Outside Chip Storage of Bambusa arundinacea

S. G. MOKHASI,
S. G. HANDIGOL,
N. S. JASPAL
and R. L. BHARGAVA.

As no data was available on outside chip storage in this country, an investigation on outside chip storage in comparison with bamboo stack was carried out in West Coast Paper Mills Ltd, Dandeli. The study period was between March and November for 9 months. The effect of storage on both chip pile and bamboo stack is quite comparable. Bulk, breaking length, tear factor and burst factor show a variation during storage. However the values of chip pile and bamboo stack show very little differences and thus they are comparable with each other. Economically 30 to 35% saving in the material handling can be achieved by adopting outside chip storage.

INTRODUCTION

Several people in foreign countries have worked on Pulp wood storage and outside storage of chips, studying in detail the effect of storage. This work was carried out mostly in Southern part, and Pacific North of U.S.A., Sweden and to some extent in Japan and Australia.

Lindgren made extensive studies on the losses due to deterioration in Southern pine pulp wood (1, 2). For unbarked wood he reported specific gravity losses between 8-10% after 6 months summer storage. But the peeled pulp wood showed only 3-9% loss in specific gravity after one year storage. The study by Ference and Gilles on the storage of Southern pine, gum and oak showed that all the three woods deteriorated rapidly in the warmer months and more slowly during the colder months. Specific gravity losses for 6 months storage were 9.6% for pine, 7.2% for oak and 13% for gum (3). Chesley and co-workers compared open storage to under water storage of Southern pine pulp wood and reported a loss of ovendry weight of 7.6% for wood stored for 6 months in the yard as compared to no loss for under water storage after 12 months (4).

A few papers have also mentioned the studies on the yield and the quality of pulp produced. Though the reports do not agree in all respects the following few general trends could be observed.

i) An increase in fines during chipping of stored wood.

ii) Specific gravity losses, decay and decrease in wood substance during storage.

iii) Loss in digester capacity due to the lower specific gravity.
iv) Loss of pulp yield between 3-6% on wood charged to the digester and

v) Strength properties loss — expressed as tear factor due to increased storage. But some have shown no appreciable changes (3, 5, 6, 11) during storage of pulp wood.

The study of outside chip storage was started around 1950. This study started originally in the mills where chips were purchased in bulk as residues of Saw mills. When the obvious advantages were revealed in handling, the study was extended to the other mills also where wood was stored, and outside chips storage was adopted in these mills.

Jhon. H. Clerk reported major economics and operational advantages. He has reported a saving of $500,000 for a medium size mill due to :

I. i) Reduced fiber loss.

ii) Decreased handling cost.

iii) Man power saving.

iv) Reduced maintenance cost.

v) Greater storage per acre.

vi) Elimination of production losses because of wood room, wood yard breakdowns etc. (7)

II. Chips of different species could be blended more uniformly before going to pile or different species could be stored separately and blended to the desired proportion at the time of reclaiming the chips from the chip pile. (8)

III. Chip piles tend to be more uniform in moisture content than the stored round wood, so that digester furnish involving several species could be improved (8, 9).

IV. Chips made from green wood are more uniform than those produced from stored round wood which may be partially dry. Dry wood may break and broom during debarking and chipping. (7,10).

V. A continuous chip supply is assured because the chip pile acts as a buffer stock between the digesters and wood processing equipments. (8,9).

S. G. Mokhasi, Senior Chemist,
S. G. Handigol, Senior Chemist.
N. S. Jaspal Chief Chemist
W. C. P. Mills Ltd., Dandeli (N.K.)
Dr. R. L. Bhargava, General Manager, West Coast Paper Mills Ltd. and Andhra Pradesh Paper Mills Ltd., Rajahmundry (A.P.).

VI. More accurate measurement for volume could be made in chip piles and an accurate inventory be kept. There is no standardized designs for outside chip storage as this depends upon the several factors faced by different mills (11).

Location of chip pile should receive careful consideration from the standpoint of delivering and reclaiming of chips as well as drainage and the prevailing winds. Proper selection of the site will avoid the deposits of fly ash, dust and dirt (16).

Usually the piles are constructed on hard, clean level ground. Some people used saw dusts, bark or hagged fuel and sometimes old felts as base. A hard surfaced black top or concrete is said to be more satisfactory base though they are expensive (11).

In building chip piles mostly pneumatic handling equipment is used. Ritcey has very ably studied the handling of chips (17). Chips delivered from a pneumatic system fall in evenly and greater compaction occurs than that with simple gravity discharge to the chip pile. A recovery pit is used usually, to reclaim chips from the pile. Tractors deliver the chips from the pile to the reclaim pit. Reclaiming of chips especially from large piles is carried out from the top of the pile. Fire hazard was a problem of importance to the early users of chip pile. But it was found that fire hazard was small. (17, 18).

It was found that the surface fires could be extinguished with a minimum of water. Dry chemical was also found useful but it is recommended that this should be followed by water. In the case of bamboo there appears to be greater chance of fire loss in the stack than in the chip pile. It is because stacked bamboo has larger void spaces which should accelerate the fire.

It is observed that chip piles heat up spontaneously whereas round wood stacks do not. This heat generation affects water vapour movement within the pile and causes changes in wood extractives. At high temperature such conditions prevail which will help the growth of micro-organisms not generally associated with wood storage (11). Temperature studies on compacted pile of Southern pine show an uniform condition. In the interior, compacted portion of the pile a rapid initial rise in temperature has occured. It has shown a general trend of increase in first few weeks and then a rapid decreasing trend for some more weeks and settled gradually to ambient temperature (19,20,21). Experimental piles of hard wood chips have also been studied in the Southern part of U.S.A. (22). Bois and co-workers built their chip piles one of oak and two of gum. One of the gum piles kept wet during the study by sprinkling with water. As in the studies of the temperature increase in the uncompacted portion of the pile were less than in the compacted areas.

The moisture content depends upon the size of the pile. In the smaller experimental piles, the general sequences of event was as follows. During the initial rise in temperature, the moisture content of the interior chips fell, while the moisture content of the top chips increased. When the pile temperature decreased, the moisture content of the interior chips increased, ultimately maintaining uniform moisture content throughout the pile. In the large piles in which temperature did not decrease as in the small piles, moisture content of the interior chips remained below that of the surface chips. Water transfer is caused by the temperature difference in pile. As the water vapour moves upward some of it will condense in the cooler portion of the pile, increasing the moisture content of those chips (18,22,23).

Deterioration of wood by decay results in actual loss of wood substance, which is measured in terms of specific gravity. In considering the merits of chip storage this is one of the factors considered in relation with wood loss in round wood storage. Many workers studied about wood loss during chip storage (16,20,23,24). In general it is found that loss of wood substance of chip pile storage and round wood storage are comparable. Compaction of the pile is one important factor as non-compact areas show more wood lass. Wood species and surrounding climatic conditions are also important factors in increasing the decay.

The micro organisms isolated from stored wood are of four basic types:

1) Stain and mold fungi (Ascomycetes and fungi imperfecti)

2) Rot or decay fungi (Basidomycetes)

3) Soft rots (Ascomycetes or fungi imperfecti)

4) Yeast and Bacteria.

In both United States and Sweden among the stain and mold fungi, species of Trichoderma, ceratocystis, Pencillin etc. were found in chip pile (24,25). Yeast and bacteria have also been reported to be present in chips pile. Lindgren and co-workers (24) reported that the soft rot organisms were an important cause of deterioration in both soft wood and hard wood chip piles.

The ultimate success of outside chip storage depends upon the influence of storage on yield and quality of pulp which may off set the economic gains in handling chips. (11). The influence of storage on yield and quality is complex, and opposite views were observed. But this is not surprising as this depends upon the local conditions, species of wood, method of cooking employed etc. Sauscier and Miller (11) compared Southern pine chips during summer and winter storage with round wood storage. No significant difference was observed in sulphate yield between fresh chips and stored chips or between stored chips and stored wood. Other workers who also studied Southern pine confirm these results. Position in the pile had so effect on pulp yield (19).

Hard wood chip piles have also been studied (22.23). In both the studies kraft pulp yields based on chips charged to the digester for oak and gum were not significantly different from fresh chips. Bjorkman (25) observed losses in yield while studying soft wood chip piles of pine, spruce and birch. Most pulp yield data in the literature are given on the basis of weight of ovendry wood charged to the digester. These data are somewhat misleading since these yields should be based on the weight of the original wood. Rothrock and co-workers (19) reported pulp strength deterioration of 5% per month for pine expressed as tear factor. This magnitude of decrease was observed in only Southern part of U.S.A. But in Western regions it was concluded that there is no or a very little decrease in strength properties even after 3 years of storage (18).

Annergren and co-workers (11) made an exhaustive study on outside chip storage of spruce and birch. Laboratory pulping by the sulphite and kraft methods of chips stored for 1, 4 and 13 months showed no chan-

ges in strength properties from fresh chips. Mill scale pulping for chips stored for 4 months also showed no loss in strength properties when compared to fresh chips or stored round wood.

If wood is attacked by brown rot fungi the alkali solubility of the wood increases. Under these conditions, it would appear that in pulping, the need for chemicals would increase. Bois and co-workers (22) found this to be the case in pulping a mixture of gum and oak. In order to mainatin a constant $KMnO_4$ No. for the 5-6 months stored sample additional alkali usage over the original wood of 5.7% and 9.5% respectively was found. But other studies on oak, gum and pine wood found that no significant changes in active alkali additions were necessary, to maintain constant permanganate Number (19,20,23).

It has been observed that the brightness of ground wood pulp decreases as the length of storage of pulp wood increases (11). During outside storage, chips darken in colour considerably (24). But for sulphate pulping chips discolouration does not appear to be an important factor. Somen (20) reported that the brightness of the unbleached pulp remained constant for 32 weeks of chip storage. Bois etal (22) showed that in their kraft pulps brightness was not seriously affected but due to the position of the pile the dirt content was higher because of fly ash.

The outside chips storage has been viewed as a means of accelerated aging due to the greater area of exposed wood surface compared with the round wood. On the other hand this seasoning effect which are advantages in sulphite pulping result in decreased yields of tall oil etc. in Kraft pulping. In soft, woods in addition to different distribution of fatty acids, the extractives also contain resin acids and terpene. The extractives content of the wood decreased during chip storage but not during log storage. The enzymatic hydrolysis of the fatty acids esters and oxidation of the unsaturated fatty acid occur during both type of storage but at a faster rate in chip pile storage (11).

The effect of storage period depends upon the species, climatic conditions and pulping process employed. In Pacific North Western part of U.S.A. chips could be stored for 3 years or more without or little evidence of deterioration (5). In southern part of U.S.A. deterioration takes more rapidly than in Pacific North West of U.S.A. This is the reason for different workers to suggest various duration for storage. Holekamp (10) recommends 3 months summer storage but Somen (20) gave a maximum of 16 weeks time.

In India in almost all the Pulp and Paper Mills woods or bamboos are stored in the yard. There is no information in this country regarding the storage of chips in open air. So, in West Coast Paper Mills investigation regarding the out side chip storage of bamboos was carried out. A comparitive study was carried out between bamboo storage and bamboo chips storage. The study was mainly to determine the effect of storage on yield and pulp quality.

EXPERIMENTAL

Chip pile construction and storage of Bamboo

An even ground was chosen measuring 40 m. x 26 m. free from grass and shrubs. Healthy green bamboos (Bambusa arundinacea) received directly from forest were taken and chipped using the portable chipper (Tata-KMW portable chipper model HH 22OT). Half of the bamboos from each truck were chipped and the remaining were stacked as such. After chipping the chips were spread on the ground and a pile measuring 12m x 12m x 3m was prepared mannually in the shape of frustrum of pyramid **(Fig 1)**. Chipping and storage was simultaneous. The bamboo stack measured 12m x 12m x 3m. In the four corners, first bamboos of uniform diameter were put to make a sort of supporting piller and then the remaining bamboos were put horizontally. It took about 15 days to cut about 100 tonnes of bamboos and storing and stacking of 100 tonnes of bamboos in the stack. A number of 2.5 cm dia. M. S. pipes were inserted at different levels and places to note down the temperature of the pile **(Fig.2)**. A dial thermometer with a long arm was used to record the temperature. Temperatures were recorded twice in a day from April to June. Afterwards when the equilibrium condition was obtained, temperature was recorded occasionally.

An experiment was carried out on the effect of Sulphur on chips during storage. Sulphur varying betwen 0.005 to 0.1% was added

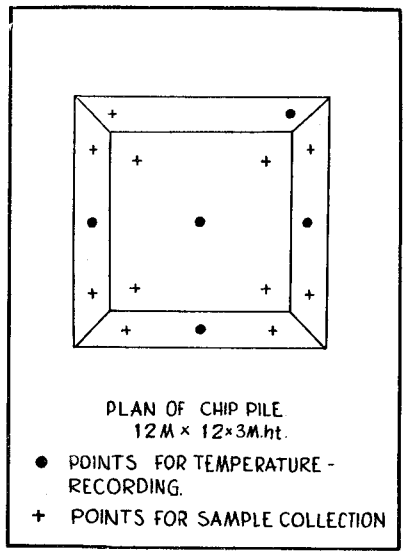

Fig. 1. Plan of chip pile showing points for temperature recording and sampling of chips for analysis.

based on chips, to the chips in three different wire gauges containers and these were put about one meter deep inside the pile. The Chips were observed for any attack of fungus etc. as compared with the two samples containing no sulphur.

SAMPLING

Samples were collected from different areas up to 1 meter deep by digging from top and sides and one composite sample was prepared. From the bamboo stack bamboo culms were removed from different areas by breaking the stack and a composite sample was made and chipped using the portable chipper and a final sample was prepared by the quartering method. These samples from chip pile and bamboo stack were usually collected in the first week of every month. Then the composite samples were tested for:

1) Chemical analysis

2) Pulping characteristics

3) Bleaching and

4) Strength properties of both bleached and unbleached pulps.

1) **Chemical analysis:**

Chips were cut into small pieces and then were powdered in a laboratory Hammer mill. Chip powder passing through 40 mesh and —40, +80 mesh (British

standard sieves) were used for anasis. Ash, silica and pentosans were determined using the sample passing through 40 mesh. 1% NaOH solubility. Alcohol-benzene solubility, Lignin, holocellulose and alpha cellulose were determined using the sample passing through 40 mesh and retained on 80 mesh. Tappi standard methods were used in all the cases except holo cellulose which was carried out according to Sodium Chlorite method. The results are recorded in **Table II** and **Fig. 2.**

2) **Pulping.**

Cooking was carried out in laboratory autoclave (rotating digester with automatic temperature controller) with a capacity of 16 liters, rotating 2 R.P.M. using the following conditions through out the experimental period.

1) Chips — 2kg (oven dry)
2) Chip size — 1.5 to 2″
3) Bath ratio — 1 : 2.5
4) Steaming & cooking period ($2\frac{1}{2}+1$) hours.
5) Cooking temperature — 170°C
6) $KMmO_4$ —20 ± 2.

Fresh water was used to make up the volume. Only the active alkali content was varied to get the pulp having 20 ± 2 $KMnO_4$ No. After cooking pulps were washed in laboratory diffuser type washer and screened in a laboratory NAF Jet Defibrator to remove uncooked pieces and finally, laboratory hydro extrator was used to remove water. Results are given in **Table III** and **Fig. 3.**

3) **Bleaching:**

Bleaching was carried out in plastic buckets, using C—E—H system to a fixed brightness of 76-78%. Viscosity of bleached pulps was determined by cupraethylene diamine method. Results are given in **Table III.**

4) **Sheet making and strength properties :**

Pulps both unbleached and bleached were beaten in laboratory Hollander beater at 30.40 and 50 °SR freeness and standard sheets were prepared on British Sheetmaking Machine and air dried. After conditioning, sheets were tested for bulk, breaking length, tear factor and burst factor and folding endurance test.

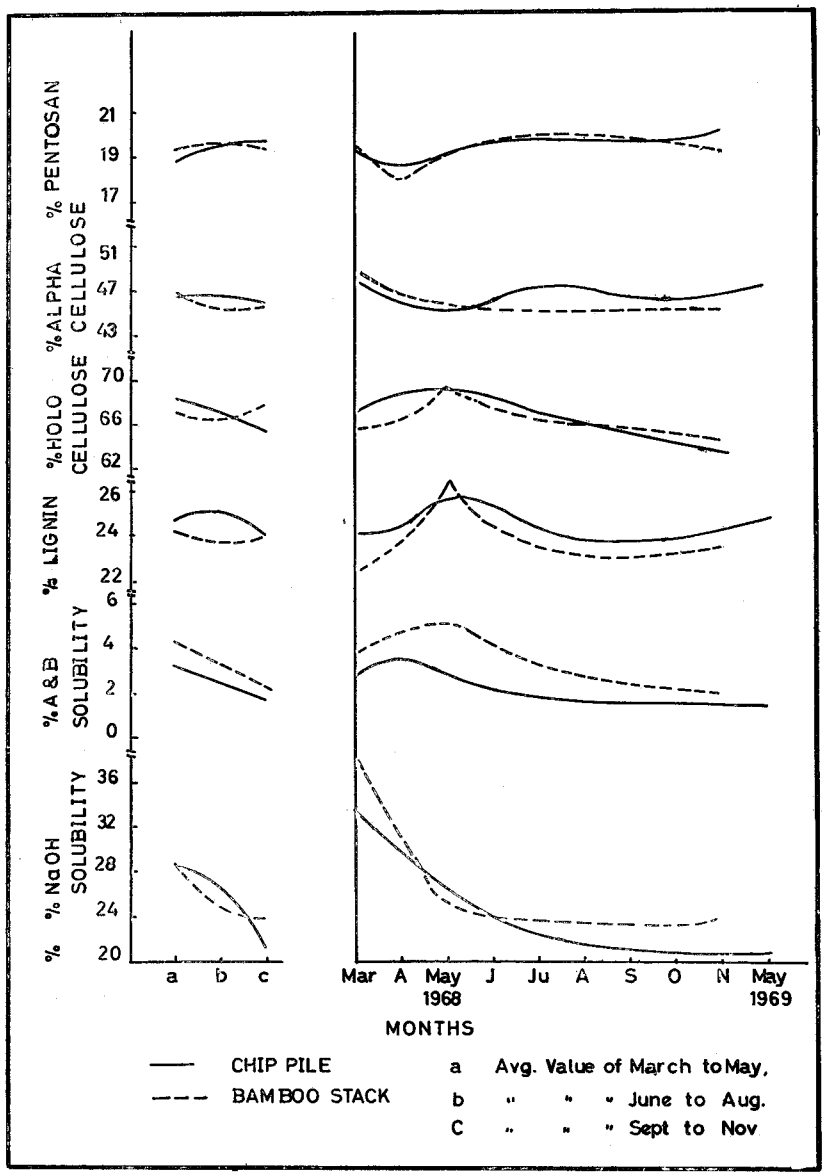

Fig. 2. Chemical analysis of Bamboo chips from Chip pile and bamboo stack.

OBSERVATIONS & DISCUSSION

For the study the results are grouped into three groups namely

a) March to May
b) June to August and
c) September to November.

An average value of each property was found out in each group.

I). **Effect of sulphur on chips during storage**

The chip samples with and without sulphur were removed from the plie after 15 & 21 days. In the case where no sulphur was used a few small black specks were observed but in samples with sulphur, chips remained as they were originally in fresh condition.

II) **Visual Observation:—**

The chips had darkened after two months of storage. But this was only 3-5 cm deep. Lot of dust and fine chip dust was accumulated on the surface as the chip pile was situated near the Chipper House area and many trucks were plying on a dirt road near-

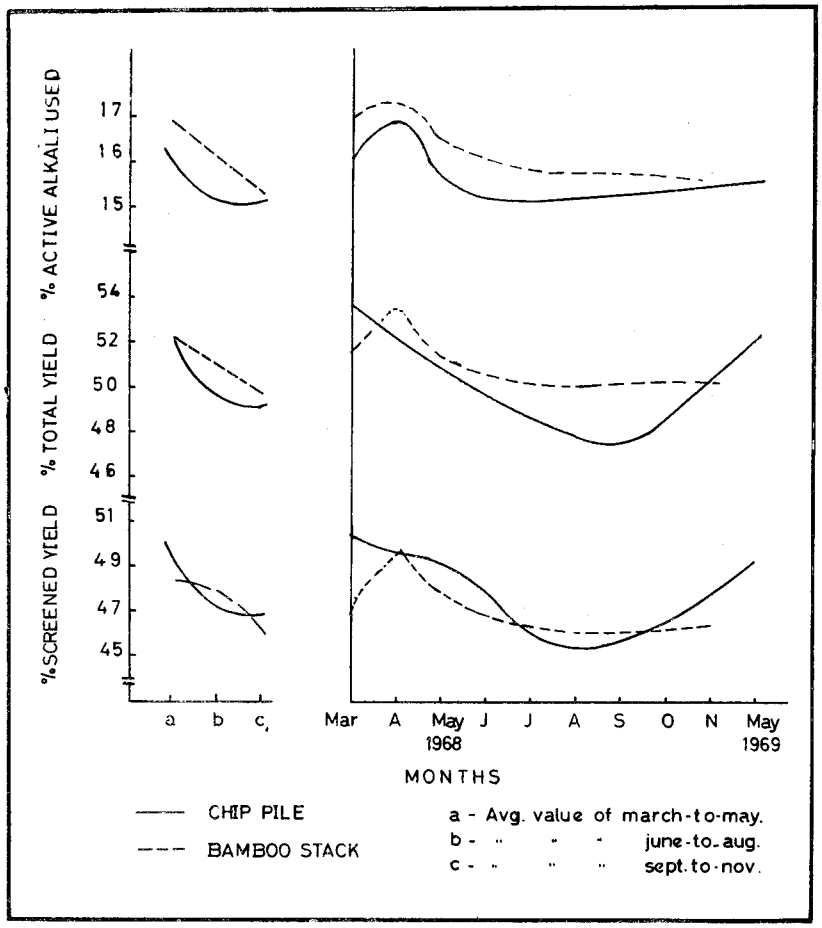

Fig. 3. Pulp yield of chips from chip pile and Bamboo stack.

by. But the chips inside the pile were mostly in good condition. When the final sample was collected after 14 months, dismantling the whole pile, the chips were found to be in good condition deep inside the pile and in the bottom area as well.

Bamboo in the stack turned yellow to pale yellow after 2-3 months of storage and remained so, to the end of the experimental period of 9 months. Dust was accumulated on the surface of the bamboo. Some black patches were observed on the bamboo surface after 3-4 months.

III) **Temperature**

In the initial period the temperature in the chip pile had shot up to 50°C in the central area about 1 metre deep from the top, wtihin 15 days. But then it decreased and settled around 28-36°C. Temperature remained the same in the subsequent months. There was no change in the temperature in bamboo stack (Table No. 1, Fig. No. 2).

IV **Moisture:**

As the green bamboos were used, initially the moisture content in chips was varying between 30 to 45%. After 2 to 3 months during summer, it had reduced to 12 to 15%. The movement of the vapour was noticeable in early morning on the top surface of the pile, when the surface was covered wtih fog. But during rainy season as the pile was soaked with water to about 1.5 meter deep, the moisture content went up 55 to 62% while in the case of bamboo stack it went upto 35.%

V.) **Fungus attack**

When the green bamboos were cut, because of high moisture content and high atmospheric temperature, some white mold had formed on the surface of the chips only in certain areas of the pile. But this had vanished when the chips were spread out uniformly. Only in a small section of the pile mostly in non-compact area chips became dark. But the chips deep in side the pile were not attacked and there was not any visible decay even after 14 months of storage. Some white and dark patches were observed on the surface in bamboo stack and in certain areas of the stack fine yellow coloured powder was formed in the hollow structure of the bamboos, after a period of 3 to 4 months.

VI) The average ash content in chip pile for a, b, and c groups

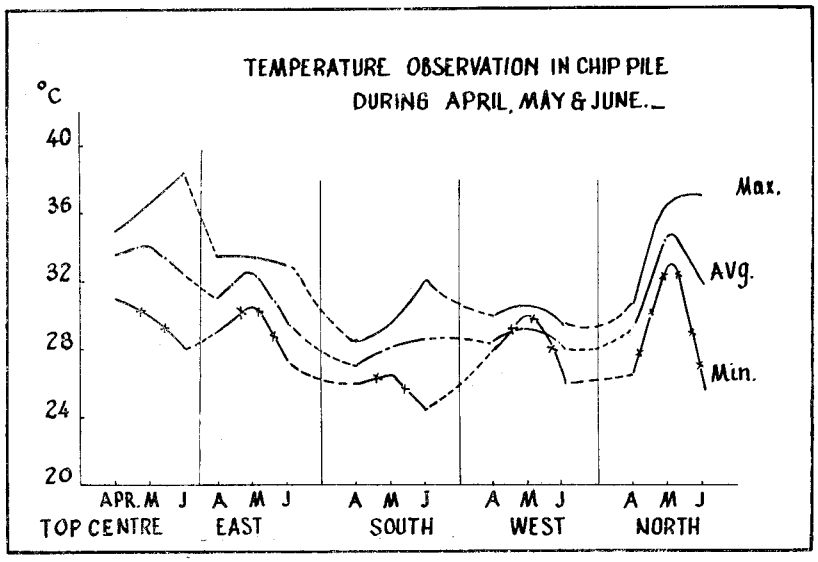

Fig. 4. Temperature in the chip pile at various points during the first three months.

was 3.53%, 3.16%, and 3.25% respectively and in bamboo stack it was 3.1%, 3.42%, and 3.11% respectively. The average silica content in chip pile was 1.9%, 1.85%, and 2.16% and in bamboo stack it was 1.40% 1.86%, and 1.55% respectively. It can be observed that the group-wise values in chip pile and bamboo stack remained almost same. But the ash and silica contents are slightly on lower side in the bamboo stack than in the chip pile. The slight difference can be attributed to the fact that the chip pile and bamboo stack were situated near Chipper House, where dust and dirt is usually air borne and which settled on the pile and stack.

1% NaOH solubility for a,b,c groups were 28.3%, 26.7%, and 21.3% in case of chip pile and 28,3%, 24.8% and 23.9% in case of chip pile the value obtained after 14 months was 20%. In both the cases a decreasing trend was observed from a to c group, to the same extent. There was no evidence in general of any significant decay, as no concurent results of higher NaOH solubility were obtained apart from the earlier samples which were of green and freshly cut bamboos. In general the results of 1% NaOH solubility in chip pile and bamboo stack are comparable.

Alcohol-benzene solubility was 3.08%, 2.48%, 1.82%, in case of chip pile and 4.19%, 3.51% and 2.30% in case of bamboo stack for a, b and c groups respectively. In both chip pile and bamboo stack. Alcohol benzene solubility decreased gradually from a to c group. But the values in case of bamboo stack are slightly higher than the chip pile in each group. The gradual decrease could be explained by the fact that resins and resinous fatty acids oxidize during the storage. The slight lower value of chip pile compared to the bamboo stack is due to the more surface area exposed to atmosphere than in the case of bamboo stack. The lignin content remained almost same for a, b and c groups in both the chip pile and bamboo stack. The values were 24.72%, 25.19%, and 24.32% in case of chip pile and 24.15%, 23.73% and 23.88% in case of bamboo stack. The values of chip pile and bamboo stack are comparable even groupwise. Lignin content remained almost the same during the experimental period.

Holo-cellulose content was 68.39 %, 67.06%, 65.43% in case of chip pile and 67.19%, 66.38%, 67.59% in case of bamboo stack for a, b and c groups respectively. A gradual decrease could be observed, though slightly from a to c group in chip pile. But in the case of bamboo stack there was not much changes from a to c group. However, the values of chip pile and bamboo stack do not show any significant difference between different groups.

Alpha-cellulose for chip pile was 46.35%, 46.48% and 45.97% and 46.58%, 45.41% and 45.51% for bamboo stack, for a, b, c groups respectively. The values for chip pile and bamboo stack remained the same for all the three groups and no appreciable change was observed. The pentosan content was 18.78%, 19.6% and 19.80% in chip pile and 19.27%, 19.46% and 19.45% in bamboo stack for groups a, b and c respectively. It could be observed that the values remained almost same in each group and the values of chip pile and bamboo stack are comparable for each group.

PULP YIELD AND PULP QUALITY

Screened yield for groups a, b and c were 49.9%, 47.0%, 46.8% in case of chip pile and 48.4%, 48.3%, 46.5% in case of bamboo

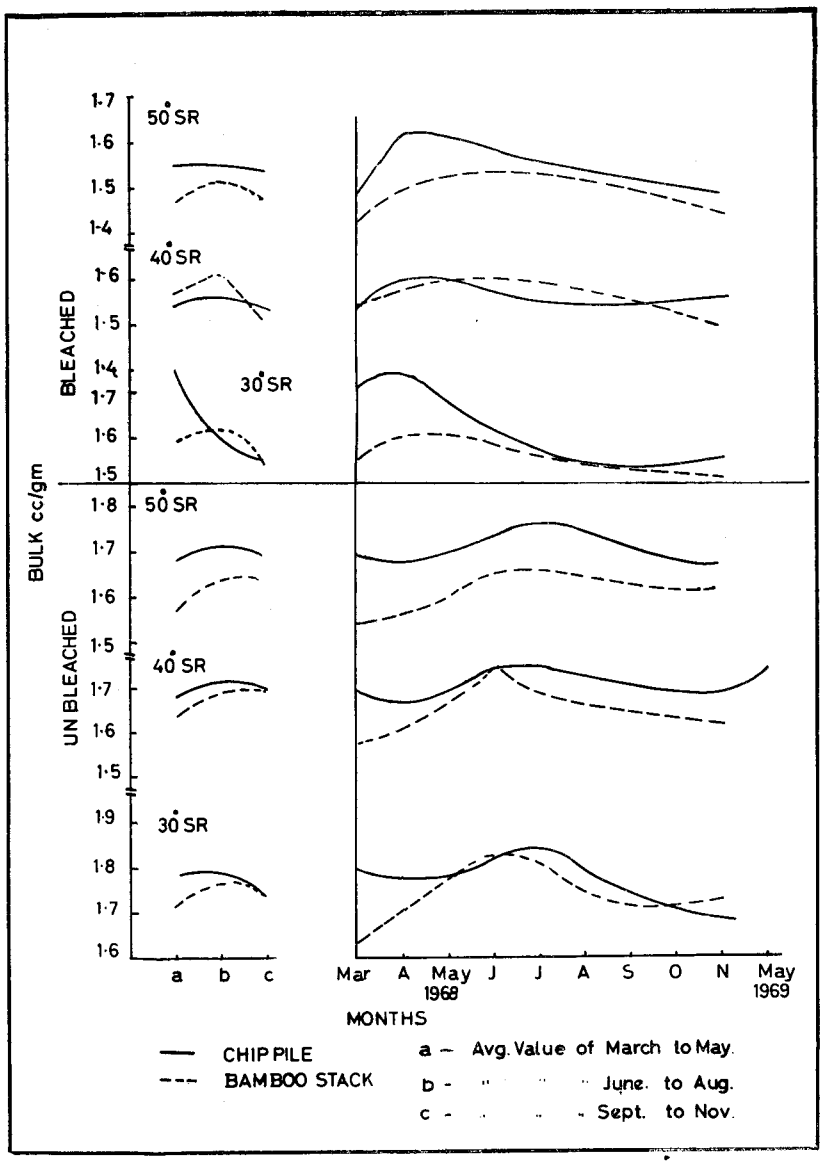

Fig. 5. Bulk characteristics of unbleached and bleached pulps from chip pile and Bamboo stack.

stack respectively. About 3.0% decrease in yield could be observed from a to c group in chip pile and about 2.0% decrease in case of bamboo stack from a to c group. However, group-wise results of chip pile and bamboo satck are quite comparable. Total yield of chip pile for a, b and c group were 52.3%, 49.0%, and 49.2%; for bamboo stack it was 52.4%, 51.2%, and 49.9% for groups a, b and c. Here also about 3.0% and 2.5% decrease in yield could be observed in case of chip pile and bamboo stack respectively. However the group-wise total yield of chip pile and bamboo stack are comparable. Thus, it could be observed that effect of storage is same both in case of chip pile and bamboo stack.

BLEACHING

Bleach consumption remained same for both chip pile and bamboo stack. It was 10.2%, 10.1% and 11.1% for chip pile and 9.9%, 10.4%, and 10.7% for bamboo stack for groups a, b and c respectively. The consumption of bleach liquor for chip pile and bamboo stack are quite comparable. Bleached yield was also almost same for chip pile and bamboo stack. In case of chip pile it was 42.3%, 43.3%, and 41.8% and 42.69% 43.6% and 41.7% in case of bamboo stack for groups a, b and c respectively. Pulp brightness after bleaching was between 76.0% to 77.0% in both the cases. Though the chips were darkened in case of chip pile during storage, there was no adverse effect on bleaching and brightness values of the pulp. However, a slight decrease in viscosity was observed in chip pile and bamboo stack for a, b and c group. The visocity was 13.7, 10.8 and 11.5 cp in case of chip pile and 14.5 cp; 10.3 cp; and 11,3 cp in case of bamboo stack respectively. But the values of chip pile and bamboo stack for different groups are quite comparable.

STRENGTH PROPERTIES

In this paper the strength values at 40 °SR freeness for both bleached and unbleached pulp have been discussed.

Bulk values for unbleached pulp were 1.68, 1.72, & 1.70 for chip pile and 1.64, 1.69, & 1.70 for bamboo stack for groups a, b, and c respectively. The values are almost constant for chip pile and bamboo stack for all the three groups. For bleached pulps bulk values were, 1.54, 1.57, 1.54 for chip pile and 1.57, 1.61, 1.51 for bamboo stack for group a, b and c. These values are also quite comparable groupwise as well as for chip pile and bamboo stack. **Table IV Fig. 5)**

Unbleached pulp breaking length values were 6.08, 5.31 and 5.70km for chip pile and 5.95, 4.94, and 5.87 Km for bamboo stack for groups a, b and c respectively. The values of chip pile and bamboo stack are comparable but in both the cases breaking length had decreased in b group and then had shown an increase in c group. The same trend could be observed in case of bleached pulp breaking length values also. The values for bleached pulps were 6.26, 5.31, and 6.15 km in case of chip pile and 6.14, 5.73 and 5.72 km in case of bamboo stack. **(Table IV Fig. 6).**

Tear factor values of unbleached pulp were 126.3, 151.5 and 110.8 in case of chip pile and 139.8, 145.2, and 111.9 in case of bamboo stack for groups a, b and c respectively. **(Table IV Fig. 7).** Tear factor of both chip pile and bamboo stack are comparable groupwise. These had gone up in a and b group and again decreased in c group. In case of bleached pulp, the values were 105.8, 95.2 and 88.9 for chip pile and 99.4, 85.6 and 92.2 in case of bamboo stack. Unlike unbleached pulp the tear factor values have shown a slight decreasing trend from a to c group. Burst factor values of unbleached pulp were 40.8, 45.3, and 45.0 for chip pile and 41.1, 42.1 and 48.4 for bamboo stack for groups a, b and c respectively. In case of chip pile values remained same

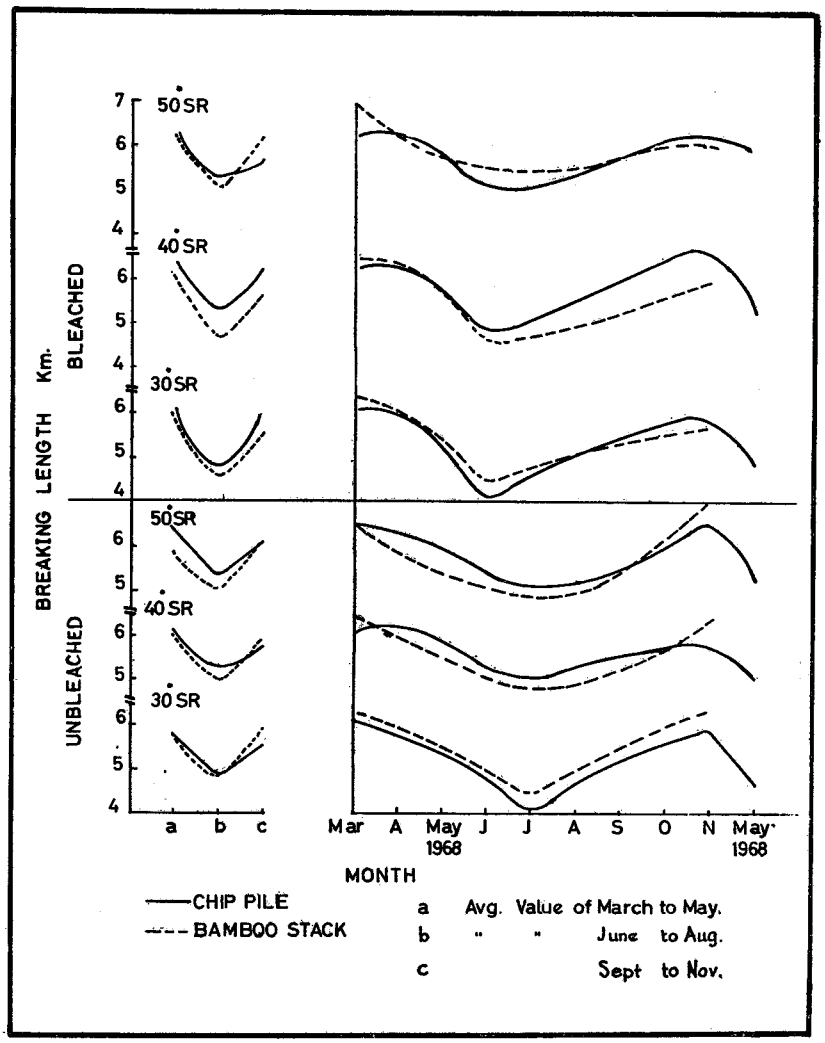

Fig. 6. Breaking length of unbleached and bleached pulps from chip pile and bamboo stack.

for b and c groups. But in case of bamboo stack burst factor had increased from a to c group. Except the burst factor for 'a' group the other values of b and c groups of chip pile and bamboo stack differ though not appreciably. In the case of bleached pulps the values were 45.2, 45.8, and 43.8 for chip pile and 44.3, 41.2, and 46.3 for bamboo stack. The burst factor values of chip pile had increased slightly but decreased in the c group. But in case of bamboo stack after a decrease in b group it had shown an increase in c group. **(Table IV Fig. 8).**

ECONOMICS OF OUT SIDE CHIP STORAGE IN COMPARISON WITH BAMBOO STORAGE

In typical mills bamboos are handled at least 4 to 5 times before the use, like transportation from forest area to Mill yard, unloading after weighments, construction of stacks, breaking of the stack usually earmarked for rainy season and loading into tippers or trucks and then unloading in Chipper House area, often they are again stacked in Chipper House area as well. Each handling costs money and there is material damage as well. If out side chip storage is adopted at least 2 to 3 handlings could be eliminated. This could be done in two ways.

1) Select one or two central points in the forest. Transport bamboos from near about areas in the forests to these points and chip them there only. Chips from these areas, then could be transported to the mill yard and tractor crawlers could be used for chip pile construction. From here the chips could be directly charged into the digester using pneumatic handling equipment.

2) The bamboo could be transported to yard where it could be chipped and stacked in piles nearby. These chips could be blown directly as mentioned above to the digester house. At present rate, about Rs. 27,00,000 are spent for handling bamboos, in a Mill of 100-120 tonnes paper of production. By adopting out side chip storage method by the 1st method mentioned above a saving of about Rs. 8,00,000 to Rs. 10,00,000 per year can be made. The saving would be less if the 2nd method is employed.

CONCLUSIONS

1) Ash and silica content remained almost same during the experimental period in the chip pile and the bamboo stack.

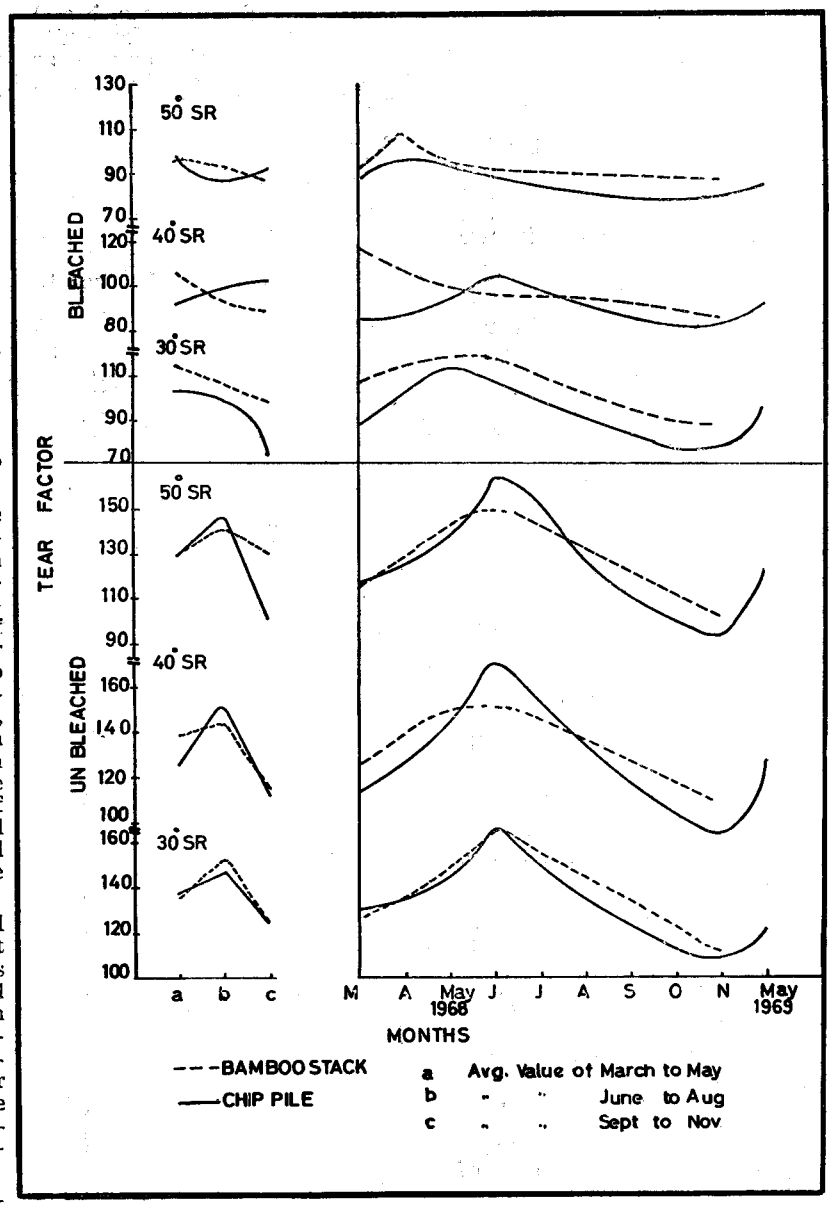

Fig. 7. Tear factor of unbleached and bleached pulps from chip pile and bamboo stack.

2) No visible deterioration could be observed both in chip pile and bamboo stack.

3) Alcohol-benzene, and 1% NaOH solubility decreased from a to c group in both chip pile and bamboo stack.

4) Lignin content remained almost unaffected during the experimental period in chip pile as well as bamboo stack.

5) A decrease of 2% in Holo cellulose is observed in chip pile. But there was not any appreciable change in the case of bamboo stack.

6) Alpha Cellulose remained unaffected during the experimental period in both chip pile and bamboo stack and the values of chip pile and bamboo stack were comparable.

7) Pentosans remained mostly constant without any change during the experimental period in chip pile and bamboo stack.

8) In both the chip pile and bamboo stack a decrease of about 3% in yield was observed in b group. However the pulp yield of chip pile and bamboo stack were comparable.

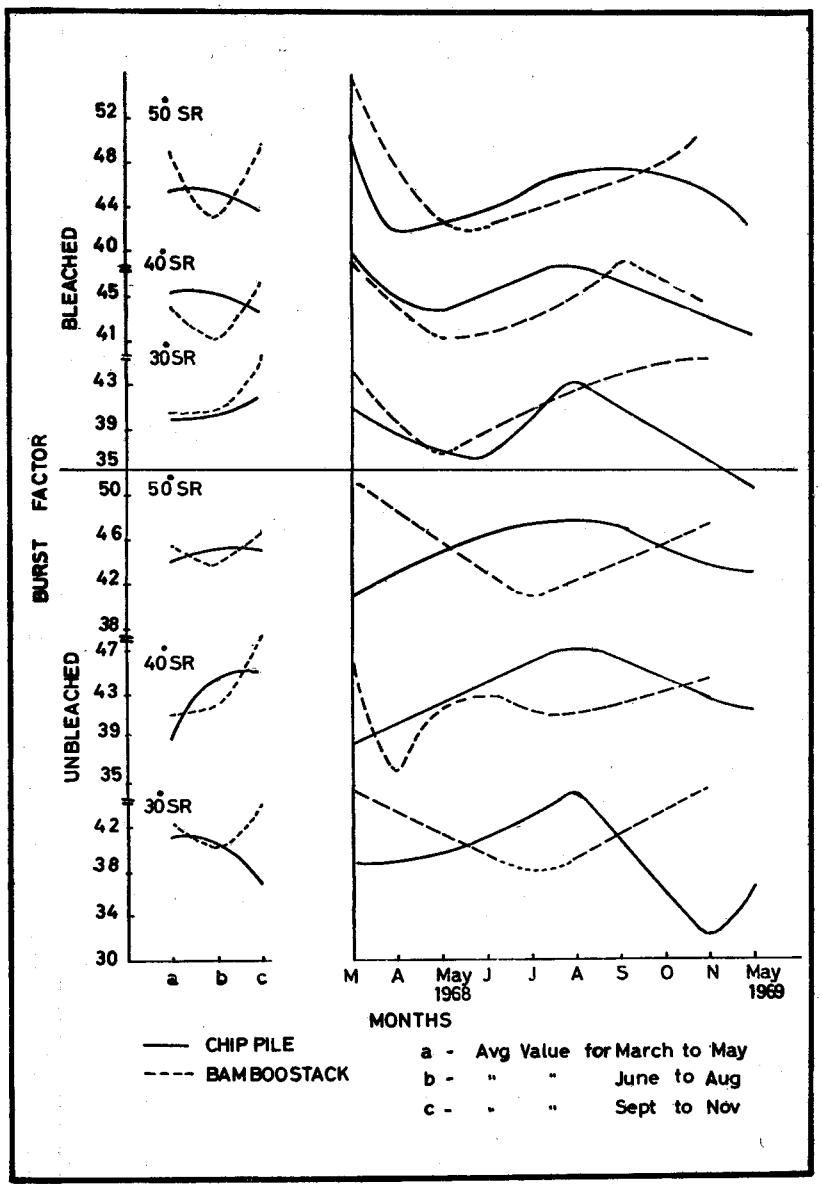

Fig. 8. Burst factor of unbleached and bleached pulps from chip pile and bamboo stack.

9) Bleached yield remained same during the experimental period in chip pile and bamboo stack. However a slight decrease in viscosity of bleached pulp was observed.

10) A slight increase in bulk was observed. But the bulk of chip pile and bamboo stack were comparable.

11) Breaking length had decreased after 3 months but increased again from 6 months both in case of chip pile and bamboo stack. The values of chip pile and bamboo stack are comparable.

12) Tear factor had increased after 3 months and showed after 6 months a decrease both in the case of chip pile and bamboo stack. The difference between bamboo stack and chip pile groupwise is not appreciable.

13) A slight difference was observed in burst factor of chip pile and bamboo stack. But the difference was insignificant.
In general, it was observed that the effect of storage is same both in case of chip pile and bamboo stack and the result of chip pile and bamboo stack are comparable. So as far as quality is concerned, chip pile storage is as good as that of bamboo storage.

14) A saving of 30-35% could be achieved in bamboo handling if out side chip storage is employed.

REFERENCES

1. Lindgren RM Tappi forest Prod. Res. Sao Proc. 5(169) 1951
2. Lindgren RM Tappi 44(6): 419 1961
3. Ference, G. M. & Gilles, T. L. Tappi 39(6) 206 (1956)
4. Chesley K. Tappi 39 (9): 609 (1956)
5. Keaton H. L. & Gilles Spie, W. F. Tappi 34 (1):21 (1951)
6. Mc G. Nun Forest prod. Res. Soc. Proc. 5:162 (1951)
7. Clark, J. H. Pulp paper 37 (6): 80 (1963)
8. Weatherly, J., Pulp paper 37 (10) 127 (1963)
9. Clark, J. H. Pulp paper 37 (10) 127 (1963)
10. Holekamp, J-A. pulp paper 36 (13): 37 (1962)
11. George J. Hazny Tappi October Vol 49. No. 10 (19.6)
12. Blackerby, L. H., pulp paper 36. (21): 77 (1962)
13. Blackerby L. H., Pulp paper 39. (28): 44 (1965)
14. Outside chip storage pulp paper 38 (19): 24 (1964)
15. Blackerby L. H. Pulp paper 39 (17): 39 (1965)
16. Birkhimer Tappi 43 (12): 989 (1960)
17. Ritcey, G. C. Pulp Paper Mag. Canada 63(C): T116 (1962)
18. "Guide to out side chip storage" Pulp and paper 35(22): 45 (1961)
19. Rothrock etal Tappi 44 (1): 65 (1961)
20. Somen R. A. Tappi 45 (8): 623 (1962)
21. Thornberg, W.L., Tappi 46 (8): 453 (1963)
22. Bois etal. Tappi 45 (8) 609 (1962)
23 Crane etal. Tappi 43 (12): 188A (1960)
24. Lindgren etal.. Tappi 44 (6): 419 (1961)
25. Bjorkman etal.. Tappi 46 (12): 757 (1963)
26. Holekamp.. Paper Trade J. 142. (49): 36 (1958)

Appendix

TABLE NO. I. Temperature in the chip pile

Period		Top centre	East °C	South °C	West °C	North °C
April	Max.	35.0	33.5	28.5	30.0	31.5
	Min.	31.0	29.0	26.0	28.0	26.8
	Avg.	33.5	31.2	27.1	28.4	29.3
May	Max.	36.5	33.5	29.5	30.8	37.0
	Min.	30.0	30.5	26.5	30.0	33.0
	Avg.	34.2	32.5	28.0	29.4	34.9
June	Max.	38.5	33.0	29.5	30.8	37.0
	Min.	28.0	25.5	24.5	26.0	25.5
	Avg.	32.4	29.5	28.5	28.0	31.8

TABLE II Chemical Analysis

Group	Period	Ash % CPS	Ash % BSS	Silica % CPS	Silica % BSS	1 % NaoH Solubility % CPS	1 % NaoH Solubility % BSS	Alcohol Benzene solubility % CPS	Alcohol Benzene solubility % BSS	Lignin % CPS	Lignin % BSS	Holo cellulose % CPS	Holo cellulose % BSS	Alpha cellulose % CPS	Alpha cellulose % BSS	Pentosan % CPS	Pentosan % BSS
a.	Mar. 68	3.39	2.69	2.08	0.97	33.50	38.50	2.65	2.71	24.04	22.20	67.19	65.57	47.70	48.53	19.08	19.39
	Apl. 68	3.53	3.52	1.65	1.80	20.10	21.80	3.73	4.51	24.28	23.62	—	66.36	—	45.00	18.11	17.92
	May. 68	3.68	3.08	1.99	1.43	23.48	24.60	2.86	5.36	25.84	26.62	69.58	69.63	45.00	46.20	19.14	20.49
	Average	3.53	3.10	1.90	1.40	28.30	28.30	3.08	4.19	24.72	24.15	68.39	67.19	46.35	46.58	18.78	19.27
b.	Jun. 68	3,37	3.57	1.40	1.87	36.00	24.50	3.73	4.63	25.45	24.45	67.41	67.84	46.10	45.20	19.54	19.61
	July 68	3.12	3.56	1.50	1.98	24.82	23.60	1.86	2.71	26.69	23.63	68.47	65.60	47.85	44.90	20.88	20.35
	Aug. 68	2.99	3.13	1.98	1.72	29.40	26.20	1.84	3.20	2343	.23.14	65.30	65.70	47.50	46.12	18.37	18.41
	Average	3.16	3.42	1.85	1.86	26.70	24.80	2.48	3.51	25.19	23.73	67.06	66.38	46.48	45.41	19.60	19.46
c.	Sept. 68	3.25	2.91	2.36	1.32	20.78	23.39	2.32	3.11	23.04	24.77	66.21	69.85	46.20	46.12	19.67	19.97
	Oct. '68	3.36	2.35	2.14	1.27	20.25	21.80	1.73	2.26	24.65	23.19	66.71	68.63	47.38	46.50	—	—
	Nov. 68	3.15	3.68	2.07	1.87	22.83	26.36	1.44	1.53	25.27	23.68	63.69	64.30	44.13	43.90	19.93	19.13
	Average	3.25	3.11	2.16	1.55	21.30	23.90	1.83	2.30	24.32	23.88	65.43	67.59	45.97	45.51	19.80	19.45
	May 69 After 14 months.	3.99	—	1.29	—	20.00	—	1.17	—	24.80	—	70.3	—	48.6	—	—	—

CPS — Chip pile storage BSS — Bamboo Stack storage.

TABLE III—Pulping and Bleaching

Group	Period	Screened yield % CPS	Screened yield % BSS	Total yield % CPS	Total yield % BSS	Kappa number CPS	Kappa number BSS	Bleach consumption as cl_2 % CPS	Bleach consumption as cl_2 % BSS	Bleached yield % CPS	Bleached yield % BSS	Brightness % CPS	Brightness % BSS	Viscocity (C E D) centipoise CPS	Viscocity (C E D) centipoise BSS
a.	Mar. 68	50.7	47.0	53.9	51.7	33.9	29.8	11.0	10.0	40.8	42.8	77.0	77.0	16.5	15.0
	Apl . 68	49.5	50.0	52.0	53.8	27.5	31.8	9.8	10.7	43.4	43.7	77.5	74.0	10.8	14.0
	May 68	49.4	48.1	51.1	51.6	29.5	26.1	9.8	9.0	42.6	41.4	75.0	75.0	—	—
	Average	49.9	48.4	52.3	52.4	30.3	29.2	10.2	9.9	42.3	42.6	76.5	76.0	13.7	14.5
b.	June 68	49.2	46.0	51.9	50.6	32.4	30.6	10.6	10.5	46.5	42.8	78.0	78.5	—	10.5
	July 68	46.6	48.3	49.4	50.5	33.0	29.3	—	—	—	—	—	—	—	—
	Aug. 68	45.1	50.5	46.6	53.4	28.2	31.0	9.5	10.2	41.0	44.4	76.0	76.0	10.8	10.2
	Average	47.0	48.3	49.0	51.2	31.2	30.3	10.1	10.4	43.8	43.6	77.0	77.5	10.8	10.3
c.	Sept 68	45.7	46.3	47.3	48.5	35.2	29.5	11.7	10.1	41.5	41.6	78.0	79.0	11.8	11.0
	Oct. 68	46.5	46.7	48.7	50.7	30.0	33.2	10.0	11.5	41.9	42.1	76.0	77.0	—	12.1
	Nov. 68	48.3	46.6	51.7	50.5	35.5	27.7	11.5	10.6	41.1	41.5	75.0	77.0	11.1	10.9
	Average	46.8	46.5	49.2	49.9	33.6	30.1	11.1	10.7	41.8	41.7	76.5	77.5	11.5	11.3
	May 1969 After 14 months.	49.2	—	52.4	—	27.3	—	9.22	—	41.8	—	77.0	—	—	—

CPS — Chip pile storage BSS — Bamboo stack storage.

TABLE IV — Average Strength Properties of Unbleached and Bleached Pulps

Freeness °SR.		Bulk cc/g						Breaking length, Kms.						Stretch %						Tear Factor						Burst Factor					
		30		40		50		30		40		50		30		40		50		30		40		50		30		40		50	
GROUP		CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS	CPS	BSS
UN-BLEACHED	a	1.78	1.72	1.68	1.64	1.68	1.57	5.87	5.85	6.08	5.95	6.42	5.88	3.2	4.2	3.8	4.3	4.2	4.4	138.3	137.6	126.3	139.8	128.9	129.9	41.0	42.6	40.8	41.1	44.1	45.5
	b	1.80	1.78	1.72	1.69	1.72	1.65	4.89	4.83	5.31	4.94	5.26	4.98	5.1	4.7	5.1	4.7	5.3	4.8	147.1	155.0	151.5	145.2	147.4	143.1	41.2	40.1	45.3	42.1	45.4	43.6
	c	1.73	1.74	1.70	1.70	1.69	1.64	5.56	5.95	5.70	5.87	6.07	6.34	3.9	4.3	4.1	3.8	4.3	4.7	123.8	125.4	110.8	111.9	100.2	129.9	36.8	44.1	45.0	48.4	45.1	46.6
BLEACHED	a	1.70	1.59	1.54	1.57	1.55	1.47	6.01	5.96	6.26	6.14	6.16	6.29	3.8	4.5	3.9	4.5	4.7	4.8	103.0	115.1	92.3	105.8	99.4	97.1	40.0	40.3	45.2	44.3	45.2	49.1
	b	1.58	1.62	1.57	1.61	1.55	1.52	4.76	4.61	5.31	4.73	5.33	5.52	4.8	4.5	4.9	5.0	4.9	4.7	100.1	106.3	97.1	95.2	85.6	93.6	39.8	40.1	45.8	41.2	45.8	43.1
	c	1.55	1.54	1.54	1.51	1.54	1.48	5.96	5.62	6.15	5.72	5.74	6.57	3.3	4.2	4.0	4.6	3.9	4.6	74.0	98.6	104.3	88.9	92.2	87.6	41.9	45.5	43.8	46.3	43.6	49.8
AFTER 14 MONTHS																															
UNBLEACHED		1.85	—	1.77	—	1.68	—	4.61	—	4.97	—	5.15	—	3.9	—	4.3	—	4.3	—	131.2	—	126.4	—	121.9	—	36.6	—	41.6	—	42.9	—
BLEACHED		1.89	—	1.75	—	1.69	—	4.82	—	5.19	—	5.99	—	3.8	—	4.3	—	4.5	—	95.3	—	92.3	—	85.2	—	33.5	—	41.7	—	42.2	—

CPS — Chip Pile Storage. BSS — Bamboo Stack Storage.