Viability and economic study for recovery systems for small paper mills

DARANEY SACHIN*, MANAGAONKAR N.D.* AND
DR. KULKARNI A.Y.*

ABSTRACT

In rhe present environment, recession and low productiivity has hit small paper mills most, in the Indian Paper Industry.

Various factors which have had a cumulative effect in bringing down the profitability of small paper mills. have been analysed in the back ground section of this paper.
Absence of a viable chemical recovery process is perhaps a major factor which contributes heavily towards low profitability and returns in small paper mills.

The conventional soda recovery process based on evaporation incineration/causticization is not applicable to small paper mills. Simple modifications are suggested in this paper which will prove economical and viable.

When planning a small mill it would be a mistake to just scale down larger units of integrated pulp and paper mills. Technologically advanced and most modern equipment are not necessarily the most economic for small mills. An appropriate technological approach for such problems is also highlighted.

This paper also reviews some of the new concepts proposed for chemicel recovery in small paper mills, such as Ferrite process, wet air oxidation, UF/RO Technology etc. which hold promises for the future.

1) Introduction

India entered the pulp and paper industry in an organised manner only towards the begining of 20th century. Planned development of the paper industry began in 1951 when there were about 20 paper mills with a total installed capacity of about 150,000 TPA. Since then there has been rapid progress especially in the third and fourth five year plans. At present as the statistics represent there are over 220 units in organised sector with an annual installed capacity of about 25 lac tonnes of paper and paper board having roughly 60% capacity utilisation.

In the present context Indian paper industry is passing through a period of trials and tribulations. The present recession in demand for paper and pulp products seems to have adversly affected many units. Thus it is now a case of *"Survival of the Fittest."*

Due to the various fiscal encouragement given by the Government for the development of small paper mills, which could primarily use agriculture residues and secondary raw materials, there are now more than 140 mills of installed capacity below 10,000 TPA each.

Though the fact remains that small paper mills today are afflicted with many problems there are major advantages too, which can well ensure their existance and future growth. Seen in the wide perspective the present difficulties of small units are mostly due to factors beyond their control and have been often highlighted in technical forums earlier.

2) Causes of Present Day Maladies of Small Paper Mills

The pulp and paper industry today is undergoing rapid transformation all over the world, as a result of vast technological and scientific advances. But in India the technological growth has been impaired due to various reasons.

Major amongst them are :

a) Lack of appropriate technological project planning at the initial stages.

q) Lack of skilled manpower at various levels.

c) Ever rising costs of raw materials and chemicals etc.

*Parkhe Research Institute
KHOPOLI-410 203, MAHARASHTRA

d) Unsatisfactory power and coal supply positions.

e) Non recovery of cooking chemicals.

f) High cost of effluent treatment.

Out of these factors. chemical recovery and effluent treatment are the most important and deserve great attention in the years to come.

Though large mills have an integrated chemical recovery system the total absence of recovery section or suitable pollution treatment method in small unit has a major hurdle towards the over-all profitability of small units.

The conventional soda recovery process based on evaporation incineration causticization is not applicable for smaller units, and hence their pulp production costs are high.

Development of soda recovery process whereby evaporation incineration can be eliminated has been a live issue, and different treatment schemes have been suggested from time to time.

3) The Need For Chemical Recovery in Small Paper Mills

The small mills use soda as cooking chemical and a CEH bleaching sequence. To review an old statistics, of the 100 old medium/small mills accounting for production of about 2.40 lac ton of paper product in 1979, atleast half were using agricultural residues as their fibre source. Based on these assumption they used an estimated 36,000 MT of caustic soda valued at 18.00 crors which was left off in drains as effluent because no chemical recovery system existed for these mills. Today as the number of small units as well as the prices have increased to a great extent, the magnitude of such national waste is tremendous.

This problem is more aggravated when we consider effluent loads from small mills. Table No. 1 illustrates these fact. If a comparison is made between the effluent from a mill having chemical recovery mill and a mill without chemical recovery system, the former has a BOD load of about 50kg/T product as against 176kg/T (about 3—4 times more) in the later part.

TABLE No. 1

Range And Average Characteristics of Combined Waste Waters Based on Agricultural Residues (Based on 7 Mills, 7-30 TPD Capacity)

		Mills with no chemical recovery		Mills with chemical recovery*	
		Min	Max	Ave	(14)
Volume,	m^3/t				
Paper		187	383	252	455
pH		6.0	8.5	—	5.6-6.3
SS	mg/l	400	1115	615	816
	kg/t	88	239	155	371
BOD_5	mg/l	220	1067	698	350
	kg/t	85	267	176	159
COD	mg/l	2120	4563	2940	1275
	kg/t	497	741	—	581
Lignin	mg/l	320	700	563	—
	kg/t	93	197	142	—
Sodium	mg/l	200	548	398	—
	kg/t	48	142	98	—

* Bagasse Chemical Pulp (Soda)

4) The Feasibility of Chemical Recovery in Small Paper Mills

When planning a small pulp and paper mill it would be a mistake to just scale down larger units of an integrated pulp and paper mills. The technologically best process and most modern equipment are not necessarily the most economic for such a small unit. While small mill should be designed as simply as possible with the minimum of service departments; the chemical losses contribute substantially to its high costs. However the basic concept of evaporation combustion caustisization will have to be used in a simple modified way for processing the black liquor from straw/bagasse mills.

Physico-chemical characteristics of straw/bagasse black liquors need a different approach during evaporation and combustion stages of recovery. Chemical composition (high pentosan content) and silica content can lead to considerable processing difficulties during recovery operations. The problem is more acute when viscosity is considered; which has a tendency to rise sharply with increase in total solids.

With the above cocepts in mind, and considering the technology and equipment facilities available in India, the following scheme can be considered noteworthy.

4.1) Evaporation

The evaporation rate of the black liquor is not as high as it would be with conventional plants. The evaporator plant can safely raise the concentration of WBL from 10% to 25-30%. This has several advantages. Firstly the steam consumption is lower and it is fully covered by waste heat boiler and secondly at 25-30% concentrations, danger of scaling is considerably lower and requires no special precautions. Only problem with viscosity can be over come by increasing the free alkali concentration by caustic dosage to WBL.

4.2) Liquor Burning

In view of high capital investments and different physico-chemical properties of BL, installation of conventional recovery boiler has not proven economical for small mills.

For actual burning of black liquor; one school of thoughts favours *Roaster/Smelter* and other *rotary kiln*, of course, both the processes have merits and demerits of their own.

Roaster/Smelter can be operated with 55—50% solid concentration with self supporting flame. The resulting flue gases at a temperature of 700—900°C can be used in a cyclone evaporator to concentrate the BL. The smelt is taken out for further causticizing after dilution with water.

While liquor burning in rotary kiln, the burning temperature is low and the plant operates with high excess air. This has the advantage that the rise in viscosity due to silica can be overlooked. The burnt ash is not molten and hence the chemical erosion on the refractory brick lining is minimum. Further to add, owing to the high volume of waste gases and low temperatures, there are no radiating heating surfaces and hence heat losses can be reduced. The flue gas obtained can be used in ventury scrubber and the chemical ash obtained is transfered to the causticizing department.

4.3) Recaustisization

The recaustisizing unit is similar to that of conventional plants. As the silica content in raw white liquor pose a settling problem in clarification it should be done in drum filters or else two compartment clarifier can be used economically as the drum filters has more operational cost than the clarifier.

5) Economic Feasibility of Chemical Recovery in Small Mills

For a conventional MEE/Smelter/Caustisizing scheme the economics are worked out and are as illustrated in Table No. 2. Table No. 3 gives a picture of approximate capital investments required for such scheme.

The approximate investment in a recovery section for 30 TPD plant is estimated Rs. 135 lacs and 175 lacs for 50 TPD mill respectively. The cost of regenerated caustic falls within economic acceptable units, even for 30 TPD mill. It can be safely concluded that 30 TPD mill recovery is marginally viable and it improves further at 40 and 50 TPD levels.

TABLE No. 2

Economics of Installation of a Recovery Unit

	Units			
Capacity of paper mill	TPD	30	40	50
Capital investment required	Rs. lacs	135	155	175
Amount of caustic recovered	Ton/day	4.67	6.24	7.79
	Ton/year	1401	1872	2337
Cost of Production of Alkali caustic in Recovery Section :				
Steam consumed	Ton/year	21600	28800	36000
Steam cost @ Rs. 110/Ton	Rs. lacs	23.76	31.68	39.60
Lime consumed	Tons/year	1821	2430	3030
Lime cost @ Rs. 550/Ton	Rs. lacs	10.01	13.36	16.66
Power consumed	KWH/ Lacs) year	28	32	36
Power cost @ Rs. 0.42/KWH	Rs. lacs/Yr	11.7	13.4	15.1
Auxiliary fuel	Rs. lacs/Yr	2.0	3.0	4.0
Maintenance	Rs. lacs/yr	1.0	1.75	2.0
Wages	Rs. lacs/yr	1.0	1.5	1.75
Total Operating cost	Rs. lacs/yr	49.47	64.69	79.11
Cost of recovered caustic (Before interest & Depreciation)	R/Ton	3531	3455	3385
Interest @ Rs. 13%	Rs. lacs/yr	17.5	20.1	22.75
Depreciation @ Rs 7%	Rs. lacs/ys	9.4	10.8	12.2
Total interest & depreciation	Rs. lacs/ys	26.9	30.9	34.9
Interest & Depreciation per ton of caustic recovered	Rs /Ton	1920	1650	1493
Total cost of recovered caustic	Rs./Ton	5451	5105	4878

TABLE No. 3

Details of Approximate Breakup of Capital Investment Required

(For Chemical Recovery Section)

Paper Mill Size		TPD	30	40	50
Item					
1.	Evaporation plant	Rs. lacs	40	45	50
2	Smelter/Cyclone unit	Rs. lacs	45	50	55
3.	Causticizing plant	Rs. lacs	40	45	45
4.	Tankages, civil etc.	Rs. lacs	10	15	25
	Total	Rs. lacs	135	155	175

6) New Trends in Chemical Recovery Front

During the last two decades, intensive R & D activities have been diverted on the development of simplified soda recovery process for small paper mills. In course of time many novel concepts were proposed but most of them were not suitable for Indian level of technology and economic feasibility. Among the crowd the following three concepts hold promises for the future :

a) Ferrite process.

b) Wet air oxidation.

c) UF/RO Technology.

6.1) Ferrite Process :

A Japaneese developed technology rely on the reaction of Fe_2O_3 with sodium carbonate, known as Direct Alkali Recovery system (DARS), while obviously limited to soda pulping; this system has the advantage of using naturally occuring mineral hematite, right from the ground. Detailed laboratory and plant scale trials have been coducted in India at CPPRI.

In this system 30% concentrated BL is burnt with ferric oxide at a temperature of 850°C. The main reaction involved is decomposition of sodium carbonate (above its melting point (850°C) followed by formation of Sodium ferrite. The reaction can be explained as,

$$Na_2CO_3 + Fe_2O_3 \text{ ——— } 2NaFeO_2 + CO_2$$

The Sodium ferrite is leached with water forming NaOH and regenerated Fe_2O_3.

$$2\,NaFeO_2 + H_2O \text{ ——— } 2NaOH + Fe_2O_3$$

The furnace of choice is a fluidized bed and there is no smelt as the Sodium ferrite has an extremely high melting point.

In this process, causticizing efficiency is unaffected by presence of compounds like Sodium Silicate, Sodium thiosulphate, and Sodium Sulphate, About 85–90% causticity can be achieved and also the ferric oxide recovered has good settling properties. More important is that the regenerated Fe_2O_3 can be used repeatedly without appreciable loss of causticizing efficiency.

Economical analysis of this process has indicated its best suitability and the process shows promises of being well suited to small mills due to its simplicity and lower capital investments.

6.2) Wet Air Oxidation :

Wet air oxidation (Zimermann Process) utilizes the concepts of oxidation of organic constituents of BL by air under high pressure and temperature conditions to yield green liquor, eliminating the conventional evaporator and combustion steps. The initial investments appear to be higher than the conventional system. However this process is best suited for handling viscous straw/bagasse BL. Though the above process appear to be promising a detailed study in Indian conditions is necessary to assess its feasibility.

6.3) UF/RO Technology

UF (Ultrafiltration) and RO (Reverse Osmosis) processes are getting a wide attention in these days. This is novel concept of seperation of inorganic solids from the black liquor.

It is well known that over 60% of the total soda content of BL is present as low molecular weight salts. High molecular lignin fraction is rejected at membrane interfere and consequently can be removed as concentrate from the UF module. Further the concentration of soda compounds can be done in RO module, whereby concentrate form from the RO module, after consticisation with milk of lime yields white liquor.

Even though the above method appears to be promising detailed study and plant scale trials are highly necessary to assess the role of various parameters associated with indigenous bagasse/straw soda BL.

Probably one of the newest ideas to emerge in the recovery area is the use of reagent that eliminate the need for the lime kiln cycle or more specifically "auto-causticization" cycle based on disodium borate which reacts with sodium carbonate during firing of kraft BL. The ensuing pyrolysis releases CO_2 and on dissolution, the cooking liquor is ready to be returned to digesters. However the cost of process needs a review.

7) Conclusion

7.1) It is possible to use conventional recovery system in small scale units. The economic viability holds good even for 30 TPD and improves on 40 and 50 TPD plants.

7.2) To acertain good efficiency in recovery section, precautions have to be taken starting from raw material preparation, such as removal of leaf blades sheaty from straw, maximum depithing, BL filtration before evaporaters. These system will help in keeping in viscosity in control.

7.3) Cost of financing will play an important role in deciding the viability. Soft loan scheme if made avilable from the government counterpart to introduce installation of recovery unit, will play major role in final analysis.

7.4) Of the new process Ferrite process will be a boon the small unit if extensive plant scale trials materialised.

7.5) Problems associated with the high silica content of rice straw will require development of suitable desilication method for efficient chemical recovery.

8) ACKNOWLEDGEMENT

The authors thank management of Parkhe Research Institute, Khopoli for permission to publish this paper. shri M S Parkhe. chairman and Dr P M Parkhe. Managing Trustee and Shri N.S. Sadawart, trustee, have shown a keen interest and offered a valuable suggestion. Their help is gratefully ackonowledged.

References :

1) Monograph on appropriate industrial Technology, UNIDO.

2) N.S. Sadawarte, IPPTA, June 1984, Vol. 21, No. 2.

3) Kulkarni A. G, Mathur R.M., and Pant R. IPPTA, 1983.

4) Basu S. and Irrana K, IPPTA, 1983, PP 163.

5) Dr. Rao N.J. Environment Aspects in Processing Bagasse, IPPTA, Dec. 1986.

6) R. Ganesh, U. K. Deb 'Smelters for chemical Recovery' IPPTA, 1981.

7) Ray Surajit, Keswani S. L. IPPTA, Convention issue 1983, PP. 65.