Prospects of Hard-Wood for Pulp & Paper Industry in India

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With the dwindling reserves of softwood and ever increasing demands for pulp, paper and paper products in the world, the pulp and paper Industry had to search for alternative sources of pulping raw materials. The existence of an imbalance between softwood and hardwood reserves and rising prices of softwood drew the attention of the Industry to the utilisation of hardwood. Hardwood occupies more than half of the world's commercial forests and most of the species grew much quicker than softwood. Until quite recently, softwood supplies were adequate to meet all pulp demands of the world, and naturally all the technical developments had been directed in pulping of softwood. It was only during and after the Second World War, when the supply of softwood was very much restricted and the demands for paper and paper products rose, concerted efforts were made to use hardwood for pulping purposes. Since then a great stride has been made in utilisation of hardwood in the Industry. Sustained efforts, researches and development of better techniques and new equipments have made it possible to use hardwood short fibres economically for making pulp for all grades of paper both coarse and fine. This development has special significance to underdeveloped equatorial and tropical countries where only hardwood forests are abundant and economically exploitable.

Recently the writer had an opportunity to spend slightly more than a year in studying the processes of pulp and paper manufacturing in Australia under Colombo Plan. In that country they are using Eucalypt, a very short fibred hardwood as the chief raw material for pulp and paper products. In the following pages a short description of the different processes adopted in some of the primier pulp and paper mills of Australia is given to show that hardwood is a good raw material for paper pulp. At the beginning they faced with some difficulties in its utilisation, but a lot of original work has been done since then on this particular species and now they are utilising it to good account. As we ourselves in India are faced with acute shortage of raw materials for further expansion of our Paper Industry we must take recourse to the utilisation of our hardwood which are unsuitable for timber to meet the ever increasing demands of our huge population for pulp, paper and paper products. We may take advantage of the research work done in Australia for utilisation of hardwood and develop our own methods to suit our conditions and raw materials. Further it is reported that Australian varieties of Eucalypt is growing very well in Indian climate and we may have adequate supply of the same for our Paper Industry in near future.

In Australia eucalypt grows abundantly in coastal areas and in Tasmania, where rainfall is 50"—60" a year. There are four main species of Eucalypt grown. (1) Eucalyptus Regnans (Swamp Gum) (2) Eucalyptus Globulus (Blue Gum), (3) Eucalyptus gignatiea (Gum top stringy bark) (4) Eucalyptus obliqua (Stringy bark). It has been found that Eucalyptus regnans is a better pulping raw materials than the other varieties mentioned above. The strength properties of three of them when beaten to the same freeness is given below :—

* Paper Maker—Star Paper Mills Ltd.

Wood Species	*Freeness C.S.F.*	*Burst Factor*	*Tear Factor*	*Concora Crush*
Eucalyptus Regnans	200	62	105	100
Eucalyptus Obliqua	200	57	102	95
Eucalyptus Globulus	200	48	102	95

It is reported that in some of the best growing forests, pulp logs upto 150,000 super feet (Hoppus measure) can be obtained from an acre. The Eucalypt is an indigenous species of Australia and in old forests trees 200 to 300 years old are found. Unfortunately such old trees are neither very suitable for timber purposes nor for pulpwood as they have got dead rotten cores, but to start the regrowth of new forests these old forests should first be cleared and used. Therefore planned method of plantation has been started after cutting down these old trees and using the sapwood portion only for timber purposes utilising the chipped offcuts of timber mill for pulping. The thinnings from regrowth and planted forests are taken out after 15 to 20 years and are used for pulping only as thin and young trees are not suitable for timber purposes. Since most of the Australian Paper Mills have integrated timber, pulp and paper mills, they prefer to use Eucalypt trees of 50 to 60 years age to get maximum timber and also good pulp wood.

The main difficulty in the use of vast tropical hardwood forests is the heterogeneity and multiplicity of species found in those forests, which can only be utilised economically if a suitable process is developed to get a uniform treatment on all varieties when cooked together. Another difficulty which we must face and solve is to find suitable equipments for the mechanical handling and chipping of our all types, shapes and sizes of hardwood available in Indian forests. World's main pulp and paper producing countries who are also the suppliers of our pulp and paper machineries, do not generally have such types of logs and so have not developed any equipment to suit to our raw materials. Therefore we must take initiative to develop these equipments to meet the demands of our pulp and paper industry. Only very recently a chipper called spiral chipper has been introduced and is said to be proving quite efficient on this type of heterogeneous logs. But in Australia, as Eucalypt species predominates in their forests and are of even shapes and sizes, they had no difficulty on that account. At the beginning Soda Process only seemed suitable for hardwood pulping but now nearly all other processes used for pulping of softwood are also being used equally well for hardwood pulping though. In Australia only alkaline cooking processes are adopted. Below a brief description of the pulping methods and the use of the same for manufacture of different qualities of paper, millwise, is being given.

Maryvale Mills (A.P.M. Ltd.):

It is claimed here that they pulped Eucalypt successfully by Kraft Process for the first time on commercial scale in the year 1929. The debarking of Eucalypt logs supplies for this mill is done manually in the bush, as it is easier when the logs are green. They have got two separate lines of digesters; one digesting Eucalypt chips and the other pine chips obtained from their pine plantations. The Eucalypt chips are further digested into two different types of pulp. (1) High Yield Kraft Pulp, (2) Bleachable Quality pulp.

The cooking conditions for high yield pulp are—11% active alkali as Na_2O on O.D. Chips, 22% sulphidity and 3:1 liquid to solid ratio, $1\frac{1}{4}$ hrs. to raise the temp. of 170°C and 100 p.s.i maintained at temperature and pressure for $\frac{1}{2}$ hr, then relieved to 80 p.s.i. and then blown. The cooking cycle is $2\frac{1}{4}$ hrs. and a pulp of 22 to 23 P. No. is obtained, with an yield of 66 to 68 percent.

The cooking conditions for bleachable pulp are 15—16%. Active Alkali as Na_2O on O.D. chips, 22-25% sulphidity liquid to solid ratio 3:1, 2 hrs. to reach 170°C temp. and 100 p.s.i. pressure.

Maintained for ½ hr. at temperature and pressure, then relieved to 80 p.s.i. and blown. The cooking cycle is 3 hrs. and a pulp of 14 to 15 p. No. is obtained. This pulp after elaborate washing and screening is bleached to a brightness of 82° G.E. by 3 stages of bleaching by chlorination, Alkali extraction and hypochlorite treatment. The bleach consumption is 6 to 7%. The high yield kraft pulp is used for the manufacture of sack kraft, corrugating meddi, liner board and M.G. Kraft and wrappings on high speed wide fourdrinier and M.G. Machines. A certain percent of long fibred pine pulp is admixed to impart the strength properties to the various qualities of paper.

They have got two machines in this mill, one is a M.F. Fourdrinier and the other one is a combined M.G. Fourdrinier. The M.F. machine manufactures mainly corrugating medium, sack kraft and liner board at a speed of more than 1200 ft./min. In case of corrugating medium and liner board they use 100% eucalypt short fibres and when manufacturing sack kraft use 50% pine pulp and 50% eucalypt pulp. They claim better bursting strength in sack kraft and better crush in corrugating medium. M.G. Machine runs at a speedof 800 to 1000 ft./min. manufacturing M.G. Kraft Papers from 35 g.s.m. to 80 g.s.m. The only trouble they faced was press picking and they have eliminated it by use of self skinner top roll in 1st press position.

Associated Pulp and Paper Mills Ltd., Tasmania :

This is the premier Australian Mill producing a large range of fine papers ranging from writings, printings, banks, bonds, cartridges, duplicatings, greaseproof, glassine and vegetable parchments from Eucalypt pulp using a certain percentage of long fibre furnish. This is an integrated timber, pulp and paper mill. Logs as big as 35′ long and 6′ dia. are received at the mill site by road and rail transport. The logs are debarked by a high pressure hydraulic jet developing a pressure of 1300 lbs./sq. in consuming 600 g.p.m. and powered by a 900 H.P. motor. The good sapwood portion is cut and sent to timber mill and the offcuts, Hard wood and rejects are chipped for pulp mill. The cooking process adopted in this mill is Soda Process and the reasons given for this are a comparatively softer pulp than obtained through Kraft Process and objections of city people to strong odour of kraft process. The pulping is done in two Kamyr continuous digesters and washing of the pulp is done inside the digester by counter-flow system (developed by the technical section of the same mill). The counter-current washing system has been extremely efficient and successful and consequently their washingfilters are now lying idle. Continuous digestion gives a better and more uniform control on pulp properties and economy in chemicals and steam. The resultant pulp is bleached to a brightness of 85° G.E. by 3 stages-bleaching system.

In this mill they have 9 paper machines running at speeds from 400 ft./min. to 1300 ft./min. and manufacturing the wide varieties of paper mentioned earlier. Two of their machines are quite modern incorporating all latest developments. They manufacture most of their qualities from 100% Eucalypt pulp.

Port Huon Paper Mills (A.P.M. Ltd.), Tasmania :

This mill is using Neutral Sulphite Semi-chemicals (N.S.S.C.) process for pulping of Eucalypt. It is reported that semi-chemical pulping is better suited to hardwood, rather than softwood. The primary objective in developing the semi-chemical pulping process was to obtain higher yields of pulp, than possible by conventional chemical pulping methods. In this mill they store their chips in open storage piles, standing on a well drained but unsealed storage area. They claim chip storage in open is less prone to the attack of fungus and microorganisms and less fire hazardous. They cook their chips in a Kamyr continuous digester with special arrangement for vapour phase cooking. The cooking conditions are about 10% Na_2SO_3 with a buffer of nearly 3% Sodium Carbonate. Direct steaming is utilised,

which both blows the chips into the digester and also maintains digester temperature. 340°F temperature and 125 lbs./sq. m. pressure is maintained in the digester. Retention time in digester is nearly 2½ hrs. Yield is 72 to 75% unbleached pulp. They resort to hot refining of the treated chips direct from blow-tank, through a 800 H.P. Sprout Waldron disc refiner. Refining to a freeness of 700 C.S.F. requires 5 H.P. per ton per day. As all their pulp is exported to Sydney by ship, for use in a sister concern, they have developed a novel method of transforming the pulp into pellet form so that it can be bulk handled just like foodgrains. This process is an improvement on the bulk handling of pulp in crumbs form as the pellets have higher density and satisfactory loads can be obtained with existing equipment and transportation by sea can be economically operated. This pulp is used mainly for the manufacture of corrugating fluting medium paper. The crush test of this paper is said to be much better than that made from softwood.

Australian Newsprint Mills Ltd., Boyer, Tasmania:

During war years when the supply of newsprint was very much restricted, the Australia Government and the newsprint publishers of Australia wanted to utilise their indigenous Eucalypt wood for the manufacture of newsprint. But they had very discouraging advice and unfavourable opinion from chemists of leading newsprint manufacturing countries as to the suitability of Eucalypt for the manufacture of newsprint. Unperturbed they persevered and at last succeeded in manufacturing newsprint of comparable quality economically from Eucalypt. The mill which started with a modest production of 27,000 tons a year has now expanded to 90,000 tons a year capacity and further expansion plans are in hand.

To compensate for the very short and weak groundwood fibres of Eucalypt, they are mixing stronger cold soda semi-mechanical pulp from Eucalypt. Though the cost of cold soda pulp is slightly higher than the groundwood pulp, still they have been able to utilise their indigenous forests for their need. They are supplying more than 1/3 of Australia's Newsprint requirement.

In the beginning they faced the following difficulties in pulping and utilisation of Eucalypt for newsprint.

1. The fibre length of Eucalypt being very short produced nearly 45% fines and also consuming more power in groundwood mill.
2. The presence of tannic acid in Eucalypt was found contaminating the equipments and fouling the colour of the pulp.
3. The colour of the Eucalypt was observed to be giving a dull shade to the paper.

These difficulties were overcome as follows:

1. It was noticed that the grinding of Eucalypt under alkaline conditions (at 9-0 pH) produced longer and stronger fibres, and at the same time power consumption was considerably reduced. It is reported a decrease of 20% in the unit energy consumption for a pulp of constant strength properties or a considerable increase in strength properties at an unchanged unit energy consumption is achieved. Alkaline grinding also gives freer pulp with less fines and helps in speeding up the paper machine, though the yield is slightly less, 90 to 95%.

2. To counteract the discoloration of pulp from tannic acid all the process system contacting the pulp were stainless steel lined.

3. The alkaline grinding helped in dissolving most of the coloured constituent of Eucalypt which was thoroughly washed off the pulp. Groundwood pulp was treated with zinc hydrosulphite to attain a brightness of 60-65° G.E. Though the brightening effect of both sodium and zinc hydrosulphites are the same, yet zinc hydrosulphite is preferred as in this case the permanence of brightness is more stable and also zinc hydrosulphite works as a preservative of the pulp.

The usual furnish tor their newsprint is 60% Eucalypt groundwood, 22% Eucalypt cold soda pulp and 18% imported pine Kraft pulp. All the pulps are bleached to a brightness of 65° G.E. separately. They have got two newsprint machines, one running at 1150 ft./min. and other at 1250 ft./min. without any trouble. On the whole they make newsprint with better formation and opacity than they are making in New Zealand from their softwood pine pulp.

A comparative strength properties of newsprint manufactured from softwood in Finland, and from hardwood at Boyer is given below:

Properties	*Finish newsprint*	*A.N.M. newsprint*
Basis weight in lbs/Ream (24″×36″—500 sheets)	29.3	30.3
O. D. %	89.9	90.9
Caliper in mm/8 sheets	28.34	31.76
Bulk	1.89	2.05
Burst lbs./sq. in.	9.0	9.0
Burst factor	13.2	12.8
Tear (mean) in gms.	25.5	25.7
Tear factor (mean)	53.3	52.2
Tensile Kg./cm. (mean)	1.30	1.33
Breaking length (mean) in metres	2825	2725
Smoothness	94	68
Ash content	0.20	0.31
Opacity	85.2	95.9

Cold Soda Process

Eucalypt is being pulped by this process both by A.P.P.M. Ltd., and A.N.M. Ltd. The advantages of this process are high yield, reasonable power consumption, negligible chemical consumption and a strong good fibre. In case of unbleached pulp the yield is as high as 85 to 88%, because most of the lignin and hemicellulose are retained in the pulp. In case of fully bleached pulp the yield is as high as 60% in comparison to the yield of 45-50% from fully cooked chemical softwood pulp. This is due to the selective elimination of lignin and by bleaching without affecting the hemicellulose contents of the pulp. Cold soda process consists of treating the chips with alkali (10% strength) under normal conditions of temperature and pressure to dissolve the colouring matters and to soften the chips. Then the chips are broken up by a series of disc refiners. The caustic used is reused a number of times with a little fresh caustic soda till its colour becomes fairly dark.

General Characteristics of Hardwood Fibre:

The approximate constituents of softwoods and hardwoods are:

Comparison of softwoods and hardwoods

Properties	*Soft wood*	*Hard wood*
Major type of fibres	Tracheids	Wood fibres, vessels.
Length of fibres in mm	2.5—5.0	0.6—2.0 Vessels are shorter but very wide.
Lignin content %	25—32	17—26
Cellulose (cross & Bevan) %	55—61	58—64
Pentosans %	8—13	18—25
Density of green wood lbs./c.ft.	21—26	22—35

(From Casey Vol. 1)

From above table it can be seen that the hardwood fibres are very short and naturally need a certain percent of long fibres in the furnish to provide required strength properties in the paper. But once the requisite quantity of long fibre is available, better

and stronger papers can be manufactured from hardwood than from softwood long fibres alone. The higher density, lower lignin content and higher cellulose content of hardwood has got its advantages and of course disadvantages too over softwood. It helps in increasing the field of pulp per cubic feet of wood as well as per unit weight of wood. Therefore the storage area capacity, the digester capacity and the yield per digester increases appreciably. It is reported that per ton of pulp they are using 1.8 C units of pine wood and 1.22 C units of Eucalypt wood. (1 C unit=150 C.ft.) But due to higher density the water-transportation by floating the logs to the mill site is not possible and there is also a slight increase in the chipper power consumption.

One of the most difficult problems faced in the utilisation of hardwood for fine grade papers earlier was the difficulty in bleaching the pulp. However with the development of multi-stage bleaching, where only selective action on lignin and colouring matters are effected has made it possible to obtain very white pulp economically without damaging the fibres.

Beating of Hardwood:

Hardwood fibres have thick cell walls with narrow lumen, which normally should need more beating to develop certain degree of hydration as compared to softwood pulp. But rarely it is the case. The presence of vessels, and higher pentosan contents in hardwood, make it wet quicker than softwoods when cooked by the same processes. The pulp which contains a higher proportion of hemicellulosic material, wets up more quickly than the pulp which has been drastically cooked to eliminate most of the hemicelluloses. In case of semi-chemical pulping where most of the pentosans and hemicelluloses are retained, the pulp wets well. The beating qualities of the hardwood will of course depend on the species and the pulping process used as is the case with other raw materials as well.

Hardwood fibres being very short need special equipment for beating treatment. Hollander beaters and conical refiners are not very effective for the treatment of hardwood pulp. In case of beaters it is assumed that as the beater roll revolves, fibres collect and are stapled on the edge of each fly-bar and are carried or dragged over the opposing bars on the bed plate when they are being cut or brushed out, thus effecting beating. Due to very short fibres of hardwood such a mat is not formed on the fly bar edge and hydration is only effected by the frictional movement of the fibres. Actually this was experienced by the paper makers of Fairfield Mills (A.P.M. Ltd.), when they switched over from the use of imported long fibre to their own Eucalypt short fibre. As at that time they had conventional hollander beaters only for their beating equipment they tried to beat their Eucalypt pulp in the same beaters and found that there was very little development of hydration even after 8 hrs. beating. It has been found that disc refiners are superior to beaters and conical refiners, both in quality of pulp produced and power consumption for refining hardwood pulp. These units can be worked with a wide range of stock consistencies and can be very accurately manipulated to perform any desired action on the fibre. Though they are more expensive in initial cost, they show some savings in higher horsepower range.

As mentioned earlier a certain percent of long fibre furnish is necessary alongwith short fibre to obtain necessary strength properties in the paper, and also both the fibres cannot be beaten together to develop desired properties in each fibre, they should be beaten in two separate systems and should be mixed afterwards through proportioners, in the machine chest. This will give the paper maker flexibility and finer adjustment of refiners to achieve maximum benefits from both pulps. While blending both the fibres generally the ratio of long fibre is adjusted according to the tearing strength of the paper required and short fibre furnish adjusted according to the bursting strength necessary in the paper.

In respect of dyes, chemicals, loading and additives, the hardwood fibres behave very akin to softwood fibres.

Behaviour of Hardwood Pulp on Machines:

Hardwood pulp gives an evenly formed, bulky, smooth and opaque sheet. Since these are the properties essential for good printing qualities of paper, naturally now the mixed furnish of hardwood and softwood pulps are favoured to only softwood pulp. In some parts of America, where softwood trees are growing well, they are trying to replace some of their softwood forests with hardwood forests, so that they can have supply of hardwood pulp to incorporate the above properties in their paper.

As the short fibres of hardwood give a very good formation with all interstices of paper filled up with fines, the dimensional stability of paper is better and also the retention of fines, chemicals and loadings are higher.

When hardwood short fibres are not well beaten then the fines and fluffs are picked up by press rolls, by drying cylinders and are also wet felts tend to clog up. But by proper adjustment of ratio of long fibre to short fibre, and adequate beating this trouble can be overcome.

To import the required wet strength to the paper to stand draw tension of the wet section of the paper machine a certain percent of long fibre in the paper manufactured from hardwood is essential.

The wet web of short fibre being very weak and fragile does not stand the tension of the draw on the couch. But the elimination of all draws till the web is well dried and consolidated by the introduction of suction pick-up, twinver press and such other equipments make it quite feasible to run these short fibre pulp on high speed machines.

As per capita consumption of paper and paper products is regarded as an index of the economic and cultural standard of a nation, every nation should be self-sufficient in this prime product. India in order to meet the needs of its vast population should strive to preserve, plant and utilise all the available fibrous raw-materials, for the manufacture of pulp and paper. The progress and also superiority of hardwood for semi-chemical pulping over softwood and its high yield holds a great potential and promise for the countries where the raw-material cost is very high. Over and above the utilisation of Eucalypt for groundwood pulp is of great importance to India where we can only have hardwood for the newsprint manufacture in view of high cost and non-availability of coniferous wood. Though a great stride has been made in pulping hardwood and its usefulness has been well established abroad still much is to be done in India. It is hoped that more and more of hardwood will be utilised in time to time after exploring the various possibilities of plantation, pulping and paper manufacture.