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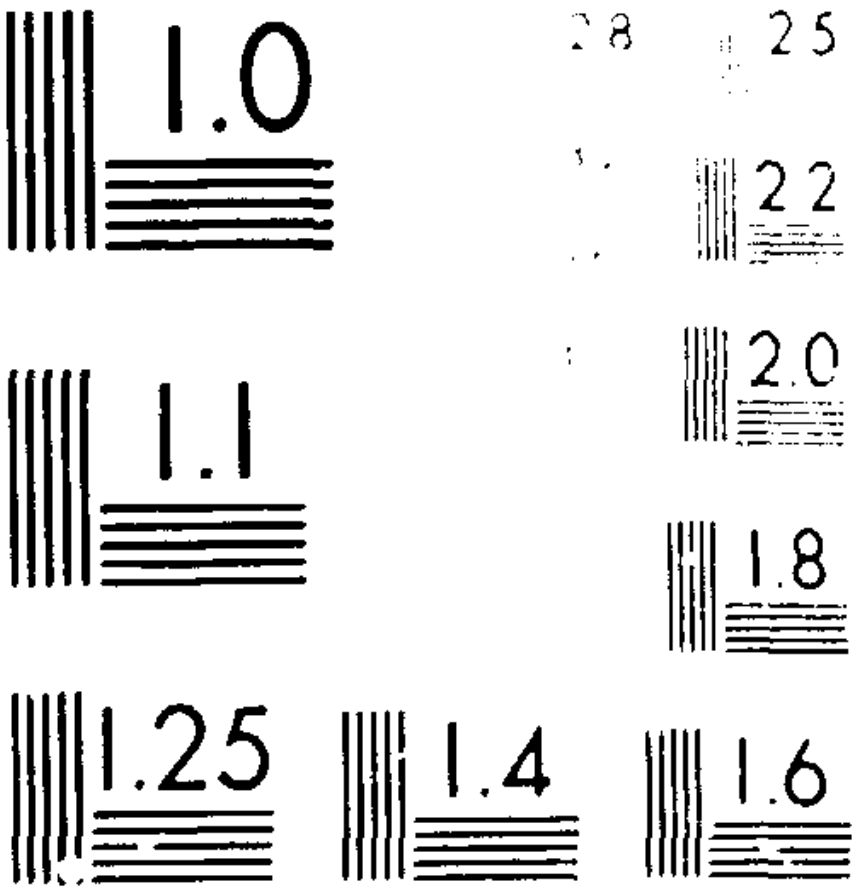
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THE PRESENT INDUSTRIAL EXPERIENCE IN USING TROPICAL HARDWOODS IN INDIA *

by

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ABSTRACT

Conventional raw material position and the necessity to use Indian tropical hardwoods by the Indian pulp and paper industry is explained. A brief description of relative availability of pulp wood in the Central Indian forests is given through its composition and standing volume.

Difficulties encountered in various sections of the mills while increasing proportion of hardwoods in admixture with bamboo are discussed qualitatively. Examples of various parameters practised during digestion and strength properties of pulps are presented. Existing practices in bleach plant and stock preparation are described. Strength, optical and printing properties of some typical commercial papers containing 30-40% mixed hardwoods are given. Position of machinery for processing the mixed hardwoods is described.

INTRODUCTION

The development of Indian Pulp and Paper Industry differs from that of most of the countries in the fact that main paper making fibres have been derived from nonwood sources. Though the paper industry was started in this country using rags, jute cuttings, waste papers, sabai grass (Eulaliopsis binata) and imported pulp, the investigations conducted by Raitt (1) around 1925 established the possibilities of using bamboo for pulp production by a modified fractional sulphate (kraft) pulping process. It was also established by Hardine (2) that acceptable pulps can be produced by an adoption of sulphite process based on which one mill was set up in West Bengal. The industry started facing shortages of bamboo as early as in the 1950s. The attention was directed to the utilisation of tropical hardwoods as an alternative raw material for paper making. Selected tropical hardwoods are used in mixture with bamboo since the 1960s in increasing proportions. It is expected that further expansion of the Indian Pulp and Paper Industry will be based mainly on mixed tropical hardwoods.

The present installed capacity of the industry in the country is about 1.6 million tonnes, and the production is at the level of 1.1 million tonnes. It is expected that in a few years the demand for the paper will reach 3 million tonnes. Therefore, the industry has been on an intensive search for finding out suitable raw material for expanding the existing mills and planning the new mills. Though a number of small mills have been set up based on agricultural residues and waste paper in the recent past, production at national level can only be geared up by installing large paper mills of capacity of 250-400 tonnes per day. As the largest source available at present is the tropical hardwoods, the industry is exploring the possibility of utilising them in the best way for meeting this need.

FORESTRY ASPECT

The use of hardwoods has been on a selective basis since 1960s but this segregation will not work out economically, as Forestry department would be intrested in clear-felling the forest to raise new plantations with-fast growing species. Therefore, the industry is making an approach of using the forestry material in the proportion as available in the forest by eliminating a few unsuitable species which are very difficult for pulping and to use most of them as existing. Presently the industry is making use of hardwoods to the extent of 30%, the remaining 70% being bamboo. For increasing the proportion to higher level than 30%, the difficulties encountered mainly in chemical recovery section and paper machine are to be got over. However, one of the recent mills set up in the country claims to have gone to the extent of using 50% hardwoods in the furnish as they have designed and planned the mill to take care of these difficulties arising in recovery and paper machine sections.

The use of tropical hardwoods is made more difficult by the large number of species existing in forests, more than 150, with divergent characteristics in density and colour which adversely affect the final pulps. Most of the hardwoods are of medium or high density and are of dark colour with a large proportion of heartwood. Some of the species and the percentage occurrence are listed in Table 1. The most important hardwood forest area is the semi-dry deciduous forest in Central India. The Forest types and the composition are given in Figure 1. The stocking density of this forest is low (60 to 120 Cu. Mtrs. per hectare). Figure 2 gives the relative standing volume of different types. Due to the large number of species present in this forest, the occurrence figures, even for the most frequent species, do not cross 15%. Some of the species (Tectona grandis, Terminalia tomentosa, etc.) are timber species, and only lops and tops are available for the paper industry.

Apart from these species, which are useful for the timber, the species for conventional fire wood are also allotted for public use before pulp wood can be extracted from the forest. The proportion of pulp wood classified by Forestry is given in Table 2. There are extensive plantations of Eucalyptus tereticornis, mainly in Northern India, Karnataka and Tamilnadu regions. Eucalyptus grandis is the main species in Kerala State which is to be used in admixture with Eucalyptus tereticornis for one of the newsprint mills being set up by the Government of India.

Soft woods grow only in the mountain regions in Northern India and the access to these areas is difficult. Nature of the terrain and erosion problems that would accompany large-scale logging place limits on supply of timber from these regions. In the North Eastern Himalayas (North Bengal) there are some plantations of Cryptomeria japonica and Cupressus cashmeriana.

PRESENT MILL PRACTICE

In most of the paper mills bamboo and hardwoods are pulped in a mixture. Some mills are pulping hardwoods and bamboo separately but majority of the mills are bleaching hardwoods with bamboo. Some of the species like Terminalia tomentosa, Xylia xylocarpa, Diospyros melanoxylon and Acacia catechu are removed from the mixture to avoid the troubles in process.

As the trunk and branches of most of the tropical hardwoods are not straight, no suitable debarking machine is available, either in India or abroad. Hence debarking of hardwoods is done manually. The general experience of some mills using hardwoods is that quite a few pulpable species are chipped more easily than bamboo. It is also observed that wood logs retain better moisture which helps in chipping. However, the dense varieties pose problems in chipping and result in frequent knife changes. Size classification and densities of hardwood chip samples collected from a mill are given in Table 3.

Presently, sulphate pulping is the only process used in India for pulping mixed hardwoods. The chemical charge required is slightly higher than for bamboo falling in the range of 18.0% as Na_2O. Though the sulphidity is maintained around 20%, the pulp yield is usually lower for hardwoods due to high extractive contents and high average lignin content. Typical cooking conditions and digestion cycle followed by one of the mills are given in Table 4. The bleachable grade pulps which are produced in the country are cooked to a Kappa number of 25 to 30 in the unbleached state. Jauhari and Bhargava (3) have observed that it is more difficult to blow hardwood pulps than bamboo or pine clean from the digester. Therefore reblows become necessary thereby consuming more steam per tonne of pulp. Due to dense nature of these woods, the penetration of the cooking liquor in the chips seems to be difficult under normal kraft process. Therefore, the mills face a difficult problem of handling much larger quantities of rejects at Knotter Screen than with bamboo. The increased proportional use of hardwoods in the mills has necessitated expansion of Knotter Screen to cope with the larger quantities of rejects. Comparative yields of hardwoods and bamboo pulps are given in Table 5.

In Brown Stock washing, hardwood pulps are observed to be requiring more washing area when compared with bamboo. The difficulties in washing are attributed to the lower porosity of the pulp mat due to more quantities of fines and short fibres in hardwood pulps. To maintain the same chemical loss at the washing stage, it is observed that more water has to be used and hence the black liquor is getting diluted, increasing the load on evaporator section.

No serious problems have been reported in screening and centricleaning sections when proper equipment is chosen depending upon the fibre length of these woods.

Bleachable grade pulps are pulped to a Kappa number of 25 to 30. The Kappa number of pulps from some hardwood species is considerably high and such species are generally excluded to avoid high chlorine consumption. Some problems do arise when hardwood pulp is mixed with bamboo pulp in the bleaching stage, as the chlorine demand of these pulps is different. The bamboo pulp requires high chlorine charge at same Kappa number. The pulp blends are bleached with a simple CEHH sequence using 6% of chlorine in the chlorination stage and 3 to 4% active chlorine in Calcium hypochlorite stages. The final brightness of pulps is in the range of 70 to 75%.

Serious problems are encountered in evaporation of black liquors from the hardwoods due to precipitation during evaporation, surge in viscosity and scaling of evaporator tubes. The nature and severity of type of problems encountered differ from mill to mill depending upon the species pulped and the equipment used. The common complaint is of sudden surge in viscosity and tube jamming. Therefore, most of the mills have resorted to using forced circulation evaporators in the final stage. New mills are installing almost a battery of forced circulation evaporators. To surmount the problem of increased viscosity and precipitation with concentration of black liquor solids, a few mills are firing the black liquors in smelters at an intermediate concentration of 35 to 40%. However, the chemical recovery is adversely affected and no heat recovery takes place in these kinds of units.

The strength properties of unbleached mixed hardwood pulps are on an intermediate level. All strength properties including the tear strength develop considerably in the early stage of refining generally upto 350 CSF. In the later stage tensile strength develops only slightly and tear strength decreases.

The development of strength properties with freeness of unbleached mixed hardwood pulps of 2 mills is presented in Figure 3. Similar data for indigenous and imported eucalypt pulps are given in Figure 4. Bleaching slightly impairs the strength properties but the decrease in tear strength is less marked than in the case of bamboo pulp. The opacity of hardwood pulps is high. The low wet web strength of hardwood pulps causes difficulties on the paper machine. This leads to frequent web breaks when furnishes with high hardwood contents are used. The development of strength properties for indigenous and imported bleached eucalypt pulps is presented in Figure 5.

Most of the Indian mills are using conical refiners in stock preparation section for refining the pulp. Recently, some new mills have set up disc refiners and wide angle refiners. In most of the cases the mixed hardwood pulps and bamboo pulps are refined together. On the paper machine press-picking and fluffing on the dryers pose problems. Old mills which had to switch over to utilising hardwoods to the extent of 30% in view of shortage of bamboo have faced problems in paper machine section due to the existing open draws. The transfer of sheets seems to be difficult whenever there are open draws. Therefore, while setting up the recent mills the organisations have taken care to have closed draws and mechanical pick-up and transfer of sheets to have minimum number of web breaks on the machine. The properties of the commercial paper made with this raw material are satisfactory and acceptable. Some of the physical properties of different grades of commercial paper containing about 30% mixed hardwood pulp and 70% bamboo pulp are given in Table 6. Another serious problem is the low surface strength of papers containing hardwood pulps due to the presence of large vessels elements in some hardwoods. The vessels are picked up by the printing press leaving white spots in the print and littering the press. Printing properties of offset quality papers are given in Table 7.

The vessel-picking ratio of Indian hardwood pulp is much higher than that of temperate zone hardwood or Eucalyptus pulps. Application of beater additives and surface-sizing of papers are used by some mills to overcome these problems. The second alternative, though expensive and sophisticated, gives much better results.

Due to difficulties in black liquor evaporation and in operation of the paper machine the use of mixed Indian hardwoods in combination with bamboo is at present limited to 30-40%. It is expected, however, that the hardwood percentage will be increased to 50 to 70%. This requires intensified research and most probably more sophisticated equipment and technology, for example, evaporation with forced circulation, or a paper machine with pick-up equipment.

NEWSPRINT

A serious problem in India as in other tropical countries is production of newsprint due to the scarcity of soft woods. There is only one newsprint mill in India at present. This mill is producing newsprint from a blend of bleached bamboo pulp, hardwood mechanical pulp and hardwood cold soda chemimechanical pulp. The hardwood used is Boswellia serrata. The same species is used for making ground wood pulp and cold soda chemimechanical pulp. The data presented in Table 8 gives an idea of the quality of pulps that could be produced from this raw material. Due to the dark colour of the raw material the newsprint is not of satisfactory quality. Two modern newsprint mills are expected to be commissioned soon based on cold soda chemimechanical pulps from Eucalyptus grandis and Eucalyptus tereticornis. In the case of the first mill, 30% of reed pulp from Ochlandra travancorica will be used in the furnish. The mill is being equipped with modern equipment including twin wire machines (Voith).

MACHINERY

Most of the mill equipment presently used in various sections for processing hardwoods is manufactured in India. Rotary as well as stationary digesters of various capacities in the range of 20 to 100 Cu. Mtrs. and blow tanks are fabricated by machinery manufacturers in India. Also, equipment used in screening and centricleaning sections is locally manufactured. In addition to the agitators for the towers, brown stock and bleach plant washers of good performance in various sizes are fabricated in these workshops. All stock preparation equipment, including wide angle-refiners, is fabricated in India, either independently or in collaboration with foreign firms. Excepting the more sophisticated parts of modern paper machines, which are imported, most of the indigenous components are used in manufacturing even larger machines with modern instrumentation. Mills intending to increase the proportion of hardwoods are able to get indigenously fabricated forced-circulation evaporators with satisfactory performance. Further, successful attempts have been made in fabricating small-size roasters and smelters to suit the processing of hardwood black liquor to be fired at intermediate concentration of 35-40% solids. Causticizers and clarifiers are fabricated locally at very competitive rates.

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TABLE - 1

BASTAR FOREST

PERCENTAGE OCCURRENCE OF SPECIES

1.	Cleistanthus collinus	6.0%	U
2.	Shorea robusta	11.6%	U
3.	Terminalia tomentosa	13.2%	R
4.	Pterocarpus marsupium	4.8%	U
5.	Diospyros melanoxylon	8.1%	R
6.	Anogeissus latifolia	11.0%	U
7.	Lagerstroemia parviflora	3.0%	U
8.	Boswellia serrata	3.0%	U
9.	Lannea grandis)	2.2%	U
10.	Garuga pinnata)		
11.	Xylia xylocarpa	2.9%	R
12.	Sizygium communii	1.5%	U
13.	Schrebera Swietenioides	1.1%	U
14.	Schleichera trijuga	1.3%	
15.	Madhuca latifolia	4.1%	U
16.	Terminalia chebula	1.5%	
17.	Buchanania lanzan	1.8%	
18.	Adina cordifolia & Stephegyne perviflora	1.6%	U
	Total	78.7%	

U - Used in mills
R - Rejected by mills.

Source :- M.P.A.V.N. Ltd.
BHOPAL

TABLE - 2

VOLUME OF WOOD BY FOREST TYPES

(a) Sal & Miscellaneous Sal Types

Special size	:	4.80 cu. mt. per hectare	4%
Plywood material	:	2.40 cu. mt. per hectare	2%
Saw Milling material	:	26.40 cu. mt. per hectare	22%
Sal Poles	:	18.00 cu. mt. per hectare	15%
Pulp wood	:	68.40 cu. mt. per hectare	57%
Total		120.00 cu. mt. per hectare	100%

(b) Teak & Miscellaneous Type

Plywood material	:	2.40 cu. mt. per hectare	3%
Sal Milling material	:	13.60 cu. mt. per hectare	17%
Teak Poles	:	3.20 cu. mt. per hectare	4%
Pulp wood	:	60.00 cu. mt. per hectare	76%
Total		80.00 cu. mt. per hectare	100%

Source :- M.P.A.V.N. Ltd.
BHOPAL

TABLE - 3

MIXED HARDWOODS FROM CENTRAL INDIA

(1) Chip size Classification

Screen opening (mm)	Retention (%)
+25.4	15.9
25.4 - 19.0	12.6
19.0 - 17.7	16.9
17.7 - 6.35	40.0
- 6.35	14.6

(2) Density

Basic density of chips Kg/m^3 = 640

Bulk density of chips Kg/m^3 = 257

TABLE - 4

COOKING CONDITIONS AND DIGESTION CYCLE FOR HARDWOODS

Active alkali	16.0%
Sulphidity	22.0%
Chip to liquor ratio	1:2.8
Loading time	90 min.
Time for addition of chemicals	15 min.
Time to raise temperature to 130°C	45 min.
Time at 130°C	30 min.
Time to raise temperature to 167°C	60 min.
Time at 167°C	60 min.
Blow time	15 min.

TABLE - 5

COMPARATIVE YIELDS OF UNBLEACHED PULPS

	Hardwoods	Bamboo
Active alkali	16.0%	15%
Sulphidity	22%	22%
Chip to liquor ratio	1:2.8	1:2.8
Yield	40-42%	46-47%
Permanganate No.	18-19	17.5
Steam consumption at about 12 Kg/cm^2	1.95 tonnes/tonne of pulp	1.7 tonnes/tonne of pulp

TABLE - 6

PHYSICAL STRENGTH AND OPTICAL PROPERTIES OF OFFSET QUALITY PAPERS

		Maplitho	Offset
1.	Furnish	60% Bamboo +40% Mixed hardwoods	70% Bamboo +30% Mixed hardwoods
2.	Grammage (g/m^2)	64.5	76.9
3.	Apparent density (g/cm^3)	0.84	0.69
4.	Tensile index (N.m/g)		
	MD/CD	33.5/19.5	38.5/24.0
	Stretch (%) MD/CD	1.8/3.8	1.8/3.9
5.	Burst index ($kPa.m^2/g$)	1.05	1.20
6.	Tear index ($m.N.m^2/g$)		
	MD/CD	4.45/4.65	6.00/6.30
7.	Fold. Kohler Molin Log. MD/CD	1.00/0.90	1.08/0.90
8.	% Ash	16.1	8.7
9.	Brightness (% Elrepho)	72.1	70.5
10.	Opacity (%)	90.2	95.5
11.	Sp. Scatt. Coeff. (m^2/kg)	37.3	40.8

TABLE - 7

PRINTING PROPERTIES OF OFFSET QUALITY PAPERS

		Maplitho	Offset
1.	Furnish	60% Bamboo +40% Mixed hardwoods	70% Bamboo +30% Mixed hardwoods
2.	Grammage (g/m^2)	64.5	76.9
3.	V.V.P. Value (Poise m/s)		
	MD Top/wire	719/747	669/783
	CD Top/wire	482/604	600/692
4.	Vessel pick No. (Per 2000 mm^2) Top/wire	20/13	11/6
5.	Print penetration (Macbeth Density)	0.16	0.08
6.	Print Surf roughness (μm) Top/wire	3.60/4.35	5.45/6.6

TABLE - 8

STRENGTH PROPERTIES OF UNBLEACHED PULPS

(A) GROUND WOOD (BOSWELLIA SERRATA)

Canadian standard freeness	ml (CSF)	-	305
Tensile index	N m/g	-	3.0
Tear index	mNm^2/g	-	0.8
Brightness (Elrepho)	%	-	30.0
Bulk	cm^3/gm	-	2.86

(B) COLD SODA (BOSWELLIA SERRATA)

Canadian standard freeness	ml (CSF)	-	260
Tensile index	N m/g	-	10.0
Tear index	mNm^2/g	-	1.4
TEA index(Wet web strength)	mNm/g	-	2.32
Bulk	cm^3/gm	-	2.34

FIG.-1

FOREST TYPES OF BASTAR

(PERCENTAGE OF OCCURENCE)

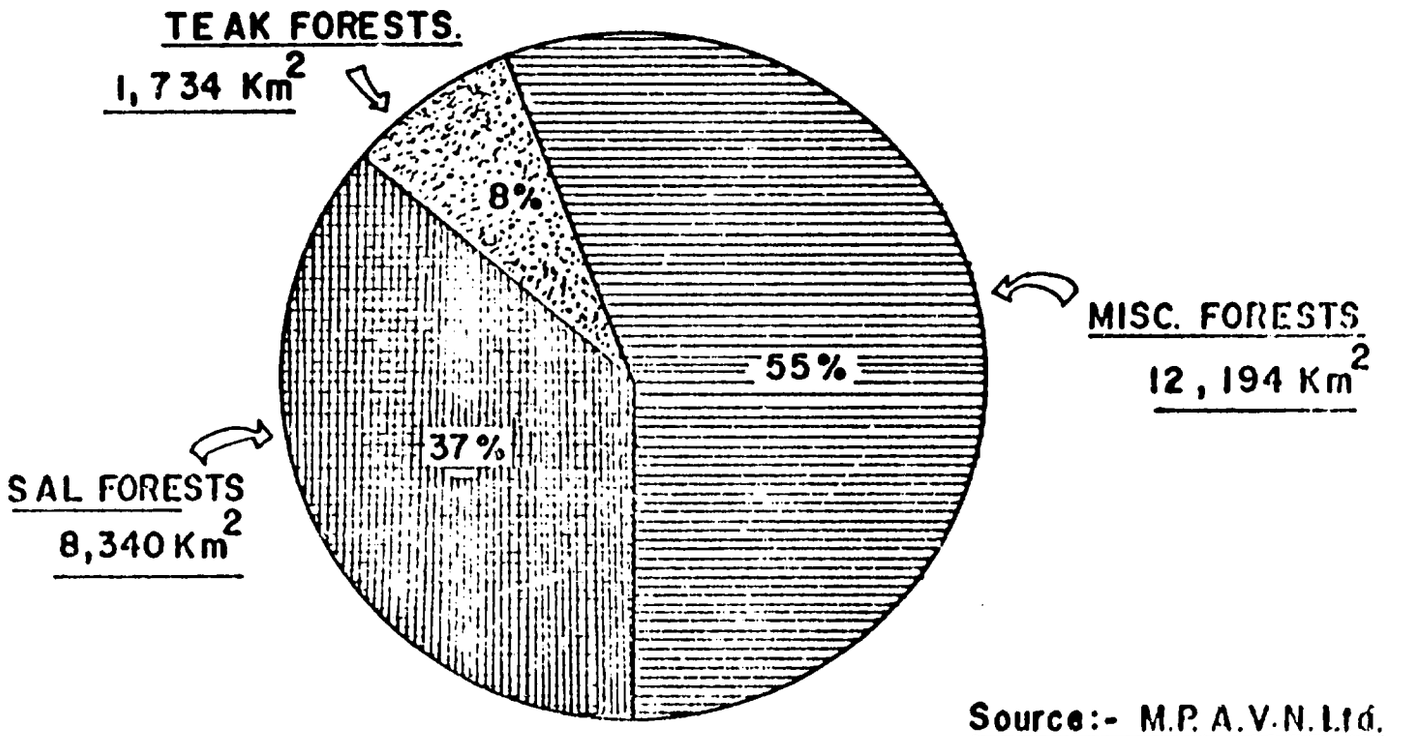

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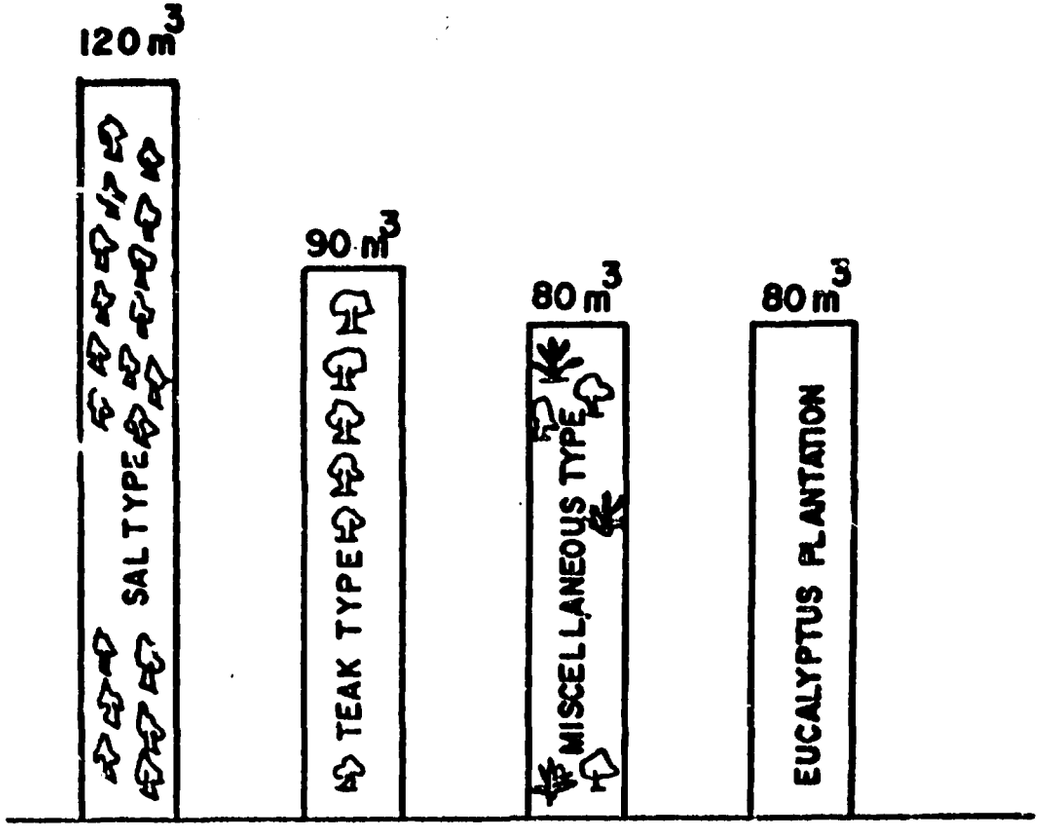
FIG.- 2

BASTAR FORESTS

(AVERAGE STANDING VOLUME PER HECTARE)



Source :- M.P.A.V.N. Ltd.
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Fig-3

INDIGENOUS UNBLEACHED MIXED HARDWOOD PULPS.

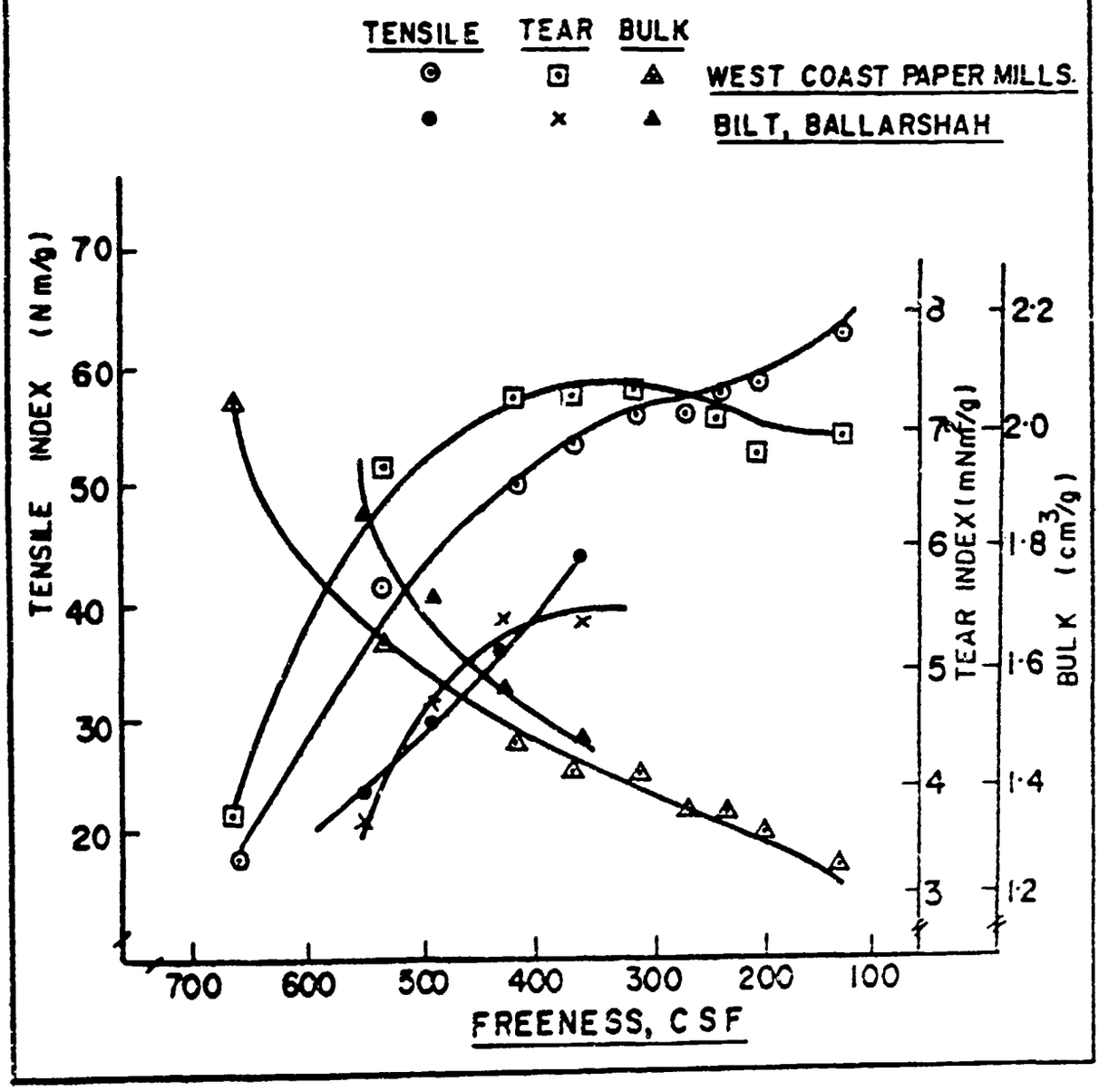

Fig.- 4.

INDIGENOUS AND IMPORTED EUCALYPT PULPS.

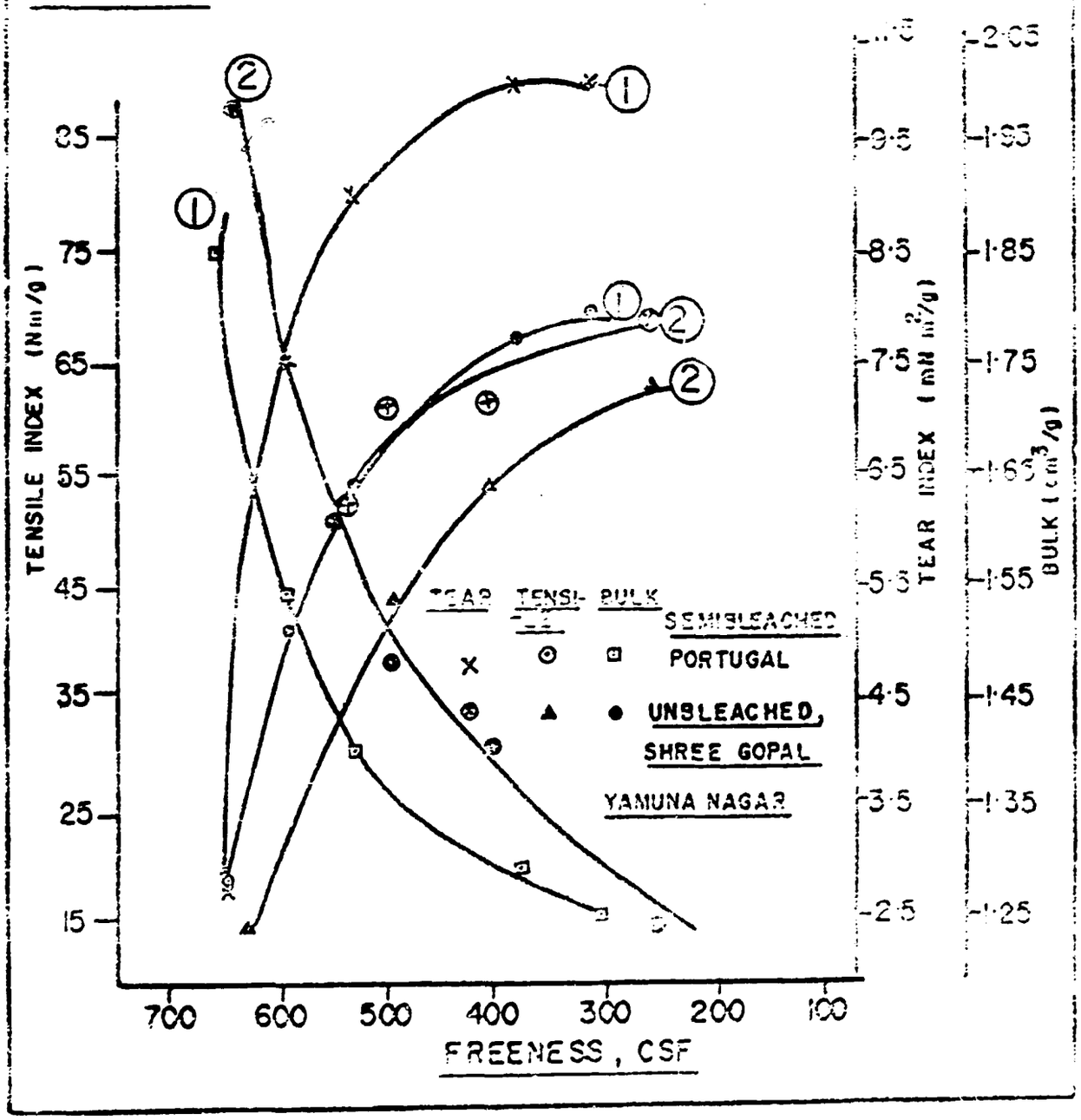

Fig. - 5

INDIGENOUS AND IMPORTED EUCALYPT PULPS.