Wet bulk storage–Quality variations in bagasse within the pile

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ABSTRACT

Bagasse being the chief raw material for papermaking in TNPL, about 4,00,000 tons of bagasse is being stored by the Wet bulk storage method The stored bagasse is found to undergo discoloration and deterioration. The darkening is not uniform throughout the pile. The surface layers are found to be affected the most followed by the middle layers. The bottom innermost layers are as good as fresh bagasse, even after one year storage period. Top layer bagasse yields a pulp of low brightness and poor strength properties The middle layer though not affected to that extent is comparable in strength properties to fresh bagasse pulp but is inferior in the pulping characteristics and optical properties. This variations in quality because of the difference in compaction and aerobicity, warrants a viable treatment method for bagasse under wet bulk storage method to prevent discoloration and degradation so as to have bagasse of uniform brightness and quality.

INTRODUCTION

Tamilnadu Newsprint and Papers Ltd, is a bagasse based integrated paper mill consuming about 3,00,000 tons of bagasse annually, for the production of Newsprint and Printing & Writing grades of paper. 75% of the paper furnish comprises of bagasse Pulp and the remaining 25% is substituted with eucalyptus hardwood Pulp. Bagasse is received only during the crushing season and the bagasse is depithed and stored in the bagasse yard by the wet bulk storage method, which facilitates maximum bagasse storage in minimum space. Bagasse thus stored undergoes discoloration and deterioration resulting in a Pulp of poor strength properties, especially low tear and dark Pulp The degradation and discoloration is not uniform throughout the pile. The quality of bagasse is found to be heterogeneous within a stored pile.

This degradation and discoloration has been attributed to the action of micro-organisms on bagasse because of the presence of residual sugars and moisture. Our study was focussed on quality variations in bagasss with respect to its physical characteristics and pulping characteristics, within a stored pile. The paper highlights the possible variations within the pile stored over the same period.

WET BULK STORAGE :

Among the various bagasse storage systems adopted viz. Baled storage, Dry storage, Moist bulk storage, Wet-bulk storage, TNPL adopts the wet bulk storage methad so as to enhance maximum quantity to be stored in minimum area. Bagssse received from sugar mill are either depithed in the sugar mills itself or depithed at mill site by moist depithing method, when 20-25% of the material present is removed as pith. The depithed bagasse at 50% moisture is conveyed to the bagasse

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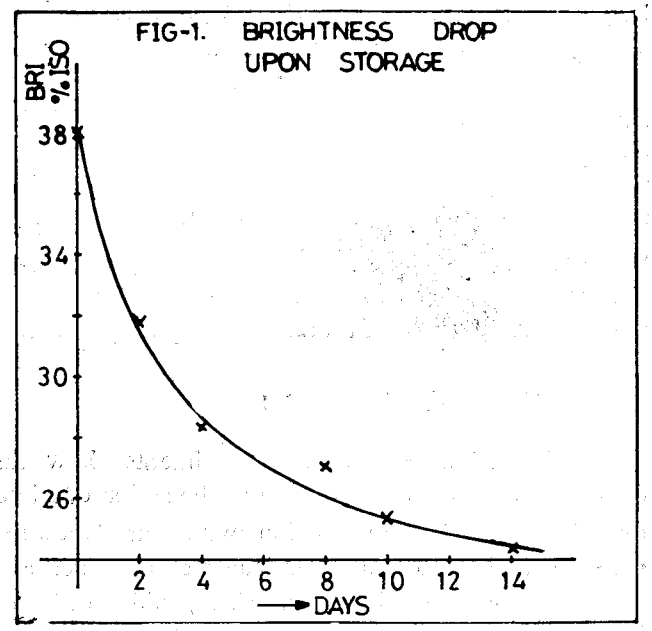
yard through Boom Stacker wherein it is slurried with water from the central channel of bagasse yard, to 3-4% consistency and dropped on the floor. The stacker moves over the entire lenght of the bagasse yard, and the bagasse is conveyed across the width of the yard through bull-dozers. Bagasse is usually stored to a height of 10-12 metres and a bulk density of about 150 kg/m³ is achieved through compaction. The two storage yards of 540m × 90m each, has a capacity of storing about 4,00,000 tons of bagasse. Water percolating from the bagasse pile is recycled back and fresh water is added as make-up. The recycled water is acidic with the recycled water has pH of 5.0-5 5. It has a brightness of 40-42% ISO. Bagasse is reclaimed periodically for pulping process through front end loaders.

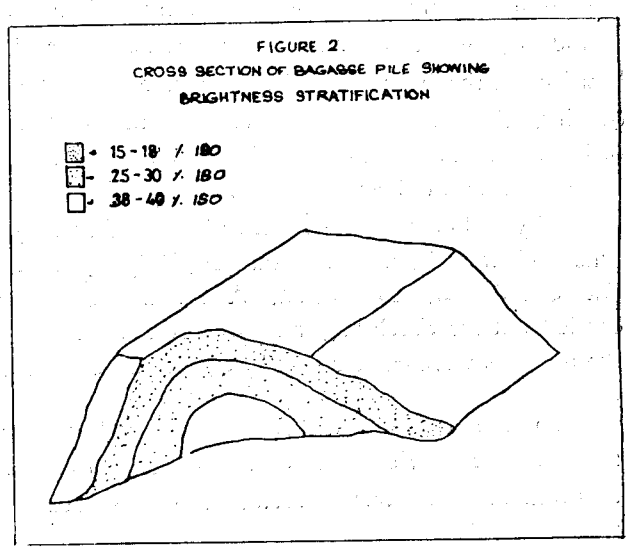
BAGASSE QUALITY VARIATIONS :

Our experience has shown that the brightness of bagasse stored for same period, is not uniform throughout a bagasse pile. With the incoming brightness varying between 40-42% ISO, it has been found that the brightness drops by about 10 points within a short storage period of two weeks, under aerobic envrionment. The decrease in bagasse brightness upon storage has been shown in figure 1. Such a decrease in bagasse brightness has been observed only in the case of bagasse stored without compaction, under aerobic environment. This darkening could be simulated with that of the bagasse over the top layers of a stored pile, wherein there is not much compaction as the inner layers and the layers are exposed to the environment. Whereas, under compacted conditions, the brightness drop is not that much pronounced as in surface layers. But brightness drop is evident in a stored pile.

TNPL produces mechanical pulp out of bagasse and the brightness of bagasse reaching the refiners is very critical to have an acceptable unbleached brightness. Very low initial brightness of bagasse leads to dark pulp of low brightness which cannot be bleached economically.

Bagasse, stored over a period, was found to have different brightness at different zones of a stored pile. When the cut cross-section of a one year stored bagasse pile is examined, it may be found that three distinct brightness zones are present, (Figure 2). The top layers over the surface upto a depth of 1.5-2.0 metres are the darkest with a brightness of 15-18% ISO only. The





layers just below that, between 2.0 metres and 4.0 metres from the surface has been found to be brighter with the brightness ranging between 25-30% ISO. The innermost layers below 5 Metres from the surface is found to be the brightest with the brightness equal to that of fresh bagasse, ie. 38-40% ISO.

The darkening af bagasse has been chiefly attributed to the action of micro organisms on the residual sugars in bagasse. (1, 2, 4) The innermost layers with very good compaction are under anaerobic conditions which enhance the brightness preservation as well as the

bagasse quality. The top layers are prone to maximum drakening due to the aerobic environment and lack of compaction. The brightness drops to as low as 15% ISO. from 40% ISO. The middle layer comes in between, with its brightness lowered to 25-30% ISO. Based on this segragation of bagasse on brightness could be made and it was ensured that only bright bagasse reaches the refiners during the mechanical pulping of bagasse. The inner layers of a stored pile with high initial brightness is used for mechanical pulp production.

EXPERIMENTAL STUDIES :

Literature survey and our experiments show that darkening of bagasse is only due to the action of micro-organisms. This in confirmation with our laboratory experiment showed that fresh bagasse, after sterilising at 120 ° C for 20 min in an autoclave, did not lose its brightness by even one point even after a storage of months. Under normal conditions a brightness drop of minimum 10 points was observed even within a storage period of 2 week. To study the influence of the discoloration on the bagasse quality and hence on the pulp quality, laboratory studies were undertaken Samples of bagasse from the three distinct layers of a one year stored pile was collected. The Samples were tested for their physical characteristics like pH, Brightness, yellowness, Chemical proximate analysis, Pulping characteristics, and pulp evaluation. A similar analysis was carried out for Fresh bagasse also for comparison. All the analysis were carried out by standard test methods.

To confirm the above studies further, similar studies were carried out on an experimental pile of 500 tons and a similar behavior was observed among the layers of the pile.

RESULTS AND DISCUSSIONS :

Physical characteristics :

The physical characteristics of the bagasse samples from different layers are given in Table 1 and presented graphically in figures 3 and 4. The results in comparison to fresh bagasse values, show that the top layer bagasse has a very low pH of 2.6 followed by the middle layer (3 6 pH) and the bottom innermost layer has pH of 4 0. Brightness of bagasse also shows a similar trend wherein the top layers are darkest (15% ISO) followed by the middle layers (33.4% ISO). The inner layers have a brightness equal to that of fresh bagasse, i.e, 40% ISO. From the results it may be concluded that bagasse stored under compaction under anaerobic conditions maintains brightness as good as the fresh bagasse even after a period of one year.

Fibre pith analysis :

The fibre pith analysis of bagasse samples are given in Table 2. Figures 5 and 6 graphically represent the Useful fibre content and Water solubles respectively. The figures show that the useful fibre content is very low (18% only) in the surface layers, whereas the other two layers have useful fibre content above 60%. The dust and solubles of the top layer bagasse is very high (23%) indicating the extent of crumbling and disitntegrating tendency of due to degradation. The water solubles in other two layers are similar and comparable to fresh bagasse. Similar trend is observed in pith content also, where the top layers show high pith content. The results show, that the bagasse on surface layers degrades to such an extent that the fibre structure itself is destroyed and gets crumbled upon disintegration. The middle layer though undergoes darkening does not suffer such a degradation. The inner layer is unaffected.

Proximate analysis :

The proximate analysis of bagasse samples from different layers are given in Table 3. The proximate analysis of fresh bagasse in comparison shows that, the Hot water solubles. 1% Caustic solubles and AB extractives are very high for the top layer bagasse samples. The holocellulose content is low for the top layer bagasse. The proximate analysis of the other two layers is comparable to that of fresh bagasse which indicates that there is no degradation of the components.

Pulping :

Pulping of the bagasse samples were carried out at 12% chemicals as Na_2O at 170°C for 20 min with a bath ratio of 1 : 4 in the laboratory programmable digester. The pulping results given in Table 4 show that the total pulp yield of the surface layer bagasse is

TABLE 1
CHARACTERISTICS OF THE BAGASSE SAMPLES

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1.	pH		2.6	3.6	4.0	5 0
2.	Brightness	% ISO	15.0	33.4	40.3	40.0
3.	Yellowness	%	63.0	35.0	31.5	31 0

TABLE 2
FIBRE PITH ANALYSIS OF BAGASSE SAMPLES

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1.	Useful fibre	%	18.0	60.2	64.8	65.3
2.	Pith	%	58.9	29.7	26 7	25.9
3.	Dust and solubles	%	23.1	10.1	8.5	8.8
4.	Fibre pith ratio		0.31:1	2.03:1	2.43:1	2.52:1

TABLE 3
PROXIMATE ANALYSIS OF BAGASSE SAMPLES

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1	Ash	%	2.00	1.84	1.59	1.70
2	Acid insolubles	%	1.73	1.80	1.50	0.9
3	Solubility in :					
	Hot water	%	18.2	5.1	4 6	4 6
	1% NaOH	%	48.2	30.8	32.6	30.3
	Alcohol Benzene	%	10.9	2.7	2.8	2.8
4	Lignin	%	19.5	21.3	21.3	20 5
5	Holocellulose	%	60.2	76.9	72.4	72.6
6	Pentosans	%	25.4	23.9	22.7	19.7

FIG-3

pH OF BAGASSE FROM DIFFERENT LAYERS

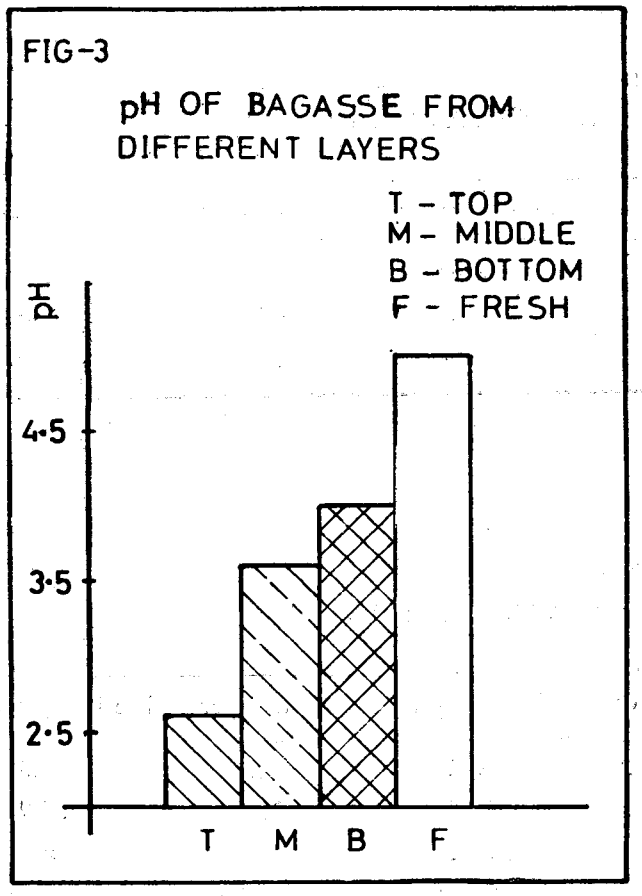


FIG-5

USEFUL FIBRE IN BAGASSE AT DIFFERENT LAYERS

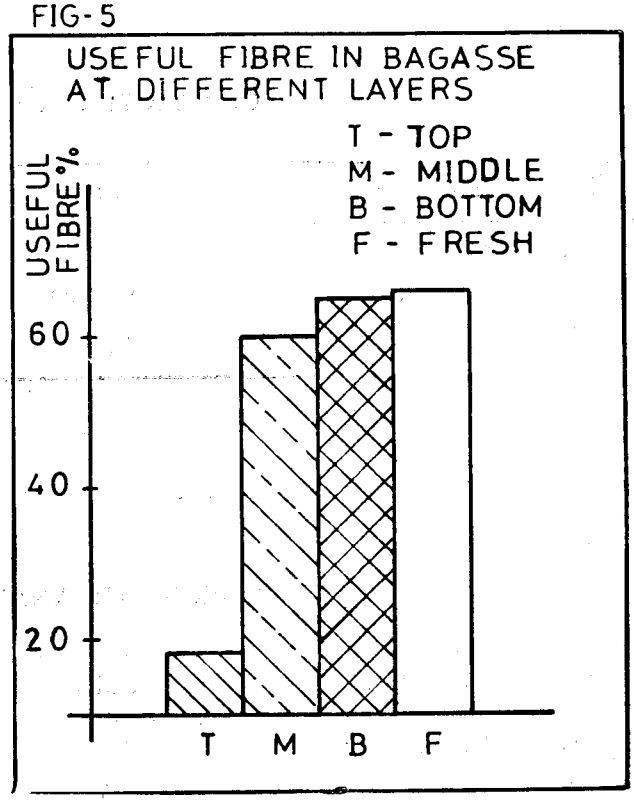


FIG-4

BRIGHTNESS OF BAGASSE FROM DIFFERENT LAYERS

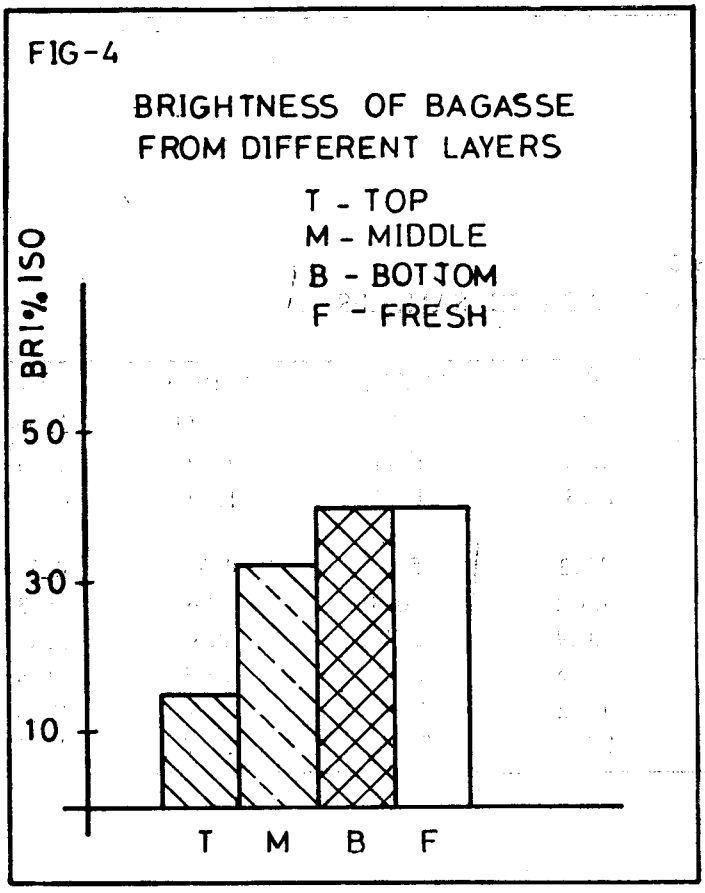


FIG-6

WATER SOLUBLES IN BAGASSE AT DIFFERENT LAYERS

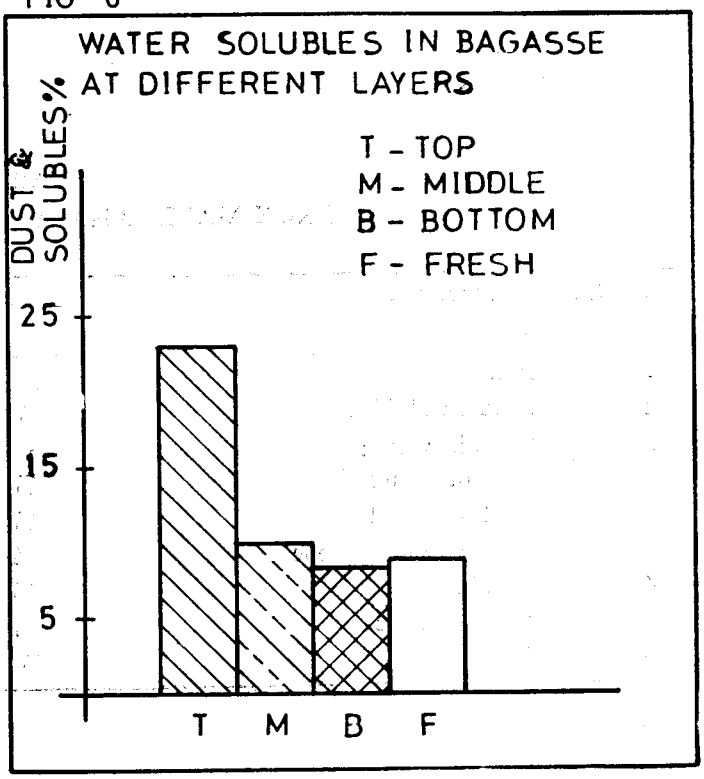


FIG - 7

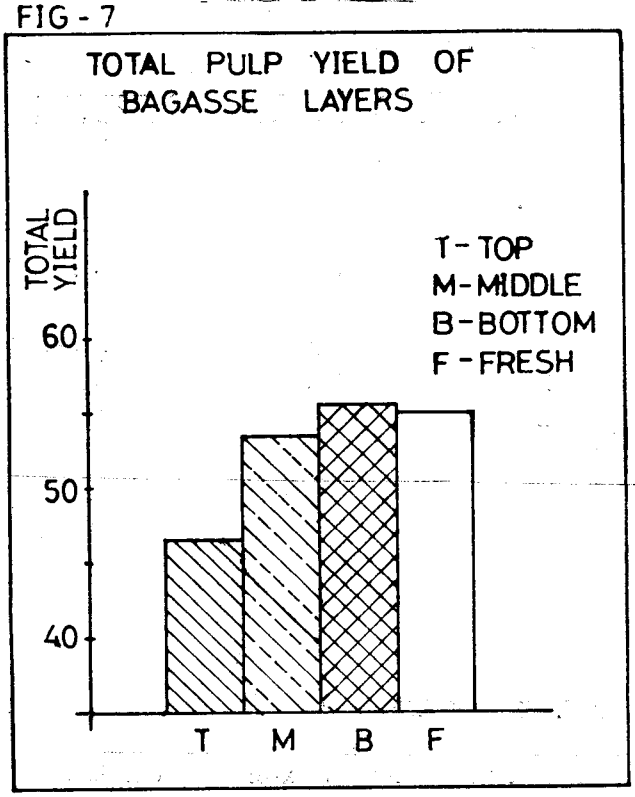


FIG - 8

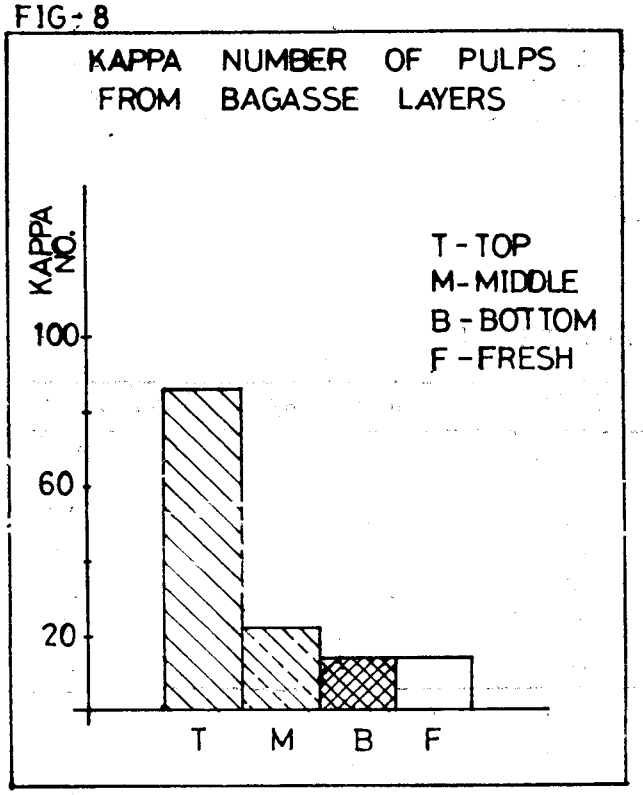


FIG-9

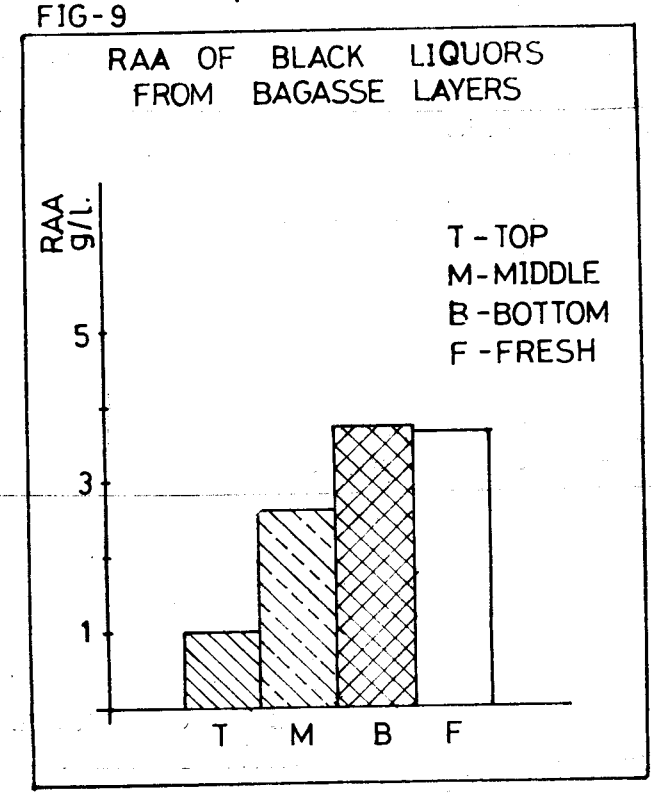


FIG - 10

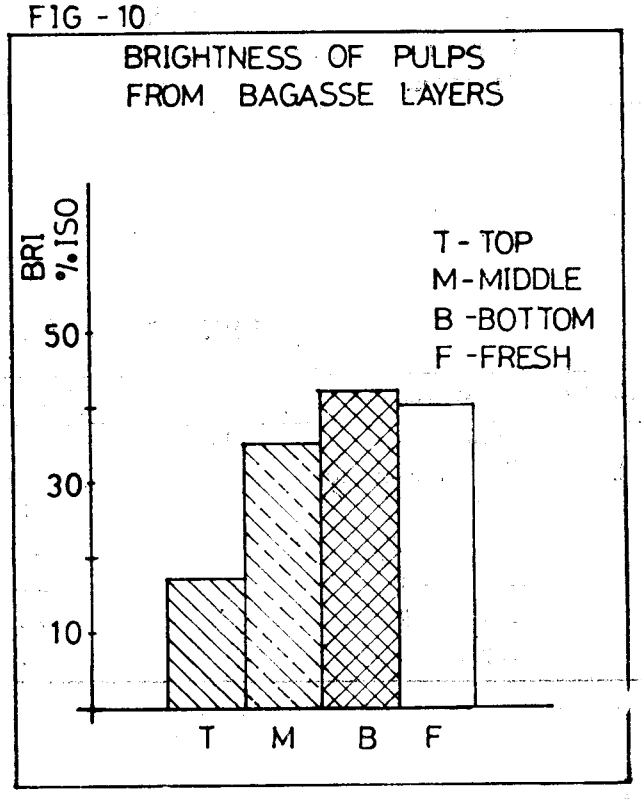


TABLE 4
PULPING CHARACTERISTICS OF BAGASSE SAMPLES

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1	Total yield	%	46.7	53.4	55.6	55.0
2	Screen rejects (0.25 mm)	%	4.1	2.1	1.1	1.1
3	Kappa number		85.2	21.5	13.8	13.9
4	Brightness	% ISO	17.5	34.8	41.6	40.8
5	Black liquor					
	pH		9.6	11.3	11.8	11.4
	*TTA as Na_2O	g/l	24.5	28.7	32.8	30.1
	*RAA as Na_2O	g/l	.99	2.56	3.71	3.65
* —	@ 200 g/l total solids					

TABLE 5
STRENGTH PROPERTIES OF BAGASSE PULPS

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1.	Freeness	ml CSF	390	450	420	465
2.	Breaking length	M	346^0	7050	7190	6950
3.	Tear factor		35.6	55.8	57.8	62.0
4.	Burst factor		16.2	42.2	43 0	39.6
5.	Brightness	% ISO	18.3	29.7	36.6	39.8
6.	Scattering Coefficient	m^2/Kg	23.2	23.1	21.8	24.1
7.	Yellowness	%	$47.^4$	35.1	30 5	36.2

TAB E 6
FIBRE CLASSIFICATION OF BAGASSE PULPS

Sl. No.	Particulars	Units	Top Layer	Middle Layer	Bottom Layer	Fresh Bagasse
1.	Freeness	ml CSF	390	450	420	465
2.	Fibre classification					
	+30	%	8.0	13.0	14.4	13 2
	−30 +50	%	25.0	40.5	38 5	37.6
	−50 +100	%	28.5	20.5	21.8	24.7
	−100 +200	%	20.1	12.8	10.4	12 2
	−200	%	18.4	13.2	14.9	12.3

FIG - 11

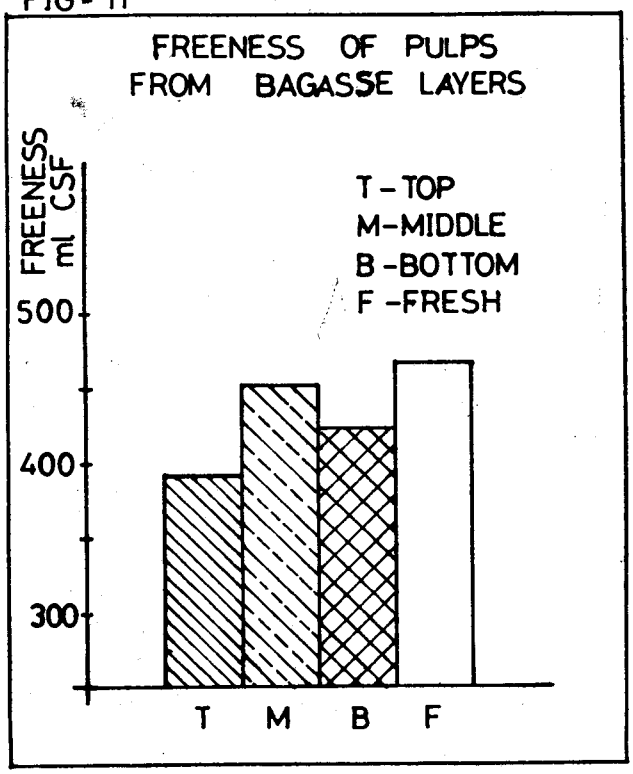


FIG - 12

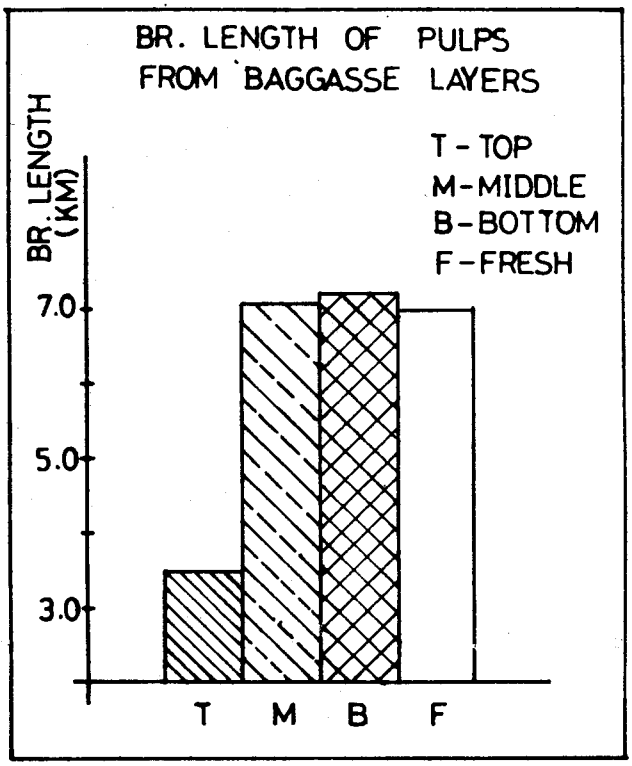


FIG-13

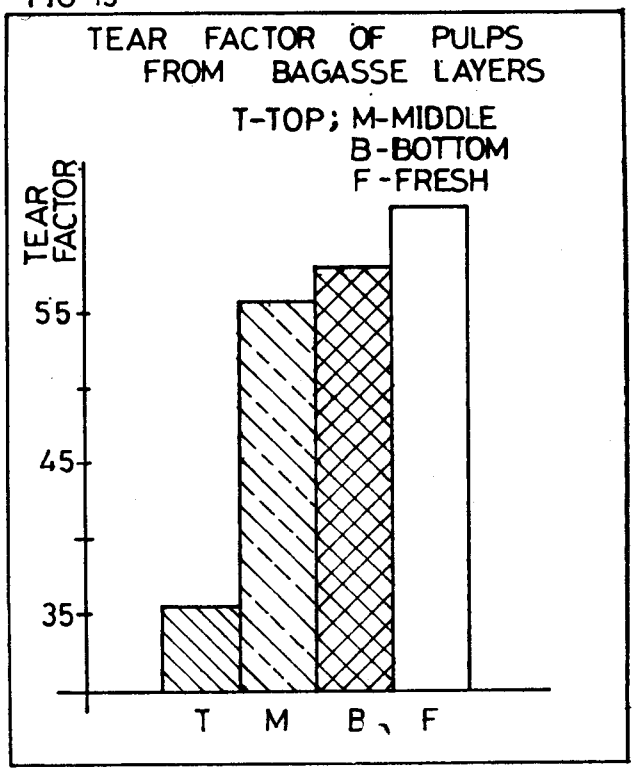
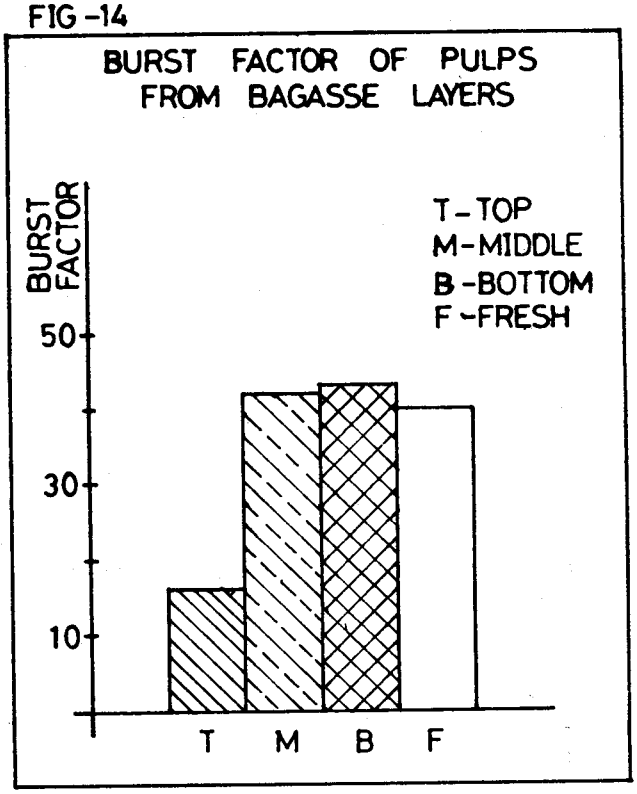


FIG -14



low (47.6%) when compared to fresh bagasse. The results presented graphically in figures 7, 8, 9 and 10 show that the top layer bagasse yields a dark pulp (17.5% ISO) with a very high Kappa number of 85.2 and very low black liquor RAA (0 99 g/l). The middle layer also shows a downward trend when compared to fresh bagasse, with lower yield, higher kappa and lower brightness than the fresh bagasse pulp. The inner layer behaves similar to fresh bagasse as far as the pulping characteristics are concerned.

The middle layer, though not chemically affected that much as shown by the proximate analysis, shows a change in the pulping properties with respect to fresh bagasse. The top layer, as evident from the proximate analysis, shows very poor pulping properties.

Properties of pulps :

The strength and optical properties of the pulps are given in Table 5. The results presented graphically in figures 11, 12, 13 & 14 show that the pulp made from the top layer bagasse has lower freeness with poor bonding strength and low tear factor. The pulp has a low brightness. On the other, the pulps of other two layers have similar strength properties, comparable to fresh bagasse pulp.

The results indicate that the middle layer though darker than the inner layer, produces a darker pulp but with comparable strength properties. Only the brightness is affected.

The fibre classification results given in Table 6 show that the long fibre fraction in the top layer bagasse pulp is very low and the middle fraction has shown an increase and a slightly higher fines content. The fibre classification of the other two layer bagasse pulps are similar and comparable to fresh bagasse.

OBSERVATIONS AND CONCLUSION :

- Bagasse stored by the wet bulk storage undergoes discoloration and degradation by the action of micro organism because of the presence of sugars and high moisture. The darkening is not uniform throughout the pile.
- Stored pile shows three distinct zones of different brightness.
- Experiments show that the top layers under aerobic condition, suffer severe discoloration and degradation making it unsuitable for good quality pulp production.
- The middle layer has comparable strength and bonding characteristics to those of fresh bagasse, but shows difference in pulping characteristics and optical properties.
- The bottom innermost layers are preserved totally from darkening and degradation, and are as good as fresh bagasse.
- Our studies have been concentrated on the chemical pulping of the bagasse samples. A still distinct difierence may be expected when mechanical pulping is carried out. The middle layer will produce a darker pulp demanding higher bleach chemicals.

Bagasse preservation techniques developed so far do not talk about brightness preservation. The Bagatex 20 process developed (4) is said to preserve brightness also, but is unsuitable for wet bulk storage method. A viable alternative method to take care of the heterogeneity in bagasse quality has to be developed so as to ensure uniformity in brightness as well as quality.

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