Agr cultural residues vis-a-vis Indian paper industry

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SUMMARY

The increasing scarcity of conventional raw materials like Bamboo & Hard Wood etc. to cope-up with demand of paper and paper products necessiates the utilization of the non-conventional raw materials such as agricultural residues to the maximum possible extent The paper deals briefly with the availability of these residues and the various constraints in the way of their utilization along with the possible remedial measures to tackle them.

The per capita consumption of paper is a direct function of the quantum of literacy, material income and industrialization in a country. U.S.A. at the moment, reigns supreme with a figure of 273.1 Kgs. India, with a figure of 2 1 Kgs. lags far behind making it obvious that the demand for paper and paper products in India will continue to follow an unabated upward trend for many years to come.

The installed capacity of 18.7 lac tonnes as on 31st March '82 has to be increased to a maximum of 40 lac tonnes by 2000 AD in order to meet the domestic consumption of paper expected to be 36—78 lac tonnes by that period[5]. It is, therefore, evident that the development of Indian Pulp & Paper Industry has to be accelerated for which raw-materials shall be required in abundance.

The only potential sites now available for setting up of new integrated pulp & paper mills based on Bamboo and Hard Wood are districts of Koraput and Bastar in Orissa and Madhya Pradesh respectively, some areas in Assam State and Tarai area in Uttar Pradesh but due to various constraints no new big mill has come up so far. However, recently only one small mill of 60 TPD capacity is being set up in Koraput District, Orissa which means an addition of 20,000 TPD to the existing capacity. Even, if a few new big mills are installed in the above areas, it will add 2 to 3 lac tonnes of capacity at the maximum to the present installed capacity of 18.7 lac tonnes raising it to a maximum of 21-22 lac tonnes. Still, there would be a gap of around 18-19 lac tonnes of installed capacity to meet our requirement of 40 lac tonnes by 2000 AD.

The raw materials, commonly used in Indian pulp and Paper Industry, to-day, are Bamboo and Mixed Hardwood which are getting scarce day-by-day even for the present requirement, what to say of future. The existing integrated pulp and paper mills are now exploring the possibility of captive plantation to ensure regular supply of raw materials to their mills. May be, the mills to come up in future, too, think on the same lines. The successful implementation of this proposal involves both the Government and the mills and unfortunately no satisfactory progress has so far been observed in this direction. Efforts must continue but this is a long and complex process before it could give results,

In the above background, it is important and utmost essential that efforts are made to explore the possibilities to utillse Agricultural Residues like Bagasse and Straw, etc. to the maximum possible extent.

AVAILABILITY OF AGRICULTURAL RESIDUES

Presently, out of the total land available in our country, only 45% is under cultivation producing,

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on an average, the agricultural residues as under[1]:—

	Million Tonnes/Annum
Rice Straw	75
Wheat Straw	60
Bagasse	4
Total	139
Say	140

The present paper production utilizing these wastes is around 3 to 4 lac tonnes consuming about 9-10 lac tonnes per annum of the above raw materials. If only 1% of the available residues could additionally be spared for the paper industry, around 4 5 lac tonnes of addional capacity could easily be obtained.

UTILIZATION OF AGRICULTURAL RESIDUES

Pulp and Paper Mills based on the agricultural residues can be installed as small or medium size mills. Even the existing integrated mills could expand their capacity by adding units based on these raw materials. Ordinary grades of papers can easily be made exclusively by these raw materials.

The new mills can blend their pulp with the purchased conventional pulp to produce better grades of paper. Similarly, the existing mills can blend their pulp with the non-conventional pulp and produce reasonably good quality products In this connection, big size mother pulp mills of capacity 1 0 lac tonnes per annum can be given a serious thought. It could be based on either conventional or non-conventional raw materials and the pulps so produced can be sold to units as per their requirement. May be, pulp mills based on non-conventional raw materials supply their pulp to the pulp mills based on conventional raw materials too for blending. The recovery of chemicals, a big constraint for small units, too, can be planned without much difficulty in such cases. Even if 3 to 4 small pulp mills of 30 35 Tons/Day capacity, based on Agricultural residues, are installed in close vicinity, the recovery of chemicals can be made possible by pumping the black liquor of various units to a single unit provided with a recovery plant. However, the proposal would certainly involve certain commercial and administrative problems, which are to be looked into carefully and a feasible proposition can be made if the concerned take it as a national problem.

Higher utilisation of the agricultural residues can be achieved to meet the future demand if the existing mills based on conventional raw materials come forward to expand their capacities by installing small units based on agricultural residues. The recovery of chemicals would not pose that much of problem for them as their existing recovery system can handle the additional black liquor along with their existing black liquor after mixing in desired proportion.

CONSTRAINTS IN THE UTILISATION OF AGRICULTURAL RESIDUES AND POSSIBLE REMEDIAL MEASURES

The major constraints for the utilisation of the agricultural residues in high quantity in our industry are :—

a) Smaller fibre length and low yield.

b) Collection, transportation and storage of the raw-materials in view of their high bulk,

c) Economic viability of chemical recovery.

d) Unassured supply in view of their present uses and the reluctance on the part of the producers to go in for a substitute. For example, Bagasse from Sugar Mills—Since their boilers need modification to use coal besides the question of investment and assured supply of coal.

e) Effluent disposal problem.

In the foregoing paras the authors shall now deal with some of the remedial measures to overcome the above constraints at various stages of the processing.

a) Storage

Agricultural residues being very bulky in nature, collection centres with adequate storage capacities have to be organised. The loose material has to be made into bale form by bailing presses which helps in reducing the storage space, transportation and handling cost, fire hazards and raw materials decay, etc.

(b Pulping Process

Some of the main agricultural residues have been compared below with bamboo with respect to their lignin, hemi-cellulose and cellulose contents and fibre dimensions. (1 & 2)

Sl. No.	Raw material	Composition			Fibre Dimensions	
		Lignin	Hemi cellulose	Cross & Bevan Cellulose	Average length	Average dia
		%	%	%	mm	Microns
1.	Rice Straw	25 5	21	53.5	1.13	16
2	Wheat Straw	21.5	23.5	51.5	1.10	12
3.	Bagasse	21	26.6	54.9	1.38	18
4.	Bamboo	27.8	15 1	59 9	1.65	12

Besides the above, the other non-conventional raw materials like jute and sabai grass, etc., available abundantly can also be used in the paper industry.

The primary function of all the pulping methods is to loosen and liberate the fibres. Out of two basic methods of pulping, i. e. mechanical and chemical, in mechanical pulping, the fibres are separated from each other by rupturing the cementing non-cellulosic materials and the fibre walls are drastically broken down. This gives high yield but the pulp quality is poor due to mechanical degradation. The chemical pulping consists of dissolving the middle lamella by acid, alkaline or neutral liquors resulting in the fibre separation without the mechanical degradation. This gives lower yield than the mechanical pulping but the pulp has good strength characteristics. Both Soda and Sulphate chemical processes are suitable for producing pulp of acceptable quality with moderate yields. Sulphate process somewhat improves the yield and strength properties of the pulp. However, where fully bleached pulp has to be produced, these advantages are marginal. The corrosive action of the sulphate process demands selective and expensive material for construction of the equipments thereby increasing the capital investment.

All the above technical and economical considerations, therefore, favour the choice of soda pulping process which is uniquely suited for the open type of fibrous raw materials like bagasse and straw.

Prewashing or soaking with fresh water, mill effluent or alkaline waste water can either be manually carried out in shallow ponds or mechanically depending upon the quantum of raw material. Mild hammering operation during prewashing, temperature and duration of treatment play an important role in removing extraneous matter and a good part of undesired soluble organic matter as well as adhering silica from the raw material.

Disintegration of these raw materials can be done either in a chopper or crusher to convert it into smaller size before digestion in a Batch/-Continuous Digester. The Continuous Digester being a highly capital intensive imported item, batch digesters (Rotary globe or tumbling type) can serve the purpose.

The typical cooking conditions and pulp yields of some of these agricultural residues using soda process are as follows (2)—

Sl. No.	Raw Material	Chemical addition as NaOH	Cooking temp..	Bath Ratio	Pulp Yield screened
		%	°C		%
1.	Rice Straw	12	140	1:5	45
2.	Wheat Straw	10	140	1:5	5.-55
3.	Bagasse	12	150	1:5	61-65 (depithed)

The freeness of the unbleached bagasse pulp varies between 20-22° SR when well depithed bagasse is used for pulping whereas the freeness of straw unbleached pulp is 28-30° SR.

Although, both the pulps are of slow drainage characteristics compared to conventional pulps, straw pulp is more sluggish and requires more specific area for washing. Hence, 4-stage counter current washing with a filtering area of about 1.5 T/M²/Day to achieve harder vacuum conditions[7] as compared to 3.5 T/M²/Day required in general, for conventional raw material is recommended. Coarser wire clothing of 40-45 mesh are found more suitable for washers. Although, fiber loss is comparatively high in washing over coarse wires, it is well compensated by higher output, better washing and removal of pith. Free alkali in cooked pulp is helpful in better washing and removal of pith. Free alkali in cooked pulp is helpful in better washing over washers as well as during evaporation in evaporators.

A vortrap of suitable size to entrap sand and heavy matter, followed by centricleaning arrangement is enough for screening. Bleaching sequence is generally similar to that of conventional one i.e. C-E-H-H system. 4-stage bleaching with 1.6 T/M²/Day filtration area is generally recommended for these raw materials[7], as compared to 4.5 T/M²/Day for conventional raw materials.

c) Paper Making

Agricultural residues being generally short fibred and richer in hemi-cellulose do not need high refining. Mild rubbing and defibration is enough to give an adequate stock for paper making.

The pulp stock is sluggish in nature and hence a paper machine with higher drainage system, longer wire length, more number of suction boxes and suction presses, open type wet felts, more effective system of felt cleaning is essentially needed to achieve better machine performance and desired quality of paper. Use of beater additives and fibre bonding chemicals can give added advantage of reducing pitch trouble, press stickness and felt and wire checking, etc.

Shrinkage in paper web in drying section is also more in these cases To avoid wrinkles and uneven drying, it is necessary to have a carefully adjusted drying in machine dryers.

d) **Chemical Recovery**

The installation of a chemical recovery unit to recover the chemicals from black liquor improves the economics of the pulp mills based on agricultural residues. In smaller paper mills upto 30-35 TPD, the possibility of putting chemical recovery unit is oblique. The economics of putting chemical recovery, especially, in straw based mills is not alluring because of expected high furnace oil consumption to the tune of 250 litres/ton of pulp (approx.), due to the low calorific value (2700 K. Cal/kg) of Black Liquor solids, varying organic/ inorganic ratio (bagasse 66/34, straw 59/41) and high silica content in straw. All these have significant influence on the burning characteristics of the Black Liquor. Studies are to be made to substitute the furnace oil by some other auxillary fuels like producer gas which may improve the economics. However, the installation of the Chemical Recovery, besides recovery of chemicals shall reduce the pollution problem too, which is a social obligation.

The chemical and heat recovery system in a soda mill is similar to the kraft recovery system normally practised in the conventional mills with little changes in the design and capacity of the equipments and operating techniques.

Black liquor with around 10-12% solids content available from brown stock washers can be concentrated to 45-50% solids by a multiple-effect evaporator. This strong black liquor has to be further concentrated to 62/64% solids in cyclone evaporators for firing into the recovery boiler.

The typical analysis of straw black liquor from various evaporating stages is given below[2]—

Optimum free alkali has to be maintained in the weak black liquor by introducing fresh caustic to overcome the problem of viscosity and rapid scale formation in the multiple-effect evaporators. Normally, the weak black liquor from washing contain 4-6 gpl as NaOH, which has to be raised and maintained at 10-12 gpl as NaOH, Black liquor of minimum 60% solids concentration can be fired into the Recovery Boiler. Since, reducing atmosphere is not required, air supply both at the primary and secondary stages can be controlled with considerable ease. Steam generation would be around 6-7T/Hr. from a Recovery Boiler of 30-35 TPD pulp capacity. Since sulphur is not present in the soda liquor, there is no reduction of sulphur in the recovery furnace.

To make-up, caustic soda (NaOH) can be directly added to the white liquor (or) the make-up chemical sodium carbonate can be added to the recovered green liquor and further processed in causticizing.

Sl.	Particulars	BSW	After NaOH addition	EFFECTS 1	2	3	4	5	Cyclone Evaporator
1.	Total solids on (the wt. of the liquor) %	13.82	14.00	17.05	21.24	28.05	36.07	47.23	63.4
2.	on wt. of total dry solids—%								
2.1	Ash Oxide)	41.53	52.71	52.6	53.48	53.61	52.5	52.51	52.83
2.2	Free NaOH	2.48	9.75	7.78	7.82	7.73	7.72	8.40	4.65
2.3	Silica (SiO_2)	3.84	3.57	3.60	3.31	3.61	3.59	3.51	8 30
2.4	Total Sulphur	1.90	2.85	2.85	2.94	2.55	2.75	2.52	3.87
2.5	Total Alkali (Na_2O)	—	—	—	—	—	—	—	18.50

Due to presence of silica, the fluegas carryovers tend to deposit on the surface of screens and boiler banks. These deposits on fusion at high temperature, could be very hard and difficult to remove. Therefore, the location of the screens, Boiler Banks and position of soot blowers shall have to be substantially modified over the conventional design to ensure the boiler passes and tube surfaces clean for long periods of trouble free operation.

Causticizing operation follows the conventional design normally practised in Kraft Pulp Mills.

The presence of silica in green liquor, generally, in the form of sodium silicate hinders the lime settling in clarifiers. Hence, the capacity of the clarifiers has to be considered higher than the conventional design to ensure better settling.

CONCLUSION

There is a great potential for agricultural residues in the Pulp and Paper Industry of our country.

However, it has to be planned dynamically and utilised efficiently to meet the future demand of paper in our country. As the recovery of chemical is a big constraint for small mills from the econmics point of view, the existing conventional mills could come forward to set up smaller units based on these raw materials at their mills to expand their capacity enabling a combined recovery system to work. Alternatively, the mother Pulp Mill concept can help considerably in this direction.

Besides meeting the raw material requirement for the growth of the paper industry, utilisation of agricultural residues is of strategic significance as a lever for enriching the rural economy and ensuring balanced growth. This deserves more attention than that it has received so far. The technological problems, if any, can be easily solved as we have considerable faith in our technocrats and also experience in this direction.

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