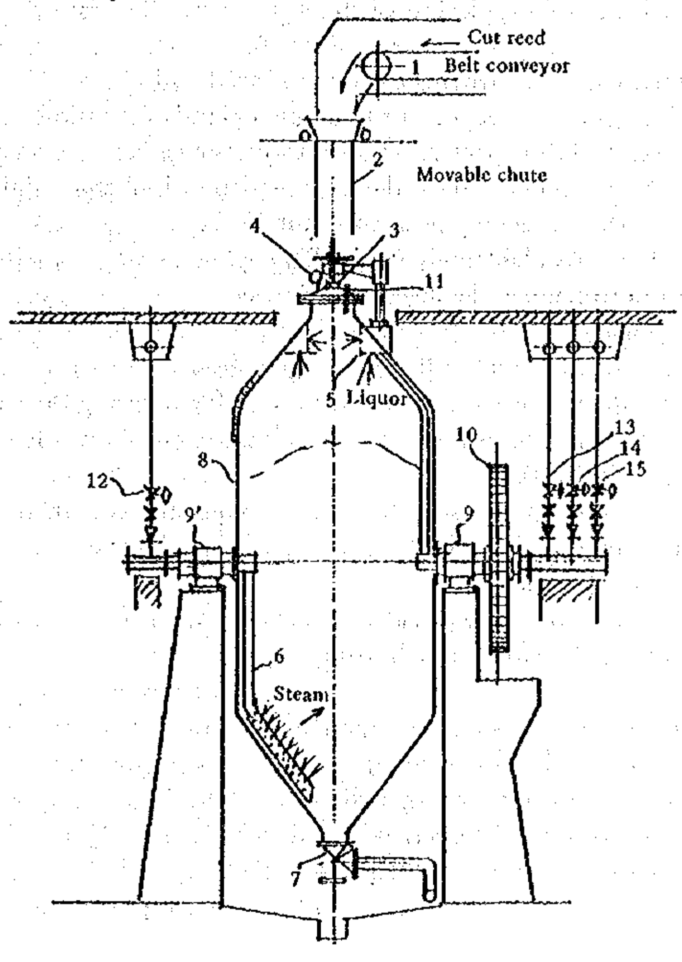


Fig. 4 Construction of Revolving Digester



3. Details of Revised Points of Cooking Department

I was not able to see the drawing of the digester arrangements installed in the new mill. Therefore, I will give an example of the usual digester arrangement. (See Fig. 3 and Fig. 4).

Fig. 3 shows the liquor piping system in a digester house. In the original design, white liquor is diluted by hot water when preparing cooking liquor.

This method is incorrect since white liquor dilution must be done by reusing black liquor being washed out of the washer.

The reasons are as follows:

1) Dilution with hot water reduces the consistency of the black liquor being washed out of the washer.
2) Dilution by using black liquor has no bad effects on pulp, even when bleaching pulp.

It is very important to keep the density of black liquor high since it helps lower evaporation load.

Fig. 4 is a design of a typical revolving digester. In this figure,

1: A belt conveyor for conveying cut reeds from the silo.
The mixing screw conveyor in the original plan is not suitable, because this system cannot work at full capacity. However, by using a belt conveyor system, the charging time of the reed shortens, the cooking liquor is charged simultaneously thorugh an axis (both axes are a pipe as shown in Fig. 4).
2: Movable chute (Available only when charging)
3: Hanging arm to remove the digester top cover.
4: Pressure gauge.
5: Top strainer for gas relief or liquor charging shower.
This arrangement is used in two ways, - one for relieving the gas in digester and the other for the liquor shower when the reeds are charged into the digester.
6: Steam pipe with strainer
Steam is led into the digester through the opposite axis, when filling with reeds and raising the temperature.
7: Angular type blow valve.
8: Digester is made of stainless clad steel.
9: Fixed bearing, 9': Thrust free bearing.
10: Gear arrangement.
11: Thermometer direct inspection type.
12: Remote control valve for steaming.
13: Remote control valve for charging liquor.
14: Remote control valve for gas relief.
15: Remote ocntrol valve for auxiliary use (spare).

4. Rough Estimate for Production

Volumes of digesters:	$70m^3$(each) x 6 digesters
Density of reeds when filled in a digester:	150 kg/m^3(B.D.)
Raw materials required in charging one digester:	$150kg/m^3$ x $70m^3$=10,500 kgs
Pulp yield on bone dry basis:	50%
Pulp production stone cooking:	10,500 kg x 0.5 = 5,250 kgs(B.D.)
Cooking time:	
Reed and liquor charging	60 min.
Temperature raised to 160°C	120
Retention time at 160°C	60
Pulp blowing from the digester	30
Interval time	30
Total	300 min = 5.0 hrs.
Number of times of cooking per day:	24 hrs ÷ 5 hrs x 6 digesters = 28.8
Pulp production per day:	5,250 kgs x 28.8 = 151.2 tons/d → 150 tons/d.
Amount of cooking chemicals required:	
Active alkali ($NaOH + Na_2S$) for bone dry reed:	18%
Sulphidity: $Na_2S/(NaOH + Na_2S)$	20%
Chemicals required at one cooking:	10,500 kgs x 0.18 = 1,890 kgs
Composition: (NaOH(mw.40) ÷ ½Na_2S(m.w. 39))	
NaOH: 1,890 kgs x 0.8 =	1,512 kgs
Na_2S: 1,890 x 0.2 =	378 kgs
Density of white liquor as active alkali:	120g/liter → $120kg/m^3$
White liquor required at one cooking:	1,890 kgs ÷ 120 kg/m^3 = $15.75m^3$
White liquor required per day:	$15.75m^3$ x 28.8 = $454m^3$

Black liquor requirement for dilution of cooking liquor per charge

(Assuming, liquor and material are in the ratio of 3:1)

Black liquor required to dilute white liquor:

(10.5 (tons of reed) x 3) - (15.75 (kg of white liquor) = 15.75 tons

Steam required at one cooking (= 1.2 tons per ton of pulp)

1.2 tons x 5.25 = 6.3 tons

5. Which is Better, Batch Cooking or Continuous Cooking

Advantages in continuous digester cooking.

1. Simplicity in operations.
2. Easy to control the quality or the production.
3. Low steam consumption.
4. Easy to recover heat from blown-out pulp.
5. Pulp yield is high according to the cooking with a low liquor ratio. This means a kind of vapour phase cooking.
6. Hot refining under pressure condition is possible, this means also high yield.

7. Reeds and bagasse or mixture of both are available for cooking.
8. Steaming is even (no peak load), this is good for a boiler.
9. Floor space for installation is small.
10. The bad smell of relief gas from a digester can be easily removed.

6. Iron Trap System

A centrifugal separator is used to remove iron pieces and sand from the brown stock in the original plan. But, I think, the centrifugal separator often clogs with sand dust or iron pieces at the botton hole. Therefore, operation will have to be stopped often for cleaning.

In order to continue operation for a long time, a large space is necessary to store the separated alien substances as shown by the gravitate iron trap in Fig. 5.

Fig. 5 Iron Trap

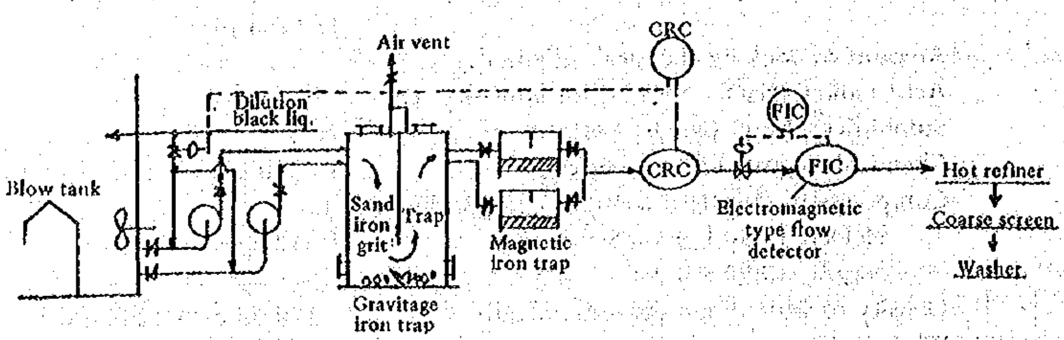
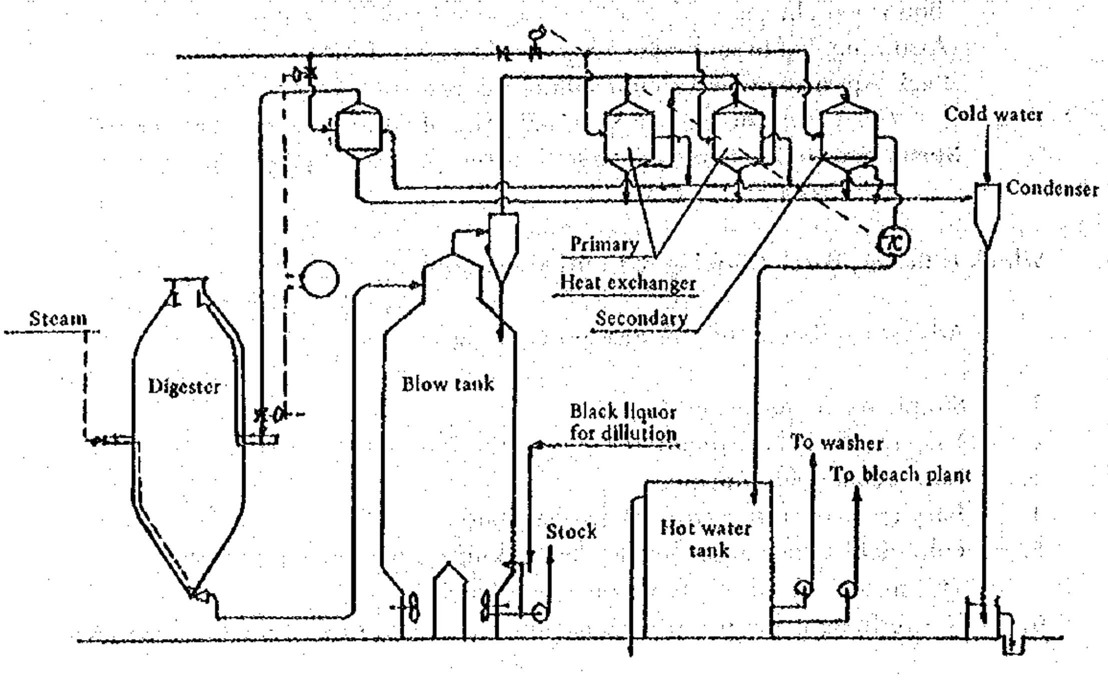


Fig. 6 Surface Condenser System



In this figure there are two kinds of traps, one is a gravitate separator and the other is a magnetic iron separator.

7. Blow Heat Recovery System

The system in the original plan is not suitable. The reason is that flashing steam which comes from a blow tank contains considerable dirty components i.e. black liquor mist, bad odor substances and waxy materials. The condensate from this vapour is not clean.

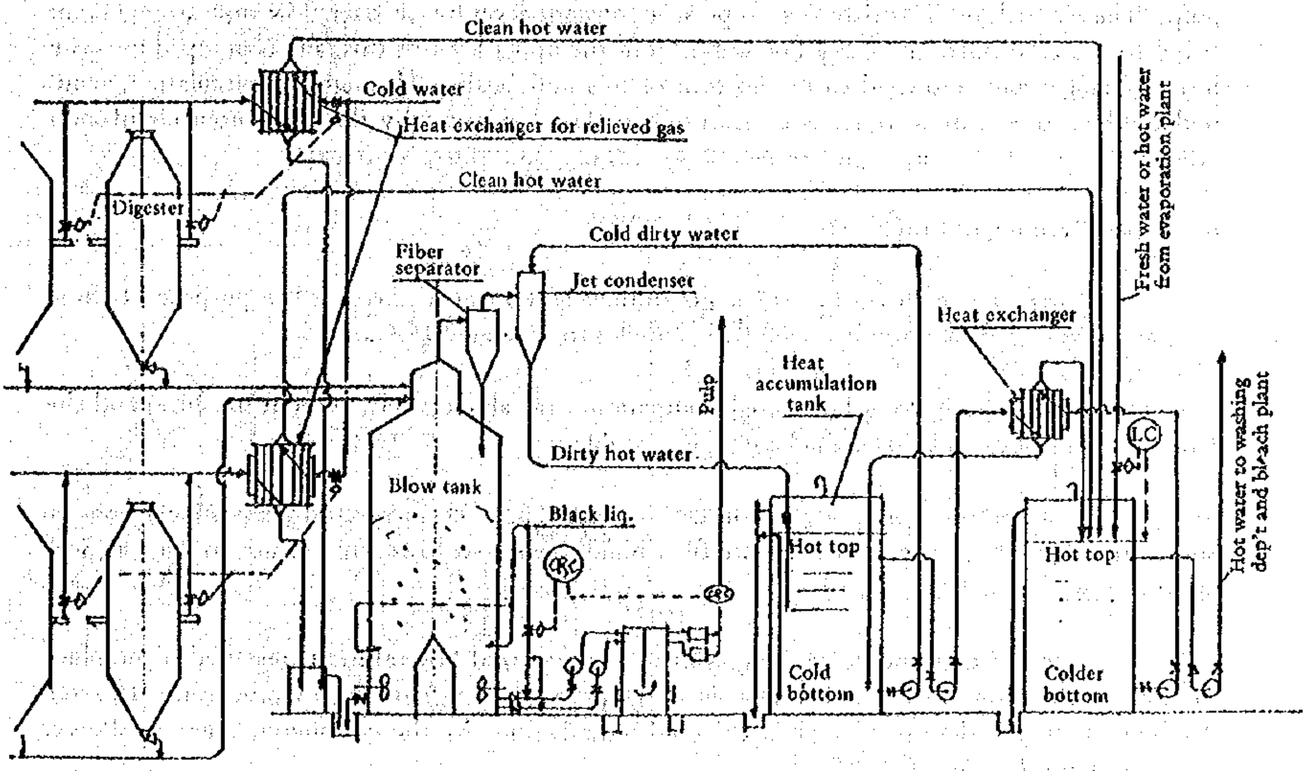
To make bleached pulp, such dirty hot water cannot be used as a shower in the brown stock washer.

For the purpose of obtaining clean hot water, there are two ways as shown in Fig. 6 and Fig. 7.

1) Heat exchanger system (Fig. 6)

This system consists of a series of surface condensers. As a condenser, a spiral heat exchanger is usually used. The surface area of the heat exchanger will be adequate as follows:

Fig. 7 Indirect Heat Recovery System (Heat Accumulation System)



Digester relief gas		$40m^2$ x 1 heat exchanger
Blow heat recovery	Primary	$80m^2$ x 2
	Secondary	$80m^2$ x 1

Average temperature of clean hot water taken from the above heat exchanger is over 90°C to 70°C (in summer → in winter).

This system has many advantages as follows;

1. Small floor space
2. Simplicity in operation and maintenances
3. High efficiency of heat recovery
4. Low cost in operation, owing to low power consumption
5. Low installation cost.

Construction of the spiral heat exchanger is shown in Fig. 8. There are two kinds of heat exchangers, one is the vapour to water type (left) and the other is the liquor to liquor type. The left type is employed in this case (Fig. 6).

2) Heat accumulation system (Indirect heat recovery system)

According to this system, dirty hot water which is condensed from flashed steam is first stored in an accumulation tank. Water in this tank at high level is hot, and is cold near the bottom. The cold bottom water is pumped into a condenser to use as falling water when blowing pulp. The water level in this tank is kept at a constant level by an over flow pipe arrangement fitted to the cold bottom. Dirty hot water from the upper level of this tank is pumped into the heat exchanger and returned to the bottom of this tank again. Through this circulation, accumulated heat of the dirty water is transmitted to clear hot water by the continuous circulation system.

8. Hot Refining of Stock

Fig. 9 is a flow chart of a hot refiner and a coarse screen. The purpose of these arrangements is to defibrate uncooked fiber bundles to separated fibers.

Refining is done under high temperature (at about 85°C, without pressure) and the consistency of pulp must be as thick much as possible.

In another method, as shown in Fig. 10, a Disintegrator (Top Finer) can be substituted for a hot refiner to defibrate fiber bundles without lowering freeness too much (See: specification in Fig. 10).

In the continuous cooking system, a pressurized hot refiner is installed at the place just before the blow orifice and works with high pressure (8 atg) and high temperature (160°C). The conditions are the same as when the cold blow is done by the continuous digester. Power consumption is low in this case.

Fig. 8 Spiral Heat Exchanger

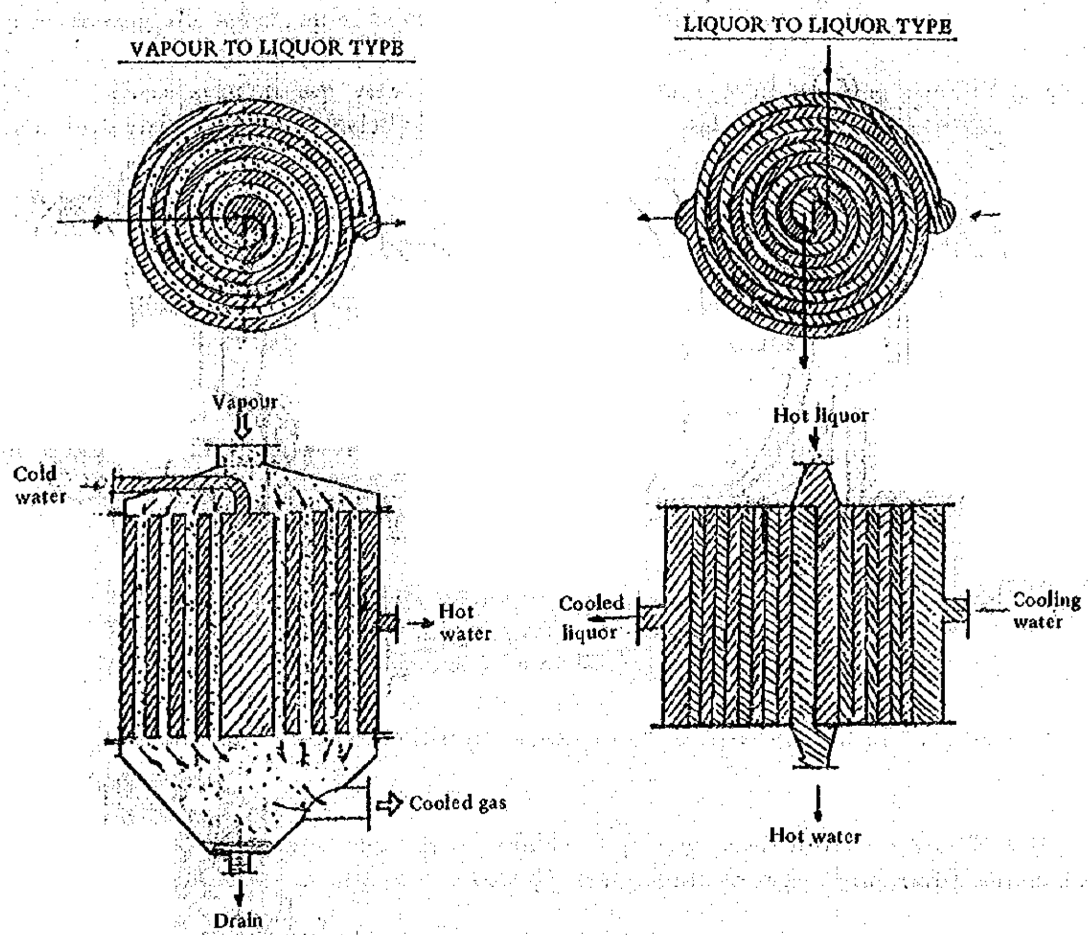


Fig. 9 Hot Refining and Coarse Screen Arrangement

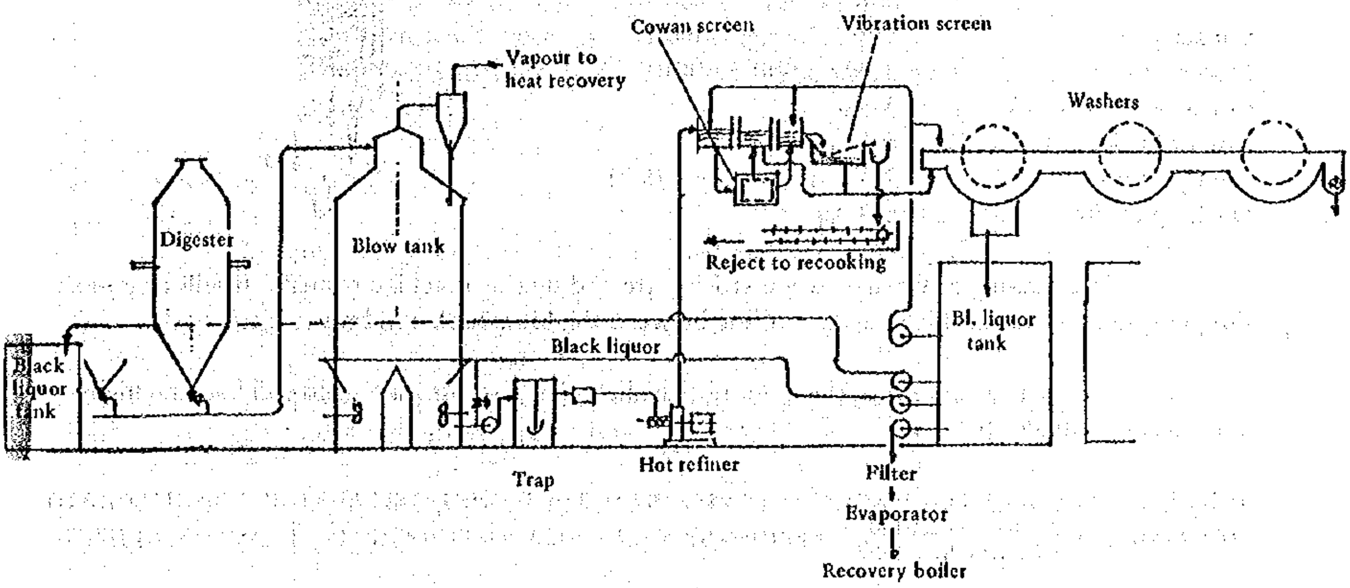
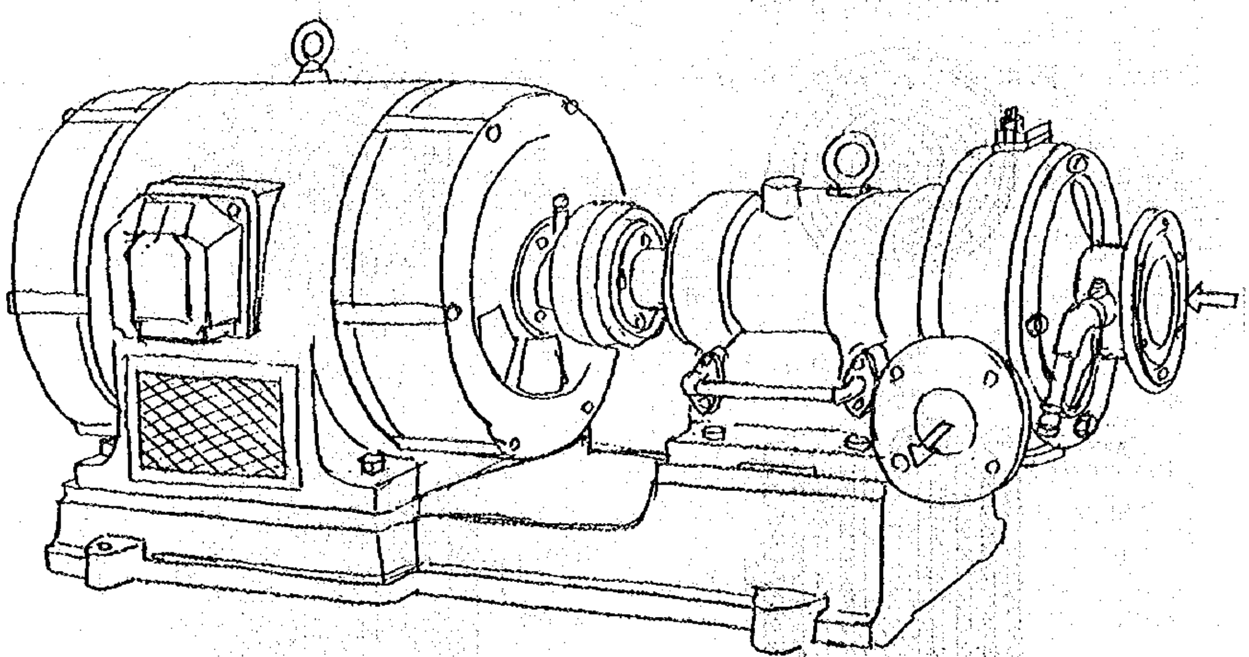
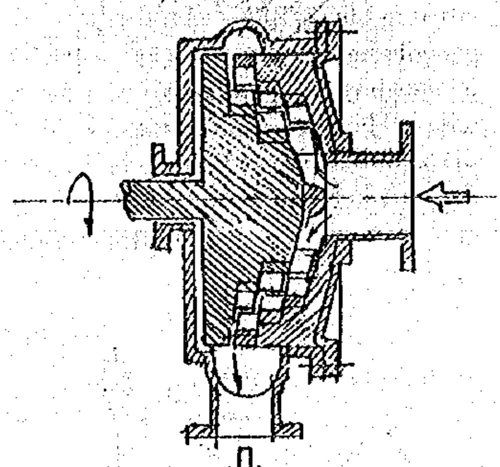


Fig. 10 Top Finer Aikawa Iron Works Japan





TOP FINER is a stock disintegrating machine which consist from three stages of disintegrating blades.

Power consumption:	30-50 kwh/ton of pulp
Freeness dropping:	23cc by C.S.F. at 3% consistency
Capacity:	600-1,500kg/h (b.d.)
Motor:	55kW 3,000-3,600RPM
Consistency of stock:	3-5%
Life of blade:	6-24 months
Inlet pressure:	2-3m Aq. (not over/5m)
Outlet pressure:	5-8 Aq.

Decreasing of freeness when stock is treated by this machine is small. It will be a most unique system to install this machine on line between the blow tank and brown stock washer.

Such a system keeps the K-number high, and as a result pulp yield will become higher and washing will also be good.

→ BLOW TANK → STOCK PUMP → GRAVITATE SEPARATOR → MAGNETIC SEPARATOR → DISINTEGRATOR (TOP FINER) → (COWAN SCREEN / COARSE SCREEN) → BROWN STOCK WASHER → SCREENING DEPT' → SILO ← REJECTS

The remaining fiber bundles which were not disintegrated must be removed with a coarse screen and the rejects must be cooked again mixed with raw cut reeds.

These systems are very important to maintain good washing conditions and to maintain high yield of pulp, especially in the case of bagasse pulping.

9. Washing Department

The success of bagasse pulping depends on the result of washing. And washing is considerably influenced by freeness of stock. When the freeness of stock is low, brown stock is not only washed well, but also the capacity of the washer becomes low.

Freeness is in direct proportion to the K-number in cooking, then the K-number is an important index in washing. The washer illustrated in the original plan is not the best.

The reasons are as follows:

1. The washer is a single stage wash type.
2. The washer needs a suction pump and a vacuum pump.
3. The washer is not equipped with an air blow off system.

I recommend the KAMYR type brown stock washer, instead of the above type for the following reasons:

1. It does not require any liquor extraction pump or a vacuum pump. This washer has only short suction legs and a drain pipe which serves as a pulp layer formation and a fraction tank.
2. Due to this arrangement, a pulp layer is formed in the bulky condition on the drum surface, which gives easy penetration to the washing water.
3. There is less foaming trouble in this washer.
4. This washer can wash twice on one drum.
5. Taking off the washed pulp from the drum is done by the air blow off system perfectly and easily.

10. Screening Department

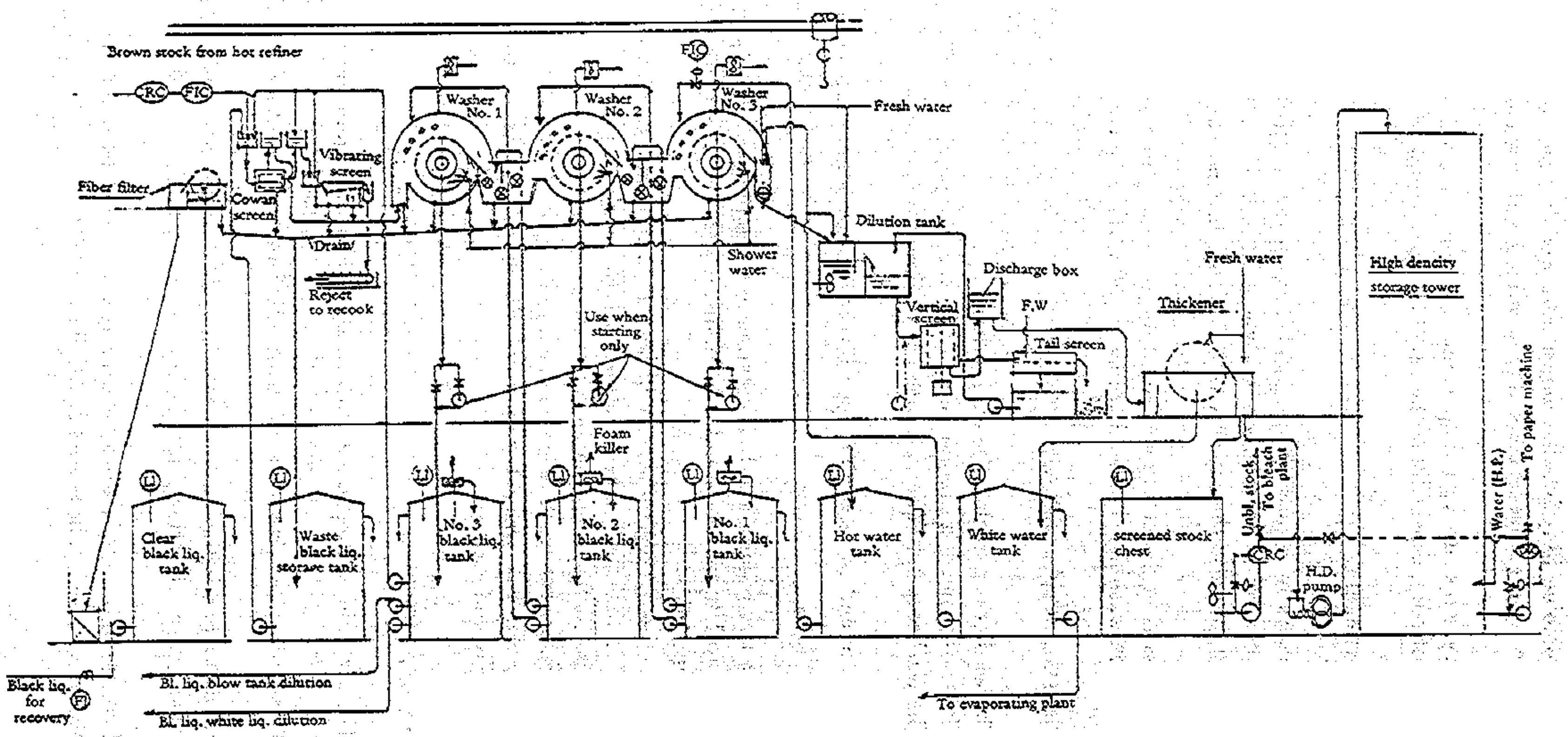
The screening arrangement in the original plan is complicated.

It is not a good idea to install many vibration screens here.

As explained before, a hot refiner and a coarse screen must be equipped before the washer. A coarse screen (vibration screen) is not necessary here.

Even in this case, a COWAN-type coarse screen (See Fig. 15) should be installed instead of a vibrating screen. The reason is as follows:

Fig. 11 Washing and Screening Department



The perforated hole of the vibrating screen is too large to remove sheaves from bagasse or reed stock at this port. And the perforated hole of this screen cannot be made smaller due to the principle involved.

Using the above idea, the screening arrangement can be corrected as shown in Fig. 2 and Fig. 11.

According to the above flow diagram, the arrangement can be simplified.

Centri-cleaning equipment is not required here. But this equipment is absolutely necessary just after bleaching, because fine dirt comes into the pulp thorugh the mill water, steam line and scales dropping from the vessels.

When production is running smoothly, high density storage is not always necessary, and therefore, it would be better to install a pipe directly to the bleach department as a by pass.

Reusing of White Water:

To save mill water, white water extracted from the thickener must be used for falling water at the barometric condenser in an evaporation plant. But in summer, the high temperature water cannot be used unless it is passed through an air cooling system.

To Reduce Alkali Loss:

For this purpose, a waste black liquor collecting tank should be provided around the washing house. Black liquor drained from each machine is collected in this tank at first and is then gradually returned again to an inlet box of the washer.

The Capacity of the Washer of the Original Plan:

According to my experience, 5 tons of wood pulp per m^2 per day can be handled on a washing drum. The washer in this plan has a surface of 50 m^2 on each machine. Accordingly, the capacity of this washer will be 250 tons per day, but the freeness of bagasse stock is low and so the capacity of this washer might be much lower.

11. Bleaching Plant

Reed and bagasse pulp are easy to bleach as the lignin contents of this pulp are low, and so three stages of bleaching (which consist of the sequence of C-E-H) should be sufficient. Considering the destruction of cellulose while bleaching, the initial K-number should be kept high such as 13 or more before bleaching.

The bleaching system of the C-E-H-H sequence in this plan should be adequate to keep the brightness of pulp at 85-87.

The relation, between the K-number and the chlorine requirement is shown in Fig. 13-a.

According to this graph, if the k-number is 13, the chlorine requirement becomes 4.5% for bone dry pulp.

The bleaching operation will be as follows:

Chlorination stage:	Chlorine gas must be added at the inlet point of the chlorine mixer. See Fig. 13.b.
Caustic extraction stage:	50 gr/lit. NaOH liquor is added at the inlet of the caustic steam mixer.
Hypo bleaching stage:	Sodium hypochlorite (NaOCl) liquor which has a strength of 25 g/lit as available chlorine is added.

Bleaching Conditions of Usual Operaton in Bagasse and Reed.

	(C) Chlorination Cl_2(gas)	(E) Caustic extraction (NaOH)	(H) Hypo bleaching (NaOCl)
Chemicals	Chlorine	Caustic liquor	Bleach liquor
Flow of stock in the tower	Up flow	Down flow	Down flow
Consistency of stock	3.5 - 4.0%	8 - 10%	8 - 10%
Temperature	35°C (max.)	40-55°C	35-40°C
Chemicals to be added	3-5% Cl_2	2-2.5% NaOH	0.1-0.5% NaOH 1.0-2.0% *
Retention time in the tower	30-60 min.	30-60 min.	60-90 min.
p.H. at Beginning to End	7.5 → 2.0	11.0 → 9.0	10.0 → 8.0
Brightness after each stage	35-40	25-30	84-86

* As available chlorine

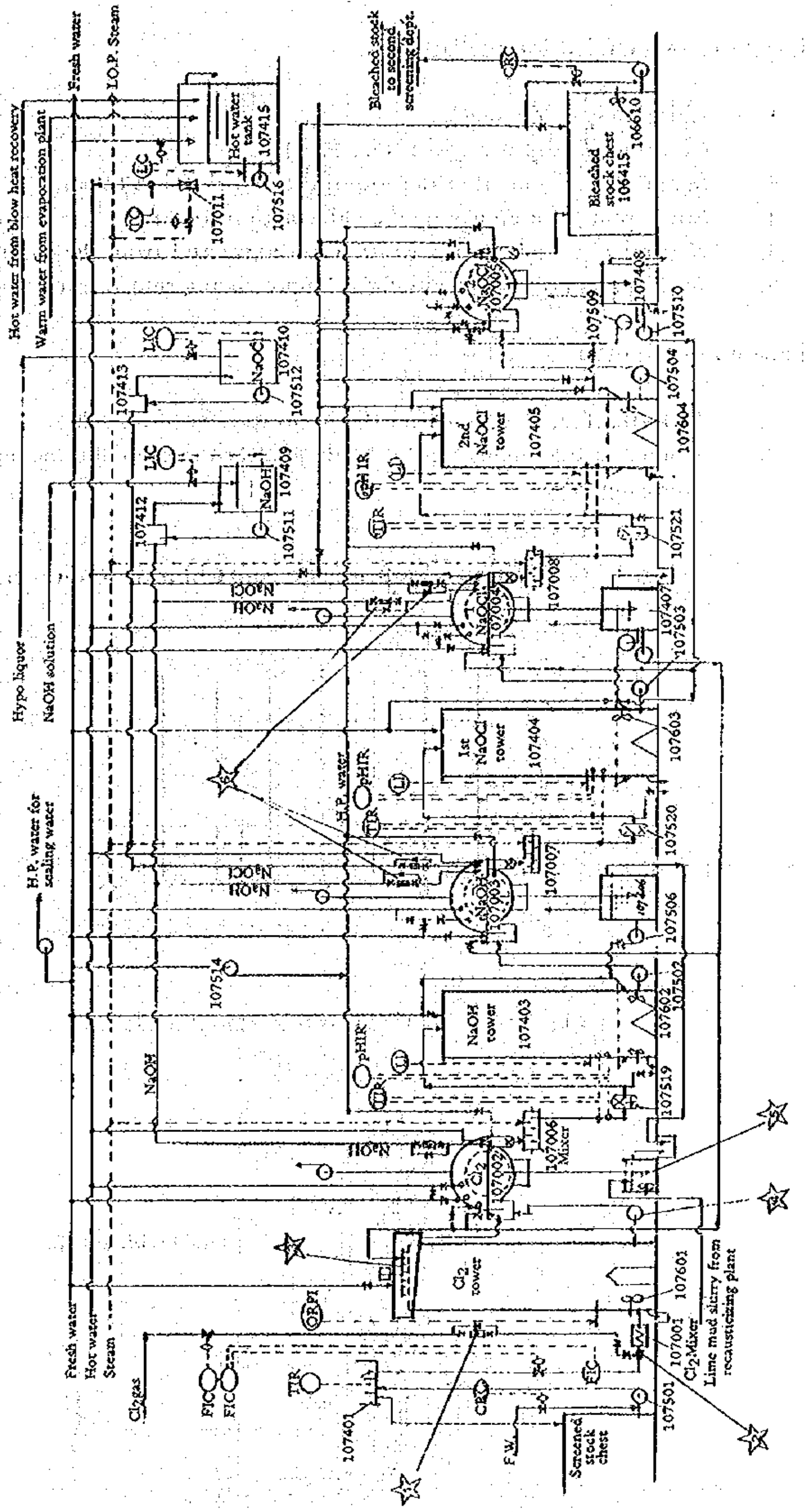
The hypo bleaching stage can be divided into two stages. In such a case, the ratio of distribution of chemicals added will be kept at about 8 : 2.

All towers of bleaching in this plan can maintain sufficient retention time as shown in the following table.

		Dimentions dia m x height m	Volume m^3	Pulp consistency %	Retension time At 100 t.p.d. production	at 150 t.p.d. production
C	Chlorination tower	3.25 x 17.00	141	3	60 min.	40 min
E	Caustic extrusion tower	3.25 x 13.50	112	8	130 min	87 min
H_1	1st Hypo. bleach tower	3.75 x 16.00	176	8	200 min.	130 min.
H_2	2nd Hypo. bleach tower	3.75 x 16.00	176	8	200 min.	130 min.
	Hi-Density storage tower		1000 x 2	8	19 hrs x 2	13 hrs x 2

Note: 100 t.p.d. (24 hrs) = 4.17t/hr 150 t.p.d. (24 hrs) = 6.15t/hr

Fig. 12 Bleaching Plant



Equipment recommended for intallation:

1. Chlorine gas flow meter.
2. Chlorine gas injector (See: Fig. 13-b).
3. Scraper arrangement at the top of the chlorination tower.
4. Stock pump for emptying the chlorination tower.
5. Neutralizing tank for the waste water extracted from the chlorination filter.
6. Flow meters of NaOH and NaOCl liquor being sent to each stage.

Equipment not required:

1. Acid treatment by HCl after the hypo stage is of no value.
2. Storage at high density must be done after the second screening as mentioned on the following page.

Fig. 13-a. Relation with K-number and Chlorine Requirements

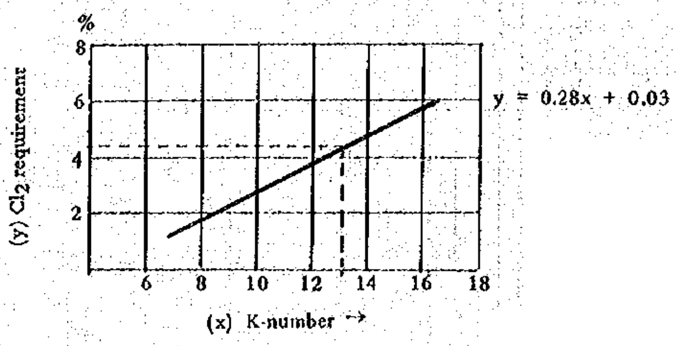


Fig. 13-b. Chlorine Gas Injection Nozzle

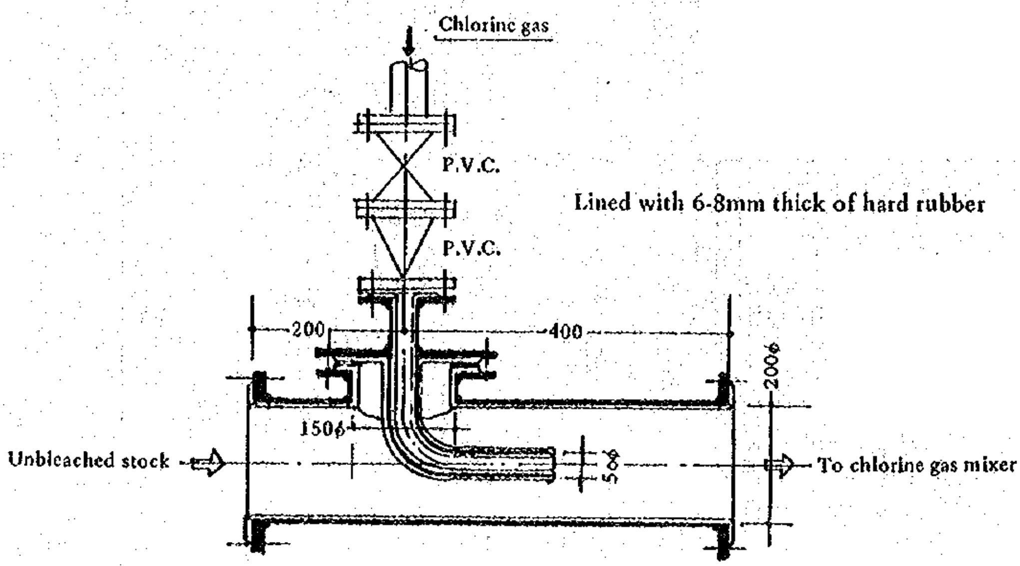
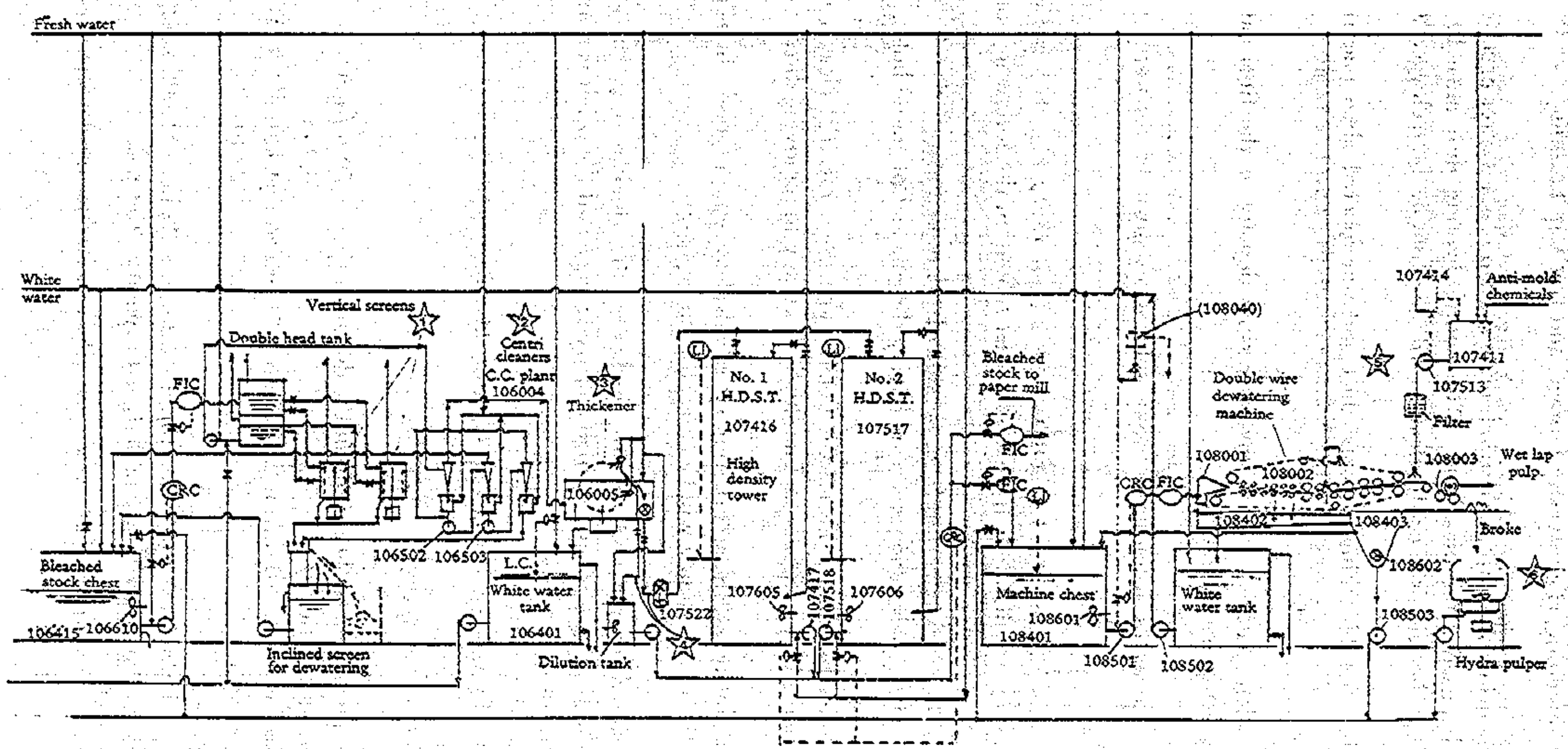


Fig. 14 Secondary Screening System and Wet Lap Forming



12. Secondary Screening, High-density Storage, and Wet Lap Forming

As mentioned before, a centri-cleaning system is not always necessary before bleaching. It should be used after bleaching. The centri-cleaning unit must be equipped with a screening machine, otherwise, the centri-cleaners will be often become clogged with rejects.

During the bleaching process, dust and unexpected alien materials mix with the stock.

The alien materials which have the same density as the fiber cannot be separated from the stock by using centricleaners.

Fine pieces of resinous or waxy substances must be separated through a slotted screen.

1 For this purpose, a LAMORT type screen (See, Fig. 16) is the most suitable. This screen is different from a selectifier screen on the following points.

   1) The stock enters in from outside of the screen plate.
   2) The screen plate is a plate having slits instead of round holes.

2 As a centri-cleaner, the RADICLONE type (See, Fig. 17) cleaner is good, since this cleaner is very compact and has high efficiency in removing dirts.

3 As a thickener, the self suction type (valveless type) is good. In using this thickener, the fiber consistency will be about 8% (in bagasse).

4 At the discharge end of this thickener, the thickened stock is divided by two methods --, one is sent to high density storage and the other is sent to another stock chest for direct use.

13. Estimation of Capacity of Wet Lap Forming Machine

(*mark means assumption)

Machine speed (8-24 m/min in the document)	20 m/min*
Working width	0.8 m
Basis weight (at 20 m/min speed) (at 62% moisture)	1 kg/m^2* (O.D.)
Working time	22 hrs.*

Capacity:

$1 \text{ kg/m}^2 \times 0.8 \text{ m} \times 20 \text{ m/min} \times 60 \text{ min} \times 22 \text{ hr} = 21{,}000 \text{ kg/22 hr.}$

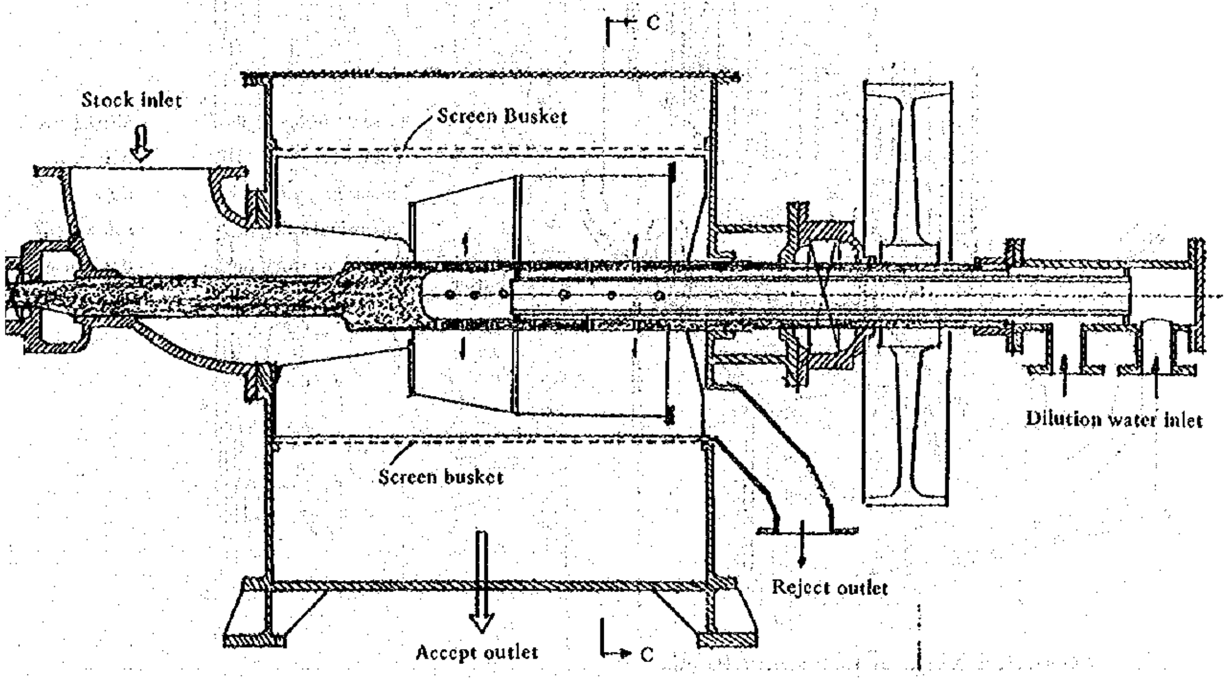
This total is larger than the designed capacity, 20 t.p.d.

* Low freeness stock makes basic weight low, otherwise machine speed must be lowered.

6 A hydropulper which is used to recover wet broke should be employed.

6 In hot weather, pulp will be covered with mold and changes into blue, yellow or pink.
Anti-mold chemicals must be sprayed on the surface of pulp to keep from getting moldy.

Fig. 15 Cowan Screen Type KX (Hitachi-Fooper)



Pulp consistency	1.0 - 1.5%
Inlet stock pressure	1.8 - 2.4 m.Aq.
Pressure of shower	0.4 - 0.5 kg/cm^2

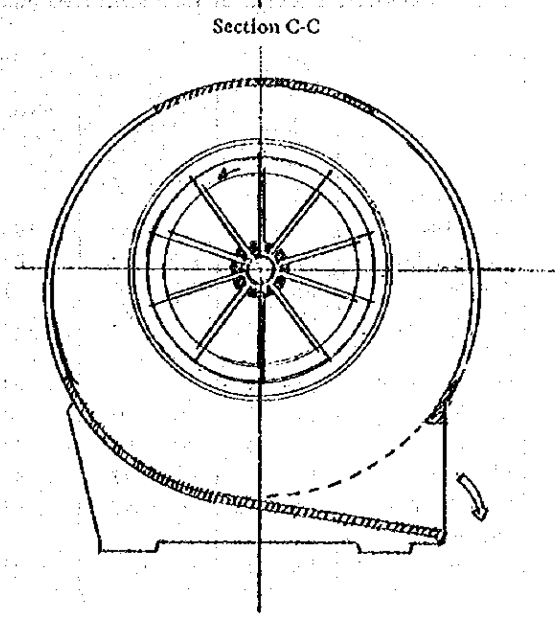
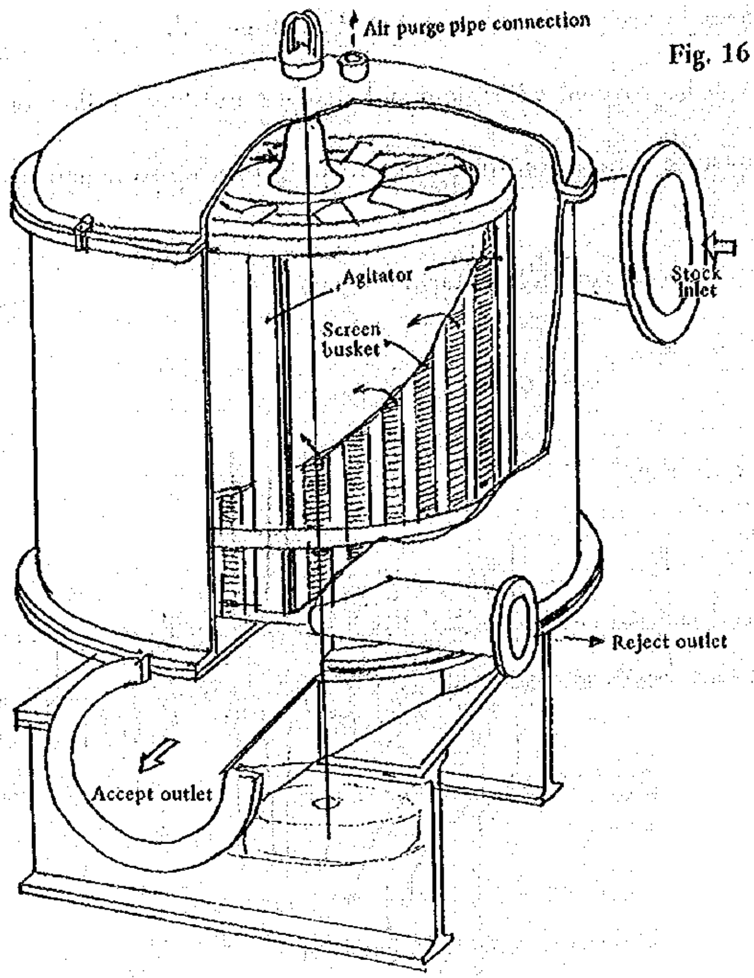


Fig. 16 Aikawa Lamort Screen Type B

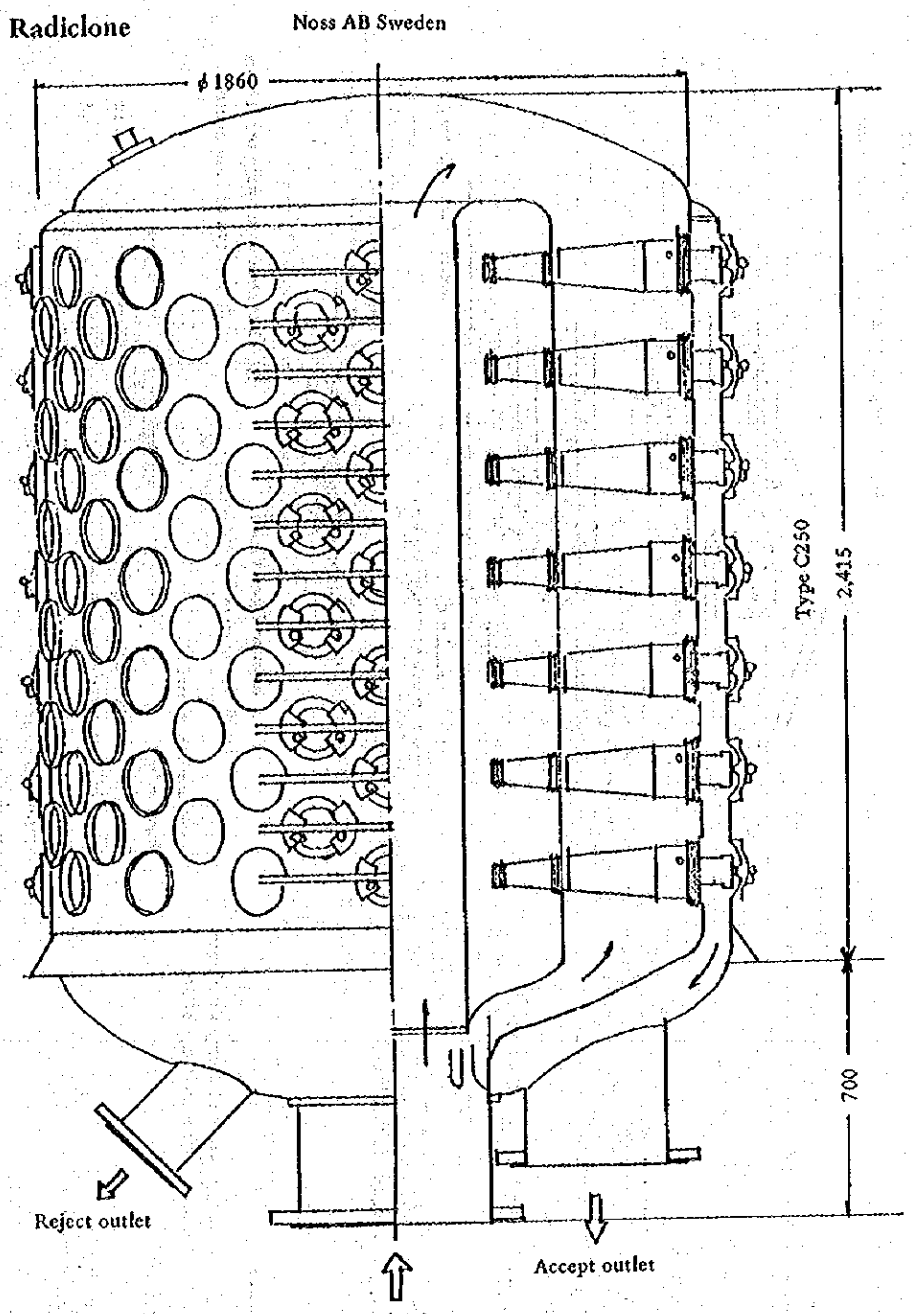


Type B-1000	Slitted screen plate
Width of slit	0.35 mm
Consistency of stock	0.8%
Pressure of stock inlet	0.5 kg/cm^2
Pressure of stock outlet	0.2 kg/cm^2
Horse power required	37kW

14. Estimated Yield of Bagasse or Reed

	Bagasse				Reed			
	Loss %	Yield %	Overall yield %	Materials kg	Loss %	Yield %	Overall yield %	Materials kg
Oven dry raw materials	-	1.00	100.0	336.0	-	1.00	100.0	277.0
Pre-depithing	(-) 18	(x) .82	82.0	276.0	-	-	-	-
Storing	(-) 4	(x) .96	78.6	264.0	(-) 20	(x) .80	80.0	210.8
Wet depithing	(-) 15	(x) .85	66.7	224.0	-	-	-	-
Cutting	-	-	-	-	(-) 10	(x) .90	72.0	199.5
Materials initial			100.0	224.0			100.0	199.5
Cooking	(-) 50	(x) .50	50.0	112.0	(-) 45	(x) .55	55.0	109.7
Screening	(-) 2	(x) .98	49.0	109.0	(-) 2	(x) .98	53.8	107.4
Bleaching	(-) 8	(x) .92	45.1	101.0	(-) 6	(x) .94	50.6	101.0
Sheet forming	(-) 1	(x) .99	44.6	100.0	(-) 1	(x) .99	50.1	100.0
10% moisture air dry	(+) 10	(x) 1.10	49.5	110.0	10	(x) 1.10	55.2	110.0

Fig. 17 Radiclone



Capacity (C-250-208 Type) 52,000 litre/min.

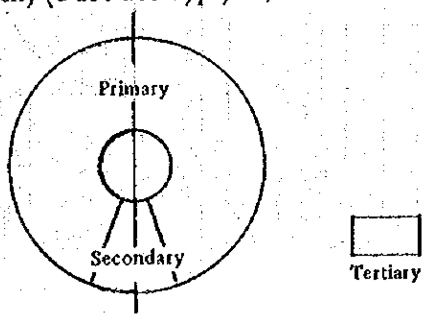
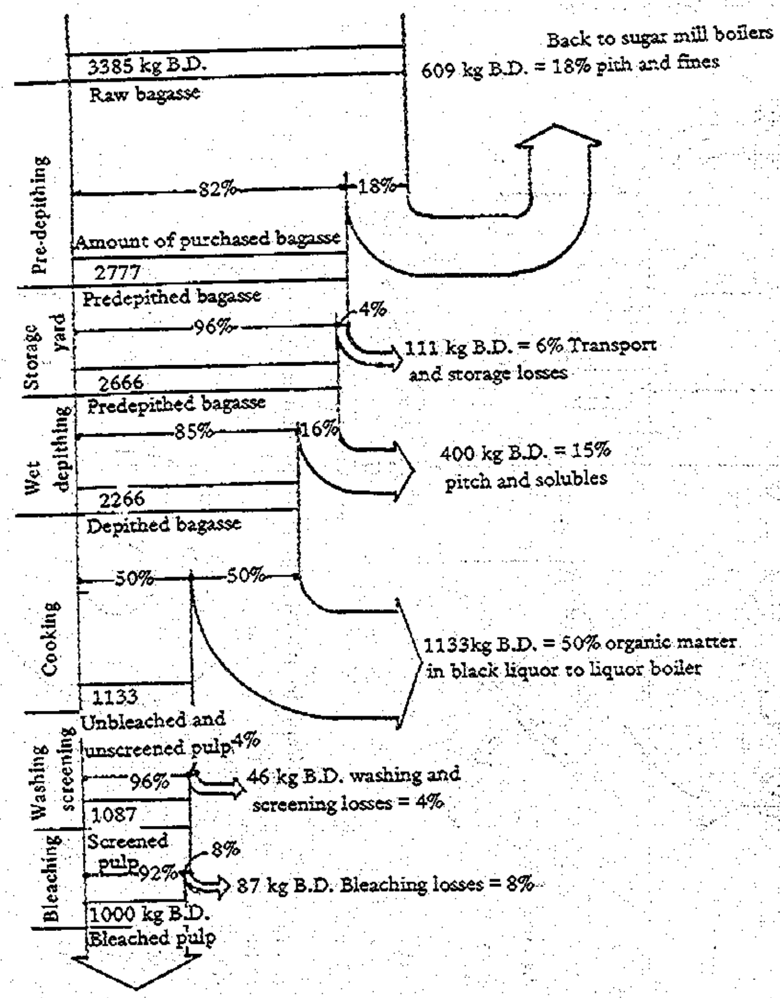
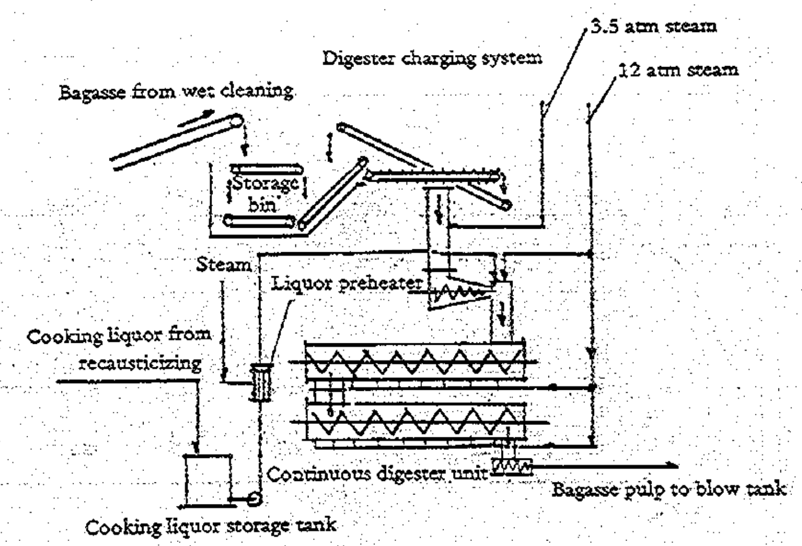


Fig. 18 Pulp Yield



(Pulp & Paper International June 1975)

Layout of the digester house with conitnuous horizontal tube digester



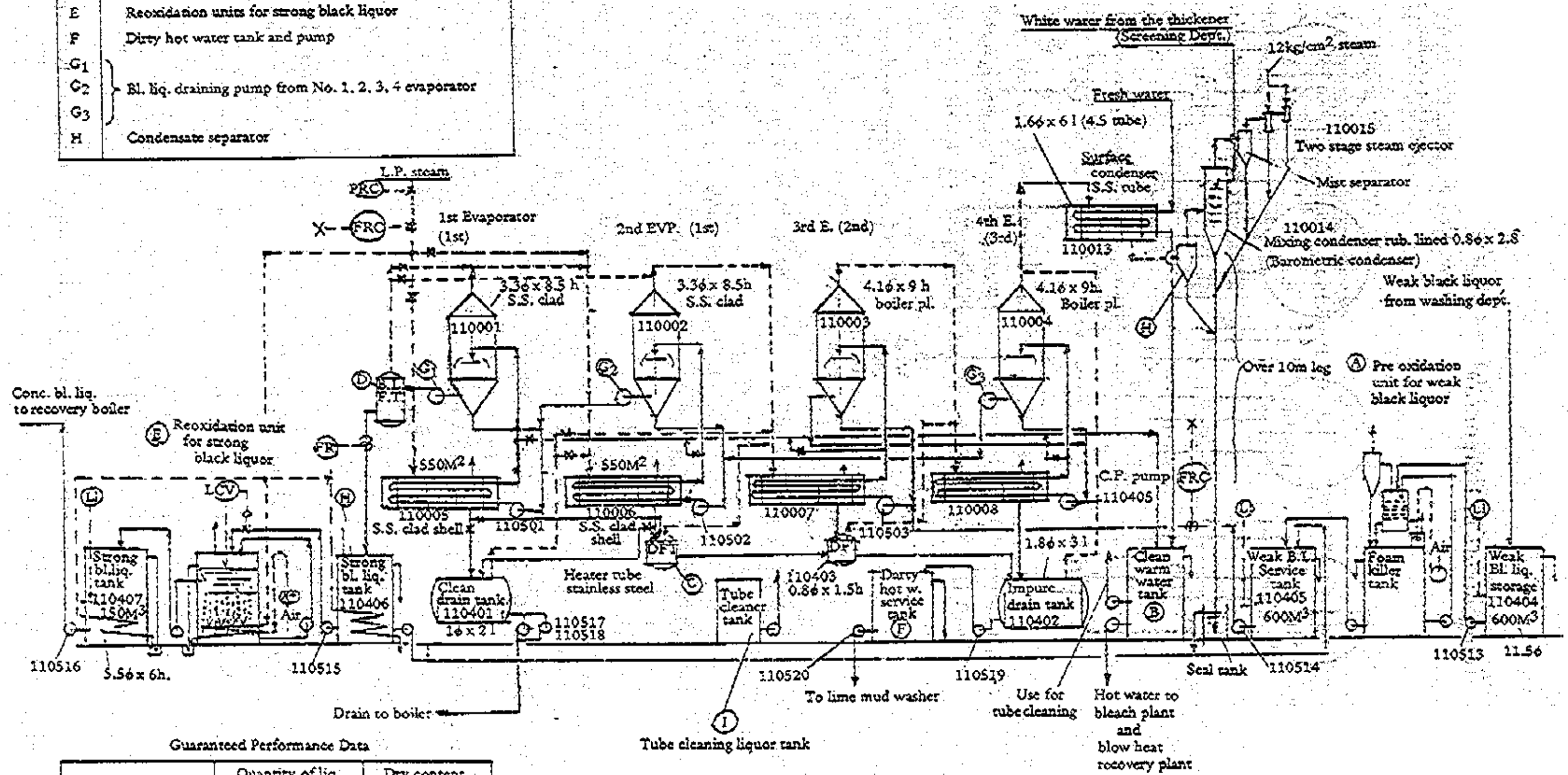
(Pulp & Paper International June 1975)

Bagasse Fiber Yields (at different steps in production)	Yield	Bleached wood pulp production: 300 tpd of food board	
Raw cane-100 pounds			
Sugar mill	70%		
Pulp mill secondary depithing	90	Debarker	87
Digester and hot stock screening	55	Digester	45
Brown stock washer	99		
Screen and cleaner	99		
Bleach plant	98	Bleach plant	93
Paper machine cleaner	90		
Paper machine screen	99	p.m. screen	99.5
Finished paper	99.5		

P & P May 1970

Fig. 19 Evaporation Plant

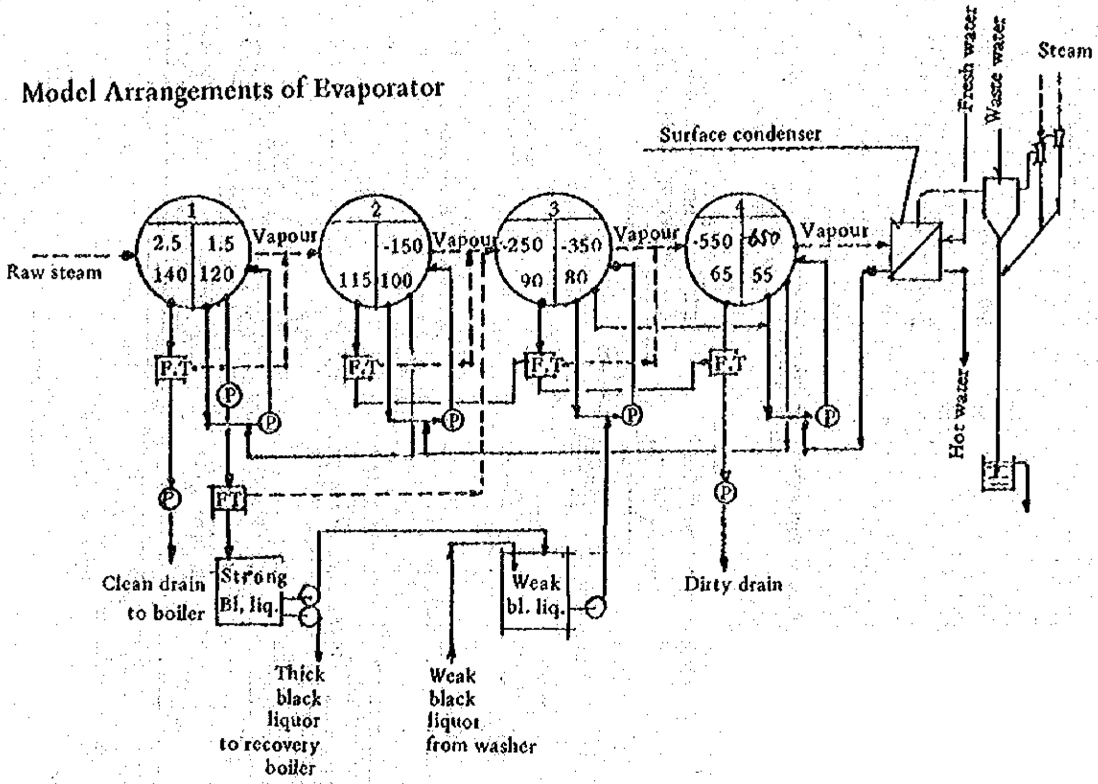
A	Pre-oxidation unit for weak black liquor
B	Clean hot water tank
C	Drain flash tank for 2nd evaporator
D	Black liquor flash tank
E	Reoxidation units for strong black liquor
F	Dirty hot water tank and pump
G_1, G_2, G_3	Bl. liq. draining pump from No. 1, 2, 3, 4 evaporator
H	Condensate separator



Guaranteed Performance Data

	Quantity of liq.	Dry content
Input	73.33 t/hr	12 %
Output	19.55 t/hr	45 %
Evaporation	53.78 t/hr	

Fig. 20. Model Arrangements of Evaporator



15. **Evaporation Plant**

Fig. 19 is a hypothetical flow diagram of this department. Approximate calculation of capacity of 150 t.p.d. production is as follows:

Input (Weak black liquor) (See page 9)	
Solids out of a digester at one cooking	
Organic matter dissolved by cooking (Lignin)	5,250 kgs.
Inorganic matter used for cooking (Chemicals)	1,890 kgs.
Total	7,140 kgs.
Water out of a digester at one cooking	
In cooking	
Water in the cooking liquor	15,750 kgs
Condensed water by steaming	6,300 kgs
Evaporated steam by blow flashing	(-) 5,000 kgs
In washing	
Dilution hot water used with a washer*	42,000 kgs
Total	59,050 kgs
* Pulp production at one cooking	5,250 kgs
Dilution factor	8
Hot water used for washing at one cooking	5,250 kg x 8 = 42,000 kgs.
Concentration of weak black liquor	$\frac{7,140}{59,050}$ = 12%
Number of cookings per day	28.8
Total solids per day	7,140 kg x 28.8 = 205,632 kg/d = 8,568kg/h
Total water in weak black liquor	59,050 x 28.8 = 1,700,640 kg/d = 70,860 kg/h.
Total	1,906,272 kg/day = 79,428 kg/h.
Output (Thick black liquor)	
Concentration	45% solids ... (8,568 kg/h.)
Water	55% (8,568 x $\frac{(100 - 45)}{45}$ = 10,472 kg/h.)
Total	19,040 kg/h.

Water must be removed from the liquor through an evaporator.

70,860 - 10,472 = 60,388 kg/h

But I think, the actual load of an evaporator would be bigger in comparison with the guaranteed performance below.

	Quantity of liquor	Dry content
Input	73.33 kg/hr	12 %
Output	19.55 kg/hr	45 %
Evaporation	53.78	

From past experience, an evaporation plant with a 1,600m^2 heating surface produced 200 t.p.d. of hard wood pulp. But in this case, the solid content was 18% in weak liquor and 45% in thick black liquor. So the heating surface area of an evaporator used for producing one ton of pulp was 8m^2. These evaporators were all natural circulation types.

In this extension plan, a heating surface area of 2,000 m^2 of evaporation plant provide for 150 t.p.d. production.

A forced circulation system has an increased capability of 150% more than the natural circulation system. Therefore, this evaporation plant is good for 150 t.p.d. bagasse pulp production as shown below.

Brief check:

$$\text{Solid \% ratio in black liquor} = \frac{18\% \text{ (in wood)}}{12\% \text{ (in bagasse)}} = 1.5$$

$$\text{Evaporation ratio} = \frac{100\% \text{ (in natural circulation)}}{150\% \text{ (in forced circulation)}} = \frac{1}{1.5}$$

Bagasse pulp to be produced 150 t.p.d.

$$\text{Heating surface area required} = 150 \text{ (in bagasse)} \times 8 \text{ m}^2 \text{ (in wood)} \times \frac{18}{12} \times \frac{100}{150} = 1{,}200 \text{ m}^2$$

This is sufficient in capacity to produce 150 t.p.d. (having 2,000 m^2 in this plan)

16. Oxidation of Black Liquor

Black liquor must be oxidized twice through on oxidation tank before and after evaporation.

Purpose of oxidation is as follows;

1) Sodium sulphide component in the black liquor is changed to sodium thio-sulphate, and thus becomes stable.
   This helps to prevent the decomposition of Na_2S and H_2S,
   $2Na_2S + 2O_2 + H_2O \rightarrow Na_2S_2O_3 + 2NaOH$
   $H_2S + 2O_2 \rightarrow H_2SO_4$
2) Sodium methyl mercaptan is changed to di-methyl-di-sulphide
   The former chemical is gaseous, but the latter is water soluble.
   $2CH_3SNa + O_2 + H_2O \rightarrow CH_3S\cdot SCH_3 + 2NaOH$
3) By decreasing sulphurous vapours from the black liquor, corrosive action of the evaporator heater tube is reduced.
4) At the same time the bad smell of H_2S, CH_3S (methyl mercaptan) is also decreased.
5) For these reasons, volatile sulphur is fixed while evaporating and sulphur loss is kept to a minimum, namely sulphidity of the liquor is kept in good condition.
6) Since the oxidation of black liquor is not as stable, the oxidation of liquor must be repeated again after evaporation.
   The bad smell from the recovery boiler stack is climianted by re-oxidation after evaporation.

Pre-oxidation and re-oxidation processes are shown in (A) and (E) of Fig. 19.

17. Foaming Trouble at Evaporation

The liquor route shown in the documents of this plan is incorrect.

Weak liquor must be charged into the third evaporator, instead of the fourth evaporator.

See, model arrangement in Fig. 20.

The temperature of the last evaporator is about 55°C, on the other hand, the weak liquor which is charged into evaporator is about 80°C. This difference of temperature means that a large quantity of heat comes into the (fourth) evaporator from outside the system.

This new heat entry causes the weak liquor to boil at this stage. In addition to this, the thin liquor causes more foaming.

To avoid the above unfavorable conditions, the weak liquor must be charged into the third evaporator, having the same temperature.

Of course, the concentration of the weak liquor should be increased by adding strong (thick) black liquor before charging to minimize foaming.

18. Scaling Trouble in an Evaporator

Both reeds and sugar cane contain much silica in their stalks. Ash of these materials is in a range of 3 - 6%, on the other hand, in case of wood, the ash is only 1%.

About 60% of the ash from reeds is said to be silica (SiO_2).

Scaling trouble in an evaporator originates largely from the silica component contained in the black liquor of bagasse or reeds.

The liquor velocity in the evaporator heater tube must be high up to prevent scaling trouble. For the above reason, the natural circulation type evaporator is unsuitable for evaporation of bagasse in comparison with a forced circulation type evaporator.

Therefore, evaporators in this plan are good from this viewpoint.

It is said that concentration of black liquor after evporation should not be over 40% solids to avoid scaling trouble.

Analytical data of black liquor composition.

		Reed	Wood
Sodium	Na	20.0	18.5
Carbon	C	35.5	38.3
Hydrogen	H	3.5	3.1
Sulphur	S	3.1	3.4
Oxygen	O	33.0	36.5
Nitrogen	N	1.9	0.2
Silica	SiO_2	3.0	-
Total		100.0	100.0

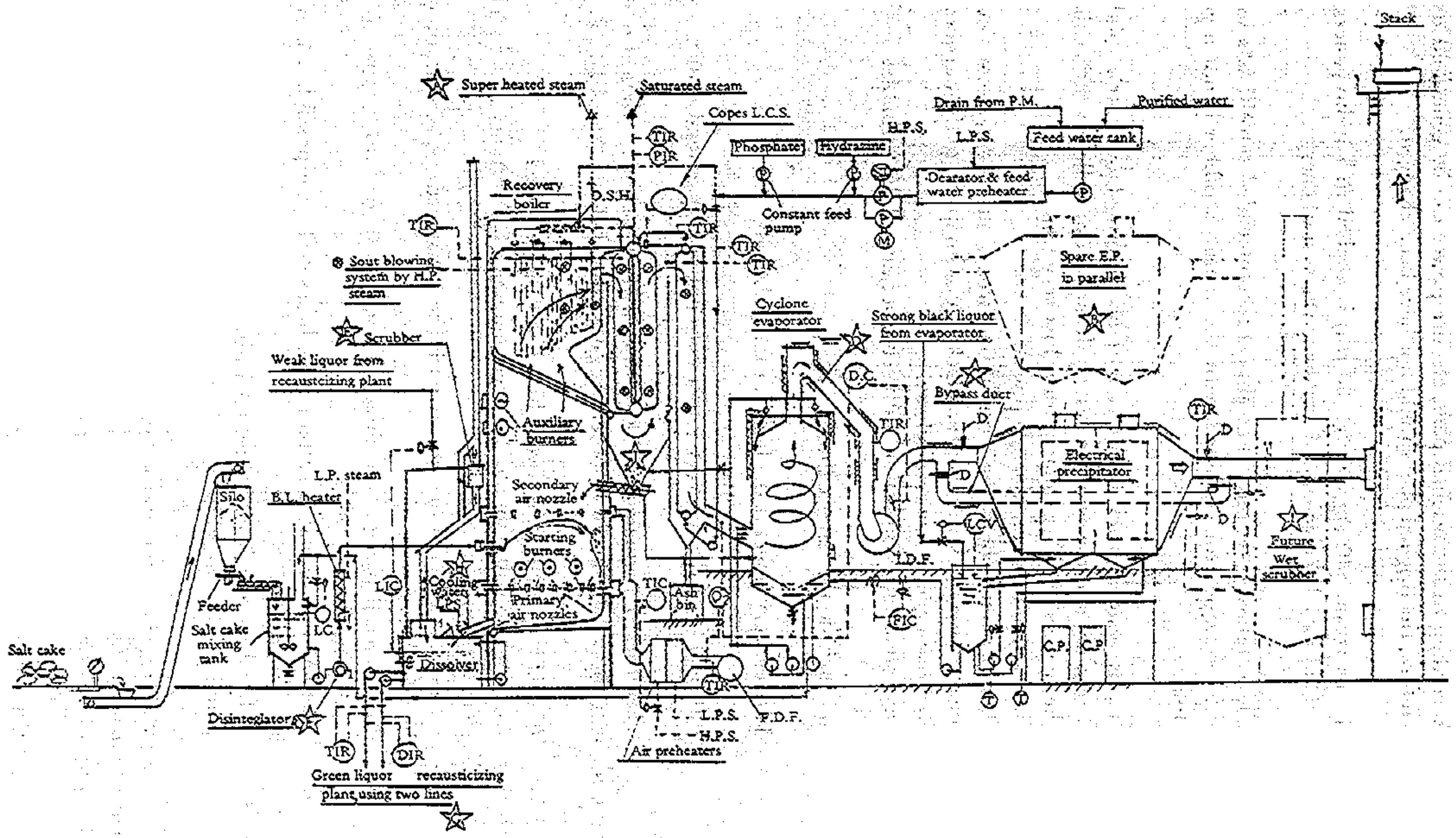
19. Tomlinson Type and Other Types of Recovery Furnaces

Features of the recovery boiler design in this plan is as follows;

B & W – Tomlinson → Venturi – Cyclone evaporator → Stack
Boiler

	Present (revised) plan	(The Original plan)
Capacity of steam generation	38 t/h	(31)
Steam pressure (designed P)	25 kg/cm^2	(45)
Steam pressure (working P)	20 kg/cm^2	(40)
Steam temperature	213°C	(400)
Temperature of feed water	103°C	(170)

Fig. 21. Recovery Boiler Arrangement



According to the original plan, electirc power can be generated using high pressure steam, and therefore, the original plan should not have been changed.

If this steam (40 atg, 400°C, 30 t/h) is applied to a turbo-generator, 2,500 kW of electric power could have been generated, reducing the cost of energy.

The Tomlinson system is not always recommended since it is a rather troublesome system. A cyclone evaporator conbined with the venturi scrubber is not a good system. The reasons are as follows;

1) In this system, black liquor cannot be thickened over 50% solids, because liquor circulation and the spraying system do not move well over 50% solids.
2) The venturi scrubber cannot catch dust very well.
3) This system uses considerable power.
4) Those systems (both the Tomlinson furnace and the cyclone - evaporator) require considerable work to clean the black liquor lumps from the corners.
5) The steam generation rate is low.
6) Long continuous operation is difficult because of dust trouble.

In conclusion, I can say that;

The recovery boiler is the heart of the pulp mill.

But the life of the recovery boiler does not usually extend over ten years.

Therefore, I recommend that at the next opportunity when a new recovery boiler is required, another system should be ordered as descirbed below; (See, Fig. 22, 24)

1) A fluid burning type recovery boiler must be installed.
2) Working pressure should be high enough (for instance 60 kg/cm^2) to generate electric power.
3) As a direct evaporator contact with the exhausted gas, a cascade evaporater should be installed.
4) An electrical precipitator should be installed after this evaporator for completely recovering the soda dust.
5) The water purification system must be as perfect as possible when using such a high pressure boiler.
6) A bleeding and back pressured turbine (60 →15→2.5 atg) is recommended in conjunction with this boiler.

With regard to the direct contact evaporator, (See, Fig. 23) the cyclone evaporator system has many defects as mentioned before. Especially, piling or clogging with dried masses of black liquor often cause trouble in operation.

On the other hand, in using a cascade type, such trouble is decreased. But with a

Fig. 22. Two Types of Black Liquor Burning System

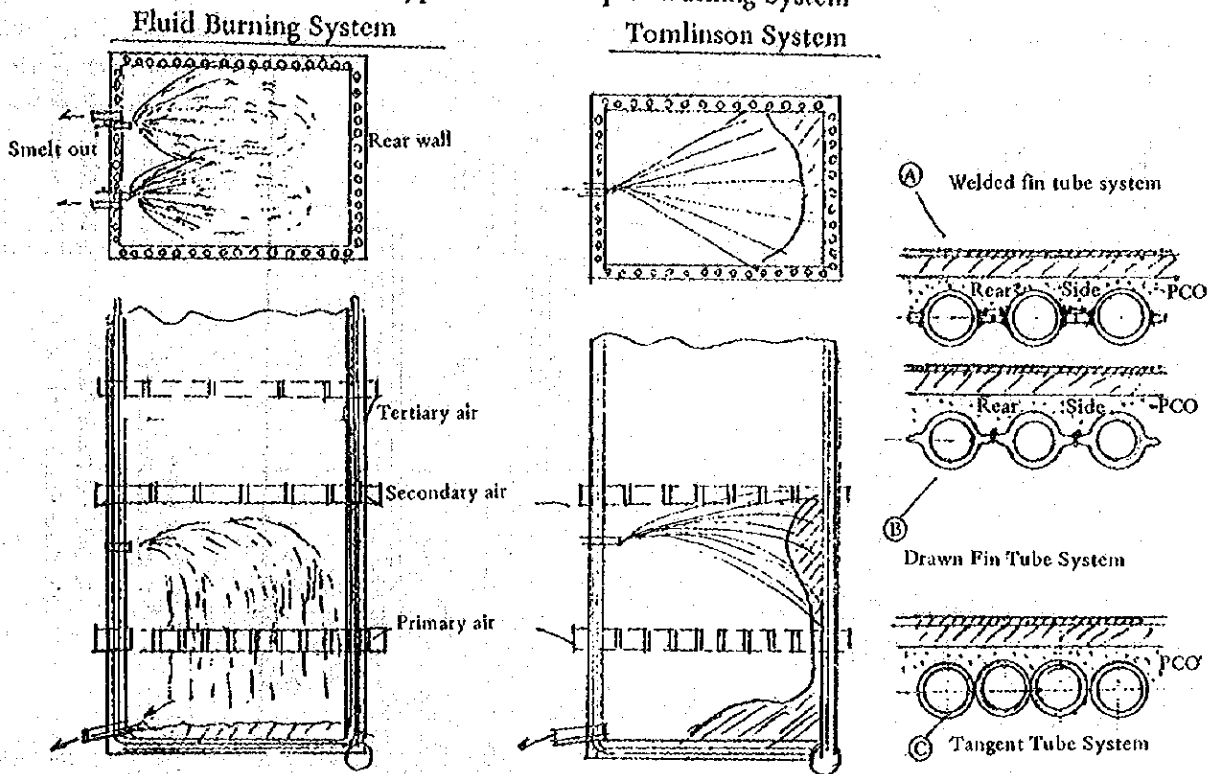


Fig. 23. Various Types of Evaporators

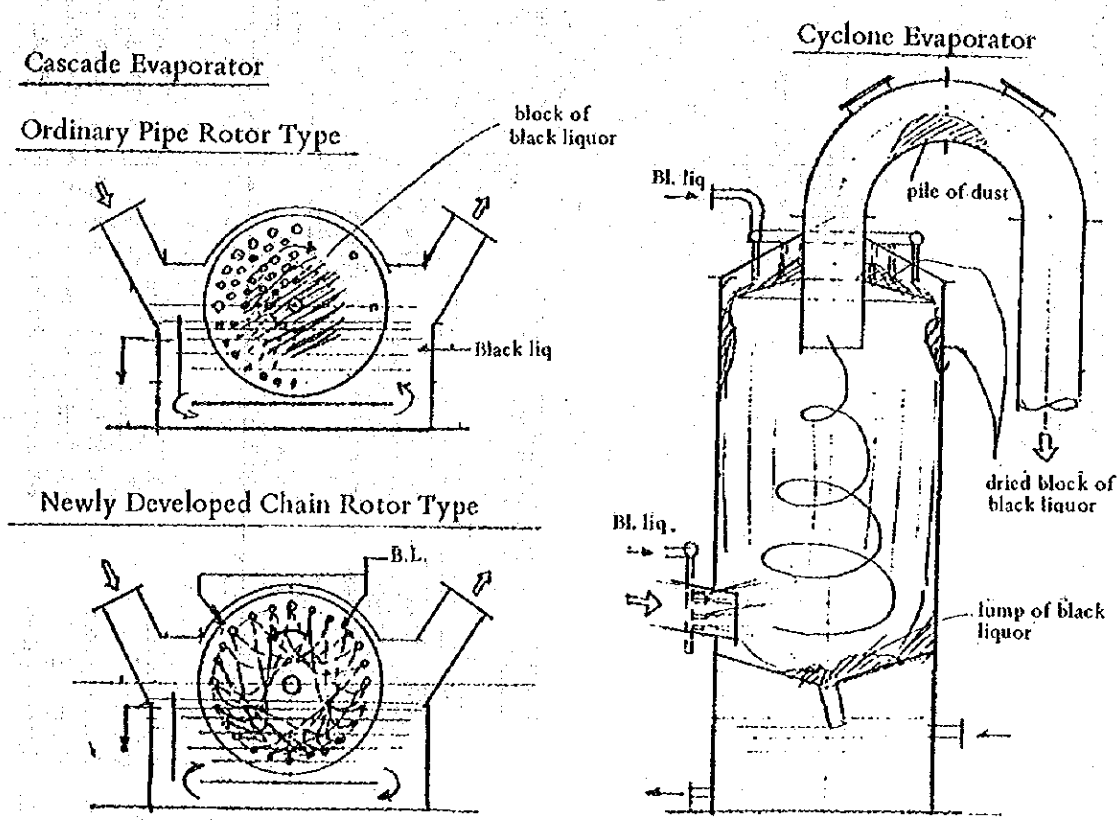
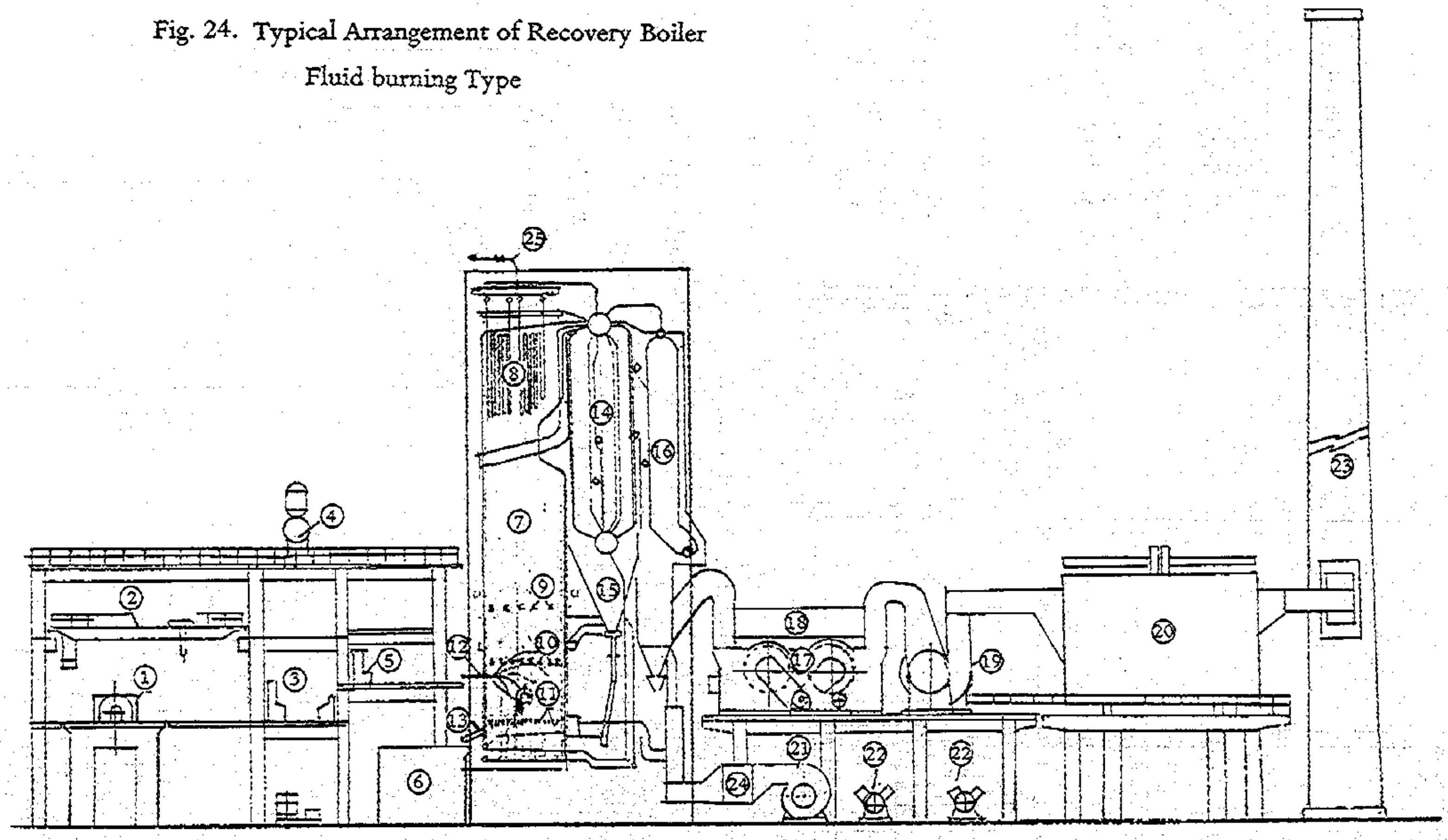


Fig. 24. Typical Arrangement of Recovery Boiler

Fluid burning Type



1. Turbo Generator
2. Crane
3. Controll Room
4. Deaerator
5. Operation Room
6. Green Liquor Dissolver
7. Furnace
8. Super Heater
9. Tertially Air Port
10. Secondary Air Port
11. Primary Air Port
12. Spray Nozzle
13. Smelt Spout
14. Boiler Tube
15. Ash Hopper
16. Economizer
17. Cascade Evaporater
18. Bypass Duct
19. Induced Draft Fan
20. Electrical Precipitator
21. Forced Draft Fan
22. Air Compressor
23. Stack
24. Air Preheater
25. Steam Outlet

high concentration of black liquor such as 55% solids, the deposited salt leaves lumps around the shaft of the rotor. To avoid such trouble, I developed a new type of evaporator which has a rotor filled with many of rows of chains.

This type can thicken to 60% solids without any trouble.

20. Inspection of Recovery Boiler Capacity in This Plan

Caloric of dry solids in the black liquor (described in the document)	3,100 kcal/kg
Total solids to be treated per hour (in the document) (by calculation in this report p. 29)	8,800 kg/hr

Generally, the calorific load in the combustion chamber of a recovery boiler is represented as follows;

(A)	in case of a small scale furnace:	170×10^3 kcal/m^3/hr
(B)	in case of a large scale furnace:	120×10^3 kcal/m^3/hr

The following table shows the heat balance of the recovery boiler (in the case of the wood sulphate process). Heat balance sheet per kg of dry solid in black liquor.

Boiler input	kcal	%	Boiler output	kcal	%
1. Calorie from dry solids	3,500.0	82.0	1. Sensitive heat of steam	2,621.2	61.4
2. Sensitive heat of black liquor	108.8	2.5	2. Sensitive heat of exhaust gas (at dry)	159.2	3.7
3. Sensitive heat of steam, used for black liquor, heating up	21.9	0.5	3. Sensitive heat of the moisture in the exhausted gas	972.4	22.7
4. Sensitive heat of air for burning	149.1	3.5	4. Heat required by reduction of salt cake	261.6	6.1
5. Sensitive heat of feed water	498.3	11.5	5. Heat required by melting of soda	14.8	0.3
			6. Sensitive heat of smelt	94.5	2.2
			7. Heat losses by radiation and others	154.4	3.6
Total	4,278.1	100.0	Total	4,278.1	100.0

Boiler efficiency = 61.4%

Arranged input heat based on this table and the documents:

item (1) (2) (3) (4) (5)

3,100 + 108.8 + 21.9 + 149.1 + 498.3 = 3,878 kcal/hr (input heat)

Volume of furnace according to the document,

4.5 m (width) x 4.95 m (depth) x 12 m (height) = 267 m^3.

Approximate calorific load factor in the furnace in this plan is as follows:

$$\frac{3,878 \times 8,800}{267} = \frac{34,126}{267} \times 10^3 = 128 \times 10^3 \ kcal/m^3/hr.$$

This figure is almost equal to case (B) on the previous page. It has adequate capacity for treating 150 t.p.d. pulp production.

Amount of steam of boiler output:

Available calorie for generating steam is as follows:

3,878 (kcal/kg) x 8,800 (kg) x 0.6 (Efficiency) = 20,475,840 kcal/hr

Quantity of estimated steam generation by using only black liquor.

Steam pressure, atg.	50	30	20
Temperature, °C	400	250	210
Enthalpy of steam, kcal/kg	Super heated steam, 760	Saturated steam, 680	Saturated steam, 670
Calorie, kcal/hr	20,475,000	20,475,000	20,475,000
Quantity of steam, t/hr	26.9	30.0	30.5

at 150 t.p.d. production

Difference:

38 – 30 = 8 t/hr steam must rely on oil or natural gas.

21. Recausticizing Plant

Black liquor extracted from reeds or bagasse contains much silica as indicated before.

This makes it difficult to reuse lime mud in the recuasticizing process.

1) Silica components in the black liquor as Na_2SiO_3 are changed into $CaSiO_3$ when being causticized with CaO.
2) Silica cannot be removed from this system even when the lime mud is reburned.
3) Silica will accumulate gradually into the lime recycle system.
4) Silica components make it difficult to separate the clear white liquor and the lime mud from the causticized liquor.

For these reasons, the separated lime mud at the recausticizing process must always be disposed. of and quick lime (CaO) must be made from the raw lime stone ($CaCO_3$) each time.

In order to minimize alkali loss caused by this wasted sludge, the sludge must be washed sufficiently with the lime mud washer. A precoat filter is good for this purpose.

22. Explanation of Flow Chart in Fig. 25

Mark ☆A

Location of the green liquor storage tank in the original plan is incorrect because alien substances in the green liquor will precipitate here at first and green liquor clarifier will become of no use.

Therefore, the position of both the above tanks must switched as shown in the figure.

Mark ☆B

The green liquor must be heated at over 90°C, otherwise causticizing is not done well. Spiral type or plate type heater is suitable for heating the green liquor.

Mark ☆C

For washing the lime mud with a lime mud washer, wasted drain extracted from the evaporation plant can be used.

Mark ☆D

As a lime mud washer, a precoat filter is good. (Revised plan)

Mark ☆E

The green liquor pipe line from a dissolver tank to a green liquor clarifier and weak liquor line from a lime mud washer to a dissolver should be used alternatively by switching, because the green liquor pipe line often becomes narrower with the deposited soda, but the weak liquor can dissolve this deposited soda.

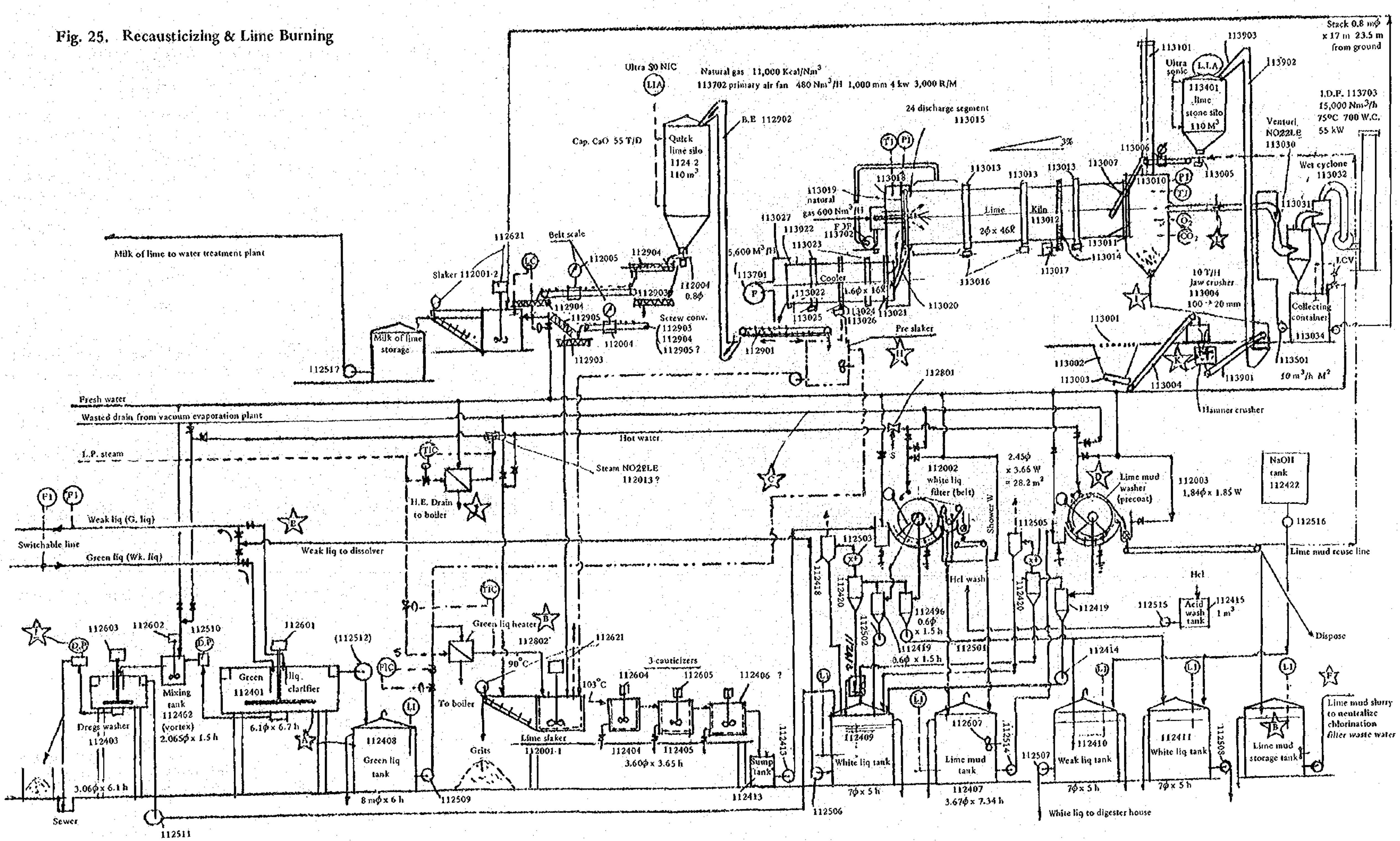
Mark ☆F , ☆G

A part of the waste lime mud would be used as a neutralizing chemical of waste water from the chlorine filter.

And the remains would be used in a cement mill.

A lime mud storage tank is needed for storing lime slurry here.

Fig. 25. Recausticizing & Lime Burning



Mark ☆H

Burnt lime must be slaked directly by charging into a preslaker at first for utilizing heat, not to be stored in a lime silo.

By this method, the temperature of the green liquor would rise to about 100°C, so the green liquor heater would be of no use.

A conveyor (112,901) to a preslaker should be reversible for using two ways, to a lime silo and to a preslaker.

Mark ☆I

At this point, a diaphragm pump should be used.

Mark ☆J

Instead of the direct steam injection type, a spiral heat exchanger is recommended to be installed and condensed water here is returned to a boiler.

Mark ☆K

When lime stone is burned, grits of lime must be crushed into fine pieces of less than 5 mm.

For this purpose, a hammer mill should be installed under the jaw crusher.

23. Evaluation of Capacity of Recausticizing Plant

White liquor requirements:

by description in page 9.

NaOH	1,512 kg/cooking x 28.8	= 43,546 kg/day
Na_2S	378 kg/cooking x 28.8	= 10,886 kg/day
Total alkali	1,890 kg/cooking x 28.8	= 54,431 kg/day

White liquor density:

120 g/liter → 120 kg/m^3

54,431 kg/day ÷ 120 kg/m^3 = 454 m^3/day → 19 m^3/hr .... (1)

CaO or $CaCO_3$ requirement:

Formula in causticizing:

$$Na_2CO_3 + CaO + H_2O \rightarrow 2NaOH + CaCO_3$$

106   56   2 x 40   100

CaO requirement:

$$\text{per day} = 56 \times \frac{43{,}546}{2 \times 40} \text{ kg/day}$$

$$= 30{,}482 \text{ kg/day} \rightarrow 1{,}270 \text{ kg/hr} - CaO \quad \ldots\ldots\ldots\ldots \quad (2)$$

Formula in calcining lime:

$$CaCO_3 \rightarrow CaO + CO_2 \quad (-42.5 \text{ kcal/kg})$$

100 56

$CaCO_3$ requirement:

$$\text{per day} = 30{,}482 \text{ kg/day} \times \frac{100}{56}$$

$$= 54{,}432 \text{ kg/day} \rightarrow 2{,}268 \text{ kg/hr} - CaCO_3 \quad \ldots\ldots\ldots\ldots \quad (3)$$

Belt filter:

Surface area of a belt filter in this plan:

2.45 m (dia) x 3.14 x 3.66 m (width) = 28 m^2 .... (4)

Capacity of a belt filter when separating the white liquor is said that:

1.5 m^3 (W.L.)/hr/m^2 (of surface area of one drum)

So the capacity of this filter would be

$1.5 \times 28 = 42 \; m^3/hr > 19 \; m^3/hr$

This figure is adequate for the lime mud treatment in this plan.

Size of a drum of precoat filter:

1.84 m (dia) x 3.14 x 1.85 m = 10.6 m^2

According to my experience, a precoat filter which was the same in size was able to treat 70 t.p.d. (b.d.) of lime mud.

Because of this experience, this filter (10.6 m^2) is sufficient to treat 54.4 t.p.d. (abovementioned (3)) of lime mud.

Lime kiln:

Dimension of lime kiln in this plan:

2 m (dia) x 46 m (length)

Simplified formula to obtain capacity of lime kiln in as follows:

$CaO\ t.p.d. = K \cdot L \cdot D^2 \times 3.21 \times 10^{-1}$

K = Moisture factor of lime mud.

Moisture	Factor	
40%	1	
30	1.014	
20	1.028	
10	1,042	
5	1.046	(moisture of crushed lime stone is about 5%) 1.046
0	1.056	

L = Length of kiln = 46 m

D = Available inside dia. of kiln = 1.8 m
(2 m – 0.2 m (0.1 m thick of brick x 2))

3.21 = factor, based on experience

Substitution:

$$CaO = 1.049 \times 46 \times (1.8)^2 \times 3.21 \times 10^{-1} = 50\ t.p.d.$$

This figure is correct by my experience and it will be enough to cover 30 t.p.d. CaO by calculation ((2) on page before) but in an actual case, CaO demand will be over 40 t.p.d.

Retention time in the kiln is expressed by the following formula:

$$T\ (min) = \frac{F \times L \times K_2}{S \times N \times D}$$

T = Retention time, namely lime calcining time in the kiln (min)

F = Factor due to reposing angle:
in lime mud, this figure is 11.2

L = Length of kiln, = 46 m

S = Inclining angle of kiln:
$3\% \rightarrow 90^\circ \times 3\% = 2.7^\circ$

D = Inside dia. of kiln:
$2\ m - (0.1 \times 2) = 1.8\ m$

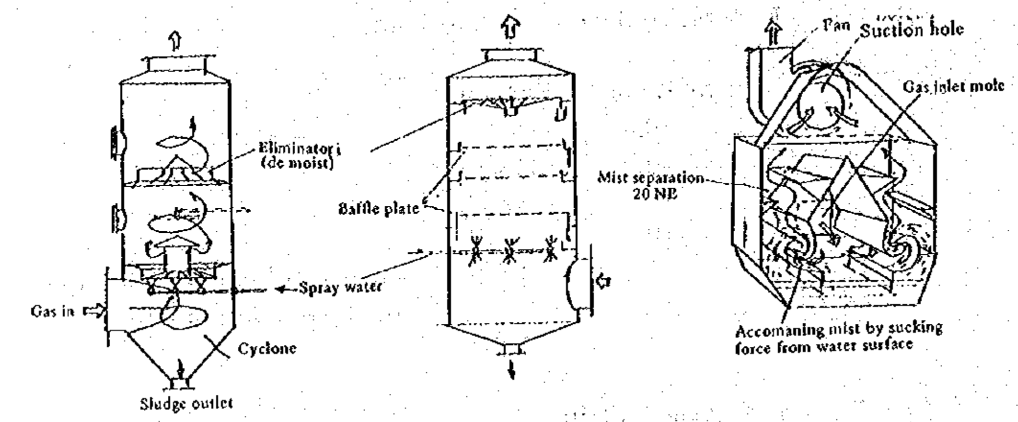
K_2 = Factor: Usually, this factor is 1.0 when running smoothly.

N = R.P.M.: Suppose, 1 R.P.M. in this case

$$T = \frac{F \times L \times K_2}{S \times N \times D} = \frac{11.2 \times 46 \times 1}{2.7 \times 1 \times 1.8} = \frac{515.2}{4.86} = 106\ min$$

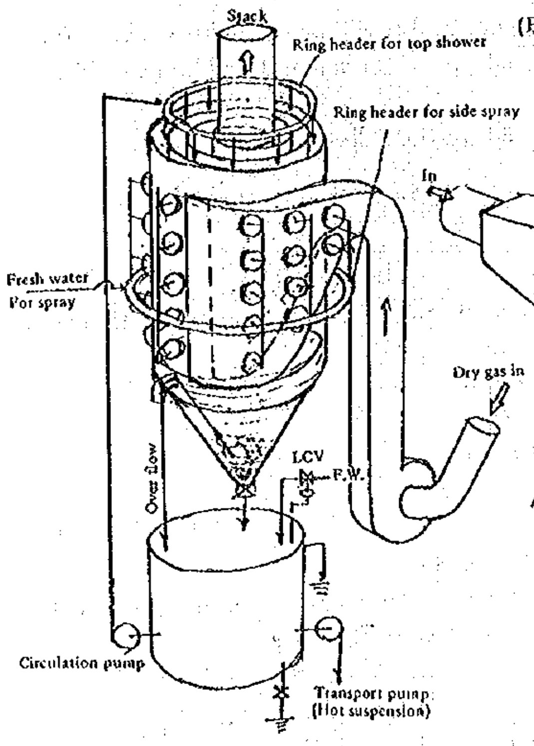
Temperature at calcining zone must be kept over 1,200°C actually, but decomposing temperature of $CaCO_3$ is said to be 898°C.

Fig. 26. Various Type of Scrubbers

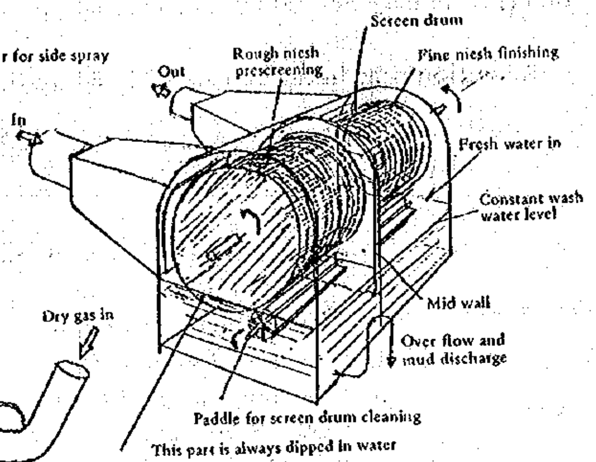


(A) Ducon Scrubber (USA) (B) Peabody Scrubber (USA) (C) Roto-clone Scrubber (USA)

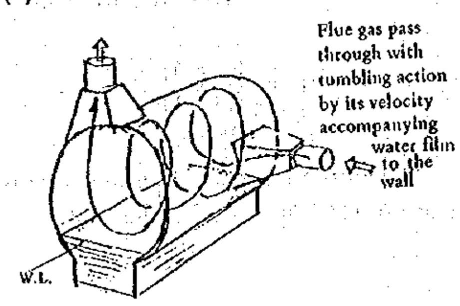
(D) Wet Spiral Wall Scrubber (H. Okumura)



(E) Wet Screen Wall Scrubber (H. Okumura)



(F) Air Tumbler (USA)



24. Dust Scrubber

In this plan, the venturi-cyclone system is employed as a lime kiln scrubber.

But, this system is not suitable for the following reasons:

1) The pressure drop is very large between the before and after venturi section, this has bad effects on the burning condition of the kiln, especially on draft conditions.
2) This system requires considerable power for the inducing fan and also for the water injection pump.
3) Dust percentage in the waste gas at the end of kiln is very high, so clogging trouble caused by the dust might occur often in the scrubber of the original plan.
4) Erosion in the venturi causod by high velocity, high density of dust and the vacuum condition will be large.
5) The dust collecting efficiency will be poor. See, Fig. 27.

Many Ducon type (A) and Peabody type (B) are used in Japan.

These types have less draft loss than the venturi type.

(D) is a spiral wall system and (E) is a wet screen wall system, both were developed by the author. The former (D) consist of spiral walls having many special spray nozzles around the outer wall.

It is hard to obtain more than 90% dust collecting efficiency with these installations. But I had good results by using the wet screen system (E) in series. Nowadays, the electrical precipitator system is considered the best way for collecting dust from the lime kiln.

REPORT PART II

REPORT ON VISITING TO THE BASLAH PAPER MILL

(EXISTING MILL)

June, 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

REPORT OR VISIT TO THE BASLAH PAPER MILL

Contents

1. Schedule on visiting the Baslah Mill

I visited the Baslah Mill and stayed for four days from the 20th to the 24th of March.

20th, March

I left Baghdad at noon by plane, and arrived at the Baslah Mill at 3:00 P.M. I met several of their staff members in the office, and then inspected the new mill (Baslah Extension Mill) being guided by Mr. Samir, who is an Egyption engineer.

21st, March

It was vernal equinox day. I took a walk by the Shatt-al Arab river in the morning. In the afternoo, Mr. Samir guided me through the old mill (Existing Mill) until evening.

22nd, March

In the morning I met Mr. Edward (Chief of Civil Engineers). At his discretion, Mr. Samir and I left the mill by car to visit Misan Mill and arrived there at noon. This mill was just being built at that time. On the way I saw a sugar factory from the car, but I was not allowed to visit there.

23rd, March

In the morning, I had time to talk about operation conditions with several mill operators of the existing mill. I left there at 11:00 a.m. for Baslah airport, but I could not get a flight in the afternoon, so I had to take a car arrived at Baghdad at midnight.

2. Description of Inspection (Abstract)

(1) Baslah Extension Mill (New mill)

1) All mill arrangement were handled very well.
2) There seemed to be something inadequate in the details, which I will mention later.
3) I was curious as to why the same arrangements were made for old mill and the new mill since the old mill is not operating well.

(2) Baslah Existing Mill (Old mill)

1) The installation is very good.
2) The mill operations are not running well, and so production did not reach capacity, though it has been operating for several years.
3) There are several points which should be improved as described later.
4) The quality of products is unsatisfactory, so the quality must be checked more closely and be improved.
5) The production rate is very low and there is considerable consumption of chemicals; especially the recovery of chemicals is not done well.

6) All staff members in the mill pay attention to the production rate and manufacturing costs.

(3) Misan Mill

This mill is just being built.

1) It appears that the river near the mill site was too narrow and the water level too low.
2) I do not know about details of this project, but I can make some suggestions about this plan as described later.

3. Detailed descriptions – Baslah Existing Mill operation –

Production rate

The cause of poor productivity is based on the following reasons;

a) Operation stops very often, and the time for repairs takes too long;
b) Operation conditions are not good, especially for cooking.

Counterplan for the above causes

a') While I was in the mill, the recovery boiler was not running for two days because of water leakage from the boiler tubes.
Water leakage from the boiler tubes of the recovery boiler is very dangerous, because when water pours down on the smelt, it often causes an explosion.

1) We must carefully watch for hair-cracks and corrosion or erosion of the boiler tube surface.
A hair-crack can be found by adopting a die-check test and the corrosive state can be measured by using ultra-sonic thickness measurement equipment. Such checking must be done yearly.
2) The machine shop should be properly arranged. The repair team must be properly ready to work at any time, even at night.
3) Spare parts should be stored in a store house.
4) A technician for welding work, especially a licensed high pressure vessel welder, must always be ready at anytime.

b') Inefficiency of mill operations is apparently caused by unsuitable cooking of bagasse. Namely, low (bad) freeness of cooked stock creates difficulty in washing and consumption of chemicals high.

1) To obtain good results in washing, the freeness of cooked stock must maintain a high K-number in cooking and should go up to about 13 (6 to 8

at present).

(2) At the same time, pith cells must be removed as much as possible at the depithing stage before cooking.

(3) Cooking mixed with bagasse and reeds can obtain good results, not only in washing but also in the quality of paper.

(4) Cooked stock should be treated by using a hot refiner or a disintegrater at first and then screened before washing. Separated sheaves here should be returned to the silo for recooking with new bagasse.

(5) When I saw the brown-colored stock, it was bleached due to overcooking and was different from the usual color.

The K-number was 6-8, freeness was 24-21 in S.R. (Shopper-Rieglar) system corresponding to 575-520 in C.S.F. (Canadian Standard Freeness). The numerical value means overcooking. This means the pulp yield is l ow. In moderate cooking, about 13 in K-number is around 650 cc in C.S.F. (18° in S.R.).

Generally, freeness of hard wood kraft pulp (unbl) is about 700 cc and soft wood is about 800 cc in C.S.F.

4. My viewpoint on cooking of bagasse – Temperature and time of cooking –

Recently, most mills install a continuous digester in cooking of bagasse, which results in the following cooking conditions:

Amount of active Alkali added to bagasses in cooking as Na_2O:	12 - 14%
Maximum temperatur of cooking:	165°C
Retention time at maximum temperature:	20 min.

On the other hand, the cooking conditions in the Baslah Mill using the batch cooking system is as follows:

Amount of active Alkali:	13%
Maximum temperature:	130°C
Retention time at Max. temperature:	150 min.

As you can see from the above, the cooking temperature of the Baslah Mill is too low. If the temperature was raised to 160°C even in using the batch system, the retention time could be adequate with about 30 minutes. It is generally said that the cooking time is reduced to one half, according to the increase in temperature every 10°C in cooking. (But, only in the case of about 150°C)

The minimum cooking temperature limit is usually as follows:

Stalk of reeds or sugar cane:	Over 140°C
Hard wood:	Over 150°C
Soft wood:	Over 160°C

The difference of the above cooking temperature depends on the difference of the melting point of each lignous material,. Therefore, cooking temperature of 130°C in this mill is too low, and it results in many sheaves which cannot be dissolved.

The best way to decrease sheaves in the cooked stock is to defibrate by using a hot refiner or disintegrator just after cooking. And in continuous cooking, pressurized hot refining is done between the cold blow unit and orifice (blowing port).

Sulphidity of cooking liquer

In comparing simple caustic soda cooking liquor with kraft cooking liquor, the former is more active than the latter in cooking.

As the former dissolves not only lignin but also cellulose to some extent, the pulp yield is usually about 10% less than with kraft cooking (the latter). In kraft cooking, sulphidity has a serious meaning. When sulphidity is less than 20%, there is no effect in braft cooking. In the Baslah Mill sulphidity is said to be about 5%, by this figure, kraft cooking has entirely no meaning.

Low sulphidity in this mill is derived from the low recovery rate of chemicals. Namely, a large amount of caustic soda is used to make up cooking liquor before the charge to digester.

Therefore, if the recovery of cooking chemicals becomes normal, sulphidity will be higher accordingly. As a way to raise sulphidity in cooking, use Sodium sulphide (Na_2S, x H_2O) instead of Caustic soda or directly add Sulphur (S) to the digester. By the addition of Sulphur, mono (x = 0) or poly (x = 1, 2, 3) Sulphide (Na_2S_{1+x}) is made in the digester. It is said that, poly sulphide has the same effect as sulphidity.

5. *How to increase production — Digester operation condition in Baslah Mill —*

	Bagasse	Reeds
Time to charge raw material and cooking liquor;	120 min.	50 min.
Time to steam for raising maximum temperature;	150 min.	100 min.
Retention time at maximum temperature;	(130°C)	(140°C)
	150 min.	120 min.
Time to steam for increased pressure preceding blowing;	10 min.	10 min.
Pulp blowing time;	20 min.	20 min.
Total time;	450 min.	300 m9n.
	(7.5 hrs.)	(5 hrs.)
The number of times of cooking in bagasse per day;	24/7.5x6=19.2	
The number of times of cooking in reeds per day;		24/5x6=28.8
Pulp production at one time of cooking;		
Bone dry weight of raw materials at one time in a dgester	13 tons	14 tons

		Bagasse	Reeds
Yield by cooking, at K-number of ( )		(7) * 45%	(14) 50%
Pulp production per day by the above calculation (not actual)			
in bagasse	13 x 0.45 x 19.2 =	112.3 tons	–
in reeds	14 x 0.50 x 28.8 =	–	201.6 tons

Improvement in cooking method

(1) Cooking mixture of bagasse and reeds

Cooking condition on the supposition that both are mixed:

Time to charge mixed raw material and liquor;	90 min.
Time to raise to the maximum temperature;	150 min.
Retention time at maximum temperature (at 160°C);	30 min.
Steaming proior to blowing is not necessary	—
Pulp blowing time;	15 min.
Total time	285 min. (= 4.75 hrs.)

Pulp production per day will be as follows: (13+14)/2 x 0.50** x 24/4.75 x 6
= 204 tons/day

(2) If a screw mixing feeder above a digester is changed into a screw conveyor system, the time for charging will be about 30 min. Cooking liquor can be charged through another pipe at the same time by this system.

In the case of

* 45%	K-number is 7 and Sulphidity is 5%.
**50%	K-number is 13 and Sulphidity is 22%
	Numbers of digesters are 6

6. **Brown stock washing**

In order to obtain high productivity and recovery of chemicals in bagasse pulping, it is important that freeness of cooked stock be kept higher, more than 600 cc in C.S.F. to obtain good washing results as mentioned above.

If bagasse and reeds are cooked together and the K-number is kept about 13, freeness of cooked stock will be about 650 cc in the Canadian Standard, but the present freeness in the Baslah Mill of bagasse cooking (without reeds) is about 520 – 575 cc in C.S.F. (= 24 –

Fig. 1 Relation with C.S. Freeness and S.R. Beating Degree

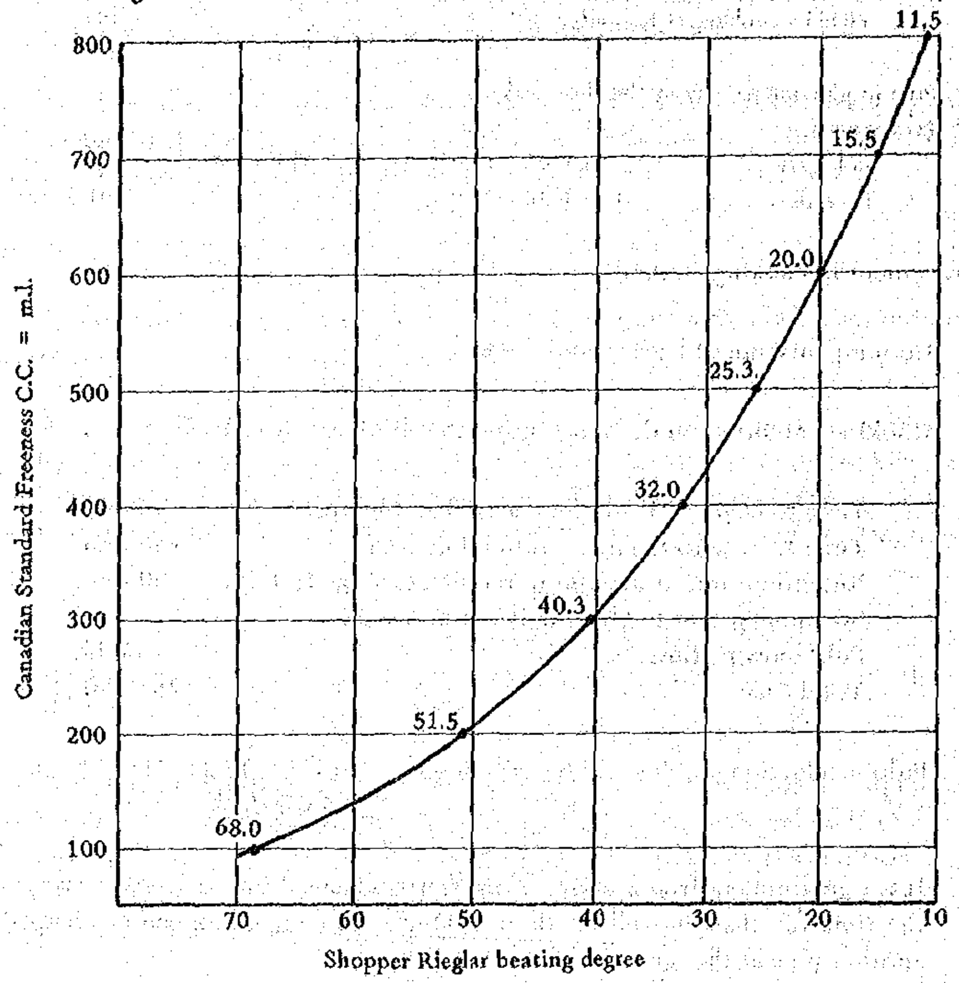


Fig. 2 Chemical Analysis of Various Raw Materials

	Reed	(Hawaii) Bagasse	Hard Wood	Soft Wood
Hot water extructs	3 – 6 %	2.5 %	– %	– %
Total cellulose	54 – 60	76.6	54 - 61	53 – 62
α - Cellulose	36 – 44	38.1	38 – 49	40 – 45
Lignin	15 – 20	20.2	23 – 30	26 – 34
Pentosan	25 – 28	26.7	19 – 26	7 – 14
Ash	2 – 3.2	1.7	1.0	1.0
SiO_2 in the Ash	63			

21 in S.R.)

See Fig. 1 Relation of both. Let us consider the sheet forming condition on a washing drum surface in the case of "A" and "B" in Fig. 3 below.

"A" is when freeness is moderately high such as 700 to 750 cc in C.S.F. (for instance, wood pulp). The pulp layer on the drum surface is formed as a soft and bulky layer, so this layer permits washing liquor and free air to pass through easily so that the vacuum inside the drum does not rise more than the limit, for instance, minus 2 meters by water column. Then the barometric leg of this drum is adequate to within 3 meters eliminating the need for a vacuum pump.

"B" shows an example when freeness is as l ow as 500 to 600 cc in C.S.F. (for instance, bagasse pulp). The pulp layer consists of two layers, but it is not as thick as "A". The inside layer is made by slow stock(such as plastic film) and is hard to penetrate the wash liquor. (also air)

Therefore, the increased vacuum here by vacuum leg or pump makes this layer tighter. Because of this the pulp layer cannot become thick and washing cannot be done well, which means low washing capacity. In such case, to keep the vacuum high using a vacuum pump is not the correct method. (increases tightness only) In connection with this explanation, I will introduce the KAMYR-type brown stock washer.

Fig. 3 Washing Conditions

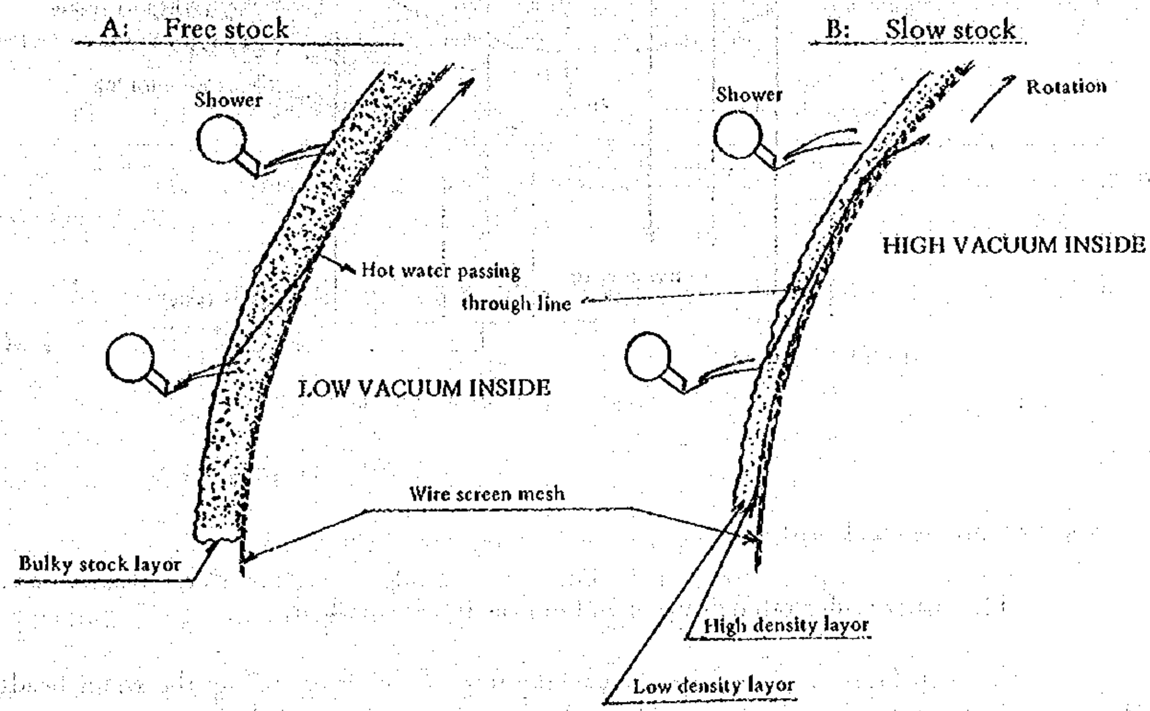
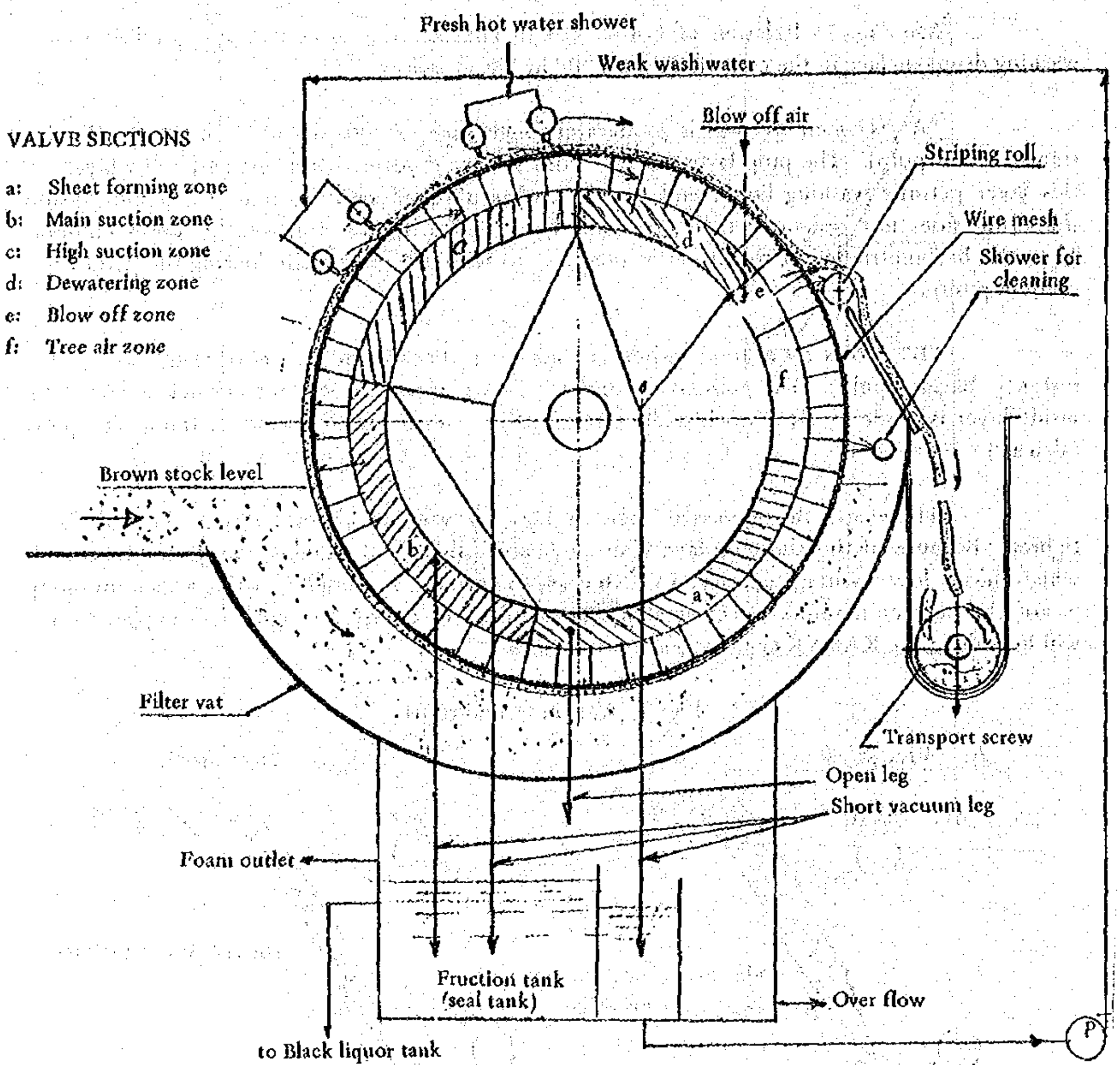


Fig. 4 Brown Stock Washer Type Kamyr (with short suction leg)



7. KAMYR Brown stock washer

This washer is illustrated in Fig. 4 and in principle is excellent.

The pulp layer is formed by the sucking force which is caused by the water head difference of the water level inside and outside of the drum in a bulky condition.

The vacuum section is separated into two parts, and each section has a short barometric vacuum leg, about three meters in height. These two legs enable two stage washing. At the place where a stripping roll is fixed, an air blow off system is provided to easily take off the pulp layer from the drum. Pulp consistency at the discharge end is usually 16% and soda loss is not over 20 kg per ton of pulp in a tandem arrangement of two machines.

Judging from this point of view, the present washer in Baslah Mill is not the best.

The dilution factor could be reduced from 12 (at present) to 8 if the pulp layer on the filter drum is formed safter and bulkier by using the KAMYR brown stock washer.

8. Stock preparation and Paper manufacturing

Freeness of the stock just after refining is about 400 cc in C.S.F. (= 32° in S.R) and in the flow box of a fourdrinier it declines to 350 cc by mixing with white water and wet brokes. But freeness of bagasse stock is already about 500 cc before refining and so bagasse does not need thorough refining and so bagasse does not need thorough refeining.

Bagasse fiber has a tendency to be hydrated easily by refining and does not fibrilize like soft wood fiber. Bagasse stock contains more pentosan than soft wood pulp. Pentosan serves as the adhesive material for bonding each fiber of paper. Pith-cells in bagasse stock weaken the strength of paper and decrease capacity very much. When refining the stock, pith-cells are hydrated easily.

The following are my impressions of several kinds of paper which were manufactured in this mill. See the sample piece at the end of the report.

a) Paper for the use of envelopes made from kraft pulp bleached:

The texture is uneven, and the sheaves from bagasse remain. I presume that the tear factor is low.

b) White paper for writing or printing made from bleached kraft pulp of soft wood (imported pulp):

The texture is uneven and the paper surface is not smooth.

c) Coated paper:

Color of the paper is not good, gloss of paper surface is not uniform and there are many streaks on the surface, brightness is also low. Texture of base paper is not even. The result of coating is influenced largely by smoothness of base paper.

9. Blending of pulp

To obtain good paper with an even texture, long fibers such as soft wood pulp have to be shortened and beaten lightly to fibrilize the fiber. Fiber of hard wood has about 1/3 soft wood in its length and width, which helps to even the texture of the paper. Due to these characteristics, hard wood fibers are now mainly used for printing and writing paper. So as to keep the paper strong in a wet condition on the paper machine, at least 10% to 20% of soft wood pulp should remain.

Bagasse pulp consists of various fractions as indicated in Fig. 6 on the next page.

To strengthen the paper and to improve capacity, soft wood pulp should be blended with bagasse pulp.

Blending of pulp is very important when making paper. It is not good to use only one kind of pulp. Expecially, bagasse pulp should be mixed with reeds and soft wood pulp so as to increase capacity and strength and also to obtain uniform texture.

I can recommend blending of pulp in the following proportions:

For writing or printing paper and base paper for coating;

Bagasse bleached kraft	40%	add clay 10%
Reeds bleached kraft	40%	
Soft wood bleached kraft	20%	

For wrapping or sack paper:

Bagasse unbleached kraft	30%	no clay
Reed unbleached kraft	30%	
Soft wood unbleached kraft	40%	

For envelope paper:
Half bleached pulp is available

For board paper:
For top and bottom layer

reed unbleached kraft	40%
bagasse unbleached kraft	40%
soft wood unbleached kraft	20%

For middle layer

reed unbleached kraft	50%
bagasse unbleached kraft	50%

For corrugating medium:

Unbleached bagasse pulp	100%

Depithing and cooking are not stringently required. Strong mechanical treatment is needed to produce this paper.

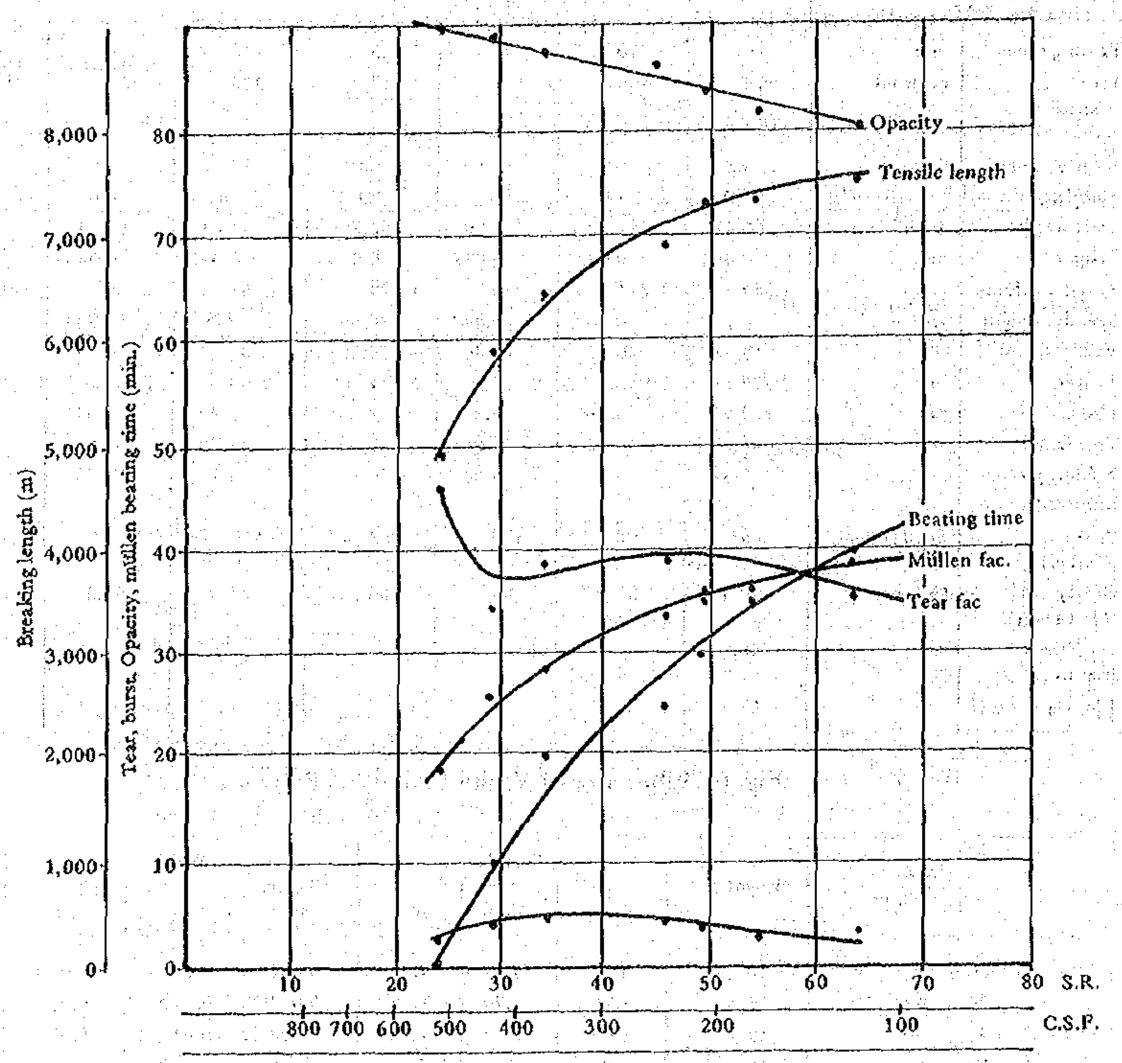
Fig. 5 Physical Test Result of Bagasse Pulp

Test		Unbleached Bagasse Pulp (de-pithed)						
Beating time	min.	0	10	20	25	30	35	40
Freeness (Canadian standard)	cc or ml.	523	425	356	242	224	183	128
Dranage time	Sec.	4.8	6.2	8.1	10.0	14.4	20.5	31.5
Shrinkage	I	3.0	4.0	5.0	5.0	6.0	8.0	9.0
Basis weight	g/cm^2	66.47	57.42	62.50	62.75	62.01	61.48	63.00
Caliper	mm	0.092	0.073	0.077	0.074	0.072	0.068	0.067
Specific volume	cc/g	1,384	1,271	1,230	1,179	1,161	1,106	1,063
Specific weight	g/cc	0.723	0.787	0.813	0.848	0.861	0.904	0.941
Mullen factor	–	18.82	26.13	28.86	33.60	35.14	35.50	39.17
Tensile	m	4,979	5,956	6,474	6,831	7,294	7,362	7,540
Elongation	%	2.95	3.18	2.70	2.22	2.29	2.34	2.88
Tear factor	–	46.06	34.62	39.05	39.34	35.75	35.68	35.19
Folding factor (dd/PBSB)	–	2.54	3.91	4.98	4.89	4.13	3.78	4.15
Polosity (Gurley)	Sec./100 ml.	40	98	190	382	798	–	1,200
Opcity (Photo volt)	%	90.0	89.0	87.5	86.5	84.0	82.5	80.5
Brightness (Photo volt)		36.5						
$KMnO_4$ number		12.4						

Fig. 6 Fiber size of Various Kinds of Pulp

	Mesh classification	Weight %	Length			Width			L/W
			max.	min.	ave.	max.	min.	ave.	
Bagasse	Over 24 mesh	40.4	4.24	1.32	2.43	0.031	0.012	0.020	122
	24 – 42	15.2	2.76	0.77	1.53	0.024	0.010	0.015	102
	42 – 80	19.4	1.64	0.52	1.13	0.024	0.016	0.013	87
	80 – 150	15.1	0.92	0.36	0.64	0.020	0.010	0.013	49
	150 pass	9.9	0.68	0.20	0.46	0.016	0.008	0.012	38
Reed		–	1.8	0.8	1.30	0.020	0.010	0.015	87
Soft wood (Spruce)		–	3.80	2.41	3.22	0.063	0.025	0.034	87
Hardwood (Beech)		–	1.31	0.83	1.01	0.027	0.013	0.019	57
Bamboo		–	1.79	1.33	1.56	0.014	0.010	0.013	133
Rice straw		–	1.41	0.29	0.94	0.029	0.005	0.014	67

Fig. 7 Physical Property of Bagasse Pulp



10. Recovery system —Low recovery rate of chemicals—

1) The recovery rate of cooking chemicals in this mill is said to be about 50%, but the usual recovery rate is about 80% at least in the ordinary bagasse pulp mill. (96% in wood sulphate) I believe the cause for this may be due the following:

a) Difficulty in washing, because of low freeness of cooked stock. As a result, the consistency of black liquor is very low. (8%?)
b) Difficulty in evaporating by carrying-over black liquor.
c) Soda loss in disposing lime mud.
d) Liquor and fiber loss caused by frequent operational stop and start.

e) Soda loss from the stack of the recovery boiler due to the non-installation of an electrical precipitator.

Counterplan for the above items

a') The couterplan for this has alreadу been mentioned before but an outline is as follows.

1) Cooking of mixed bagasse and reeds is advisable.
2) Cooking temperature must be raise to 160° C and the K-number must also brought up to about 13.
3) The dilution factor should be kept low.

b') For this item

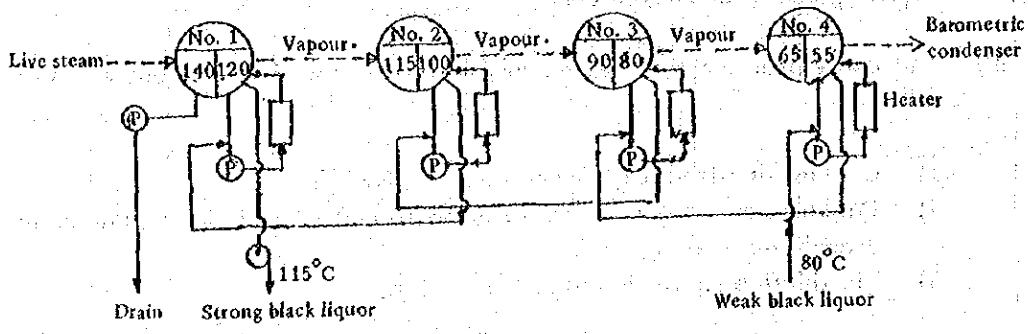
1) Carrying over of black liquor is caused by violent foaming and this foaming trouble occurs when there is considerable boiling and the liquor consistency is still low.
A multiple effect evaporation system is based on multiple utilization of regenerated steam similar to the cascade vacuum system.
Therefore, except for live steam used at the top (first) evaporator, new entry of any heat is undesirable at any stage, because such new heat entry breaks the heat balance of this system.
However, in this mill, a large quantity of new heat enters in the fourth (the last) evaporator. See, Fig. 8.
The boiling point at the last stage would be about 55°C at 650 mm Hg vacuum, while the temperature of black liquor fed at this stage in this mill is about 80°C. New heat entry due to this diffirence of temperature in the last evaporator causes violent boiling and foaming at this stage in the high vacuum condition. So the black liquor feed must be changed in the third evaporator where the boiling point would be about 80°C at about 400 mm Hg in vacuum.

2) Method to recollect black liquor from vapour;
To recollect black liquor from vapour, I recommend the installation of a liquor trap (Cyclone separator) and a surface condenser in the vapour pipe line as shown in Fig. 9. The separated black liquor from the vapour is returned to its own line.
I wonder why a surface condenser is not employed in this mill. Is the reason because, it is not as useful in summer, because the temperature of the cooling water will be higher than 40°C? If this is so, an air cooling system must be used to cool the water line.

3) Another method to reduce foaming
Foaming trouble does not occur at high consistency. Due to this fact, dilute black liquor should be mixed with concentrated black liquor for the purpose

Fig. 8 Evaporator Piping Arrangements

Present Method in Baslah



Recommended Method

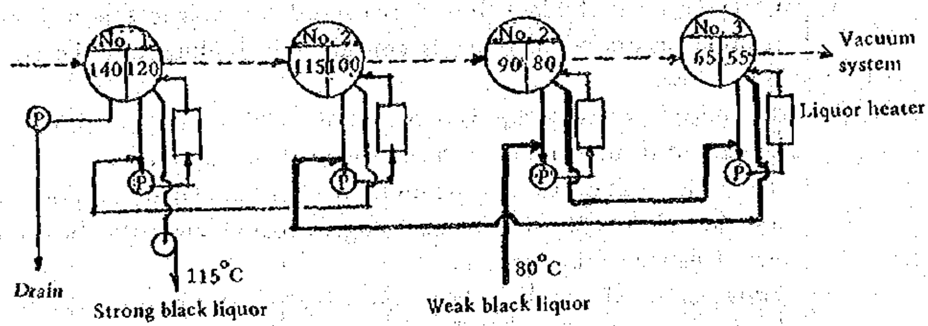
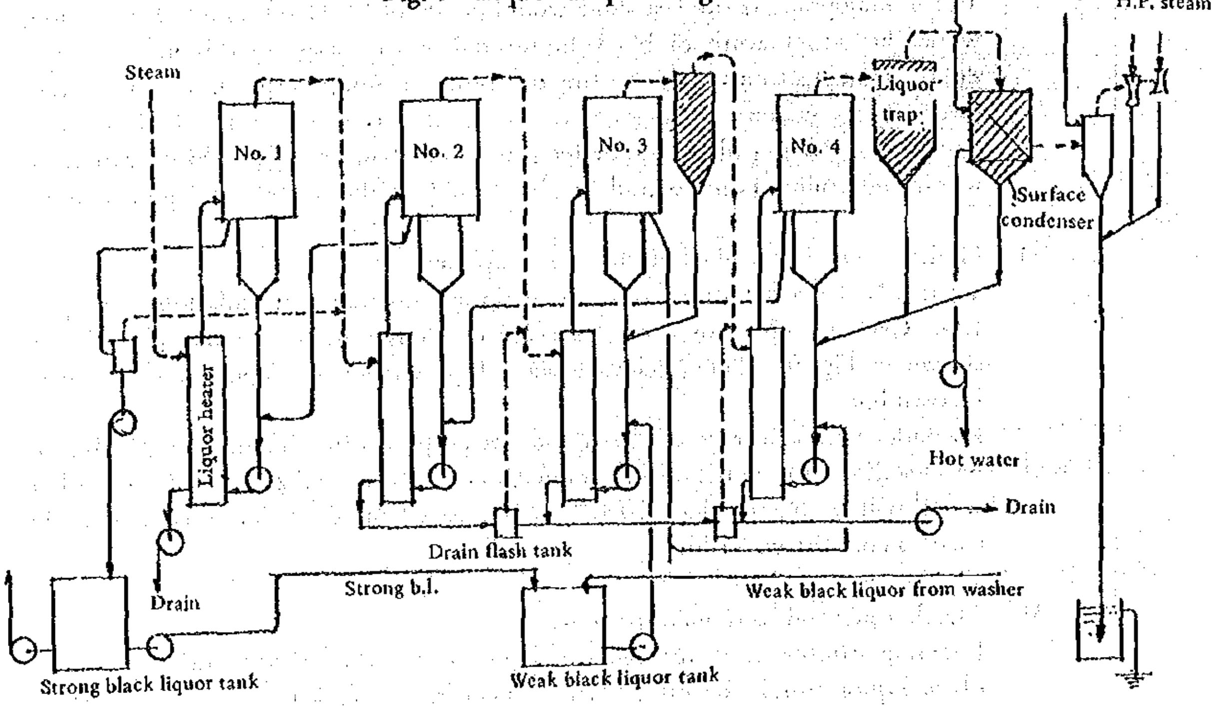


Fig. 9 Liquor Trap Arrangements



of raising the consistency before charging.
This method is already employed in this mill, but liquor foaming has not yet been prevented since boiling at the last effect is still violent.

c') Bagasse and needs contain considerable silica.
When bagasse and reeds are used in the kraft process, the silica component in them disturbs the recausticizing process.
Sodium silicate in green liquor is changed to calcium silicate when calcium oxide is added in the causticizing stage.

$$Na_2SiO_3 + CaO + H_2O \rightarrow 2NaOH + CaSiO_3$$

But calcium silicate can not reproduce calcium oxide as calcium carbonate ($CaCO_3$) by calcining in the lime kiln, and remains in the lime mud.
Presence of calcium silicate in the white liquor separation stage makes it difficult to separate clear white liquor from sludge. For this reason, the lime mud which is separated in this stage should not be reused.
Separaed lime mud using the lime mud filter must be washed clean with hot water to reduce alkali loss.
The only way to reduce alkali loss caused by disposed lime mud is to wash the lime mud sufficiently using hot water and recover it as weak liquor in the dissolver.

d') Maintain good conditions for a long period without stopping, training is important for all operation.
Careful observation with the eyes and ears is required. See the illustration in Fig. 10. Listen for unusual sounds using a stethoscope rod or a hammer, check abnormal temperatures or vibiation by touching all moving parts with your hands.
At the recovery boiler, before firing the boiler must be checked by using the boiler feed water pump to make sure that there is no leakage from boiler tubes by abserving the pressure gauge.

Fig. 10 Watching and Listening at Pump

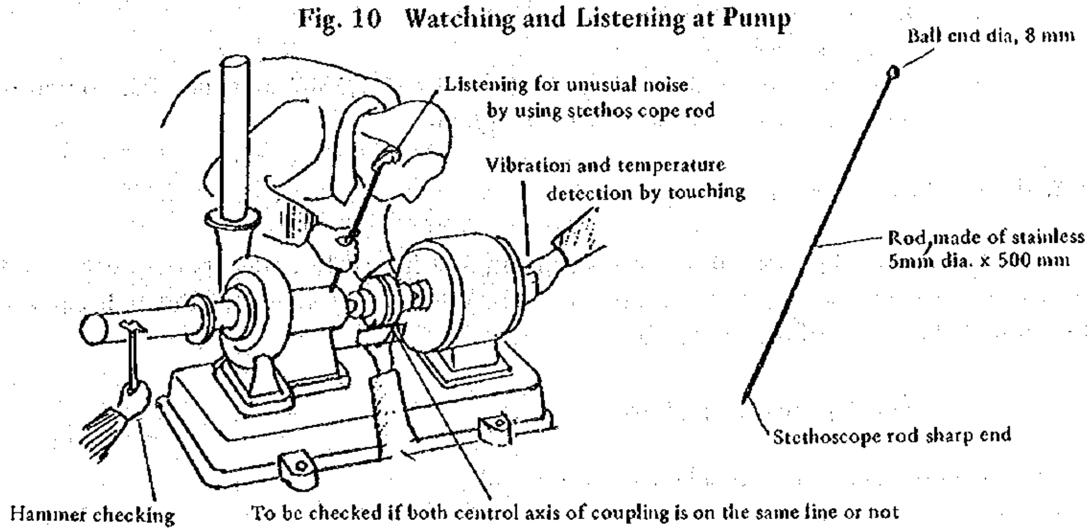
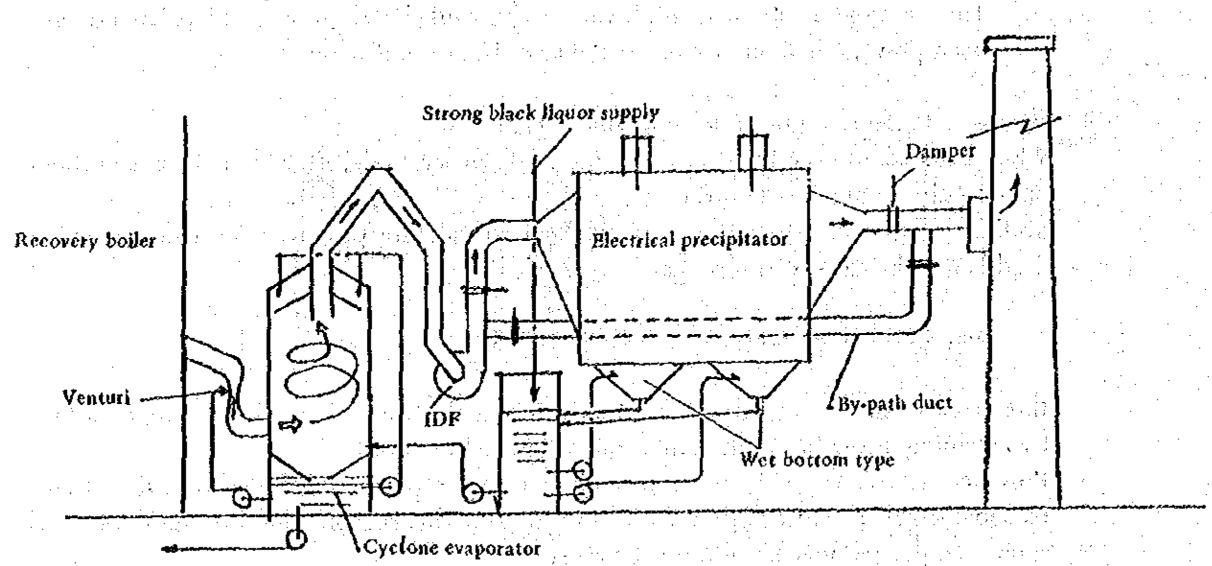


Fig. 11 Flying Soda Dust Recovery System Employing E.P.



e') In this mill, recovery of flying soda dust from the exhaust gas of the recovery furnace, is unsufficient by only using the venturi-scrubbing system.
To reduce stack loss, an electrical precipitation unit must be installed as illustrated in Fig. 11.
With regard to the Electrical precipitator

- o The wet bottom type electrical precipitator is much better than the dry bottom type.
- o Efficiency of dust collecting rate is usually about 98%.
- o A by-path duct must be installed for the purpose of repair work.
- o The temperature of the gas should alway be kept over dew-point (about 130°C).
- o Draft loss is about 20 mm by water column.
- o Voltage is about 50 kv.
- o Dust contents of the inlet gas will be 5 - 10 g/Nm^3 and the dust contents at the discharge end becomes 0.1 - 0.2 g/Nm^3

11. With regard to the management system

I wonder why this mill has not been running smoothly under its own capacity for several years since its opening, but has not yet improved. I presume that this is because the organization of the mill staff is inadequate.

The following are my opinions:

1. Communication is not adequate in this mill.

It is absolutely necessary to install telephones and interphones in the mill.

2. A copying machine is needed to make copies of important communications for dissemination to all departments.

3. A meeting should be held to discuss production plans and repair schedules at least weekly or monthly.

4. To do good a repair job, excellent mechanics and engineering disigners should be employed in this mill.

5. The mill should have a complete machine shop with spare parts.
The repair staff must be ready for work at anytime.

An example of a Pulp and Paper Mill managing organization in Japan.

1. Raw material department
Purchasing, Storing, General affairs, Accounting and Transportation

2. Office work department:
General affairs, Labor's affairs, Accounting, Purchasing and storing products management, Shipping and Mill guard

3. Production department;
Raw material treatment, Cooking, Washing, Screening, Stock preparation, Pulp or paper manufacturing, Finishing, Paper converting and Finishing

4. Power plant department;
Evaporation plant, Recovery boiler, Power boiler and Water treatment system Electric power station and other equipment

5. Engineering department;
Planning, Mechanical design of improvement and repairing
Repairing work and Machine shop management

6. Administration department;
Products quality test, Purchased material's test and Researching for development Production watching, Production cost surveying

7. Environmental contral department;
Waste water treatment work, Air pollution control work and Mill water preparing work

12. Misan Mill

1. The river by the mill seems inadequate to supply water to the mill or to dispose of

the waste water.
What is the water level in summer and in winter?
Does the river flood?
Is there a good place to build a wharf by the riverside?

2. As I described before bagasse should not be used alone and should be blended with reeds.
Judging from other mill experiences, bagasse can be harvested stably every year, but reeds are not as constant.
On the other hand, if this mill and the Baslah Mill are operatiing well (total production should be over 300 t.p.d), the above two kinds of raw amterials will be in short supply.
I suggest that only is the Misan Mill, bagasse and reeds be used and in Baslah Mill, imported hard wood (and soft wood) be used.
(I know of a route to obtain hard wood logs from Sumatrals)

3. In this project I hear that many vibration screens will be installed as a predépither of bagasse.
But I think that this machine is not suitable and recommend another type of machine, for instance, the hammering type machine such as the Peadco, Ritz or Horkel depither.

4. Egg tray are usually made from old newspapers, but wasted rejects from the pulp mill can be used to some extent by blending.

5. I heard that the continuous cooking system will be employed in this mill. The continuous cooking system with a horizontal cooking tube is good for bagasse and reed cooking.
Moreover a pressurized refining system is recommended to be installed at the discharge end of the cooking tube.

6. According to the above system, sheaves in the cooked stock will decrease in spite of a high K-number, and as a result, the washing of stock will become easier, and also this will have fovorable influences on all recovery systems.

7. Before washing brown stock,a coarse screen must be installed to remove sheaves at first, rejects here must be returned to the raw material silo for recooking.

8. As a recovery boiler, a fluid burning system (not Tomlinson system) is recommended.
Of course superheated high pressure steam from the recovery boiler should be sent to the turbo-generator to produce electric power.

9. An electrical precipitator must be installed in the recovery boiler system.

(I do not know too much about the project design and I did not have an opportunity to see the specifications)

派（派）77-15

イラク国紙パルプ工業
帰国報告書の要約

１９７７年６月

国際協力事業団

派遣紙パルプ専門家　奥村春人

在イラク日本大使館　河本一等書記官殿

昭和５２年６月　　日

イラク国派遣　ＪＩＣＡ，紙・パルプ専問家

奥　村　春　人

本書は私のイラク滞在中の報告書をイラク政府のMINISTRY OF INDUSRYの紙・パルプ担当官に提出するに当って，河本一等書記官の要望により，報告書の要点を取纏めたものであります。

私は１９７７年１月２６日から３月２６日迄BAGHDADに滞留しこの間に３月２０から２３日までBASLAH PAPER MILLに出張した。

当国における私の仕事は当初MISANに建設さたる新しいBAGASSE PULP MILLの仕様書を固めることとなっていたが，到着して見るとBASLAHの増設工場の仕様書の検討と運転指導に変更された。

実際問題としてこの仕様書の検討に時日を要し，契約期間の２ケ月間に全部を調べ切れないので一部は省略した。この部分は報告書の第１部として取纏めたBASLAHの既設工場の運転状態に対する批評は帰国後取纏め報告書の第２部とした，MISANの新工場については，単に建設現場を瞥見したのみで詳細を知らないから僅かに知り得たことについて意見を述べるに留めた。

私の語学力の不足のため再三文章に手を加えたり書き直したりしたため報告書の提出が遅れたことを御詫びします。

尚ほ，報告書を先方に届けて頂く際にも，然る可く御詫びを御伝達下さる様御願いします。

報告書第1部の内容

本文はBaslah sxtension millの工事の機器仕様書（Document）に関する検討書である。本文を作成するに当っては工事会社であるKrauss-Maffei社（西独）からイラク工業省に提出されたDocumentと簡単なFlow sheetのみが示されたに過ぎない。

Krauss-Maffeiの計画は大筋において妥当であり良心的であると思うが，細部においては意見を異にする点もある。それらを列挙すると，

- Continuous cookingを採用すべきであった。何故旧設備と同様なBatch cooking方式が択ばれたのか不明であるが，Batch方式ならばどうすべきであると謂う解説を行った。
- Cooking liquorの調整に当ってWhite liquorの稀釈は温水を以ってせず必らずBlack liquorを使用すべきであることを説明した。
- Blow heat recovery方式はdirect方式だと汚れた温水しか採れないからindirect方式であることを解説した。
- 蒸煮されたパルプ中の異物除去装置の改変を説いた。
- 異物を除いたパルプはRefinerとCoarse screcuとで処理すべきことを説明した，除塵粕は再蒸煮に附する。
- Brown stock washerはKAMYR typeを択ぶべきであった。
- Screeningの設備は納得出来ない。改変が必要でありその方式を解説した。
- High density storage towerの役割について使除及び工程の変更を説いた。
- Bleachingの操業標準を設定し詳細なフローシートを提示した，最終の段階での塩酸添加は不必要である。
- Vacuum evaporatorの系統において液の流入経路に不合理があるから改める必要があることを指摘した。
- Recovery boilerにおいて此の計画にあるTomlinson furnaceとUenturicyclone evaporatorとの組合せ方式は好ましい方式ではない。最近の一般的な方式を解説した。

  Recovery boilerの当計画において最初は発電可能な蒸気条件としながら後に発電に使用不可能な低温低圧に変更したのは著しく不合理である。
- Recaustierzing plantにおけるSilicaの害と対策について説いた。

報告書第２部の内容

Baslah 第１工場の設備は拡張工事仕様書から漂白設備を取去ったものと同じであった。この設備は既に４年以上も経過しているのにも拘らずその生産能力は設計値の本位じか発揮出来ないでいるがその理由が何故であるかを解明しその対策を述べた。

その原因は装置とこの装置に合わせる為の操業条件等を挙げることが出来る。

- Bagasse の蒸解時に未蒸解の繊維束として残る分を少なくするため低温で長時間蒸煮しており煮え過ぎの傾向が強い。（これをR価という表示でいうとK価が低いと言う）この為めパルプの炉水性が悪くなり特に蒸煮したパルプから煮汁（黒液）を洗浄することが困難となり処理能率が下がり且つ黒液の回収が困難になる。この黒液を集めて濃縮し，回収ボイラーで燃焼し炉底から熔融して出る Smelt を水に溶かし生石灰を加えて苛性化し白液として蒸煮液を回収するのであるが，この薬液の回収率が当工場では一般の半分にしか当らない。

  これは黒液の回収率が悪いためであり各工程で黒液のロスが多いためである。これらの対策として次のことを advice した。
- Bagasse と reed とを混合蒸煮することを考えること。Bagasse の有する欠点（一般に炉水性が悪いことは）芦の炉水性が良い為めに半ば救済さたる。
- Blow tank と Washer との間に referier （又は desintegrator ）と Coarse screen を挿入して sheave の発生をなくする。

  この装置の挿入によって sheave を発生せしめることなくK価を高め炉水性の良いパルプで蒸煮で得ることを許されるようになる。
- 蒸煮は高温・短時間でK価が高い蒸煮を行う。これにより蒸煮の歩当りが上昇し且つ生産性が著しる高まる。最終的に１５０トン／日の生産が出来るようになる。
- Brown stock washer は KAMYR 型に取替えることが好ましい。
- Vacuum evaporator における Foaming trouble によって Black liquor の流失損失が多いが配管方式に誤りがあるからこれを説明に基いて改めるとよい。
- 紙の質が悪いが，紙質がよくするのには或程度良い性質を備えた木材パルプを混合使用することが好ましい。その例を掲げサンプルを添えた。

一般的な問題としてこのような低生産に平然として居られる監督者の立場を不思議に思うと共に，工場管理に何等かの欠陥があると推測した。その対策として

責任生産意識・原価意識の高揚

従業員の再教育の徹底

営繕作業の円滑化（修繕材料の常時確保と技術者の常時待機）

相互の連絡方法の改善（電話インターホーンの新設，コピー機の購入）

等の重要性を説いた。

Misanの新設工場に対する見解

当計画については仕様書も図面も提示されていなかったから詳細を批評することは出来ない。唯，工事が漸く着手されたばかりの現地に赴いてその立地環境を走り見したに過ぎない。

第一印象として全く辺鄙な荒野の一角に建設されつゝあるが果して用水に確信あってのことか，裏を流れる河が那か狭小で頼りない印象を受けた。亦洪水はあり得ないのかも気がゝりであった。

製造工程中，Bagasse の predepithing の工程で多数のVibrating screen を使用する予定のようであるが，何故，一般的に用いられている hammering 方式の depithing machine を採用しないのか疑問を投げかけた。

Continuous cooking 方式のことであるからそれはよいとしてPressurized refining 設備をこれに附加することを説いた。

Recovery boiler の型式か何式であるか不明であるがTomlinson 方式でなく一般のFluid burning 方式とCascade evaporator の組合せにより且つ発電をすることを薦めるに留めた。