Depithing, Storage and Stacking of Bagasse

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Within the last two decades, the technology of pulp and papermaking from bagasse fibre has made tremendous strides. It has reached today a stage, where we can say with confidence that any variety of writing and printing grade of paper can be successfully manufactured out of bagasse fibre as major furnish. Though half a dozen of paper mills exist in different parts of the world where paper from bagasse is made with quite a high content of this fibre in furnish, no sufficient information is available from these mills for the benefit of pulp and paper technologists.

Bagasse is a fibrous material of such nature that it is amenable to pulping by any method, acid, neutral or alkaline, and with every method it gives a pulp of its own characteristics. Variations in one or more than one factor like depithing, cooking chemical and its dilution, pressure, temperature and duration of cooking, bleaching and age of storage of bagasse, individually and collectively exert great influence on the quality of pulp made for papermaking from bagasse. Equally important and significant is the way in which this pulp is processed in stock preparation to make it suitable for running over high speed paper machines successfully and with least troubles. Whatever has been reported earlier in respect with manufacture of paper out of high content of bagasse fibre in furnish, say 75% and above, has been confined to production at slow speed machines operating below a speed of 400 ft./min. High bagasse paper made at high speed machines is still a rarity. In the modern age of challenging economics and massing demand for more and more paper of varied qualities, the technology needs raw materials and processing methods which can meet the call of the day. This situation can be met only when we can process bagasse economically in such a way that its high furnish content, 80% and above, can be successfully run on modern high speed paper machines, and at the same time we can give strong paper of any variety prevalent in present market. Adaptability and usefulness of any pulping method lie only in the facts stated above.

For the first time in the history of paper-making in South Asia, the Mandya National Paper Mills Limited, with its factory at Belagula, near the famous Brindavan Gardens in Mysore State, commenced its production in April 1962 using bagasse as its primary raw material. After having struggled for over a year the mill personnel were successful in stabilising different processing operations to manufacture various grades of paper with high bagasse furnish above 75%.

I-Stage Depithing at the Sugarmill:

Bagasse is obtained from Mysore Sugar Company situated at Mandya, about 26 miles away from the Paper Mills. The latter employs a moist depithing system having two horkel depithers supplied by Messrs. Parsons & Whittemore of U.S.A. These alongwith two baling machines are installed at the sugarmill premises where the pith portion is removed during depithing operation and sent back to sugar mills for burning in the boiler for steam generation. A sizeable portion composed mainly of pith, fines and soluble organic matter is removed during depithing which constitutes 25% of the green bagasse fed.

Depithing in Horkels:

The green bagasse coming from cane crushers and having on an average 50% moisture is conveyed

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to the horkel machines through a set of conveyors, the last of which is provided with a weightometre to record bagasse intake. Both the horkels operate in parallel and feed to each of them can be controlled as desired. Each of these horkels is driven by a 140 HP motor at 688 RPM and is rated to depith 9 metric tonnes of green bagasse per hour.

These horkels consist of horizontally operated swing hammers of specific shape and design. There are two different zones inside the machine, the first is called the Mill Zone and the second one the Beating Zone. In the Milling Zone, the total hammers used are 90 (70 milling, 10 travelling and 10 lifting type). The bottom of this zone is provided with screen plates of 5 mm, 6 mm and 7 mm round holes proceeding along with the zone. The milling zone and the heating zone are in a way partitioned by a baffle-plate of about 1-1/2″ height fixed in the lower segment of the bottom sieve plate, after which the beating zone starts. Provision of this baffle plate helps in controlling retention time of bagasse inside the milling zone. This also helps in controlled depithing performance. Clearance between the hammers and the screen plates play a significant part in smooth operation of the horkels, which has been found to be quite effective when kept 1/2″ apart. In the beating zone, where 7 mm. round hole screen plates are provided, 12 paddle hammers operate. These hammers help in separating the pith from beaten bagasse and push the depithed bagasse out on to a conveyor going to baling machines.

The pith portion, which consists of fines, and broken fibre also to some extent, besides soluble organic matter, is blown back to multi fuel-boiler by means of blowers. The depithed bagasse is baled into bales of 17″×22″×30″ size at a compaction ratio of 1 :3.5. Each bale weighs about 80 kgs and can be conveniently handled as such during stacking and transport. Loading of bales on trucks is done manually. In tying of bales, mild steel wire of 14 gauge size is used and its consumption comes to about 1 tonne for every 500 tonnes of green bagasse baled.

A sample survey of pith fibre contents of green bagasse and horkel depithed bagasse and horkel separated pith is given below:

TABLE I

	% Useful Fibres	% Pith & Fines	% Water Soluble
i. WHOLE BAGASSE:			
	57.4	32.5	10.1
	53.0	33.0	14.0
	53.2	32.2	14.6
	54.0	30.0	16.0
	50.9	33.8	15.3
	54.2	32.2	13.6
	53.2	35.4	11.4
	51.2	32.4	16.4
	54.6	30.8	14.6
	50.2	33.8	16.0
AVERAGE :	53.19	32.61	14.20
ii. DEPITHED BAGASSE:			
	69.8	18.9	11.3
	66.7	18.6	14.7
	67.0	18.4	14.6
	76.2	17.2	6.6
	67.0	20.6	12.4
	67.4	17.1	15.5
	67.2	17.8	15.0
	70.4	19.4	10.2
	68.1	22.0	9.9
	67.7	20.0	12.3
AVERAGE:	68.75	19.0	12.25
iii. PITH & FINES:			
	26.8	57.7	15.5
	21.3	65.9	12.8
	21.4	63.1	15.5
	22.8	55.6	21.6
	23.4	58.8	17.8
	19.5	61.0	19.5
	27.8	60.9	11.3
	25.2	57.4	17.4
	21.6	62.3	16.1
	17.2	71.8	11.0
AVERAGE:	22.7	61.45	15.85

It is evident from the figures given above that the whole bagasse has on the average a fibre/pith ratio of 53.19:32.61 which after horkel depithing is enriched to 68.75:19.0. The separated pith portion also contains broken fibre in the ratio of 22.7 : 61.45. Computing these values as given below, removal of 62.5% of pith fines is achieved in I-stage depithing of bagasse in moist stage in the horkels.

However, it has also been observed that during the crushing period, as the fibre/pith content in green bagasse varies with the maturity of the cane crop, depithing at the Horkels also improves. Pith removal by Horkel depither works to 2/3 of the total pith content in the whole bagasse.

From the average data given above, the quantity of pith and fines in depithed bagasse for 53.19 metric tonnes of fibre would be:

$$\frac{19 \times 53.19}{68.75} = 14.7 \text{ metric tonnes}$$

showing thereby that 32.61—14.7=17.91 metric tonnes of pith and fines are removed besides removal of solubles and dust comes to $\left(\frac{12 \times 53.29}{68.75} = 9.48 \text{ metric tonnes}\right)$ 14.2—9.48=4.72 metric tonnes.

Along with the removal of pith fines and solubles, some fibre also gets broken and is removed along with 17.91 metric tonnes of pith and fines. This quantity comes to $\frac{22 \cdot 7 \times 17 \cdot 91}{61.45} = 6.61$ metric tonnes. Therefore remaining fibres in depithed bagasse would be 53.19—6.61=46.58 tonnes. Hence,

	Fibre	*Pith*
INPUT	53.19	32.61
OUTPUT	46.58	14.70
REMOVED	6.61 +	17.91= 24.52 tonnes

Initial pith and fines would be :
32.61—6.61=39.22 tonnes

Hence depithing efficiency :

$$\frac{32.52}{39.22} \times 100 = 62.5\%$$

Formation and quantity of broken fibre depends on the configuration of hammers in the horkel machine, moisture and feed rate of bagasse, R.P.M. of the horkel rotor and hole size of sieve plates. It has been observed that breaking of fibre is minimum when horkels are fed at their full rated capacity. In case of lower feed rates, fibre breaking is found to be more.

Handling and Storage of Bagasse:

The crushing season at the Mysore Sugar Company normally lasts for about 180 to 200 days a year and during this period the entire quantity of bagasse required for the paper mill have to be collected. With about 320 operating days, the paper mill has to store half the quantity of partially depithed bagasse at the mill yard for its raw material requirement during the off-crushing season. The climatic conditions prevailing at Belagula are comparatively milder and does not necessitate any covering of stacks of bagasse against deterioration.

At the Mandya Sugar Company, no space is available to store baled bagasse. Therefore, all the bales coming out of the balers are immediately transported by trucks to the paper mill site. In loading the trucks and their subsequent unloading at the stack yard, some bales break in manual handling. This breakage is found to be about 10 to 15% of the total quantity of bales stacked. To some extent the broken bales prove useful in tight packing of bales in truck loading. Whatever loose bagasse is formed in this process cannot be stored with the stacks, otherwise the aeration of the bales is adversely affected. This loose bagasse is, therefore, sent to the process as early as possible.

In manual handling of bagasse, right from balers to stacks and process feed, labour requirement per tonne is found as follows:

For handling in depithing upto baling	2.0 man hrs./tonne
For truck loading	2.0 man hrs./tonne
For unloading the trucks at paper mills	0.16 man hrs./tonne
For feeding loose bagasse from stacks to pulp mill	5.0 man hrs./tonne
For building the bagasse stacks	9.0 man hrs./tonne
For feeding for wet depithing	1.0 man hr./tonne
Total manhours requirement per tonne of bagasse.	19.16 man hours

Stacking of Bagasse Bales:

As has already been mentioned, each bale on an average weighs 80 kgs., when fresh; but it has been observed that there is a very rapid loss in weight during the first 12 days in storing these bales under shade as illustrated below:

	No. of days	Loss of moisture
After	2 days	10.9 %
	4 days	17.22%
	6 days	20.8 %
	8 days	27.8 %
	10 days	31.1 %
	12 days	35.3 %
	14 days	36.3 %

Bagasse is bulky in nature and, therefore, its manual handling is comparatively costlier than raw materials like wood or bamboo. Average density of B.D. depithed bagasse in baled and loose forms is 9.8 and 3.7 lbs. cft. respectively. In stacking great care is necessary to give enough aeration space to avoid excessive heat formation due to fermentation reactions going on inside the bales. If proper precaution is not taken, there are chances of fire hazards. Due to this reason, it is always necessary to remove all the loose bagasse from the stacks and also to minimise the breaking of bales during handling. It is also observed that drying of bales is quicker than a heap of loose bagasse, because in the latter, heat of reaction is dissipated through quickly. This also gives rise to rotting of bagasse with subsequent development of mould and deterioration of fibre; whereas bagasse in a baled form has got long keeping properties without such deterioration. In view of insurance regulations and preservation of bagasse, certain precautions are necessary in maintenance of a stack yard.

1. Contamination of sand and stones should be avoided. Otherwise it finds its way to the process along with bagasse. To avoid this the yard flooring should be cemented or paved with stones and be provided with adequate drainage system to avoid water stagnation under the stacks.
2. The roads in the yard should also be properly cemented in order to collect spillage during handling; otherwise the same cannot be reclaimed free from sand and dust.
3. The stack formation is arranged with slabs of 12 bales, 4 bales per row in three rows such that between two adjacent slabs there is an air space of about 10″ on every face. In the second layer the bales may be placed at right angles to those in the first layer to interlock the pile and create stability. The air space between 2nd and subsequent layer can be reduced to 8″. As the stack gains height number of bales in the rising layer gradually reduce to keep the stack tilting inward, otherwise vertical stacks tend to topple over the ground. In this way a stack can be built to a height of 25′ on a plinth of 150′ x 50′. The average weight of such a stack comes to about 1000 metric tonnes. Each of such stacks is built with an inter-distance of 30′ apart to enable effective fire-fighting in emergency. It also helps in smoother movement of trucks and carts.

Formation of too big stacks is also not advantageous. When stacks are very big, moisture and heat generated in the central region of stack are retained for a longer time because of insufficient aeration. This consequently deteriorates the quality of bagasse which turns brown in colour like burnt bagasse and it also enhances rusting of the baling wire. On account of these conditions a considerable number of bales get disintegrated to the extent of 30% of the stacked quantity. Such conditions of stacking should always be avoided.

Use of mechanised system of stacking the bales is highly desirable in bagasse handling. For economical transport and less breakage of bales, use of big trailors is always preferable. If stacking cranes and bale grabs are employed in unloading and stacking operations, the handling of loose bagasse formed during manual handling can be very much reduced.