Manufacture of Newsprint from Bagasse Chemical Pulp and Chemi-Mechanical Eucalyptus Pulp

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Demand and supply of Newsprint.

1. Paper and newsprint are essential in any modern civilised society Their per capita consumption is one of the indicators for ascertaining the economic development of a country. As against a per capita consumption of 90 kg to 225 kgs. in the West European countries and USA, the per capita consumption of paper and paperproducts in India was estimated to be only 2.0 kgs. per annum. The per capita consumption of newsprint in India was only about 0.50 kg. as against the world figure of 5 6 kgs. It should, therefore, be the endeavour of the Government of India, as well as the industry, to increase the levels of indigenous production of paper and newsprint to match the demand which is bound to expand in relation to the increases in per capita income, literacy and population.

2. However, paper and newsprint industry is a highly capital intensive one with long gestation period. Traditional raw materials like bamboo are getting sca.ce and the costs of other inputs have escalated tremendously during the post devaluation period. The initial investments involved are, therefore, large and the expected rate of return moderate. Private capital is, therefore, not attracted to this industry in any significant manner, except in a few selected varieties of paper where attractive return on capital is available. For newsprint, the private entrepreneurs have not been forthcoming.

3. It is, therefore, visualised that investments in the Public Sector for setting up newsprint mills, based on alternative raw materials like bagasse, will go a long way to achieve the twin objectives of utilisation of non-conventional raw materials like bagasse, an agricultural residue, on a large scale and also to increase the indigenous production of newsprint as well as other varieties of paper in the country.

Demand Projections : Paper

4. The annual installed capacity for paper, paperboards and other varieties of paper increased from 2.12 lakh tonnes in 1956 to 23.49 lakh tonnes in 1984 (as on 1.1.85) and the corresponding annual production are 1.93 lakh tonnes and 13.61 lakh tonnes respectively.

   As on 1st January 1985 there were 249 units with an installed capacity of 23.49 lakh tonnes. Out of these 23 big units with 20,000 tonnes per annum or more, each have a total installed capacity of 11.7 lakh tonnes per annum and 226 medium and small units have an installed capacity of 11.8 lakh tonnes per annum. Production of writing and printing paper constitutes app.oximately 55% of the total paper board output.

5. HPC was advised by the Development Council for paper, pulp and allied industries to make detailed survey to forecast demand for paper and paperboard. As per the survey report, the demand for paper and paperboard is as follows,

Year	Aggregate demand for paper & paper board
1983	14 09 lakh tonnes
1985	14.82 lakh tonnes
1990	19.09 lakh tonnes
1995	24.59 lakh tonnes
2000	31.68 lakh tonnes

The projected demand of paper and paperboard by the end of 7th Plan is 19.09 lakh tonnes per annum.

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With the existing installed capacity of 23.49 lakh tonnes per annum and a capacity utilisation of 80%, it is possible to achieve a production of 18.7 lakh tonnes. Further two paper projects of HPC at Nowgong and Cachar with a total installed capacity of 2 lakh tonnes per annum shall materialise in the 7th Plan thus pushing up the production by another 1.6 lakh tonnes per annum and the production is likely to be far more than demand at the end of the 7th Plan. The future trend for these varieties of paper would be by expansion and modernisation of existing mills and by way of giving incentives to small units.

Newsprint : Newsprint units in the country.

6. There are at present four indigenous manufacturers in the country as indicated below :

   (i) National Newsprint & Paper Mills Ltd., Nepanagar, Madhya Pradesh (A Central Govt. Enterprise)–Installed capacity 75,000 MT per annum.

   (ii) Hindustan Newsprint Litd., Kerala (A Subsidiary of Hindustan Paper Corporation Ltd.) —Installed capacity 80,000 MT per annum.

   (iii) Mysore Paper Mills Ltd, Karnataka (A State Govt. Undertaking)—Installed capacity 75,000 MT per annum.

   (iv) Tamilnadu Newsprint & Paper Ltd. (A State Joint Sector Undertaking) —Installed capacity 50,000 MT per annum. (The unit has gone into production recently.

7. The production of newsprint in the Country during the last few years and the extent of imports is given below :

Year	Indigenous production (MT)	Imports (MT)
1979–80	47,385	3,12,800
1980–81	51,283	3,18,023
1981–82	64,306	3,00,526
1982–83	1,18,510	2,00,012
1983–84	1,76,338	2,14,000
1984–85	2,00,547	2,12,650

The Ministry of Information and Broadcasting has estimated the demand for newsprint during 1985–86 as 4.80 lakh tonnes. The indigenous production of newsprint during 1985–86 is expected to be of the order of 2.50 lakh tonnes. The balance quantity of 2.30 lakh tonnes would have to be imported.

8. Regionwise pattern of apparent consumption of newsprint at present is as under :

North	:	98,000 MT
South	:	112,000 MT
West	:	94,500 MT
East	:	45,500 MT

9. Regionwise installed capacity is as under :

West	(Nepa Mills)	:	75,000 MT
South	MPM	:	75,000 MT
	HNL	:	80,000 MT
	TNPL	:	50,000 MT

It would be seen that while the installed capacity of newsprint mills more than meets the present demand of the Southern region, there are no newsprint mills in the Northern and Eastern regions of the Country and the demand of this region is met partly from imported newsprint. Movement of newsprint from the Southern mills involves not only the additional burden on the material transport system but also additional freight cost.

10. The Working Group on Paper and Paperboard and Newsprint Industry for the Seventh Plan, set up by the Planning Commission, has indicated the newsprint consumption for selected year as given below :

Forecast on Newsprint consumption for selected years

Year	Forecast (lakh tonnes)
1985–86	3.90
1986–87	4.13
1987–88	4.39
1988–89	4.65
1989–90	4.94
1994–95	6.62
1999–2000	8.91

11. The Working Group on Paper and Paperboard & Newsprint Industry for the Seventh Plan set up by the Planning Commission has indicated that the total installed capacity of newsprint required in selected years is likely to be as follows :

Required installed capacity of newsprint

Year	Consumption	Installed capacity required at 80% capacity utilisation	85% capacity utilisation	90% capacity utilisation
1985-86	3 90	4.88	4.59	4.33
1986-87	4 13	5.16	4.86	4.59
1987-88	4 39	5.49	5.16	4 88
1988-89	4.65	5.81	5.47	5.17
1989-90	4 94	6.18	5.18	5.49
1994-95	6.62	8.28	7.79	7.36
1999-2000	8.91	11.14	10.48	9.90

Based on the information available and capacity utilisation in newsprint industry in India, it is safe to assume a maximum of 80% capacity utilisation. On this basis the total required installed capacity to produce 4.94 lakh tonnes of newsprint in 1989-90 is 6.18 lakh tonnes. If we have to meet this challenge and bridge the gap between demand and supply, it is necessary to create an additional capacity of 3.38 lakh tonnes per annum.

RAW MATERIALS

The forest raw material like bamboo and hardwood still form the main source, contributing almost 70% of the total production of paper and paperboard in the country.

The National Commission on Agriculture 1976, Part IX has projected the requirement of wood and bamboo for 1980 and 2000 (Table A and B) as given below :

TABLE—A

REQUIREMENT OF WOOD

(Figures in lakh)

Category	Requirement in 1980		Requirement in 2000		Additional requirement	
	M^3	% of total	M^3	% of total	M^3	% increase
Fuel wood	1886.00	87.5	2250.00	78	364	19
Timber	227.20	10.5	467.55	16	240	106
Pulpwood	41.75	2.0	176.95	6	135	323
	2154.95	100 0	2894.50	100	739	34%

TABLE—B

REQUIREMENT OF BAMBOO

(Figures in lakhs)

Category	Requirement in 1980		Requirement in 2000		Additional requirement	
	Tonnes	% of total	Tonnes	% of total	Tonnes	% increase
Non-industrial requirement	21 09	49	34 59	49	13.50	64
Pulp & Paper industry	21.65	51	35.46	51	13.81	64
	42.74	100	70.05	100	27.31	64%

According to the analysis, the present consumption by pulp and paper industry is only 2% of the total wood and 51% of the total bamboo production of the country. This picture is not going to change substantially by 2000 AD as 6% wood and 51% of bamboo are expected to be consumed by then. However, even if we consider that bamboo and wood as consumed in 1980 will continue to be available in perpetuity, the national shortfall by 2000 AD is likely to be 639 lakh M^3 of wood and 26 lakh tonnes of bamboo. Considering the domestic needs as first charge on the forestry resources, this additional requirement must be generated by the turn of this century, so that all sectors may safisfy their respective needs.

With the population expected to increase to 9456 lakh by 2000 AD compared to the present 6810 lakhs, it seems impossible that the natural forest will be capable of meeting this projected shortfall by the turn of this century. It, therefore, calls for radical measures on urgent basis to tackle this broblem.

While substantial investment is necessary to raise forest plantations for supply of raw materials to bamboo/wood based mills, no separate investment is necessary for augmenting availability of agricutural residues, as this is the automatic by-product of rice, wheat and sugarcane crops, the production of which has to be stepped up to keep pace with the growth of population if the Country is to remain self-sufficient on the food front. Moreover, consumption of straw will supplement the income of the farmers.

In view of the growing scarcity of bamboo/wood and abundant availability of agricultural residues, it is a considered view that units based on agro residues and non-conventional raw materials will play a vital role in building up indigenous paper making capacity by 2000 AD.

The major agricultural residues and non-conventional raw materials which are being used in paper making are :

1. Rice and wheat straw
2. Bagasse
3. Cotton linters, jute, hessian cuttings and rags.
4. Waste paper

The availability of wheat straw and rice straw during 1981–82 was 47.3 and 35.9 million tonnes respectively. The Planning Commission has estimated that during the Sixth Five Year Plan, the annual growth rate of production of principal foodgrains should be 4 to 5 percent.

On the basis of the above projection of 5 per cent growth rate per annum in the production of foodgrains, it is estimated that by the year 2000 AD, the availability of wheat straw and rice straw would be 113 8 and 86 4 million tonnes respectively.

The use of agricultural residues like paddy and wheat straw, etc. for the manufacture of paper has its own limitations. Nearly all the straw produced in the country is used by farmers as fodder for cattles, etc. Because of bulk collection, transport and storage create problems, rags, cotton, waste paper, jute and jute sticks, etc. can also be used for paper manufacture but only to a limited extent.

India, with a chain of sugar mills, crushes a large amount of sugarcane and thus produces vast quantity of sugar-cane bagasse, which at present goes to sugar mill boilers as fuel, excepting very little quantity going to paper and board manufacturers. India is fortunate enough to have vast resources of coal deposits and the total steam requirements of the sugar mills could be met by burning coal instead of bagasse in their boilers. If suitable measure are taken to supply coal to sugar mills and provide them boilers for raising steam, they would be able to spare the entire bagasse to paper mills In this way an industrial waste could be converted into an economic product and thereby increase the wealth of the Nation.

The availability of bagasse during 1980–81 was 15.5 million tonnes and on the basis of the Planning Commission's projection, this figure is estimated to rise to 39 2 million tonnes by the year 2000 AD. It is felt that the available bagasse would be sufficient to cater to the needs of a paper making capacity to the tune of 0 75 million to 1 million tonnes by the turn of the century.

HPC envisages a more economical proposal for manufacture of Newsprint based primarily on bagasse with a furnish of 60% chemical pulp from Bagasse & 40% Chemi-Mechanical Pulp from Eucalyptus.

SELECTION OF TECHNOLOGY FOR PULPING OF BAGASSE

Newsprint is conventionally made from a mixture of soft wood mechanical pulp and soft-wood chemical pulp. The percentage of mechanical pulp varies from 85 to 95% and the percentage of the reinforcing long fiber chemical pulp, either unbleached sulphite, or semi-bleached kraft, varies from 5% to 15%.

Until the early fifties of this century, the only method of production of newsprint pulp by mechanical means was the stone ground wood pulping, a pulping process invented more than a century and a half ago. Due to steadily increasing consumption of newsprint in the world, as well as due to limited availability of long fibre soft-wood, considerable developments have taken place during the last two decades in the production and process technology for manufacture of mechanical pulp not only from soft-wood but also from other raw materials. With the introduction of new technology, raw materials which were earlier found unsuitable for conventional mechanical pulping methods, can now be used for producing acceptable newspaper grade pulp. Utilization of resin rich pine wood in Newzealand, increasing use of indigenous short fibre hard-wood in Japan and Australia and more recently in India, are cases in point.

Requirements of newsprint

Simplicity of the grinding process, higher yield and good printability have made stone-ground-wood pulp still the most widely used mechanical pulp for the manufacture of newsprint from long fibre soft-wood. Obviously, many of the properties which are traditionally associated with newsprint are the natural outcome of the technological processes developed for the treatment of soft-wood.

While reviewing the properties of newsprint from short fibre raw materials, it would be necessary to distinguish between those newsprint properties which are incidental to traditional methods of production from soft-wood.

At the FAO Conference in Tokyo in 1960, which became the starting decade for utilisation of short fibre raw materials, the importance of this distinction was recognised and newsprint was defined as follows :

> "The term is used without any restriction as to the fibre composition, thickness, ash content, degree of sizing or finish. It would thus apply to any kind of paper capable of being run through modern printing process and are producing an acceptable sheet of printed newspaper at a reasonable cost".

The subject was further elaborated at the FAO Conference in Cairo in 1965 when a working group which considered these specifications particularly for newsprint from bagasse. It was recognised that from the stand point of newsprint user, the most important requirements of good newsprint sheet are :

1) High wet web strength necessary for
   —Good paper machine runnability i.e. less breaks on paper machine.
2) High dry web strength necessary for
   —Good runnability on high speed printing press.
3) Good fibre bonding necessary
   —To prevent linting on printing press
4) High opacity at an optimum brightness level necessary for
   —Good readability
5) Low cost of production.

Available pulping technology of manufacturing mechanical pulp from bagasse :

Bagasse consists broadly of fibres and pith. The pith content is approximately 30% of the total bone dry material. The pith is composed of large portions of Parenchyma cells and of the vessel segments. The fibre includes true fibres plus a portion of other components. The dimensions of bagasse fibres vary from 1.2 to 1.8 mm in length and about 0.02 mm in width. The length of the bagasse fibre is similar to that of hard-wood, but the fibres are thinner, have a higher length to width ratio and therefore, a higher flexibility. Due to this property, bagasse has low tear strength but a good tensile strength.

Although the potential of bagasse for newsprint production had long been recognised, early attempts to produce bagasse mechanical pulp using the conventional technology adopted for wood have been unsuccessful, resulting in producing a newsprint quality which is either technically sub-standard or whose cost was so high as to be uncompetitive.

Mechanical pulping of bagasse by means of refiner pulping or through thermomechanical pulping have not been commercially successful. Early attempts were made by CROWN-Zellerbach in West Germany to make refiner mechanical pulp using sodium sulphite at a temperature of 90° to 95° C. Later on Bauer Brothers Co. and Sprout Waldron Co. in USA also attempted to produce mechanical pulp by means of refiners and the

pulp produced had low strength and low brightness in the unbleached stage. Further trials had also been conducted by KMW in Sweden using the thermo-mechanical process. Defibrator of Sweden also experimented to produce bagasse mechanical pulp by thermo-mechanical pulping method, However, the results were not very successful.

Attempt have been made to make mechanical pulp via the chemi-mechanical pulping process by various organisations. Simon-Cusi process is based on mild cooking with caustic soda at 130°C for 10 minutes. Similar processes have also been developed by CC-Bauer of USA, Enso-Gutzeit of Finland, Hitachi-Zosen of Japan as well as Beloit-Walmsley Ltd. of UK. In the above process, depithed bagasse is impregnated with low percentage of chemicals and then refined either at atmospheric pressure or above it. It is called CTMP (Chemi-thermo mechanical pulp) when refining is carried out above atmospheric pressure. Irrespective of the refining process, the refined pulp must be bleached with hydrogen peroxide or dithionite to get suitable brightness. In all the above processes no recovery of chemicals is generally envisaged as the alkali requirement for impregnation is very low and the resulting spent liquor contains lower concentration of solids.

More recently, Beloit of USA have developed mechanical pulping of bagasse by a combination of thermo-mechanical pulping and chemi-mechanical pulping processes.

In this process the depithed bagasse is divided into two portions. One portion is subjected to pressure refining in the Beloit-Jones Refiners and then fractionated by means of screens and centricleaners. The longer and coarser fibre fraction in the reject outlet of the screens is sent to a chemi-mechanical pulping street for further treatment, while the fines fraction from the TMP street is refined subsequently in disc refiners at atmospheric pressure. This is followed by bleaching. Pulp yield would be of the order of 61% on depithed bagasse. It is doubtful whether such high yield bagasse pulp would be suitable for mechanical pulp furnish for manufacture of newsprint at a reasonable cost. Beloit claim that the overall yield of pulp of both the streets of TMP and semi-chemical bagasse pulping would be about 61% on depithed bagasse.

Another Company PEADCO, a wholly owned subsidiary of W.R. GRACE of U.S.A. has also developed a process, in which newsprint furnish is made from a mixture of bagasse thermo-mechanical pulp, bagasse semi-chemical pulp and long fibre kraft pulp. The thermo-mechanical pulping street consists of a continuous pressurised tube type digester in which the depithed bagasse is submitted to a short period prehydrolysis at 4 bar pressure at 140°C and then the water impregnated fibre is defibrated in the pressurised refiner. The pulp is then blown to the second tube digester to complete the pulping. The pulp is then bleached with hydrogen peroxide and then washed and cleaned.

The semi-chemical pulping street consists of a tube type digester in which the depithed bagasse is cooked at higher temperature. (165°C—175°C) with either caustic soda or alkaline sulphite. The mill in Indonesia (LETJER IV, in probolinggo, East Java) owned by P.T. KERTAS LETJES has been based on the PEADCO process with a fibre furnish as follow :

—55% bagasse thermo-mechanical pulp.

—35% bagasse straw semi-chemical pulp.

—10% long fibre semi-bleach kraft pulp.

It is not known whether this process has been successful and the Indonesian mill is having serious problem of manufacturing newsprint.

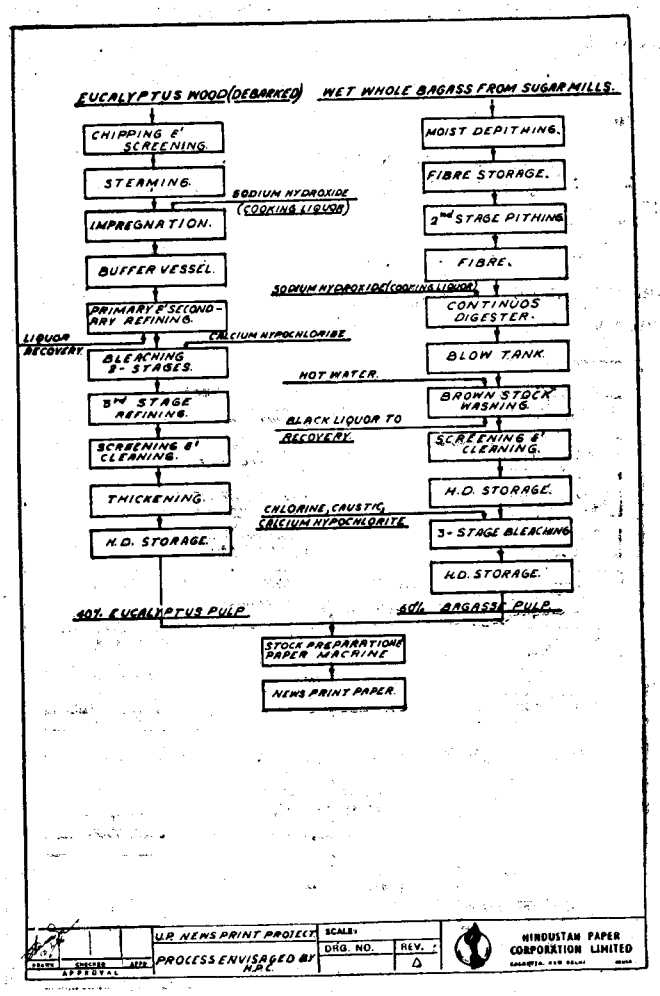
Paper del Tucumen, Argentina manufactures Newsprint by the Voith's modified Cusi process using a furnish of 83–85% chemical bagasse pulp and 17–15% of imported softwood mechanical pulp, Clay to the extent of 4—6% is used to improve the opacity. In this process, depithed bagasse is cooked with 10—12% active alkali as Sodium Hydroxide at a temperature of about 170°C and the pulp has a kappa number of 20—35. The pulp after screening/cleaning is bleached in three stages CEH sequence to obtain semi-bleached pulp. This pulp is mixed with the imported softwood mechanical pulp for newsprint furnish.

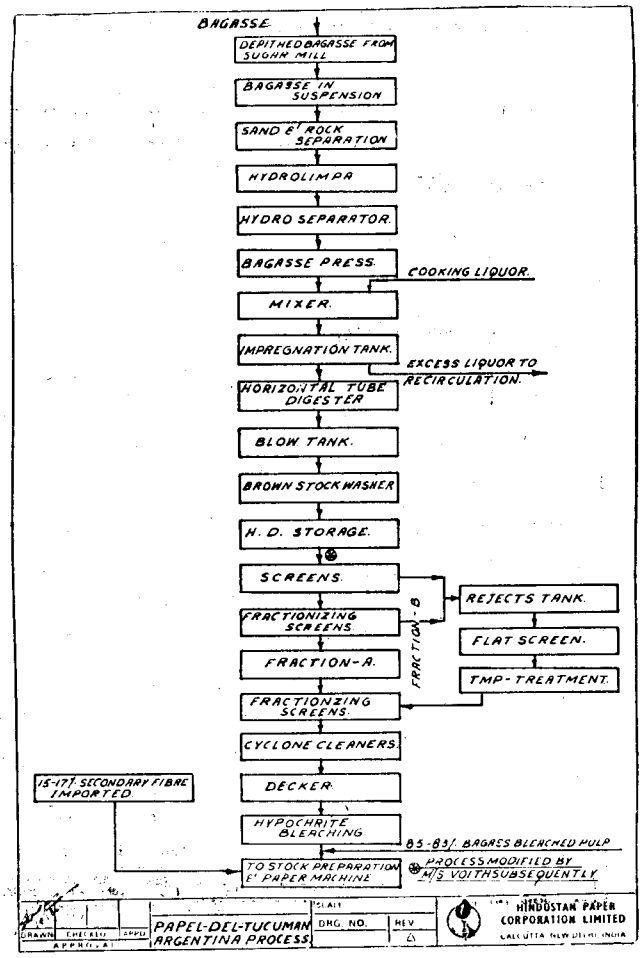
The process envisaged by HPC uses 60% bagasse chemical semi-bleached pulp and 40% CMP Eucalyptus pulp in the newsprint furnish. About 4—6% clay is added in the furnish to improve the opacity. The process for bagasse pulping involves depithing of bagasse and cooking depithed bagasse with about 6% alkali as sodium hydroxide on BD bagasse and cooking at about

165—170°C. This pulp after screening and cleaning is bleached with Chlorine, Caustic and Calcium Hypochlorite (CEH Sequence).

Chemi-mechanical pulping process is employed for eucalyptus wood chips. Here the chips after steaming to about 45—60°C is impregnated with 4—5% Sodium Hydroxide and refined in two stage refining. The refined pulp from the 2nd stage is bleached with calcium hypo chlorite and refined in the 3rd stage. CMP process for Eucalyptus is used in Hindustan Newsprint Mills, Kerala and Mysore Paper Mills, Karnataka and elsewhere for manufacture of newsprint.

The process envisaged at TNPL for Newsprint uses 50% Mechanical Bagasse Pulp (MBP) 35% Chemical Bagasse Pulp (CBP) and 15% Eucalyptus Chemical Pulp. A special run was also made using 100% Bagasse i.e. 60% MBP and 40% CBP. The runability at 50 GSM





and all the physical and optical properties were meeting the requirements. The furnish for writing and printing paper is 75% fully bleached chemical bagasse pulp and 25% bleached kraft pulp from Eucalyptus. The paper shall contain not less than 10% ash on paper.

Bleaching is with Hydrogen per-oxide for mechanical bagasse pulp and conventional CEH bleaching for chemical bagasse pulp.

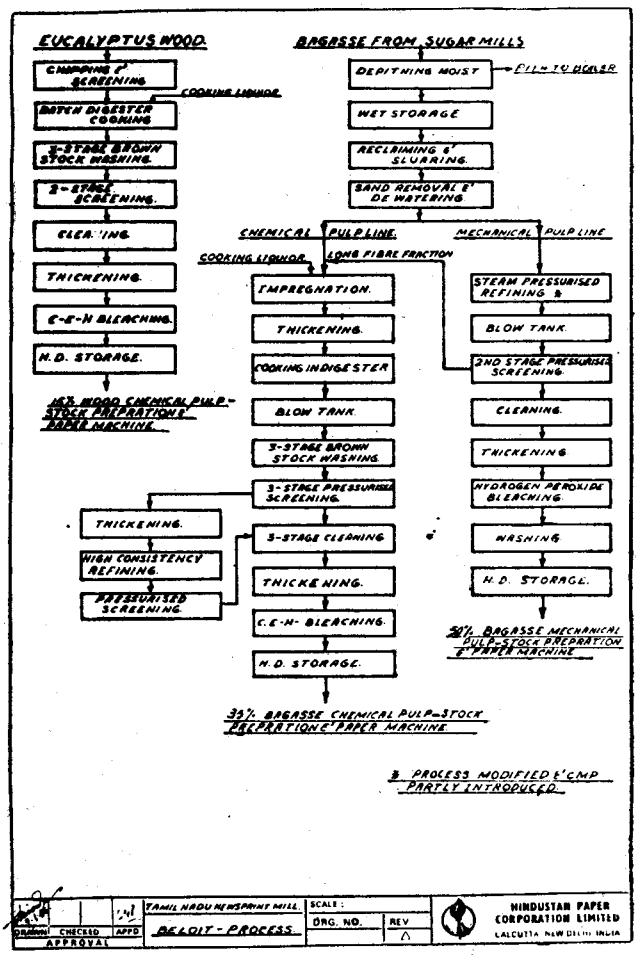
Evaluation of pulping technology :

After going through the various pulping technologies available, HPC has screened out and finally identified two different processes one adopted by Argentina and the other by TNPL. A comparative study of these two processes vis-a-vis the process envisaged for HPC's project has been made.

The Beloit high yield bagasse pulping process adopted by TNPL envisages a furnish consisting of 50% mechanical bagasse, 35% bagasse chemical pulp and 15% hard-wood chemical pulp.

The process adopted by Argentina utilises a furnish of 83—85% bagasse high yield chemical pulp and 15—17% imported soft-wood mechanical pulp.

The process envisaged for the U.P. Project would have a furnish of 60% bagasse chemical pulp and 40 % eucalyptus chemi mechanical pulp.



The flow charts for the three different processes are given above. The raw material requirements, the chemical consumption, the energy consumption and the pollution problems have been considered and evaluated and the cost of production per tonne of newsprint has been calculated. It would be seen that the furnish envisaged by HPC with 60% bagasse chemical pulp and 40% eucalyptus CMP pulp would have the lowest cost of production. This furnish has also been tried in a pilot plant scale on experimental paper machine at the Institute of Paper Technology, Trondheim, Norway under the supervision of Prof. H.W. Giertz. The test report established that it would be possible to manufacture newsprint of suitable quality from such a furnish.

Typical Newsprint properties from such a furnish have been compared with HNL Newsprint and are given at Table—I.

Influence of Ash content on the strength and optical properties is also indicated in graphs in Figures 1, 2 and 3.

TABLE—I

PULP PROPERTIES AT 6% ASH CONTENT

Furnish		Kerala Newsprint Furnish on lab. scale	
Chemical Bagasse Pulp	%	60	
Chemi-mechanical Eucalyp Pulp	%	40	70
Semi-bleached kraft Pulp	%		30 Read
Stone Ground Wood Pulp	%		
Ash Content	%	6	4
Paper Properties			
Grammage	g/m²	52	52
Density	kg/m³	685	660
Tensile Index MD	Nm/g	55	52
Tear Index CD	mN m²/g	3.8	6.1
Light Scattering	m²/Kg	44	46.5
Opacity	%	94	92.5
Brightness	%	52	53 3.

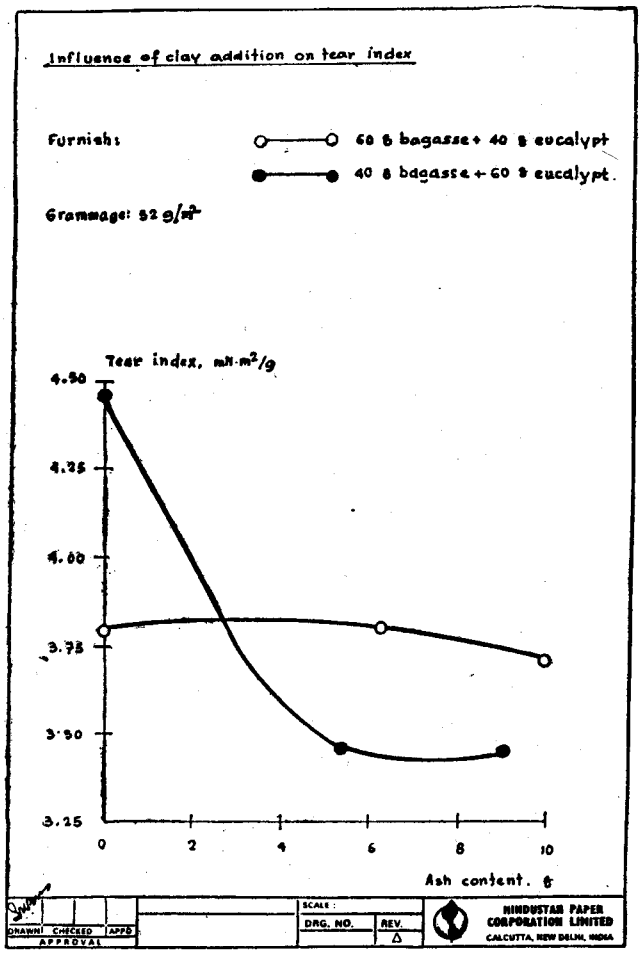


Fig. 1

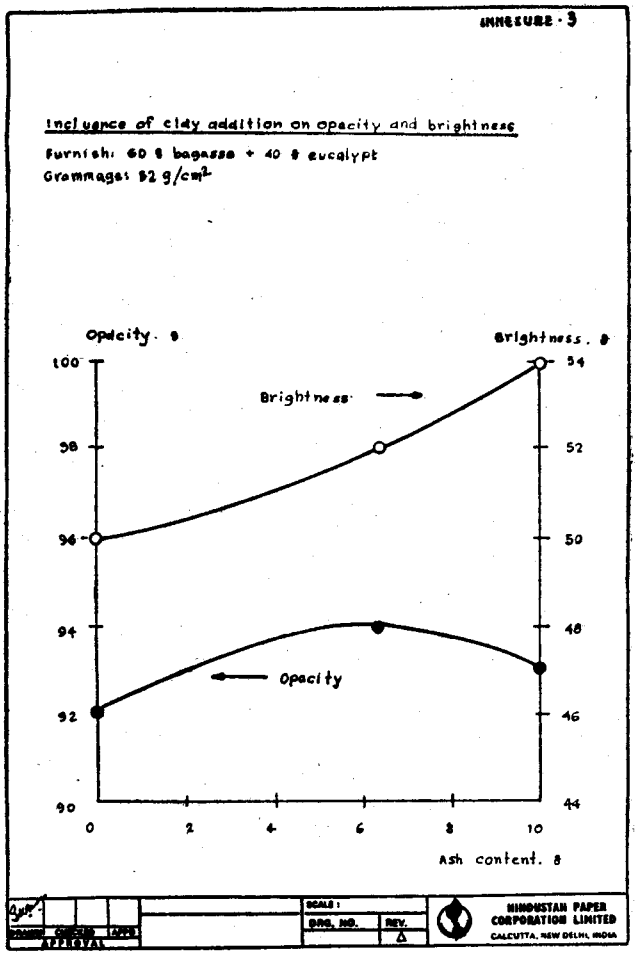


Fig.–2

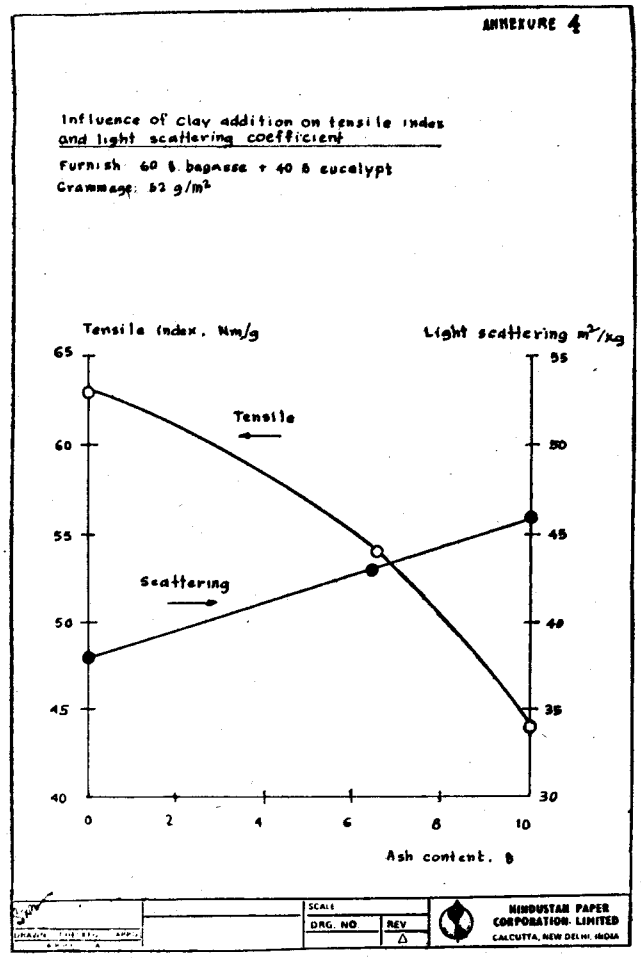


Fig –3

The advantages of this process are as follows :

1) Unlike TNPL, no unknown and uncertain bagasse pulping process is incorporated in the HPC's proposal. HPC's pulping processes are well proven. Bagasse chemical pulping has been adopted in MNPM and is in use for the last 20 years. Similarly, the eucalyptus CMP pulping process adopted and used in HNL has been very well proven enabling to make newsprint with as high as 75% CMP pulp from Eucalyptus.

2) As there are fewer pulping streets in the HPC's proposal (2 against 3/4 streets in TNPL), the capital cost of the equipment will be lower.

3) The overall fibrous raw material requirments in case of HPC's technology would be lower than that of TNPL.

4) The cost of production would be lower, since HPC's technology does not incorporate costly bleaching processes.

5) Trained Man power for the conventional chemical pulping of bagasse as well as for the already well established chemi-mechanical pulping of Eucalyptus (as in HNL) would be available.

HINDUSTAN PAPER CORPORATION LTD.

U. P. Newsprtnt Project

DETAILS OF COST OF PRODUCTION

1. PRODUCT : NEWSPRINT—(52 GSM)
2. WORKING DAYS : 330 DAYS/3 SHIFTS
3. PRODUCTION : 80,000 MT PER ANNUM

DESCRIPTION	RATE	TNPL PROCESS		H.P.C PROCESS		ARGENTINA (TUCUMAN) PROCESS	
	Rs./M.T.	TOTAL REQMT TONNES	TOTAL VALUE Rs.LAKHS	TOTAL REQMT TONNES	TOTAL VALUE Rs.LAKHS	TOTAL REQMT TONNES	TOTAL VALUE Rs.LAKHS
A. RAW MATERIALS							
1. Bamboo/Wood (AD)	500	31700	158.50	44000	220.00	—	—
2. Bagasse (Wet whole)	350	343900	1203.65	253300	886.55	310200	1085.70
3. Pulp (Purchased) AD	3290					15940	524.43
B. COOKING CHEMICALS							
1. Caustic Soda	5500	—	—	2858	157.19	1762	96.90
2. Salt Cake	5400	2168	117.07	—	—	—	—
3. Lime	550	7564	41.60	10123	55.68	9257	50.91
C. BLEACHING CHEMICALS							
1. Chlorine	1000	3025	30.25	7056	70.56	1851	18.51
2. Lime	550	1637	9.00	9945	54.70	3332	18.33
3. NaOH	5500	767	42.19	850	46.75		
4. Hydrogen Peroxide	40000	645	257 60				
5. Magnesium Salt	3500	840	29.40				
6. Sodium Silicate							
7. DPTA							
D. OTHER CHEMICALS							
1. Alum	1120	3200	35.84	3200	35 84	3200	35.84
2 Filler	500	5600	28.00	5600	28.00	5600	28·00
3. Acid, Dyes, Superphosphate & Other misc.	120	—	96.00	—	96.00	—	96.00
E. PROCESS COMMODITIES							
1. Coal	362	160000	579.20	160000	579.20	180000	651.60
2. Furnace Oil	2850	1300	37.05	1600	45.60	1760	50.16
3. High Speed Oil Diesel	1600	78	1.25	96	1.54	105.6	1.69
4. Power bought	0.58/unit	372×10^5	215.76	424×10^5	246.38	300×10^5	174.00
F. CONSUMABLES							
1. Clothing	100	—	80.00	—	80.00	—	80.00
2. Packing	120	—	72.80	—	72.00	—	72.00
G. CONTINGENCIES	5 % on items A to F	—	151.72	—	133.77	—	149.16
TOTAL OF A TO G			3186.08		2809.16		3132 43
Variable cost Rs. per tonne Newsprint			3983		3511		3916