"Mill experiences in the utilisation of bagasse and rice straw for the production of writing and printing grades of papers"

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ABSTRACT

This paper describes the prevailing conditions especially the growing demand for more paper on the one hand and the depleting forest resources, problems associated in importing the basic raw materials, detereoration in the quality of indegenous waste papers and their rising prices on the other Under such circumstances the conditions of medium and small mills is higlighted. In this paper we have made an honest effort to highlight the plight and effoits of a medium sized mill which was based on wastepaper and purchased pulp to produce writing and printing varieties of papers but which has now diversified to utilise the agricultural residues like straw and bagasse to produce pulp and paper, in its endevour to help solve the national crises facing the Indian pulp and paper Industry.

Utilisation of the agricultural residues like straws and bagasse is very important under the circumstances and hopefully the present and future answer to meet the raw material crises. Though, we have not achieved the total expertise in the processing of these agricultural residues, we have gained confidence and experience their use in producting varieties of Writing and Printing Paper. This paper describes the various problems faced by a typical medium size mill in their processing from a totalitarian view point.

In the utilisation of bagasse partial depithing to remove about 50% of the pith content helps in minimizing the various problems associated with the use of bagasse. Blending this pulp with 20-30% of softwood sulphate pulp or a mixture of soft wood sulphate and rag pulp in that percentage helps in smooth running of the stock on paper machine and in getting the desired paper properties.

INTRODUCTION

Our country is passing through a critical phase. The Gulf crisis has wiped out our valuable foreign reserves. To face the crisis Government has put severe restrictions on the imports. Though, this will affect a wide spectrum of industries the paper Industry will be the maximum sufferer, because of its dependence on huge quantities of raw materials import. The upward revision of cash margin on letters of credit from 50% to 200% for the import of raw materials like waste paper and wood pulp and 22% devaluation of Ruppee within 15 days period has hit the Paper Industry worst It is reported that most of the small and medium sized mills which were solely dependent on purchased pulp had to wind up their operations. Only those which can produce their own pulp using agricultural residues like Straw and bagasse will survive. However, the import restriction and upward revision in L.C. has pushed up the prices

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of indegenous waste papers considerably. It is already reported that some 69 small paper mills with an installed capacity of 2.18 lakh tonnes per annum are closed and another 80 Paper Mills in the country are on verge of closure (1). The reasons being raw material crisis and difficult fianance situation.

A Preadominantly agricultural country like India where agricultural residues like straws and bagasse are abundant, the immediate answer should be the utilisation of these as a fibre source. In the recent years the setting up of Sugar and Paper Mill in the same complex where the bagasse produced by the Sugar Mill being used by the Paper Mill are the best examples to show the awareness that is being developed.

AGRICULTURAL RESIDUES AS A FIBRE SOURCE

It has been established over the years that the agricultural residues like the Straws and bagasse can be potential source as the paper making fibre. Lot of published information is available in this regard. The availability of the straws is restricted to the belts where wheat and rice are grown and bagasse to those areas where sugarcane is grown, otherwise, the transportation costs will be prohibitive because of their bulky nature.

The straws and bagasse differ from one another in the physical and chemical composition. The proximate analysis of rice straw, wheat straw and bagasse is given in the Table I below.

Table I

Proximate Analysis of straws & Bagasse

SNo.	Particulars	Rice Straw Ref. 2	Rice Straw Ref. 3	Wheat Straw Ref 4	Wheat Straw Ref. 5	Bagasse Ref. 6
1.	Ash %	13.6	22.2	6.0	10.5	2.5
2.	Silica %	12 2	14.5	—	4.5	0.5
3.	Cold Water Solubility %	—	13.4	—	18.8	—
4.	Hot Water Solubility %	15.6	16.5	9.5	21.7	3.8
5.	1% NaOH Solubility %	51.3	51.4	40.2	52.5	29.6
6.	Alc-benzene extracts %	10.3	1.3	2.9	4.8	1.2
7.	Pentosans %	20.9	20.0	23.0	19.8	28.0
8.	Lignin %	8.3	9.4	21.0	–	17.0

The above analysis data reveal two striking differences The ash and silica content is maximum in rice straw, considerable in wheat straw and minimum in bagasse. The lignin content is more in wheat straw and bagasse and less in rice straw. Hence, rice straw needs less amount of cooking chemicals than the two others and it is the rice straw pulp which is used in the cheaper paper varieties because of the economic considerations

The Chemical composttion of these raw materials along with the other conventional raw materials has been recorded in the Table II.

TABDE II (6)

Chemical Composition and Fiber Morphology

S No.	Particulars	Crude cellulose %	Lignin %	Ash %	Avg. Fibre Length MM	Avg. Fibre Width Micron	Dimensions Lumen width Micron	Dimensions Cellwall thickness Micron.
1.	Coniferous (Woods) General	40-45	25-35	0.2 1.0	2.5— 7.0	33— 35	26-28	3.6
2.	Hard Wood (General)	40-62	15-25	0.2— 1.0	0.34 2.67	10— 50	11-26	2 5— 4.0
3.	Bagasse	48-58	18-22	2— 5	0.3— 3 4	9— 45	16	5
4.	Rice Straw	43-47	13	18	0 5— 2.5	4— 15	3—	3 5
5.	Wheat Straw	43-54	18	8	1.1— 1.5	9— 13	—	—

The above data reveal that bagasse fibre will be comparable to hard wood fibres in strength characteristics.

BAGASSE AS A POTENTIAL FIBRE SOURCE :

Bagasse is associated with 30-35% pith and the use of whole bagasse is associated with the following problems.

1) Pulping Chemicals consumption is more but the yields are less.
2) Pith and extraneous matter associated with it swell and become gelatinous in cooking and give rise to the following problems :—
   a) Drainage rate of the Pulp is decreased too much.
   b) Tends to clog up paper machine wire.
   c) Sticks to the press rolls.
   d) Fills up the felts and decreases the drying rate of paper.
3) Pulps obtained are poor in strength properties and dirt and shiny spots appear on paper.
4) Bleaching Chemical consumption is also more.

In order to over come the above problems depithing operations are carried out before bagasse is subjected to pulping.

A combination of dry and wet depithing methods are usually preferred.

The pith removal operations are associated with energy consumption and the pith handling and disposal problems.

It has been observed that Pulp strength charactertstics and drainage properties improve as more and more percentage of pith is removed from bagasse (7, 8). It is also true that 100% depithing is not feasible and as more and more amount of pith is removed some portion of fibre is also lost along with pith. When the pith content is reduced below 15% a marked improvement in pulp strength characteristics is observed. Below 10% pith concent, every 1% pith removal is associated with more and more amount of energy consumption. It has been reported (8) that whole bagasse when depithed to 80% of its pith content, improve yields and fibre strength properties are obtained. When bagasse is left with pith content around 10%, it does not creat much process problems. In the medium and or small sized mills which use straws as well as bagasse it may not be techno-economically feasible to have separate processing units for straws and bagasse. The straw processing unit is normally used for processing bagasse and the process can be considered similar to dry depithing of bagasse.

Fresh bagasse has a low pH of 3.5—4.0 and the pH increases to about 6.0 after about 8-10 weeks storage. When used fresh, depithing will not be better, consumes more alkali and gives lot of foaming problems in the process (9). Stored bagasse for a minimum period of 2-3 months behaves better in all respects.

PROCESSING OF RICE STRAW AND BAGASSE AT THE SIMPLEX MILLS, GONDIA

Rice straw is processed through the straw cutter, deduster and through the conveyer it is loaded into the spherical digesters through the lye mixer which ensures uniform wetting and uniform mixing of the chemical with straw.

An attempt was made to use Bagasse in existing Rice straw pulping system to overcome Raw Materials problem faced due to import restrictions, without any coventional depithing system.

The strings of bagasse bales are manually cut opened through the cylindrical rotating perforated screen of 5mm hole size. The inside part which is retained on 5mm mesh is automatically fed on the conveyer belt which leads to the lye mixer where chemicals and diluents are added and then drops into the digester. The portion which passes through the 5mm mesh is collected below and is blown by an exhaust fan outside to be collected and disposed off as pith. This pith may also contain some quantity of fibres which is difficult to ascertain. Some of the data is recorded below.

Particulars	Rice Straw	Bagasse
Moisture %	10—12	22 to 25
Dust/Pith removed %	2—5	8 — 12

PULPING OF RICE STRAW AND BAGASSE :

The dedusted rice straw and potentially depithed bagasse are pulped by the soda process in the rotating spherical digesters of 40 M^3 volume with steam heating. The pulping conditions and results are recorded below in Table III.

TABLE—III

Rice Straw & Bagasse Pulping Conditions & Results

Sr. No.	Particulars		Rice Straw	Bagasse
1.	Per digester charge Tons (bd)		5.0	5.5
2.	NaOH per charge, Kgs		350.0	740
3.	NaOH added, %		7.0	13 5
4.	Bath ratio		1:2 5	1:2.5
5.	Black liquor added M^3		10	15
Cooking Conditions :				
1.	Digester charging time,	hrs	2-2.5	2-2 5
2.	Steaming to 170°C (7 Kg/Cm^2),	hrs	2	2
3.	First degassing at 2Kg pressure,	hrs	0.25	0 25
4.	Second degassing at 3Kg pressure	hrs	0.25	0.25
5.	Cooking time,	hrs	2.0	2.0
6.	Blowing time,	hrs	0.50	0 50
7.	Total cooking cycle,	hrs	7-7.5	7-7.5
Results :				
1.	Unbld. Screened Pulp Yield	%	37.0	39-40
2.	Unbld. Screened Pulp K. No.		12-14	11-12
3.	Unbld. Screened Pulp brightness %		40-42	48-50

The cooked stock is blown into the blow tank-A schematic process flow is shown as below.

The Screened bagasse pulp is bleached by the CEH sequence to around 78-80° brightness and is used in furnish for the manufacture of all the varieties of writing and printing papers.

The bagasse pulp bleaching conditions and results have been recorded in Table IV.

TABLE IV

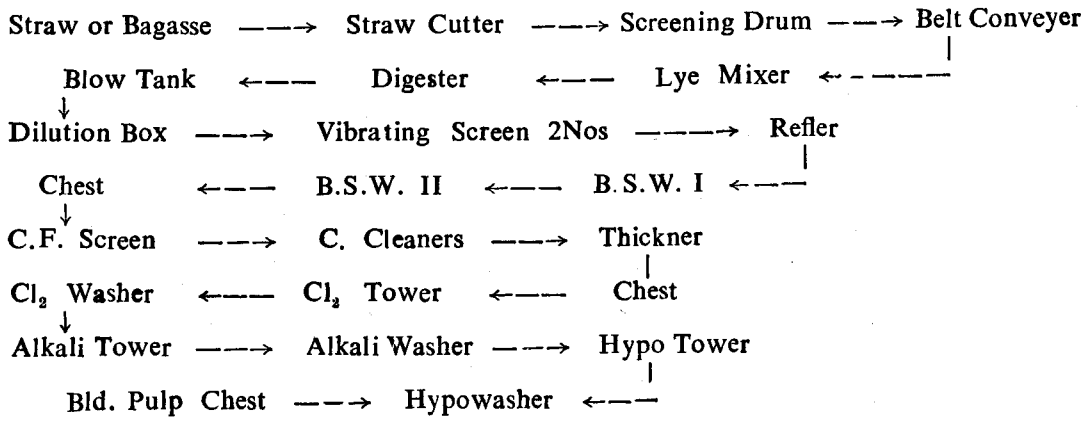
Bagasse Pulp Bleaching conditions and Results

Sr No.	Particulars	Bagasse Pulp
1)	Unbld. Pulp K No.	11-12
2)	Chlorine added %	6-7
3)	Pulp Cy %	3.2-3.5
4)	Retention Time in the tower, hrs	1.0
5)	NaOH added %	1.50
6)	Pulp Cy %	8-9
7)	Temp °C	50-55
8)	Retention time in the tower, hrs	2 5-3 0
9)	Hypo added as av. Cl_2 %	3.5
10)	Pulp Cy %	8-9
11)	Retention time in the tower, hrs	3.5
12)	Temp - °C	30-35

Results

1)	Kappa No. of the alkali extracted Pulp	6-7
2)	Total Chlorine Consumption %	9-10
3)	Brightness of the bleached pulp %	78-80
4)	Bleached pulp viscosity, CED(0.5%),CP	6.5-7
5)	Bleached Pulp, °SR	25-27

Schematic Process Flow for Straw & Bagasse



Counter current washing is done in the unbleached pulp washing and maximum utilisation of each bleaching stage back water has been practiced. The unbleached and bleached bagasse pulps have been tested for their strength characteristics and the results have been recorded in the Table V below.

TABLE V

Strength Properties of Bagasse Unbleached and Bleached Pulps.

S.No.	Particulars	Bagasse Unbld. Pulp Unbeaten	Beaten	Bagasse Bldg. Pulp
1)	Pulp Slowness, ml, CSF	500	350	270
2)	Basis weight, g/m²	59.6	60.2	60.5
3)	Bulk, Cm³/g	1.62	1.45	1.42
4)	Breaking Leagth, m	3500	4300	3200
5)	Burst Factor	20.2	28.6	19.2
6)	Tear factor	46.9	42.5	36.8
7)	Double folds	15	21	9

Testing Conditions

R.H% = 65 ± 2

Temp °C = 25 ± 1

The above analysis results show that bleached bagasse pulp is somewhat poor in strength characteristics. The main reasons for this is more amount of pith with the bagasse i. e. around 20% and more retention time during the hypochlorite stage of bleaching.

Flexibility at the Mills :

The mill has a vast flexibility in the selection of raw materials and also in the proportion in which these are blended in different paper varieties. The mill has seperate streets for—

a) Waste Papers & Pulp Processing
b) Straw and Bagasse processing
c) Rag or waste cotton processing

This gives a leverage in controlling the proper product mix and achieving the desired paper properties. The bleached bagasse pulp has been used in the manufacture of all varieties of Writting and Printing paper, ledger paper, bond paper etc. Some of the paper properties have been recorded below in Table VI.

TABLE VI

Strength Characteristics of Writing & Printing Papers

S.No.	Particulars	Cream Wove Superfine 52Gsm	Cream Wove Superfine 58Gsm	Cream Wove Deluxe 52Gsm	Cream Wove Deluxe 58Gsm	Ref.Std Cream-wove
1)	Basis weight,g/m²	52.2	57.5	51.4	58.2	± 2.5%
2)	Bulk, Cm³/g	1.58	1.49	1.45	1.49	—
3)	Breaking Length, m MD	2480	2560	2520	2660	2500
	CD	1770	1860	1720	1820	1700
4)	Tear factor MD	52.3	52.6	54.4	53.8	—
	CD	63.5	64.2	65.2	62.6	—
5)	Burst facter	16.0	15.2	17.7	16.5	—
6)	Double folds MD	12	13	12	16	—
	CD	7	6	7	8	—
7)	Ash%	4.6	5.0	10.7	6.3	—
8)	Cobb 60, g/m² T	16.8	16.5	17.0	17.0	17.0(Max.
	W	20.0	19.5	20.2	19.5	
9)	Brightness, °PV	68.0	67.0	75.0	76.0	68 0(Min.
10)	Ink feathering	No	No	No	No	Resistance to pass the test.

A comparative data of the strength properties of Creamwove Paper along with the other Creamwove papers collected from the market has been recorded in Table VII below.

All the foregoing strength characteristics data and the smooth running of the Paper Machine at 220-230 M/Min speed indicate that the product mix is quite strong. Since the bagasse pulp produced is less strong it is blended with 15-20% of long fibre pulp to improve tearing resistance.

PPOBLEMS FACED IN THE MILLS

Since we are doing the dry depithing of bagasse in the straw processing street the following process difficulties are encountered.

1. Depithing is only to the extent of 8-12% and the bagasse still retains around 20% pith.
2. Pith handling and disposal is very labour intensive work.

TABLE VII

Comparative Data of Creamwove Paper

S.No.	Particulars		Simplex Mills 52Gsm	Obtained from Market A 50Gsm	B 47Gsm	C 50Gsm	D 54Gsm
1.	Basis Weight, g/m²		52.2	49.0	47.0	46.5	59.0
2.	Bulk, Cm³/g		1.58	1.55	1.63	1.82	1.59
3.	Burst factor		16.0	13.9	14.8	14.4	16.9
4.	Brightness %		68.0	61.0	62.0	62.0	60.0
5.	Sizing, Sec		7	6	6-7	5	7
6.	Cobb 60, g/m²	T	16 8	18.0	21	20	21
		W	20 0	21 0	22	21	22
7.	Ash %		4.6	11.0	3.50	1.0	4 5
8.	Ink feathering		No	No	No	No	No

3. The wires used in the baling operation, escape along with bagasse and end up in the blow tank. They sometimes choke and jam the delivery line, pump suction, pump body etc. and cause process problems.
4. Pulp produced is having slightly lower strength characterstics.
5. Since bagasse still retains around 20% pith foaming problem is also encountered.
6. There is also some picks observed in the presses as a result of which some times paper breaks encountered.

REMEDIAL MEASURES

We are setting up a complete depithing plant/unit to overcome most of the above problems. This will be utilised for burning in the new boiler which has been ordered. Hence most of the above problems will be taken care of and we shall be able to produce a very good quality of bagasse pulp.

CONCLUSIONS

1. Partially depithed bagasse with a pith content around 20% can also be utilised for the production bleached pulp. However, problems encounted due to pith content in bagasse though not encounted with total severity neverthless they are persisting to some extent.
2. A Mill with a flexibility for the processing of agricultural residues, waste paper, rags or Waste Cotton can manuplate the process parameters to its advantage and can suppress some of the process difficulties encountered with the use of bagasse pulp obtained by processing potentially depithed bagasse around 20 % pith content.
3) Most of the varities of the Writing and Printing papers can be made using Bagasse Pulp. Around 20% of long fibred furnish is necessary to improve the tearing strength and to ensure a smooth run on paper machines.
4) If depithing is done to the extent of 75-80%, then bagasse will be left with 6-7% residual pith. Such bagasse will give very good pulp and most of the process problems will be appreciably reduced/eliminated.
5) Processing of the agricultural residues like straws and bagasse to produce paper is very vital, and the present and future answer to tide over the raw material crisis facing the country.

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REFERENCES :

1) Economic Times Dtd. 10.4.91.

2) Panchapakesan T, "Designing of Refiner System in a Paper Mill" IPPTA Vol. XI (4), P-269 (December) of 1974.

3) Pai N.M., etal "Rice Straw Pulping And Papermaking" IPPTA Vol. XII (3), P-218 (Sept.) of 1975.

4) Trivedi M.K. "Wheat Straw as a Source of Cellulose Pulps" IPPTA, Vol. XII (4), P-308 (Dec.) of 1975.

5) Unkalkar, V.G., "Wheat Straw-A Potential Raw Material for Papermaking", IPPTA, Vol. XIV (1), P-13 (Jan.) of 1977.

6) Commonwealth Bureau of pastures and Field crops. Field crop Abstracts Vol 34 No. 7 July1981

7) Mr. Keropp S. D. & Coworkers
"Sugarcane bagasse as a fibrous paper making material"

TAPPI AUGUST 1957

8) A. R. Dharwadkar, P.A. Pai, V.D. Khanolkar, P.M. Parkhe and N S. Sadawarte.

"Modern depithing methods for Bagasse and the effects on Paper making properties".

Paper presented at the Seminar on "Sugar By-Products" held at Pune on 19-20 Sept. 1981 organised by PCPL and Deccan Sugar Institute.

9) V. Sheshadri Rao, J. Sundar Ram and T.K. Ramlinga Shetty "Practical aspects of Paper making from Bagasse" Paper presented at the Seminar on "Sugar By-Products" held at Pune on 19-20 Sept. 1981, organised by PCPL and Deccan Sugar Institute.