# Machine Manufacturers' Viewpoint of Pulping as Applied to Indian Conditions

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*Emphasis on the urgent need of cooperation between pulp manufacturer and equipment manufacturer for solving the problems of pulp and paper industry is emphasised. A critical analysis of the problems faced by the Indian pulp and paper industry from machine manufacturers' standpoint at various stages of manufacture is discussed. Bamboo being the main raw material in India, the problem connected with its handling, transportation, chipping and screening is discussed. Need of chip washing, improvement of digester cooking cycle is proposed. Higher washing efficiency of the pulp and adequate sizing of filter along with new self-suction filter is illustrated. Principle of KMW's new UNI screen is presented. Due to shortage and high cost of sulphate ($Na_2SO_4$) use of Gypsum has been considered. A simple method of increasing sulphidity by black liquor oxidation is mentioned. Silica content in bamboo black liquor and its possible elimination from the system is discussed.*

## INTRODUCTION

It is absolutely essential for an equipment manufacturer to have detailed knowledge of the pulping process. The process conditions stipulate the functional specification of the machinery and equipment and also the control variables that should be incorporated in the design.

Indian pulp and paper industry is by and large based on non-conventional raw material, i.e. bamboo, tropical hardwoods, grass, bagasse, etc. Direct transplantation of all technology and know-how developed mainly to cater for North American and North European countries therefore often give lower yield and quality.

Accelerated growth of pulp and paper industry in India is very much a concern for the equipment manufacturer. It means bread and more butter for them. But the corollary is also valid, i.e. for the healthy growth of pulp and paper industry, machine manufacturing industry must also develop. Otherwise, who would build the specialized equipment for the improved process developed by Indian pulp and paper industry.

Consequently, development of pulp and paper industry must be a joint effort of the pulp and paper manufacturer and machine manufacturer. Foreign collaborators are willing to put at your disposal their machine manufacturing know-how but all this know-how must be modified and transformed to suit Indian raw materials and Indian process technology.

In view of the above it is important for a machine manufacturer to understand and analyse the technical problem faced by the industry. A thorough understanding of the problem in its depth often gives a clue to the solution. The purpose of this paper is to evaluate and scrutinize the problem faced by the Indian pulp and paper mills and also to suggest a few solutions. No claim is made that the suggestions put forward are the only ones and the correct ones.

## RAW MATERIALS HANDLING AND PREPARATION

The raw materials used by the Indian mills are by and large bamboo. The bamboo is harvested in the forest and transported to mills by rail in majority of cases although trucking is also practised. The number of operations performed from felling to feeding the chipper is:

1. Selecting the pole to be felled
2. Felling the pole
3. Extracting the felled pole from the surrounding standing bamboo
4. Delimbing the bamboo
5. Cutting the bamboo to size
6. Bundling a number of poles and tying
7. Piling — either on cart or on ground
8. Loading of lorry
9. Unloading of lorry at rail head or mill

**TABLE I Cost of Bamboo**

| Item of cost per AD ton | Cost in % |
|---|---|
| Royalty | 11% |
| Felling and bundling | 15% |
| Loading and unloading | 4% |
| Over head charges | 10% |
| Railway freight or road freight | 60% |
| Cost at mill yard | 100% |

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**In case of rail head**

10. Unloading and piling
11. Loading of waggon (often closed type)
12. Transport to mill
13. Unloading at mill and piling
14. Unpiling and conveying to chipper

The various items of cost which amount to the final price of bamboo to the mill vary widely. **Table I** shows average figure.

From the above it can be concluded that any saving in transport and handling cost of bamboo poles will greatly improve the economy of bamboo pulping. The question is, how to achieve this cost reduction.

I do not pose to have a ready solution, but an analysis of the various items of cost may be a pointer to the solution. The cost of bamboo at the root, i.e. royalty is fixed. Handling cost, i.e. operations 3, 5, 6, 7, 8 and 9 may be rationalized by :

a) cutting all the standing bamboo in a root system, i.e. the principle of clear cutting. and

b) chipping the bamboo immediately after felling and loading a box car.

Once bamboo poles are converted to chips, the handling of bamboo chips becomes easy as pneumatic transport both low pressure (fan) and high pressure (compressor) system can be adopted. Transport cost is a lump sum figure, which includes all the halting time when the material is being loaded. Bamboo poles are difficult to stack even when bundled. Therefore, manual loading and unloading practised in India takes considerable time. Mechanization of bamboo handling is very difficult due to the very nature of bamboo. Volume occupied by a ton of bundled bamboo pole often is more than a ton of chips — depending on type. Chips can also be compacted in box cars. The main advantage of chip transport lies in the possibility of its higher utilization of the load potential (of the fixed volume). Even in case of straight normal softwood pulp logs — where one cubic metre stacked wood gives two cubic metres of chips — there is a tendency to transport chips and install mobile chip mills in the forest. Chip transport over long distance today is a reality and is widely practised.

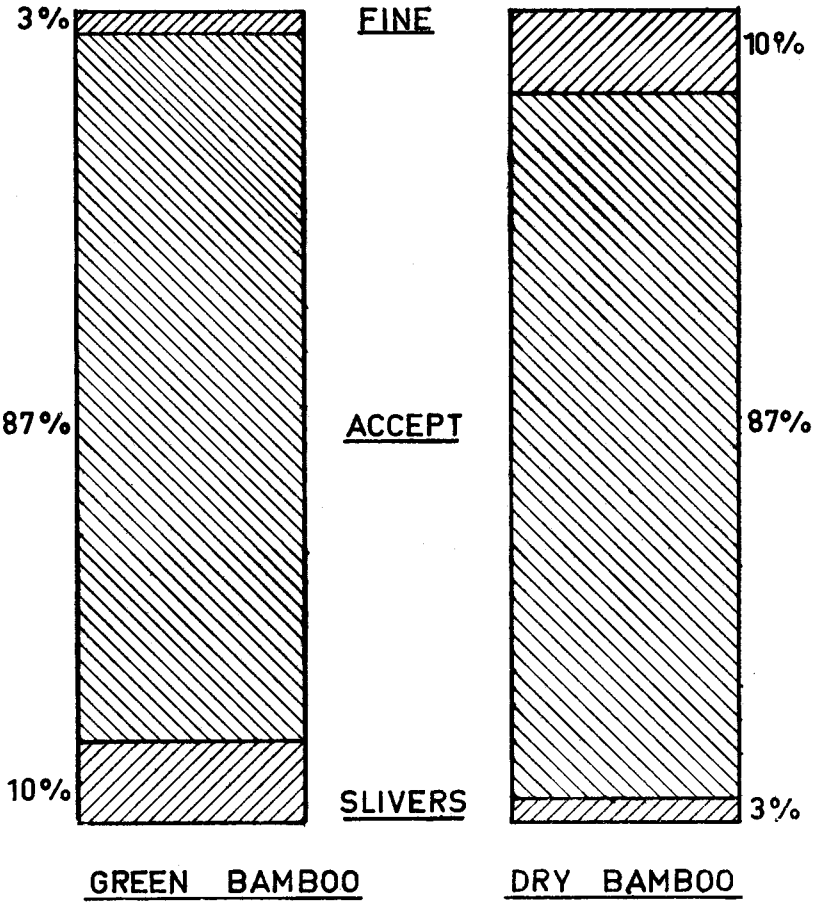



**Fig. 1 Comparison of Chip quality green Vs. Dry bamboo**

The questions that we have to raise now are :

a) Can clear cutting be practised?

b) Can chipping be performed in the forest?

The answer to the first question is beyond the scope of this paper. As regards the second question, we have designed special mobile chippers for the Indian market with TMB diesel motors. These machines have been available to the industry for a number of years but the demand has been low.

The suitability of HH 220 T chipper as a mobile unit for bamboo has been proved. There is, however, reluctance on the part of the mills to use them in the forest due to apprehended maintenance difficulties. Chipping of green bamboo is generally avoided due to high fraction of long slivers. This problem of slivers or oversize can be viewed from a different angle. While green bamboo produces more slivers, it produces less fines compared to dry bamboo. See **Fig. 1.**

Fines is a loss to the system and more so when it is produced in

**TABLE II. Comparison of Wood and Bamboo on 220 T.**

| Material | 1 Machine idle % | 2 Machine loaded % | 3 BD Chip kgs/m³ | 4 Actual Capacity ADTH | 5 Theoretical capacity ADTH End to end feeding 100% on 4 | 6 Full spout 100% end to end feed ADTH | 7 Power Potential capacity ADTH Bamboo | 8 Ratio (5/6) | 9 Equivalent pulp capacity at 50% yield on actual capacity (4) ADTD |
|---|---|---|---|---|---|---|---|---|---|
| Dry Bamboo | 78 | 22 | 200 | 3,6 | 16,4 | 23 | 22,4 | 0,73 | 43 |
| Fresh Birch | 88 | 12 | 180 | 8 | 66,5 | 74 | 44,5 | 1,49 | 96 |

ADTH = airdry (90% BD) ton per hour
ADTD = airdry (90% BD) ton per day

the mill as all cost for handling and transport is already paid for. Slivers can be rechipped to usable product but the fines cannot be used to any profitable degree.

Many mills, however, charge fines to the digester with the intention of obtaining whatever pulp they get from it. In evaluating the value of the fines, one should consider that the fines — due to their large surface area — become over-cooked, resulting in low yield. However, these fines clog the wires on the washers and deckers and reduce their dewatering capacity, thus creating bottle necks. Fines carry dirt into the system. Fines mostly find their way into filtrates and back water in the effluent. Fines consume more chemicals both in cooking and bleaching.

Equating all these negative factors against increased production often shows that use of fines is a false economy. — As a matter of fact fines may mean lowered return. Equipment is often sized up in apprehension of bad drainage property caused by fines.

We can now pose two questions:

1) Can we make slivers free chips?

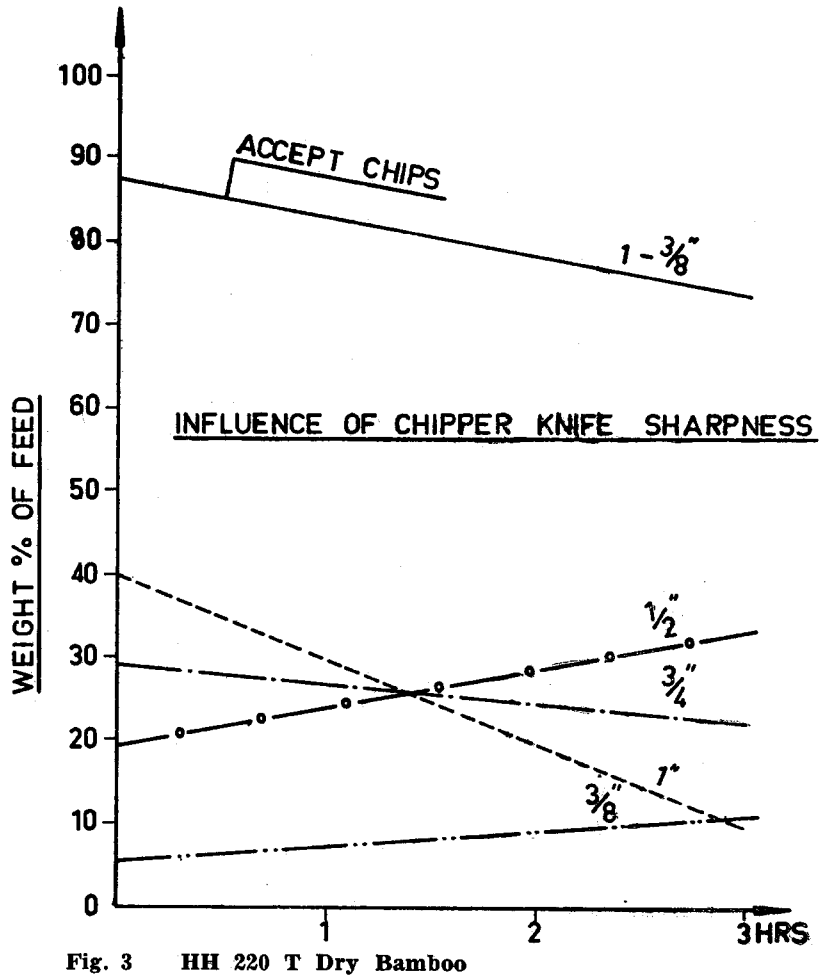



**Fig. 3 HH 220 T Dry Bamboo**

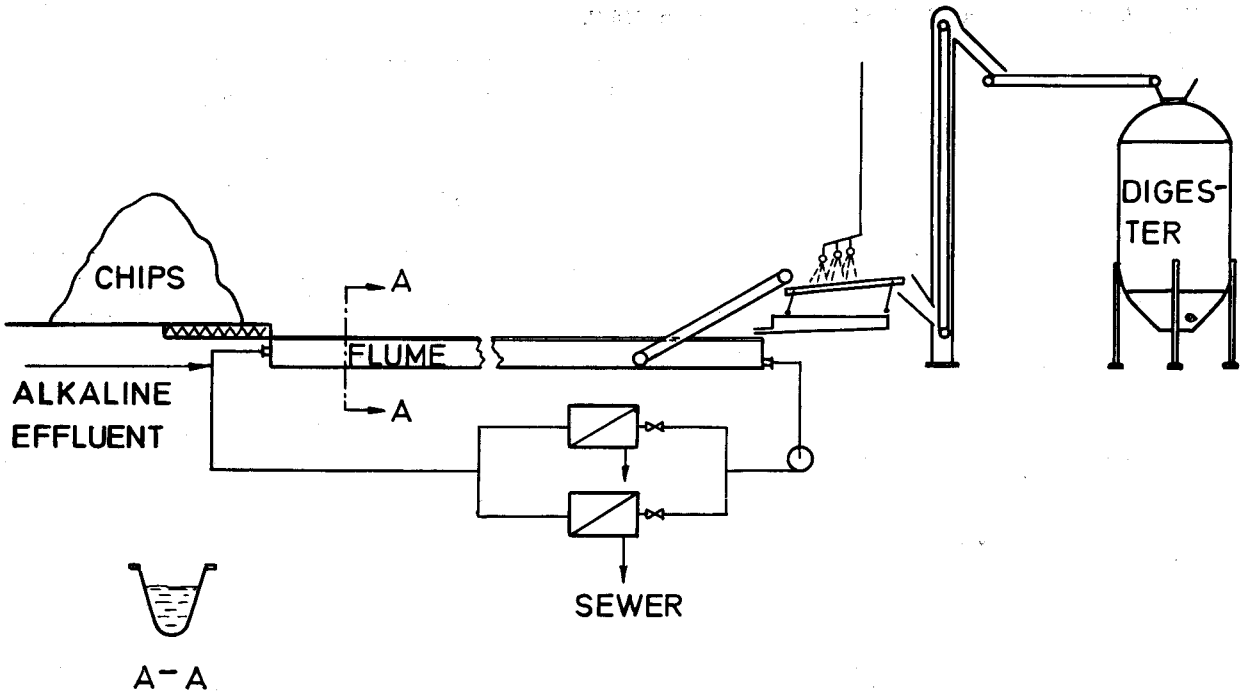



**Fig. 3 Hydraulic transport and Chip washing.**

2) Can we make good chips from slivers?

Complete slivers free chips would not be practically possible. We have therefore tried to analyse the factors which favour production of slivers.

No reliable data are available, therefore, the discussion must be a qualitative one.

The factors which govern the amount of slivers are :

a) Accuracy of knife setting
b) Fly-knife sharpness
c) Moisture content
d) Dead knife sharpness
e) Knife angle
f) Velocity of knife
g) Dimension of bamboo
h) Type of bamboo
i) Peeling character
j) Sheer stress

Influence of chipped knife sharpness on chip quality is shown in **fig. 2.** The accept chip percentage to total feed diminishes sharply after 2 hours' operation. Mills should pay more attention to this key factor.

We have developed a special type of rechipper for slivers. Hog or shredder can reduce dry slivers to chip but cannot convert green slivers to chips. Therefore chipping disintegrators were designed. We then designed a special rotor-type chipper for jute sticks, which we applied for rechipping and got very promising results. Here again knife sharpness, setting and angle are of vital importance.

The disk chippers have so far been used in chipping bamboos rather effectively and we have made the following observations:-

1. A disk chipper uses 65 per cent of disk area and 90 per cent knife length for chipping.
2. Due to the absence of suitable feeding system to the feeder spouts, the pulp mills in India are not able to make the full utilization of the chippers.
3. A comparison of HH 220T under actual working condition with normal dry bamboo and fresh birch is shown in **table II.**

With the above considerations, the fact that the rotary types of rechipper may have a wider potential, we are in the process of redesigning our rotor chippers for bamboo chipping to fulfill the following conditions :-

a. Knife is more utilized.
b. The power potential of the machine is more utilized.

There are much more interesting and unknown aspects of bamboo chipping, which must be investigated. I feel a research project jointly sponsored by all the pulp and paper mills of India for probing the problem of knife quality, i.e. metallurgy of knife material effect of moisture on chip quality etc. should be immediately launched.

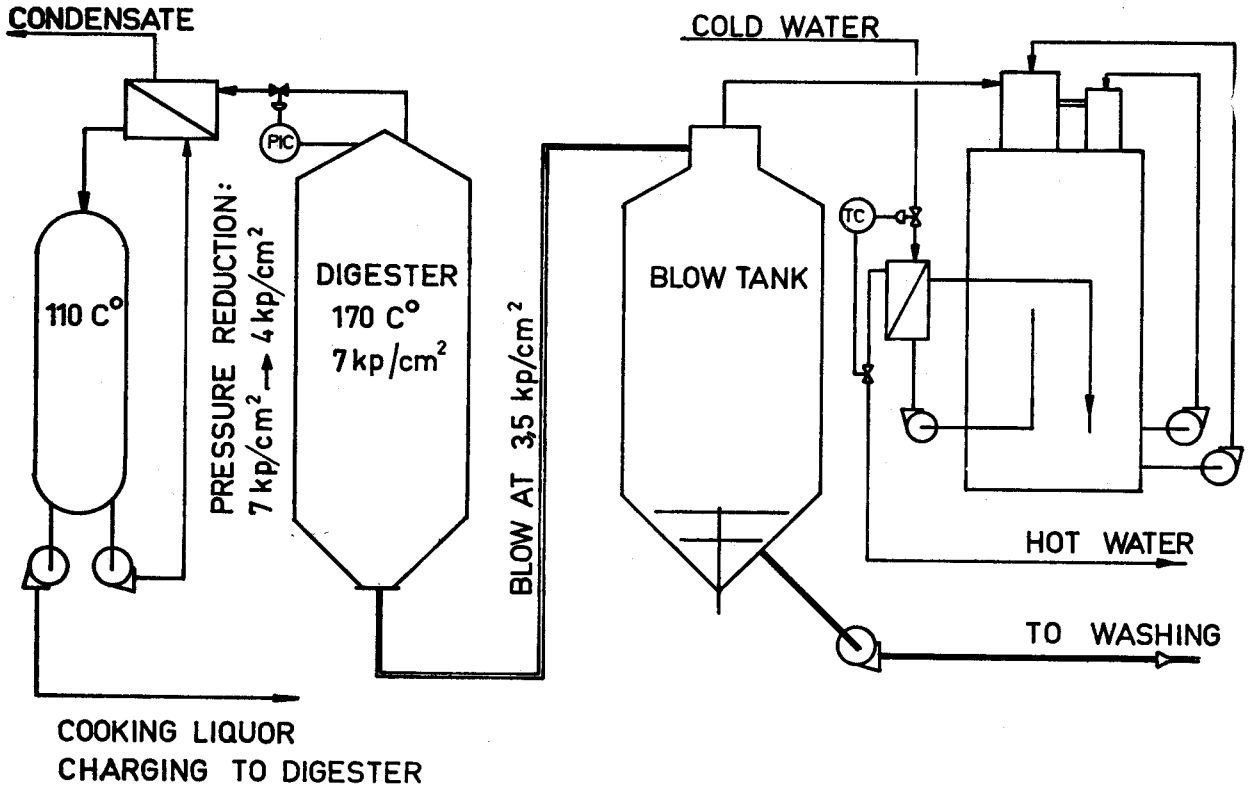



**Fig. 4 Flow diagram of cooking equipment.**

Knowledge in this field is rather limited. We must understand thoroughly the mechanism of chipping bamboo before we can finally design the perfect chipper which produces no slivers and no fines.

## CHIP SCREENING

As long as we are not able to design a chipper which produces 100 per cent accept chips we are doomed to have screening or accept inferior quality of chip for further processing. Screening is a simple tool and it acts as a protector and controller in a chip flow system. Screening therefore can be considered as a unit operation designed specifically in this particular case as:

a. Controller of chipper performance i.e. condition of the knife etc.

b. A simple safety device to avoid trouble in pulping.

c. Upgrader of chip quality.

d. Arrester of fines and dirt (input in the pulping system).

e. Arrester of impurities (input in the recovery system).

While points a — c are known and accepted, points d and e need further clarification. **Table III** shows ash content of fine fraction i.e. passing ¼" plates, as per TAPPI standard (T 16 ts—61).

The ash content of fines is roughly 3 times ash content of accept chip fraction.

## CHIP WASHING

Bamboo is one of the cleanest raw materials in native state. It has no impurities like bark. Yet most of the bamboo pulp produced is rather dirty. Adequate cleaning of bamboo ahead is the cheapest and most logical step. Today use of hydro cyclones to clean pulp later in the process is widely practised. This however must be supplemented by bamboo screening and washing. Otherwise it is shear wastage of chemicals, steam, power and wear on equipment. Washing of bamboo ahead of the chippers and or chip washing should be a standard design.

The advantage of chip washing is:

1. removal of mechanical dirt and sand
2. removal of fines

Provided a good washing system is designed it can use mill effluents to wash the chips and by doing so eliminate any fresh water requirement and at the same

**TABLE III. Comparison of Wood and Bamboo on HH 220 T.**

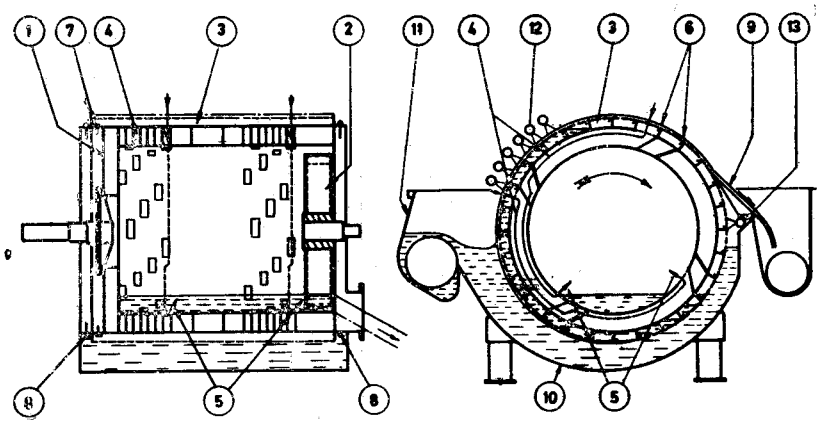
| | Chips | Fines |
|---|---|---|
| Ash % | 3,7 | 9,4 |
| Water insoluble in ash % | 3,0 | 7,5 |

time improve the outgoing effluent quality (BOD reduction).

The main disadvantage of a chip washer is water input in the system.

Although we have manufactured chip washer of the rotary drum type, which is operating successfully, high capacity requirement has prompted us to improve design on a new principle. Under Indian conditions chip flumes may be a simple way to wash and transport chips from chipper house to the digester. Simple dewatering conveyor at the receiving end can take up chip. Such a system is shown in **fig. 3.**

The biggest pulp mill in India has installed chip washers manufactured by T-J with remarkable results. There is, however, some problem of fines, which should be tackled by proper attendance at chippers and chip screens.



FILTER KMW-KAMYR-63

| | | | | | |
|---|---|---|---|---|---|
| 1 | CLOSED DRUM END AT THE DRIVE SIDE | 6 | BAFFLES | 11 | FLOW BOX |
| 2 | OPEN DISCHARGE END WITH SPOKES | 7 | AIR INLET | 12 | SHOWER PIPES |
| 3 | CELLS | 8 | SEALING STRIPS | 13 | CYLINDER WASH SHOWER |
| 4 | FILTRATE DUCT | 9 | PICK UP ARRANGEMENT | 14 | |
| 5 | DISCHARGE OF FILTRATE | 10 | FILTER VAT | 15 | |

FIG. 5

**Fig. 5 Filter KMW — KAMYR — 63**

## COOKING

Most of the mills in India are based on sulphate process for pulping bamboo. Cooking equipment is primarily batch. Three continuous digester units are operating, the 4th is under erection. Batch digesters are simple to operate although they give widely fluctuating Kappa number of the pulp between the cook and within the cook.

Improvement of batch digestion system has not been much. The total cover to cover time for Indian mills is between 5 to 8 hours. Higher thermal economy is possible by utilizing blow heat recovery. There is possibility of increasing thermal efficiency of the system by using a cooking liquor accumulator for degassing, See **fig. 4.** Such a system will improve pulp strength and reduce heat requirement.

## WASHING

The importance of good washing is realized by all mill operating

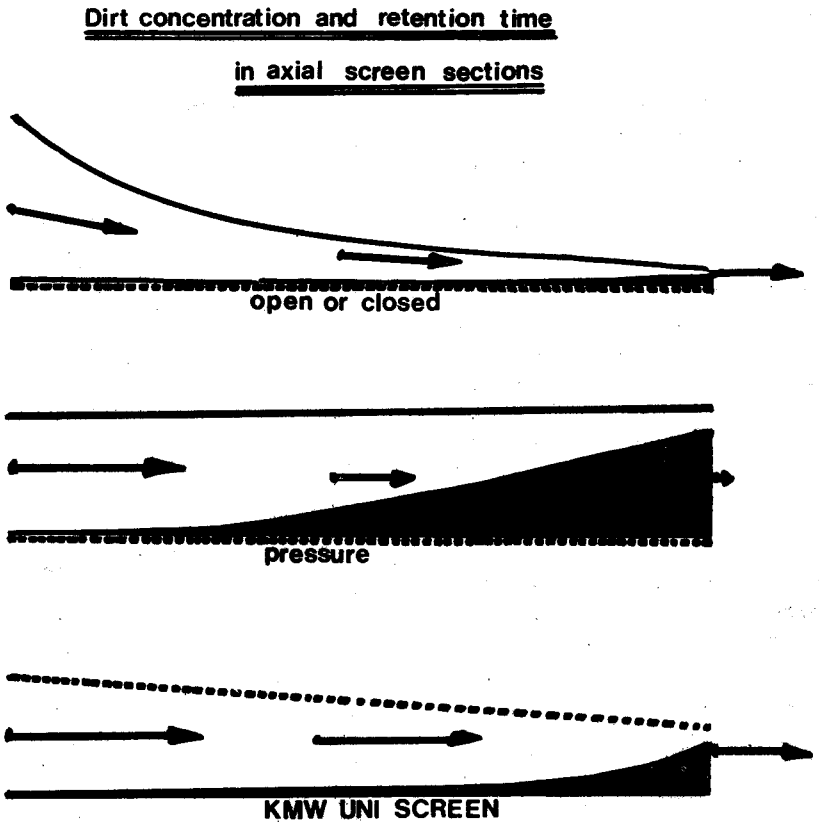



**Fig. 6 Dirt concentration and retention time in axial screen section.**

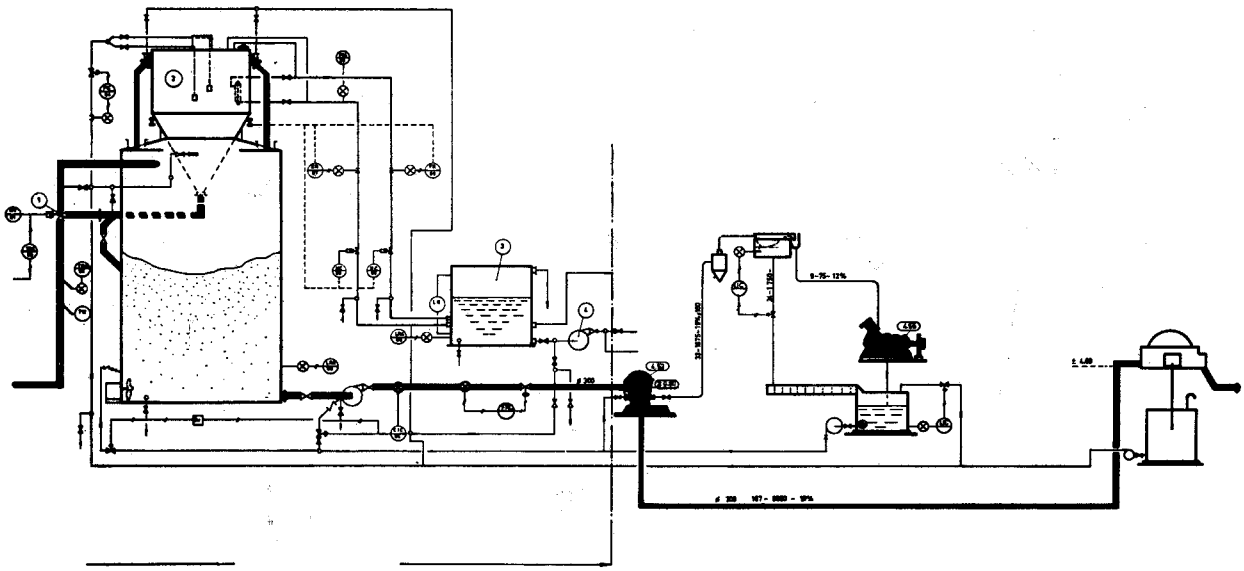


**Fig. 7 Flow sheet of a UNI — Screen**

personnel specially in the screening and recovery plant.

High cost of chemicals both sulphate and chlorine require high washing efficiency. It is better to install adequately dimensioned equipment and also 3, better 4, washing stages to improve recovery and higher washing efficiency with minimum of dilution. A 4-stage filter washing plant with a loading of 4 AD tons pulp per m²/day at a dilution factor of 2, 5 should give under proper operating condition a sulphate loss not exceeding 14 kg easily washable $Na_2SO_4$/AD pulp. Three stage washing should under similar condition have loss not higher than 19 kg $Na_2SO_4$/t AD pulp.

Orient Paper Mills, Amlai, are operating a three stage brown stock washing plant with Kamyr M-57 washer 3500 dia. 6000 mm face (manufactured in India by Telco) followed by screening and a decker of same size and i.e. vertually a 4-stage washing plant with brown stock screen baked in.

Improved design of cell type suction washer has made it possible to make units 4m dia. x 14m face with a capacity of 840 t AD/day in a single line. The advantages of the self suction washer are :

**TABLE IV. Typical Loss in an Indian Mill.**

| | |
|---|---|
| Brown Stock Washer | 20—25 kg/t.b.d pulp |
| Stack | 20—25 kg |
| Filtercake | 20—25 kg |
| Classifier grit & slaker stone | 5—10 kg |
| Jonson Knotter | 10—15 kg |
| Total | 75-100 kg |
| Recovery efficiency | 91%-89% |

1. Mat formation takes place under hydrostatic gradient increasing continuously as formation proceeds.
2. The displaced air does not mix intimately with the liquor and can be piped separately to the filtrate tank top.
3. The filtrate level in the drum acts as an air/liquor/foam separating surface.
4. The amount of air sucked through the fibre is minimum as the vacuum produced is governed by the rotating barometric leg, which loses its vacuum when air comes into the system.

**TABLE Va. Analysis of Bamboo and Pine Kraft Pulping Liquors.**

| Black liquor | Bamboo | Pine |
|---|---|---|
| Total solids | 178,0 g.p.l. | 180.0 |
| pH | 11,3 | 11,5 |
| Total titratable alkali as $Na_2O$ | 28,2 ,, | — |
| Aktive alkali as $Na_2O$ | 8,8 ,, | — |
| Organic matter in total solids | 65,0 % | 72,0 % |
| Inorganic ,, ,, ,, ,, | 35,0 % | 28,0 % |
| Silica on basis of inorganic matter | 10,0 % | —— |

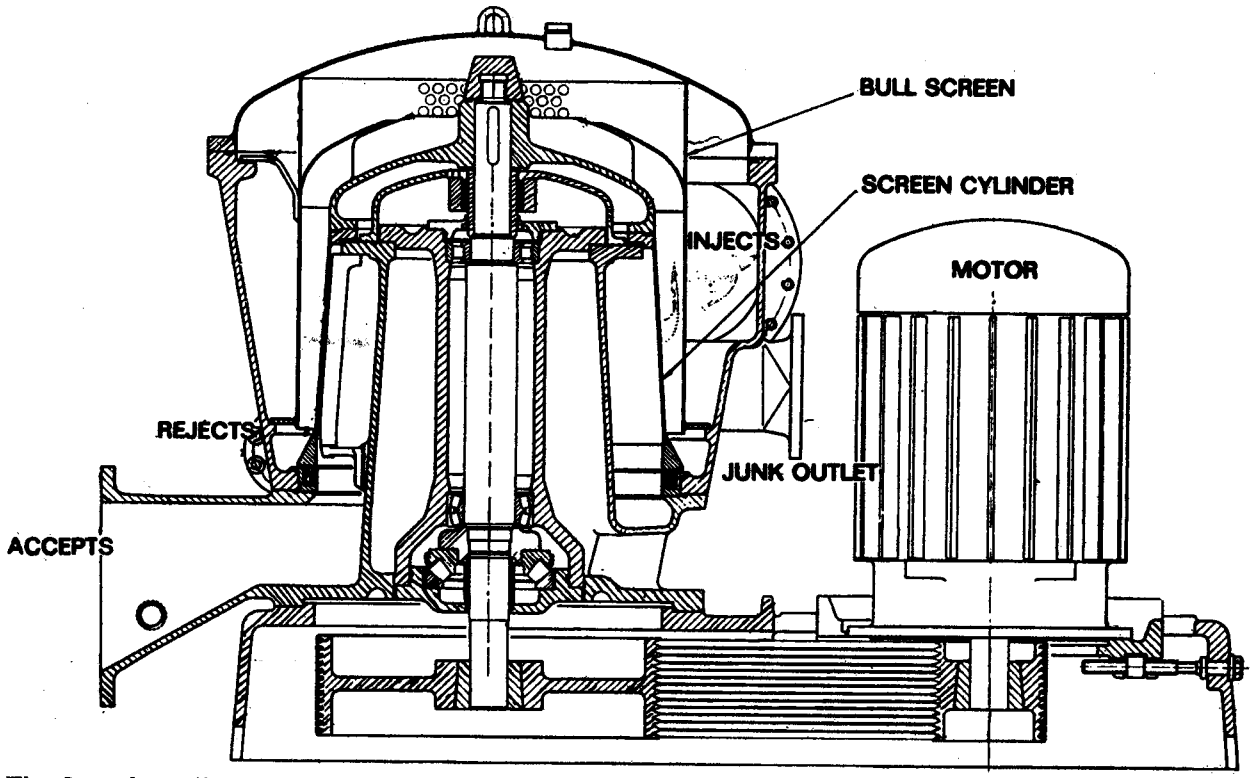



**Fig. 8 A section of the KMW UNI screen**

5. Short axial travel of filtrate in the cell resulting in minimized back wash.

**Fig. 5** shows the working principle of KMW/Kamyr M-63 washer.

## SCREENING

Objective of screening is to separate desirable fibre from unavoidable undesirable knots, shives, etc. Most of the existing outward flow centrifugal screens (where a screen plate is used as a barrier) suffer from one particular drawback. The screening of pulp takes place through a fibre network where the concentration of dirt is high. KMW have now launched a new type of screen UNI-screen, which is an inward-flow pressurized screen, which is both a knotter and a fine screen.

Dirt concentration and retention time in axial screen section is shown in **fig. 6.**

Simplified flow sheet of a UNI-screen is shown in **fig. 7.**

**TABLE Vb. Analysis of Bamboo and Pine Kraft Pulping Liquors.**

| Green liquor | Bamboo | Pine |
|---|---|---|
| Total titratable alkali as $Na_2O$ | 115,0 g.p.l. | 140,0 |
| NaOH as $Na_2O$ | 42,3 „ | 19,0 |
| $Na_2S$ „ | 14,9 „ | 40,0 |
| $Na_2CO_3$ „ | 56.2 „ | 110.0 |
| $Na_2SO_4$ „ | 1,7 „ | 6,5 |
| Silica | 11,6 „ | — |
| Reduction | 88,8 % | — |

**TABLE Vc. Analysis of Bamboo and Pine Kraft Pulping Liquors.**

| White liquor | Bamboo | Pine |
|---|---|---|
| Total titratable alkali as $Na_2O$ | 113,0 g.p.l. | 175,0 |
| NaOH as $Na_2O$ | 76,0 „ | 82,0 |
| $Na_2S$ „ | 13,5 „ | 39,0 |
| $Na_2CO_3$ „ | 12,5 „ | 8,0 |
| $Na_2SO^4$ „ | 1,7 | 8,0 |
| Silica | 1.9 | 1,0 |
| Causticity | 85,5 % | — |

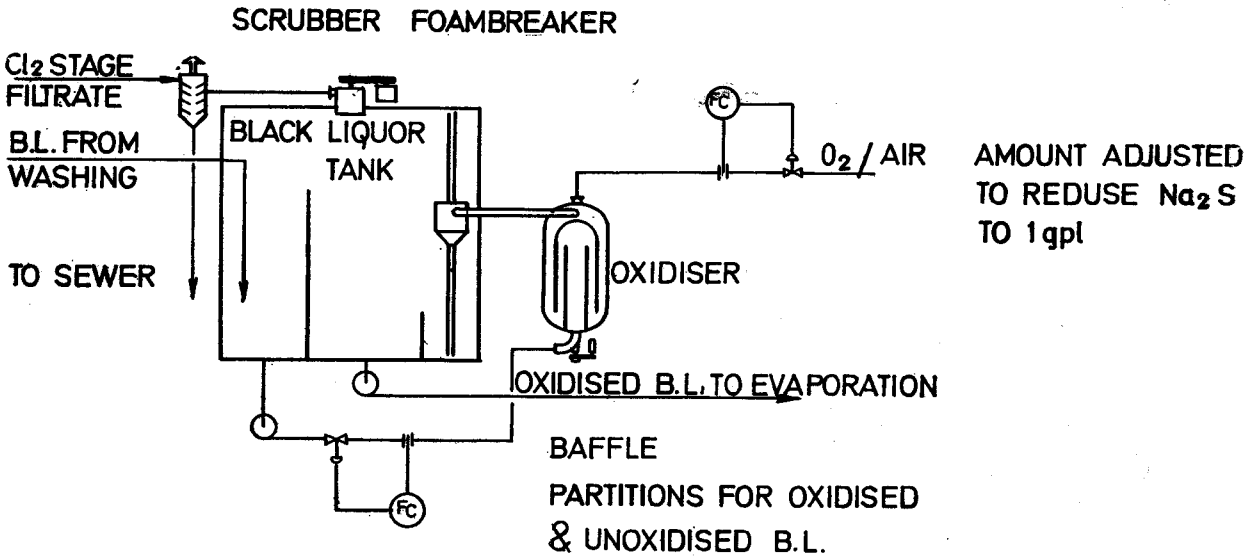



**Fig. 9 Black liquor oxidation and odour abatement system.**

A section of the screen is shown in **fig. 8.**

**BLEACHING**

High yield pulp bleaching is still in the emerging stage except in case of ground wood and newsprint grade furnish. Available systems are: Hydrosulphite (Dithionite) and peroxide. Lignin preserving bleaching is being studied to make possible high brightness high yield pulp.

Often it pays to take proper care in storage of fibrous raw-material in the initial stage. Jute sticks, hard woods, begasse if stored under proper and favourable conditions do not lose brightness drastically. Conventional bleaching of bi-sulphite and neutral sulphite pulp is common with few process complications. All developing countries suffer an unbalance of chlorine to Alkali while reverse is the case for developed countries. Above factor should prompt use of more chlorine (as for bleaching NSSC pulp). Price of chlorine however is very high. Rupees 900/t (Sweden Rs. 600/t). Oxygen bleaching now being studied everywhere may be a saver considering low price of oxygen. However use of catalyst etc. may make the process financially unattractive. No commercial data are yet available.

**RECOVERY SECTION**

Price of Sodium Sulphate in India is 3-4 times the price in Sweden.

This factor should logically prompt need of higher recovery efficiency. While in practice the case is just the reverse. Typical loss in modern Indian mill is shown in **Table IV.**

This should be compared to the sulphate loss in modern mills in Sweden varying between 45 — 50 kg sulphate/ton pulp.

The Indian pulp mills use a term called recovery efficiency which is the amount of Sodium sent back to digester house to amount received with black liquor. In order to have a complete picture of the mill losses it is convenient to report all loss as make up i.e. sulphate per ton pulp. But to shortage of sulphate many mills use caustic soda as make up chemical plus whatever sulphate they can procure. This results in low sulphidity.

One way of coming over this problem is to use Gypsum as a source of sulphur. Gypsum can be used directly in the furnace for reduction. This has been done commercially. Use of Gypsum may also reduce lime requirement.

Oxidation of black liquor is a simple and inexpensive method of increasing sulfidity, reducing veaporator corrosion, reducing toxicity of the mixed condensate, reducing lime requirement, etc. at a cost of 2-3 per cent of calorific value. A system of pressurized black liquor oxidation is shown in **fig. 9.**

Bamboo liquor is rather problematic in so far as it contains a

**TABLE Vd. Analysis of Bamboo and Pine Kraft Filter Cake.**

| Filter cake | Bamboo | Pine |
|---|---|---|
| Moisture | 61,9% | — |
| $CaCo_3$ | 8,6% | 92,0% |
| CaO | 1.2% | 1.0% |
| $Na_2O$ | 1,2% | 1,5% |
| Silica | 12,0% | 5,0% |
| Mixed oxides | | — |

lot of silica. Analysis of typical bamboo black liquor, green liquor, white liquor and filter cake is shown in table **Va, Vb, Vc & Vd** with comparative data on pine sulphate liquor.

The problems which are encountered in recovery section are:

1. Scale formation in evaporator tubes
2. Recovery boiler deposits
3. Slow clarification of white liquor
4. High lime consumption.
5. Lime mud cannot be reburnt (due to ring formation in lime kiln)

The silica build-up in a bamboo pulp mill and its equilibrium is shown in **fig. 10.**

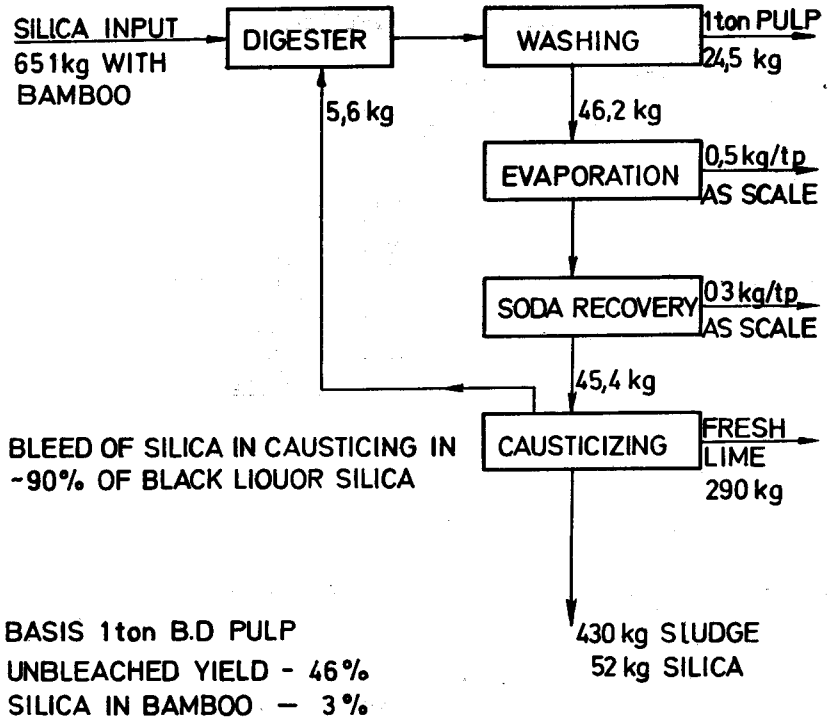
Various solutions have been proposed for removal of silica from black liquor. The principle of the methods are:

1. Liming — reaction of black liquor and burnt lime
2. Reaction with gypsum and black liquor
3. Carbon dioxide treatment of black liquor

Effforts to remove silica from lime mud for making lime mud suitable for reburning has been made lately due to high cost of burnt lime. Pilot trials with froth flotation and separation of calcium silicate crystals by wet classification are being pursued. There is up to now no commercial installation although pilot plants have been installed for removal of silica from black liquor by $CO_2$ treatment.

It appears that if any development in pulp and paper industries is to be achieved, the maximum amount of effort should be spent in this section of the mill.

Equipment cost of recovery line of a pulp mill in relation to fibre line and utility line is shown in **fig. 11.**




SILICA CYCLE IN A BAMBOO SULPHATE PULP MILL

FIG. 10

**Fig. 10 Silica cycle in a bamboo sulphate Pulp Mill.**

## PAPER MAKING

As this conference is mainly devoted to pulping, general aspects of paper making is being commented upon briefly:

We have evaluated pulp and paper strength properties from a number of Indian Mills. It is generally found that the Indian paper makers do an excellent job in obtaining a square paper. This term can be defined as the ratio of MD/CD nearing unity. This is good under certain specific condition and service requirement. This however does not do justice to the stock. This may explain the poor tensile property of Indian Kraft paper. Tear should be high as this is a major factor depending upon cell wall thickness unless severe maltreatment is done. Pressing and drying under tension which makes fibre orientation in line of applied force thus allowing the fibres to be an active strength bearing member of the sheet.

With increased jet velocity to wire velocity, freezing of formation by application of wet suction boxes immediately after forming board, controlled draw between drying section, tight dryer part felts, it should be possible to improve the strength property of the final paper. More attention to each aspect of paper making is important if improvement in the final paper is desired.

KMW's laboratory at Karlstad provides us with an unique tool to measure and study under exact operating condition these aspects of paper making. The P&P industry in India are welcome to utilise those facilities to the ex-

tent our workload permits. We are considering to undertake systematic study of the remaining problems of short fibred paper. They are press picking tendency and fuzz in dryer section.

**CLOSING REMARK**

KMW, although a machine manufacturer, has been connected with the problems of Indian pulp and paper industry for a long period and have made considerably study of the problems. Process development is not our function but we take active part in suggesting process improvement. We are interested in all phases of pulp and paper making. Suppliers like us, who cover a wide range of equipment from debarking of wood to finished paper, often are in an advantageous position to be able to isolate the cause and analyse the effects of many problems.

It may be argued that in the interest of the country at large than any particular sector of industry, the present tendency of the industry to rely heavily on imported equipment is very short-sighted. Use of foreign spares means a continuous drain in country's foreign exchange resources.

As a matter of fact under the same pretext paper consumer can ask for government support for import of better or more functional and durable paper than produced by the industry. While paper making industry wants to have sophisticated machine the paper consumer also wants sophisticated paper. There is a general tendency in India to rely heavily on government. We have not changed much over the last 100 years. Ramchandra once wrote

"There is no rain Government's fault
There is too much rain Government's fault
There is no Sun Government's fault
There is too much Sun Government's fault"

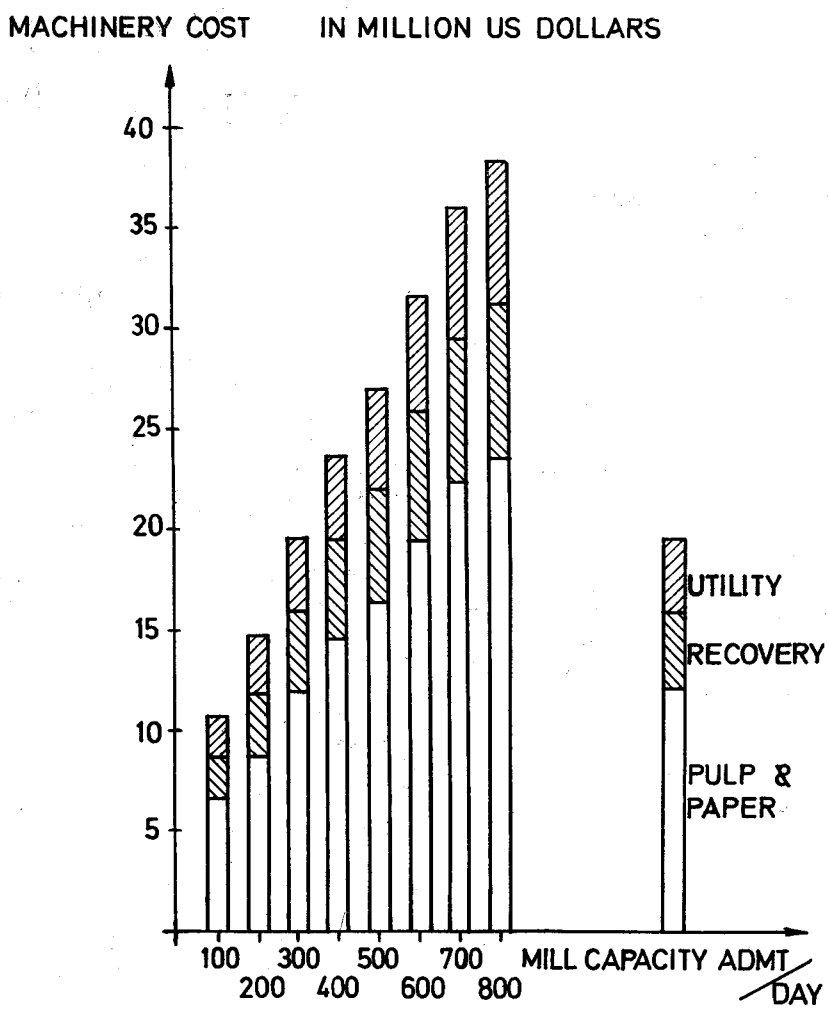



**Fig. 11 Equipment cost of Recovery lime in relation to fiber line and utility line.**

It is a challenge to the management of the industry to tackle the problems.

This seminar is directed to study of high yield pulping. One can raise the question why? Because our resources are limited i.e. both with respect to capital (more so foreign exchange wise) and raw material. Therefore, one way of achieving high yield in the broad sense of the term would be to conserve all these above inputs. To realise this one must increase overall efficiency of the plant. Less waste in the forest, less dust, less sand, less strain on transport, less chemicals, less labour, less capital and less machinery.

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I name nobody lest I forget somebody. I wish to thank the management of KMW for allowing me to present this paper.

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