Solid waste management–A case study

Dhingra H.K., Bohidar P.R., Mohindru V.K., Pant R. and Panda A.*

ABSTRACT

This paper describes a typical Indian paper mill using non-woody raw material and measures taken by the mill to handle solid waste Sources of generation of solid waste both combustible/organic and non-combustible/inorganic has been listed The measures taken by the mill to reduce solid waste, the existing methods of disposal being practiced and the future plans of utilizing and reducing the solid waste have also been outlined.

Introduction :

Paper industry generates large amount of solid waste which can be characterized as combustible and non–combustible wastes. The date of solid waste from small and large paper mills are listed in table 1

TABLE—1

SOLID WASTE GENERATION IN PAPER MILLS**

Waste Source	SOLID WASTE LPM	SPM
	Kg dry solids/tonne paper	
Raw material handling/ preparation	45	210a
Hypochlorite preparation grit	20	nil
Recausticizing lime mud	593	nil
Power plant/boiler ash*	656	1300
Waste water treatment plant		
1. Primary sludge	159	116
2. Secondary Sludge+	34	105
Total	1507	1731
% inorganic solids	84	75
% organic solids	16	25

a When bagasse is used in place of straw in SPM, the solid waste generation in raw material handling will be 550 Kg/t paper and the total solid waste will be 2071 Kg/t with 65% inorganic solids.

* Ash generation depends on % ash in coal and the amount of power/steam generated.

\+ Estimated assuming 0 5 kg MLSS produced per kg BOD removed in activated sludge treatment plant.

LPM = Large Paper Mill
SPM = Small Paper Mill

** 'WASTE MANAGEMENT IN PULP AND PAPER INDUSTRY', Subrahmanyam P.V.R., Journal IAEM, Vol. 17, 79-94 (1990)

and these data indicate the seriousness of the problem due to large amount of waste being generated This is the right time to seriously think about management of solid wastes. The consciousness to have cleaner atmosphere and introduction of stringent sanctions will force the industry to take decisions to stop environmental degradation by any type of pollutants. With commitment from the top management of paper industries, the waste management program has a fighting chance

This paper highlights some of the measures taken by the mill to manage solid waste and also the future plan they have in mind after consultation with CPPRI. Mill management curiosity to know the latest in the world and their hard efforts to implement the same are the result of managing solid waste and

*Central Pulp and Paper Research Institute,
Post Box No. 174,
SAHARANPUR INDIA

overall running the mill in good direction. The management and their team are progressive and amenable to adopting modern techniques. They have one goal, to do long range planning and have a strategy of implementation after fixing a goal. The information presented here is based on the discussi n with mill management and their staff and on the spot study by CPPRI scientists during their visits to the mill in 1990 and 1991.

Brief description of the mill :

The installed capacity of the mill is 16,800 TPA. The main raw material for paper making is rice straw. Besides this, the mill is using bagasse, gunny waste, waste paper and also imported pulp. The main product is unbleached kraft paper (40–50 ton/day) and the rest is writing and printing paper (10 tons/day). The appropriate composition of furnish for unbleached kraft paper is rice straw/bagasse pulp 40%. gunny waste pulp 40% and waste paper or imported pulp 20% and that for bleached writing and printing paper is bagasse /rice straw pulp 80% and 20% waste paper/imported pulp. The raw material consumption and some other general important data of the mill are given in table 2.

TABLE—2

SOLID WASTE GENERATION DURING 91

GENERAL SPECIFICATION OF MILL

Present Daily Production	t	50-60 T/Day
Type of Paper Produced	:	Writing & Printing (10 TPD) Kraft Paper (40-50 TPD)

RAW MATERIAL USED

(i)	Rice Straw (82%) and Bagasse (18%)	:	65%
(ii)	Gunny waste (67%) and Waste paper (35%)	:	33%
	Total	:	130 T/Day
Water Consumption		:	140 M³/T Paper
Steam Consumption		:	6 T/T Paper
Power Consumption		:	1000 KWH/T Paper
Effluent Discharged		:	5250 m³/Day.

TOTAL SOLID WASTE GENERATION (T/T PAPER)

(PAPER PRODUCTION : 55 T/DAY)

COMBUSTIBLE WASTE :

1.	Raw material preparation :		
	(i) Rice straw dust	:	0.051
	(ii) Pith	:	0.045
	(iii) Gunny waste	:	0.004
2.	Pulp Mill		
	(i) Knotter rejects	:	0.036 (Reused)
	(ii) Cleaner rejects	:	0.009 (To E.T.P.)
3.	Paper Machine		
	(i) Cleaner rejects	:	0.009 (To E T.P.)
	(ii) Back water	:	0.027 (To E.T.P.)
4.	Effluent Sludge	:	0.122
	Sub-Total	:	0.222

NON-COMBUSTIBLE WASTE :

1.	Ash from boiler house	:	0.318
2	Lime sludge from bleach prep.	:	0.016
	Sub-Total	:	0.334
	Total	:	0.556

ORGANIC SOLID WASTE GENERATION

SOURCE	(Quantity Ton/Day)
1. Raw Material Preparation	
(i) Rice straw dust (3-5%)	: 2.80
(ii) Pith (16-17%)	: 2.50
(iii) Gunny waste (0.5-1%)	: 0.22
2. Pulp Mill	
(i) Knotter rejects (6-8%)	: 2.00 Reusedin U/B Sid
(ii) Cleaner rejects (1.5-2%)	: 0.50*

3. Paper Machine

(i) Tertiary Reaction (1%)	: 0.50*
(ii) Back water	: 1.50*

4. Effluent Sludge ; 6 7

Combustible Waste : 14 22

* : Going to Etp

GENERATION OF INORGANIC WASTE

1. BOILER HOUSE

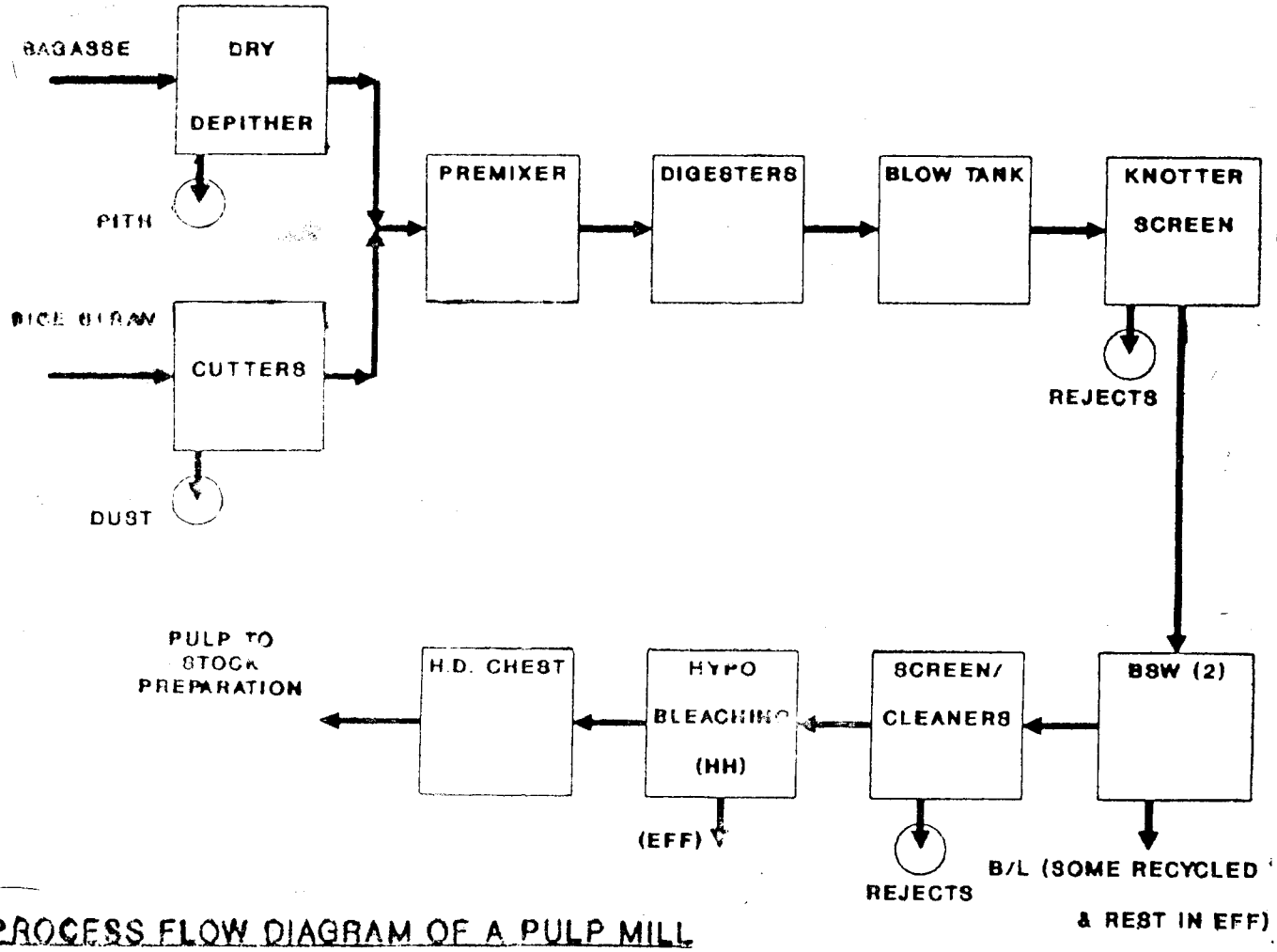
Total No. of Boilers	: 3
Type of boiler	: LIPPI, Thermax Marine
Type of fuel	: Coal
Amount of fuel (Ton/Day)	: 60-80
Boilers Efficiency	: 65%
Total steam production	: 12-16 Ton/Hr.
Steam Pressure	: 10-12 Kg/cm²
Ash generated	: 15-20 Ton/Day
	: 17.5 Ton/Day (Average Value)

2. BLEACH LIQUOR PREPARATION :

Grits & Lime Sludge	: 0.9 Ton/Day
Non-Combustible Waste	: 18.4 Ton/Day

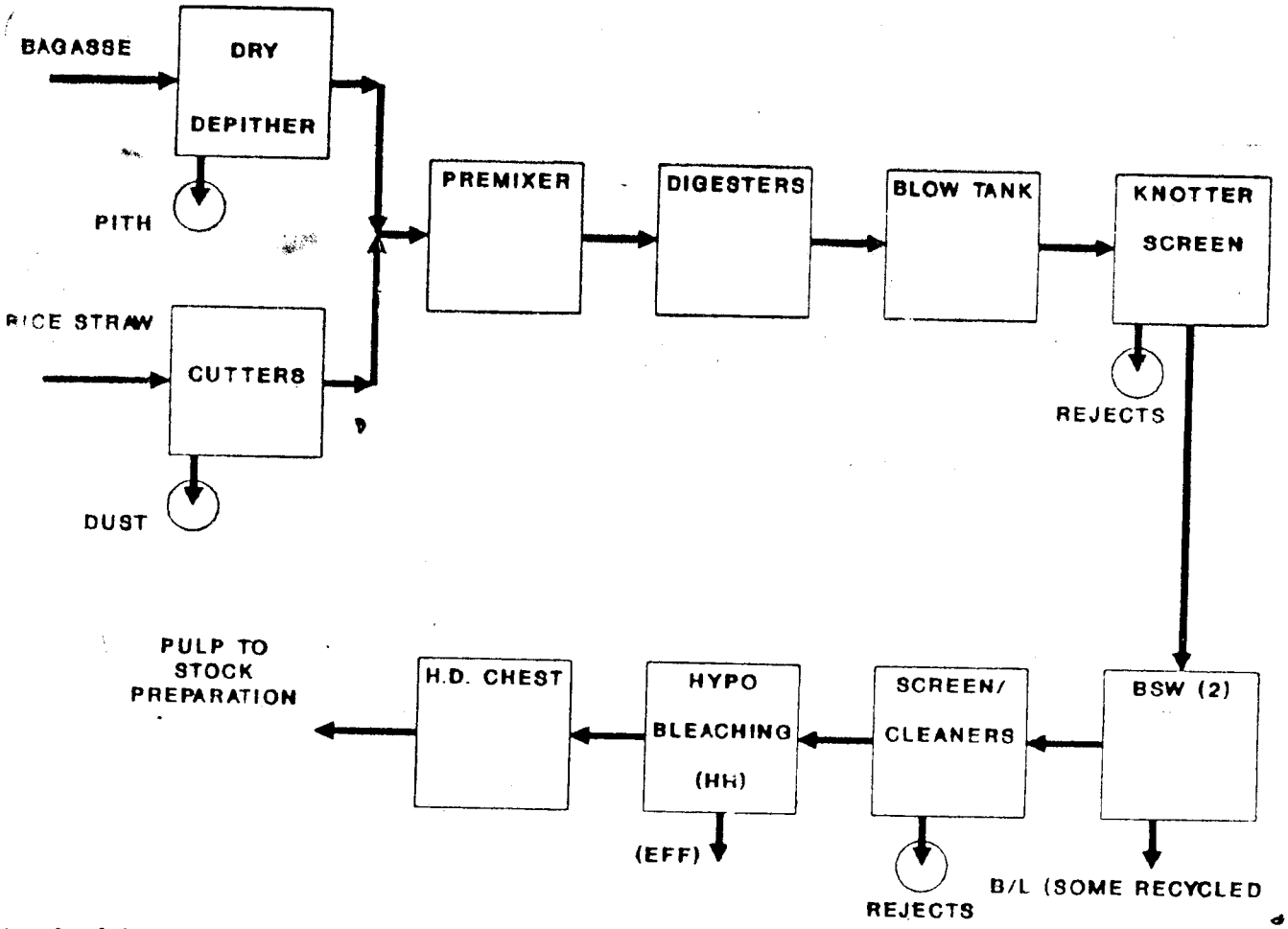
The mill has been able to reduce its water consumption from 120–130 m³/ton paper to 60–70 m³/ton paper by reusing the overflow from the secondary clarifier in the unbleached side. The process block diagram of rice straw and bagasse pulping, stock preparation and paper machine section, effluent treatment and hypo preparation plant are shown in figures 1, 2, 3 and 4 respectively which are self explanatory. The points of solid waste generation are also encircled in the process flow diagrams. In a nutshell the various points of solid waste generation are:

FIG. 1



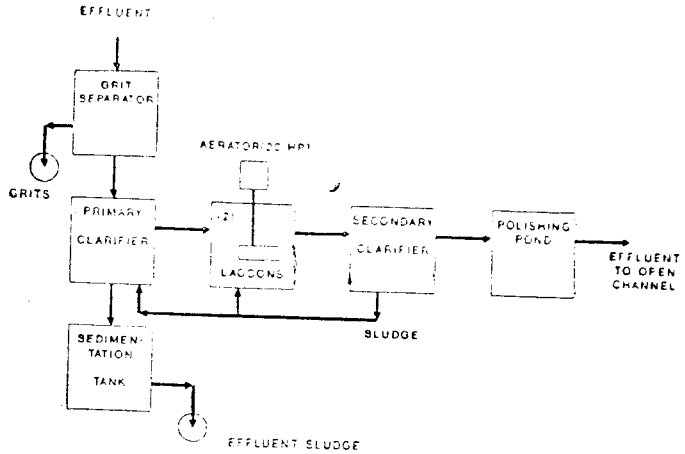
PROCESS FLOW DIAGRAM OF A PULP MILL

FIG. 2



PROCESS FLOW DIAGRAM OF A TYPICAL PULP MILL

FIG 3



PROCESS FLOW DIAGRAM OF EFFLUENT TREATMENT PLANT

FIG. 4

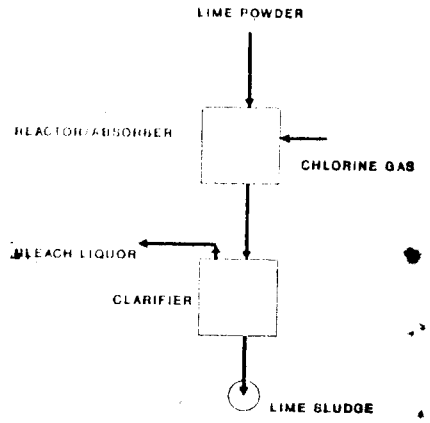


FIG 4 BLEACH LIQUOR (HYPO) PREPARATION PLANT

(A) Organic Solid Waste

1. RAW MATERIAL STORAGE
2. RAW MATERIAL PREPARATION
   (a) Rice straw dust
   (b) Bagasse Pith
   (c) Gunny waste
3. PULP MILL
   (a) Screening and Cleaning rejects from rice straw/bagasse street
   (b) Screening and cleaning rejects from gunny waste and waste paper/imported pulp streets
4. PAPER MACHINE
   (a) Cleaner rejects
   (b) Back water
5. EFFLUENT TREATMENT SLUDGE
6. COAL DUST

(B) INORGANIC WASTE

1. ASH FROM BOILER HOUSE
2. LIME SLUDGE FROM BLEACH LIQUOR PREPARATION

The data of solid waste generation collected during first visit are presented in Table 2 while that collected during second visit are presented in Table 3.

TABLE 3

Comparison Between Data Collected During Second Visit and First Visit

A. General Data

	YEAR 91	YEAR 92
Present Daily Production	50—60 T/Day	50—60 T/Day
Type of Paper	Writing & Printing (10 TPD) Unbleached Kraft (40—50 TPD)	Writing & Printing (10 TPD) Unbleached Kraft (40—50 TPD)
Furnish Composition	Writing & Printing (80% R/S or Bagasse and 20% Waste Paper & Imported pulp)	Writing & Printing (80% R/S or Bagasse and 20% Waste Paper & Imported Pulp)
	Unbleached Kraft (40% Gunny Waste, 40% R/S or Bagasse and 20% Waste Paper/Imported Pulp)	Unbleached Kraft (40% Gunny Waste, 40% R/S or Bagasse and 20% Waste Paper/Imported Pulp)
Approximate R. M Consumption	(i) Rice Straw (82%) : : 65%	(i) Rice Straw (82%)
	Bagasse (18%)	Bagasse (18%)
	(ii) Gunny Waste (67%) : : 35%	(ii) Gunny Waste (67%)
	Waste Paper/Imp Pulp (33%)	Waste Paper/Imp Pulp (33%)
	Total (TPD) 130	130
Water Consumption	120 130 M^3/T Paper	70 M^2/T Paper
Steam Consumption	6 T/T Paper	6 T/T Paper
Power Consumption	1000 KWH/T Paper	1000 KWH/T Paper

TABLE—3 CONT.

SOLID WASTE

Source	Generation (T/Day) Last Year	Present
1. Raw Material Storage	Not Accounted	3.50 (5%)
2. Raw Material Preparation		
R/S Dust	2.8 (3—5%)	3.33 (5%)
Pith	2.5 (16—17%)	2.42 (16%)
Gunny Waste Treatment	0.22 (0.5—1%)	0.21 (0.21 (0.5—1%)
Gunny Waste Sorting	—	1.50 (5%)
3. Pulp Mill		
Knotter Rejects	2.0 (6—8%) Reused	2.0 (6—8%) Reused in
Cleaner Rejects	0.5 (1%) (To ETP)	0.5 (1%) U/B Side
Screening & Cleaning Rejects From Gunny Waste (2%)/Waste paper/Imported Pulp (3%) Street	—	0.9 Going To ETP
4. Paper Machine		
Cleaner Rejects	0.5 (1%) (To ETP)	0.5 (1%) Reused in U/B Side
Back Water	1.5 (To ETP)	1.0 (To ETP)
5. ETP Sludge	6.7	3.0
6. Coal Dust	Not Accounted	0.95 (1.2—1.5%)
Organic Waste	12.22 (2TPD Reused)	14 91 (3TPD Reused)

TABLE—3 (CONT.)

DISPOSAL PRACTICE

Source	Last Year	Present	Future
R/M Storage	Land Fill	Land Fill	Boiler after briquetting
R/S Dust	Land Fill	Brick manufacture	In F. B. Boiler
Pith	Do	Do	Brick Manufacture
ETP Sludge	Land Fill	Land Fill	As a fuel if Briquette can be made

Contd.

Source	Last Year	Present	Future
Gunny Waste	Land Fill	Sold to brick manufacturer	—
Coal Dust	Sold	Sold or burnt in boiler	To make briquettes
Lime Sludge From Hypo Preparation	Land Fill	Sold to fisheries and household (for Whitewash)	—
Boiler Ash	Land Fill	Land Fill	Building material

Now these points along with treatment of effluent and also the measures taken by the mill to handle solid waste have been discussed below one by one.

A. ORGANIC WASTE

RAW MATERIAL STORAGE

Rice straw is obtained in loose form and stored in hut shaped pile. Bagasse is obtained both in loose and bale form and bales are stored in pyramid shaped piles. The losses due to storage are about 4 – 6% and some time as high as 8% and this data was not collected by us during the first visit. The waste generated due to storage is highest from all other wastes sources. It was found that there are more wastage or losses when storing the raw materials in loose form. So it will be better to have one bailing machine to reduce this type of waste. This will save 1440 TPA of straw (assuming only 2% losses) equivalent to an annual saving of Rs. 4.32 Lakh (Rice straw price approximately Rs. 300/- per ton). The mill management has already taken initiative in this direction and they are going to purchase a portable bailing machine which will be used for making bales of rice straw at the field itself.

At present the waste is being landfilled and the villagers are sometimes collecting it and they may be using it for burning. The mill has tried this storage waste in boiler but has not got success due to loose form. As per the work being done by CPPRI on briquetting, this waste can be utilized by making briquettes for burning which will save 720 TPA of coal equivalent to Rs. 7.2 lakh.

Gunny Waste Handling

Before cooking, the gunny waste is cut in cutters and during this operation, a small amount (about 0.5 —1% of waste is generated. However, they are getting 5% more waste during gunny sorting due to coating of tar and this data was not collected during first visit. Both of these wastes were being landfilled in the mill land itself and after sometime it was being disposed at some other sites Mill personnel were worried about this situation and were continuously thinking for its utilization. Now, they are selling it to brick kiln manufacturers. This waste was so suitable to brick kiln manufacturers that they took this waste accumulation of the last one year in a few days and now they were lifting daily this waste. Earlier the brick kiln manufacturers were using rice husk but due to shortage of rice husk and rise in its prices they are now preferring this waste.

Rice Straw Dust

Before cooking rice straw is cut in cutters and then screened by passing it through rotary screens having 4 segments each having 4 mm perforation for removing dust. About 3–5% straw dust is generated in cutting process. Earlier, this waste was disposed off for landfilling, but at present this dust is also being taken by the brick kiln manufacturers. But brick manufacturers are not so much interested in this waste as in the case of gunny waste from sorting. So for the future they are planning to have one fludized bed boiler and then this waste will be burnt in the boiler.

Bagasse Pith

Before cooking, bagasse is depithed in one dry depither with rotary hammer and then screened in a screen having opening of 5–8mm. Thus bagasse and pith are separated. The pith generated by this process is about 16-17%. As every user of bagasse wants to remove pith as much as possible same is the case here and so there is no chance of reduction of this waste. This waste was also being disposed off for landfilling previously but at present this is also being taken by brick manufacturers. But the mill has plans to burn pith in a fluidized bed boiler. At present the mill is going to use one of its existing boilers to burn pith in suspension and thus will observe its overall effect before burning it in the fluidized boiler.

Knotter Rejects

About 6–8% or about 2TPD knotter rejects are generated during screening of bagasse and rice straw pulp and these rejects are being reused in breaker beater of gunny waste street used for unbleached kraft paper. Thus practically there is no waste from the knotter rejects as they are totally being recirculated.

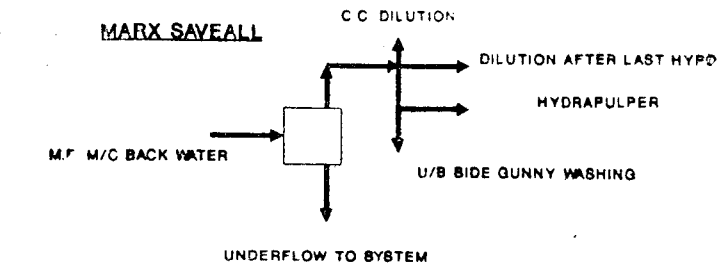
Cleaner Rejects

From last stage cleaner of pulp mill and paper machine about 1 ton of rejects are generated. Previously, these rejects were going to effluent treatment plant with other effluent but now they have installed small hill screens to recover the good fibers. These recovered

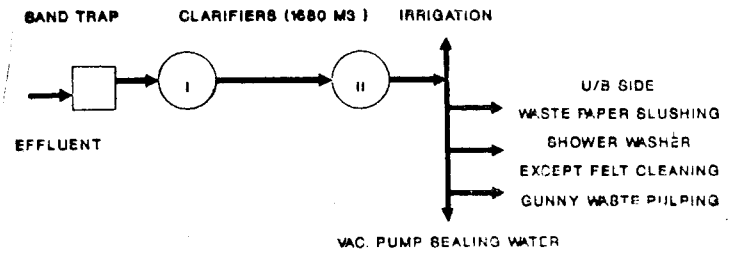
fibers are being reused in unbleached side for making unbleached paper.

Paper Machine Back Water

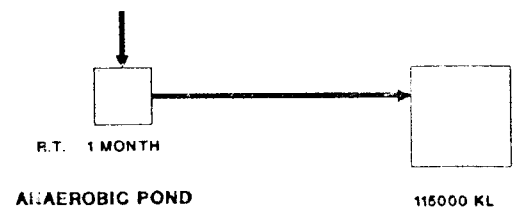
Back water from M.F. machine is pumped to one more saveall and in case of M.G. machine it is pumped to one selectifier screen. However, there was loss of about 1.5 ton of fiber from the system earlier but now due to better efficiency of system and also due to better recirculation the loss has been reduced to 1.0 TPD. Points of recirculation of overflow from the a saveall are shown in Figure 5.



(A): REUTILIZATION OF OVERFLOW FROM MARX SAVEALL



(B): REUTILIZATION OF CLARIFIED EFFLUEN



(C): B/L HANDLING .

FIG. 5

Effluent Treatment

Earlier, the mill's total effluent including black liquor was being treated in primary clarifier, two aerated lagoons, secondary clarifier and polishing pond before being discharged but they were not achieving any desired reduction of BOD and COD. So they are constructing more aerated lagoons and the black liquor is being separated from the rest of the effluent. The black liquor is stored in a constructed pond for one month & pumped to a large lagoon with three compartments (storage value is equivalent to about 115000 m^3 and can store B/L generated in one year) from where it will be discharged to drain during floods. It is believed that BOD is sufficiently reduced mainly due to anaerobic action over long period. The lagoon project is new and covers 50 acres of land. At present, they have not taken into consideration the sludge generation from this treatment as they have just started. The expert has recommended to monitor ground water qualities regularly; however they have already tested once and are planning to install test wells around the complex.

The rest of the effluent is being treated in primary and secondary clarifier. The part of the clarified water from secondary clarifier is being used by farmers for irrigation and the rest is being reused in mill after filtering through a two stage 70 mesh filter.

At present the farmers are not having any problem in utilizing clarified water for irrigation. But as per the mill management this is not a permanent solution as the farmers do not take this treated effluent for the whole of the year and they have to store it. The fresh water consumption has reduced to about 70m^3/t paper in place of 120--130 m^3/t paper earlier,

Thus, at present there is no discharge from the mill. However, the mill has to take these steps due to limitations that some modified/maintenance work is going on in canal in which the mill was draining its effluent. So discharge in canal is temporarily stopped. But the results of the present steps undertaken are of benefits. So the mill is thinking to continue some of these measures in future also.

Effluent treatment plant (ETP) sludge

As per the mill staff the data of effluent sludge being generated is about 3 tons/day on O.D. basis and not 6. 7 tons/day as collected last year. This difference in quantity may be due to sludge generated from the black liqour from the rest of the effluent. The sludge generated from the black liquor has not been estimated till now. They are much concerned about

the handling of effluent treatment sludge. At present the sludge is being dumped in land. They have tried the sludge in boiler but could not get any success. They have also contacted board mills but they are not ready to take it. However, some hand made bard industry have used it previously but later refused to take it due to poor quality of board. So in future they are planning to install double wire belt press for dewatering of sludge and they are thinking of one pelletizing or briquetting machine to make briquettes from sludge and also from other wastes such as pith and straw dust. They have been informed that this is a good alternative, as shown by the results obtained in CPPRI pilot briquetting plant. This will svae about 330 TPA of coal equivalent to about Rs. 3 lakh.

Coal dust :

Coal dust being produced is about 270–300 ton/annum and this is being sold to contractors or being used in mill itself in boilres. But in future, they will use it with other wastes to make pellets or briquettes.

In table 3 differences between data collected during last year's visit and in second visit are presented. Also disposal alternative being used last year and at presented and also future disposal have options been given.

B. Inorganic Waste

1. Cinder Ash

The mill is having three boilers and about 60–80 ton coal per day is used as a fuel. Cinder ash generated is about 15–20 ton/day which contains about 8-10% unburnt coal. At present, they are screening the cinder and unburnt are removed and sold while the rest of the cinder is landfilled.

2. Lime Sludge

For production of Hypo, they have one reactor in which lime powder is reacted with chlorine. About 0.8—1.0 ton/day lime sludge is generated and is stored in lagoon. the villagers are taking it for white wash and also for fish ponds.

In table 4, the data of solid waste from this mill has been compared with data of solid waste from other mill which is also using rice straw as a major raw material.

TABLE—4

Comparison of data of solid waste generation from three paper mills

Specification	Mill A	Mill B	Mills C
Installed capacity (T/annum)	18000	16800	30000
Present daily production, T/day	50—60	50–60	80–100
Types of paper produced	writing & printing	writing & printing (10 TPD) Kraft paper (45 TPD)	writing and printing
Raw material used	Rice straw : 70% Bagasse : 12% Cotton Linter : 10% Waste paper/ imported pulp : 8%	Bagasse (18%) & Rice straw (82%) : 65% Gunny Waste (67%) & Waste paper (33%) : 35%	Sarkanda : 70% Rice straw OR : 30% Wheat straw
	Total 160—180 TPD	Total 130 TPD	Total 260–280 TPD
Water consumption (m^3/T paper)	350	125	230
Steam Consumption (T/T of paper)	7—8	6	8—9
Power consumption (KWH/T)	1350	1000	1350

Effluent discharged (m^3/day)	17000	5250	15000—17000
Organic solid waste generation (T/T of paper)			
Basis : Avg. Production	55 TPD	55 TPD	80 TPD
Source			
Raw material preparation	Rice Straw dust : 0.08*	Rice Straw dust : 0.051	Sarkanda dust : 0.12
	Pith : 0:04	Pith : 0.045	Wheat straw dust : 0.05
		Gunny waste : 0.004	
Pulp Mill			
Knotter Rejects	0.05	0.036	0.14
Cleaner Rejects	0.02*	0.009*	0.04*
Paper machine			
Tertiary rejects	0.02*	0.009*	0.003*
Backwater	0.05*	0.027*	
Effluent Plant sludge	0.36	0.122	0.17
Sub total	0.45	0.258	0.48

*Going to effluent treatment plant

Inorganic solid waste generation (T/T of paper)			
Ash from boiler house	0.47	0.318	0.6
Bleach Plant sludge	0.04	0.016	0.16
Sub total	0.51	0.334	0.76
Total	0.96	0.592	1.24

Conclusion

In future there are a lot of opportunities in a paper mill for solid waste reduction and utilization. The opportunity to pursue a course of decision on solid waste management can propel the mill ahead. The environment and economy can be well saved.

Due to the measures taken by the mill, the mill is now able to reutilize 3 TPD of fibrous material instead of 2TPD earlier and is able to reduce solid waste generation. Earlier, total of 17.10 TPD waste was being landfilled but now only 6.53 TPD is being landfilled. Thus the measures taken by the mill have resulted in reduced solid waste and less dependence on landfill.

Of course, this is just a start and in future the mill will certainly be able to reduce solid waste problem to a large extent.

Thus awareness of the responsibility blended with outlook for a positive approach would benefit the mill while preserving the environment.

Acknowledgements

The encouragement and cooperation rendered by our colleagues, particularly by Mr. K.S, Panesar and Ms. Priti Shivhare, are gratefully acknowledged. The authors are also thankful to the management of the mill for providing all the necessary information and help during the visits.