Adaption of Existing Recovery System for Handling Blend of Black Liquors from Bagasse and Wood-Experience of Seshasayee Paper and Boards

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ABSTRACT

Depletion of forest based raw material resources has necessitated larger use of agricultural fibres by the Indian Pulp and Paper Industry. Sugarcane bagasse has emerged the best available option among various agricultural residues. SPB who pioneered the use of hardwoods in the 70's is currently pioneering utilisation of bagasse in admixture with hardwoods.

Where the chemical recovery system is designed specifically for bagasse liquors, problems associated with use of black liquor from bagasse, can be effectively tackled. Problems arise when recovery systems designed for use of liquor from wood are obliged to handle substantial quantities of black liquor from bagasse, in admixture with black liquor from wood.

Parameters which pose problems in the recovery of chemicals from bagasse black liquor are :

(a) High volume of Weak Black Liquor
(b) High viscosity of Black Liquor
(c) Difficulty to get originally required concentration
(d) Low SVR of Black Liquor solids
(e) Requirement of high bed temperature to sustain self-combustion

This article high lights the problems encountered at SPB in handling bagasse liquor and the steps taken to overcome these problems. High steam cost incurred in evaporation and increased air pollution loads due to higher direct evaporation, are areas which require immediate attention of designers and technologists to arrive at economical solutions.

Need of the day

Indian Pulp and Paper industry is currently facing the grave problem of the scarcity of forest based raw materials. Mills originally started on bamboo have already switched over to hardwoods. Even the availability of mixed hardwoods on a sustained basis is posing problem to the existing mills. In this context, sugarcane bagasse has emerged as the best available alternative among various fibres. It may be appropriate to state that bagasse is the primary product and sugar is the by-product in sugar mills. The valuable fibre 'Bagasse' burnt as a fuel in power boilers hitherto is to be pooled and diverted to paper industry to conserve the forest based raw materials.

It is high time that mills originally designed for bamboo and hardwoods will have to adapt processing of bagasse on a larger scale in the years to come.

Seshasayee Paper and Boards has been the pioneer in the usage of maximum mixed hardwoods in the fibrous raw material furnish from 70s. The mill could step up the use of hardwoods upto 90% over a span of ten years. SPB is currently pioneering in the utilisation of bagasse in admixture with hardwoods in the ratio of 40% : 60% as an internal programme by installing sugar mills near the paper industry.

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The operational parameters and characteristics of black liquor obtained from forest based raw material and agricultural fibres vary widely. While the nature of spent liquor obtained during mixed hardwoods pulping is complex, the processing of bagasse and mixed hardwoods black liquor blend aggravates the difficulty in the recovery operations.

The evaporators and recovery boilers are providing inadequate increasingly to cope up both operation wise and economywise with this change. To add to the above problems, air pollution regulations are becoming stringent. The conventional use of direct contact evaporators is to be dispensed with. These problems are to be viewed seriously and taken up by R&D wing, designers and technologists for solutions to effectively use 'Bagasse on an economically viable basis. Some of the problems during adaptation of bagasse pulping by SPB are discusred in this article.

Recovery Operation

Problem Areas

1. **High volume of black liquor**
   Impact on the evaporator unit

The poor drainage property and washability of the bagasse pulp warrants high dilution with water for maintaining acceptable washing loss. Since bagasse pulp requires more area in the Brown Stock Washing (BSW) compared to bamboo and wood pulp, the original washers are not able to cope up with the change. A volume of 10—12 m^3 weak black liquor from bagasse at 4—6% TS is not uncommon. Evaporation upto 54% solids was achieved with ease while handling bamboo liquor. It has become difficult while switching over to hardwood liquor. The problems became more pronounced in combination with dilute bagasse liquor to get even 45% TS inspite of the addition of FC evaporator in series with the conventional LTV evaporator system.

The observed drop in the free alkali (Table 1 : A) during the stages of evapcration which is a simple physical mass transfer operation, is not explainable with the existing information and knowledge. The complex reactions taking place are yet to be investigated and established.

Though the silica content (SiO_2) in bagasse liquor (1.6 g/l) was apprehended to give more problems, it did not give rise to serious difficulties in our experience (Table 2).

A considerable quantity of boosting alkali is required to maintain mobility and velocity across the heat transfer areas to get the evaporation. Some of the other problems like scaling, fibre fines reinforcement in the tubes are to be tackled by effective cleaning without slackness in the unit. Table 1 indicates (a) free alkali drop and (b) finisher effect scale analysis.

TABLE—1

A) Free Alkali drop during black liquor evaporation

Particulars	Units	Total solids	Free alkali as Na_2O on Total solids basis
Feed to evaporator (V)	%	20.01	5 06
V effect outlet	%	22.94	4.62
III effect outlet	%	25.25	4.54
I effect outlet	%	36 33	4.35

B) Analysis of finisher effect scale sample

(on dry basis)

Appearance	:	Flaky, soft, brownish gray
Loss on ignition, %	:	16.6
Silica as SiO_2, %	:	49.9
R_2O_3, %	:	3.9
Calcium as CaO, %	:	27.0
Magnesium as MgO, %	:	1.09
Chlorides as NaCl, %	:	1.02
Alkalinity as Na_2O, %	:	1.24
Sulphates as Na_2SO_4	:	Traces
Chromates as Na_2CrO_4	:	Traces

The visosity surges above the solids content of 44–46% pose the problem of evaporator efficiency and mobility across DC evaporator.

Recovery Furnace

The following parameters retard the process of com bustion conditions in the furnace.

(a) Viscosity shoot-up at 58% TS and above
(b) Difficulty in maintaining proper black liquor temperature (115°C–120°C) at the firing zone.
(c) Flow retardation from cascade to mixing tank.

(d) Slow burning of bagasse-wood liquor blend due to swelling volume ratio.

(e) Uneven bed profile on the Hearth.

(f) Blacking of ports warranting oil consumption.

(g) Unstable conditions in the furnace due to fluctuation in solids fired,

Viscosity

The influence of alkali on viscosity was studied for the relevant range. The results are given in Tables 2, 3 and 4,an d Figures I and II.

It can be seen from Table 3 that at nearly same, residual active alkali levels bagasse liquor as well as blend of bagasse and wood liquor are characterised by higher viscosity, compared to that of wood black liquor at approximately same solids level.

TABLE 2—BLACK LIQUOR PROPERTIES

Particulars	Units	Wood black liquor [1]	Bagasse black liquor [2]	Blend [1] & [2]
Total solids [initial]	g/l	176	89	140
*Residual active alkali	g/l	8.8	9.8	9.2
*Silica as SiO_2	g/l	1.2	1.6	1.44
Swelling volume ratio	ml/g	36.5	17.5	24.1
Organics	%	68.3	70 2	68.8
Calorific value of black liquor solids	cal/g	3660	3670	3669

[* at 200 gpl solids level]

TABLE 3—BLACK LIQUOR VISCOSITY DATA

Wood black liquor Residual active alkali 8.8 g/l (Na_2O)		Bagasse black liquor Residual active alkali 9.8 g/l (Na_2O)		**Blend of bagasse & wood black liquors Residual active alkali 9 0 g/l Na_2O	
Total solids (%)	Viscosity at 80°C (cps)	Total solids (%)	*Viscosity at 80°C (cps)	Total solids (%)	Viscosity at 80°C (cps)
23.6	4.0	24.3	6 0	22.4	5.0
28.2	5.0	29.3	10.0	27.9	6.0
33 3	6.0	33.7	18.0	31.4	8.0
38 6	9.0	38.3	25.0	35.1	10 0
41 8	13.0	42.5	51.0	39.8	15.0
52.7	53.0	44.6	89.0	43 6	26.0
55.4	170.0	53.7	710.0	52.8	275.0
61.6	2800.0	57.5	3200.0	61.7	3750.0
70.0	17200 0	—	—	66.1	18000.0

(* Brookfield L V.T.)
** Bagasse and wood black liquor blend (42 : 58) by vol.
(Date of sampling 14.7.1986)

Table 4—Effect of residual active alkali on black liquor viscosity*

Residual active alkali 9.2 g/l (Na_2O) Swelling Volume Ratio : 12 ml/g		Residual active alkali 10 8 g/l (Na_2O) Swelling Volume Ratio ; 20 ml/g		Residual active alkali 12.8 g/l (Na_2O) Swelling Volume Ratio : 26 ml/g	
Total solids (%)	**Viscosity at 80°C (cps)	Total solids %	Viscosity at 80°C (cps)	Total solids %	Viscosity at 80°C (cps)
36.1	10 0	39 3	11.0	35 4	9.0
42 1	14.0	45 1	21.0	39.9	10.0
47.9	60.0	51.7	67.0	42.7	13.0
52 2	90.0	60.7	975.0	50.4	35.0
59.9	1060 0	65.6	1800.0	57.5	158.0
67.5	13000.0	68 7	5700.0	61.9	500.0
69.4	76000.0	—	—	69.2	2560.0

* Bagasse and Wood black liquors blend (42 : 58 by Vol.)

** Brookfield (LVT)

(Residual active alkali determined at 200 g/l solids level)

(Date of collection of black liquor samples : 5 8.1986)

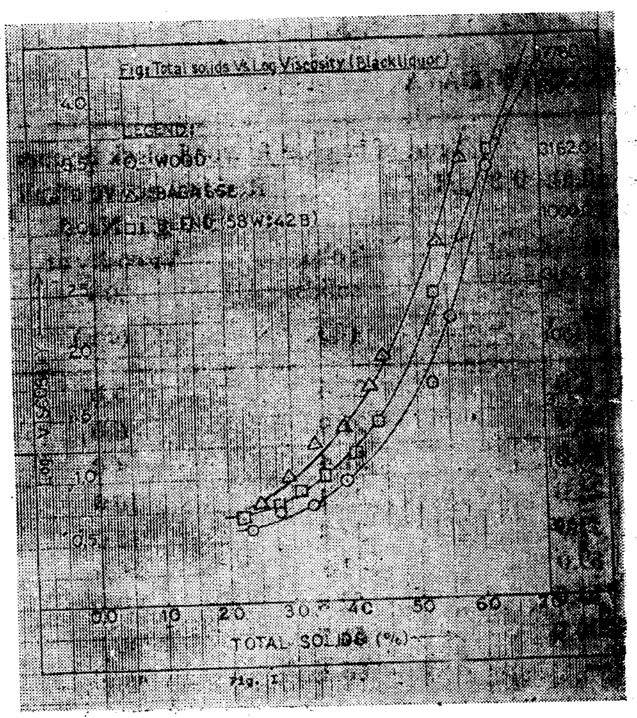

FIG.—I

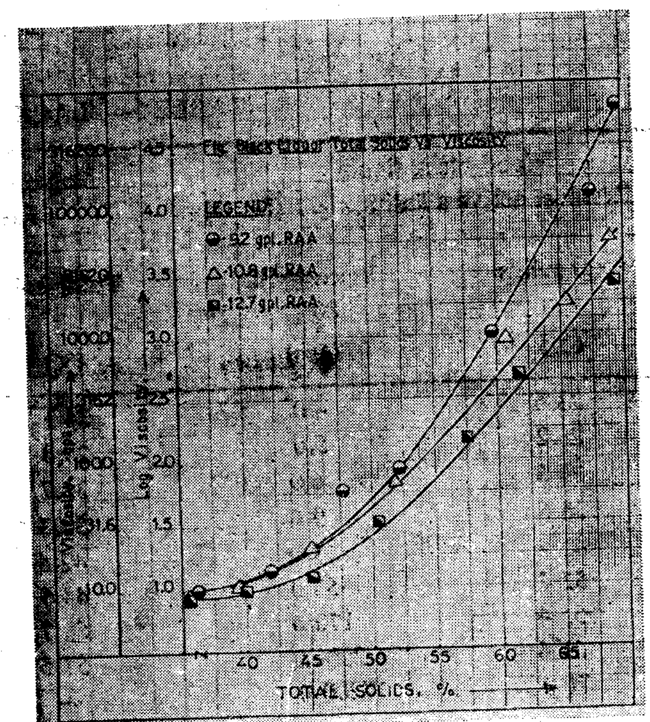

FIG.—II

Swelling Volume Ratio (SVR)

SVR is an important measurable characteristic of black liquor. It influences the drying rate of concentrated black liquor in the recovery furnace and subsequent combustion. Concentrated black liquor, as it leaves spray nozzle, loses its moisture either in space-drying or on the furnace walls. The SVR of wood liquor is 36.4 ml/g, while the bagasse liquor is having low value at 17.5 ml/g. The blend of bagasse and wood liquor assumes an intermediate SVR value of 24.1 ml/g. (Table 2).

The bagasse liquor, having low SVR, retards internal evaporation and results in a denser mass on hearth bed making air and char contact difficult. In other words, there is retarded drying and slower combustion resulting in lower bed temperature.

While this can be effectively tackled at design stage by providing larger space for drying and lower heat absorption by furnace water wall tubes in case of modern recovery units, in the existing units, problems arise. In this context, the supplier of Gotaverken boiler (Sweden) has suggested to retrofit furnace hearth refractory lining and part of side wall tubes to decrease heat absorption and increase hearth zone temperature.

The burning characteristics of bagasse blend black liquor solids is analogous to the difficulty in handling high calorific value coal, like anthracite, rich in fixed carbon and low volatiles in conventional coal fired boilers.

The problems encountered during adaptation of bagasse pulping in admixture has been referred to the supplier M/s Gotaverken (Sweden). After the supplier's study the following suggestions were made for improvement.

1. Introduction of box heater from cascade evaporator to mixing tank to improve mobility of the liquor.
2. To increase the spray angle to 60° to reduce the rear side black outs.
3. To increase the air temperature to 200°C for better combustion.
4. To increase the diameter of the black liquor spray line for providing better residence time to increase temperature.
5. Retrofitting of the refractory on the hearth of the furnace to reduce heat absorption rate to improve the zone temperature and thereby increase stability of furnace.

The above suggestions are in the process of implementation.

Impact of Economy

1. The low twaddle of bagasse liquor makes evaporation cost higher.
2. In a few cases when the liquors are fired at low concentrations due to the inability to achieve higher concentration, apart from the problems of burning, the high pressure steam output will be reduced which will again have adverse effect on economy.
3. Another factor affecting economy is viscosity of liquor and the necessity to use more chemicals either in pulping or in the recovery process for maintaining higher free RAA content.

The author wish to focus attention through this column to find ways and means to use bagasse fibre on a larger scale out of sheer necessity. Since existing mills cannot afford new tailor made recovery units, some adjustments and modifications are necessary to face the new situation. Another question is how to avoid DC evaporators to reduce air pollution and step up steam for power generation.

Conclusions

1. The existing mills are facing the new situation of handling predominantly bagasse on a larger scale.
2. Modifications and adjustments are to be made in the existing units while adapting bagasse pulping in dealing with the high viscous liquors right from evaporation to incineration of black liquor.
3. Impact in the economy, pollution abatement, designing of a suitable evaporator units avoiding DC evaporator while saving cost oriented steam energy are some of the immediate and pertinent points to be studied in detail.