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WHOLE MESTA PLANT --- A PROMISING RAW MATERIAL SUBSTITUTE FOR NEWSPRINT MANUFACTURE

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Abstract

The newsprint demand in India is likely to reach around one million tonnes by the turn of the century. Plantation grown eucalyptus and bagasse constitute two major fibrous raw materials used by the newsprint industry and technology for production of newsprint grade pulps from these raw materials is fairly well established. Cost of the newsprint comprises as high as 50% of the total newsprint publishing cost and with a sharp rise in the cost of basic inputs, particularly of fibrous raw material, there is global concern to find out alternative fibrous raw materials, to bring down the cost of newsprint. In India also there is growing concern for alternative raw materials in view of the capacity expansion, sutained availability of raw materials and production of newsprint conforming to acceptable standards and at a competitive price. Central Pulp and Paper Research Institute with its modern high yield pulping pilot plants, has been engaged in testing of different raw materials for production of newsprint grade pulps. Annually renewable fibers like kenaf and other species belonging to the jute family are grown extensively in India. Mesta (*Hibiscus sabdariffa*) is one such species grown abundantly in most parts of the country. Investigations for production of newsprint grade pulps from whole

mesta plant were initiated in 83's. After 3 years of extensive research work a satisfactory quality newsprint from whole mesta plant, employing chemirefiner mechanical pulping process (CRMP), was produced. The newsprint produced. with pulp furnish containing 90% CRMP and 10% bleached commercial bamboo pulp, was conforming to acceptable standards and withstood a printing speed of 40,000 copies an hour at high speed offset press of 'Hindu', Madras. Preliminary economics worked out have indicated that, due to relatively lower inputs (chemical, energy etc.), the resulting pulp furnish costs would be less. The studies have recorded greater degree of confidence in whole mesta plant which is well poised to take off as a raw materials substitute for newsprint manufacture. The present paper highlights the findings of the research work carried out on utilization of whole mesta plant for newsprint production.

Introduction

It has been forecasted by experts that the newsprint will continue to enjoy s the leader of communication despite competition with increasing use of electronic communication sysems. Cost of resultant newsprint is one of the key factors influencing the demand. The newsprint is made from 75–80% mechanical pulps, which are cheaper than chemical pulps and rest with chemical pulp. Thus the cost of resultant pulp to a large extent is influenced by the quality of mechanical pulp and raw materials used for production of mechanical pulp component.

Although India has made significant progress towards self-reliance in newsprint manufacture, but still substantial proportion of the demand is met through import. The newsprint demand in India is likely to reach about one million tonnes by the turn of the century requiring massive expansion of newsprint sector[1]. Plantation grown eucalyptus and bagasse constitute two major fibre resources for production of mechanical pulp component of newsprint pulp furnish. With better understanding of these raw materials and applying right conditions of treatment, it has become possible to produce satisfactory quality newsprint high yield pulps from these raw materials. However, the mechanical pulps from such short fibred raw materials do not possess the required optical and mechanical properties leading to use of increased proportion of chemical pulp component resulting in increased cost of pulp furnish.

Looking into the requirements of massive capacity expansion of newsprint industry and keeping in view the quality standards, it has become imperative to search for alternative fibrous raw material for newsprint. Plantation grown eucalyptus can meet only limited demand. Availability of bagasse on the other hand would depend on the cost of raw material and its demand for fuel.

In recent years kenaf has drawn considerable attention around the world including the developed countries like USA. United States, despite vast reserve of pine and stable supply of other conifers from Canada has been conducting research on utilization of Kenaf for newsprint manufacture.

Some of the leading Indian journalists who participated in Kenaf Conference organized by American Newspaper Publishers Association (ANPA), felt that research on newsprint from kenaf conducted in USA is valid for Indian conditions.

In India various species belonging to jute family are cultivated widely and are used in textile industry. Mesta *(Hibiscus sabdariffa),* like kenaf also belong to jute family and grows under varying climatic conditons. Jute Technology Research Laboratories (JTRL), Calcutta and other laboratories under ICAR have been conducting research on cultivation and utilization of various species belonging to kenaf family. JTRL came with observation that mesta *(H. sabdariffa)* due to its coarser, fibres, does not find much use in textile, and could be a potential fibre source for paper industry.

In the early 83's JTRL, Calcutta, Research Institute for Newsprint Development (RIND), Madras and CPPRI launched a joint project on 'Newsprint from whole mesta plant.' CPPRI undertook the pilot plant research on development of process technology for production of suitable quality high yield pulps from whole mesta plant. JTRL was assigned the job of evaluation of different species belonging to kenaf family particularly about their cultivation, availability etc. RIND offered to conduct printing trials of newsprint produced. The work was completed in the late 85's. The present paper discusses finding of the research work conducted at CPPRI on newsprint from whole mesta plant and subsequent potentiality of the fibre for newsprint industry.

RESULTS AND DISCUSSION

1. Previous Studies on Utilization of Kenaf

Since early 1930's United States, Department of Agriculture (USDA), has considered the possible utilization of crop residues for pulp and paper and subsequently concentrated its efforts on kenaf. American Newspaper Publishers Association (ANPA) took enormous interest in promotion of kenaf for production of newsprint, as an alternative against rising wood prices. ANPA and SALUT did consolidated efforts and they produced a satisfactory quality newsprint from Kenaf. The paper machine trials with 65% peroxide bleached Kenaf TMP and 35% Kenaf soda pulp were very successful[5]. Chemi Thermo Mechanical pulps produced with compacted kenaf cubes, with density as high as 640 Kg/m^3 had strength properties comparable to TMP pulp from southern pine[5]. Thus the successful research Conducted under the auspices of ANPA in U. S. had revealed that it is possible to produce newsprint conforming to acceptable standards and at a competitive price, from Kenaf[2]. These findings are valid for the application to Indian conditions. Studies on utilization of Kenaf were done by many other countries like Japan, Australia, China etc. and today Kenaf constitute one of the major fibre resource for paper industry in China. In India at CPPRI, high yield pulp production from kenaf stalks was initiated in the early 80's and TMP produced from stalks was of inferior quality, conforming the fact that it is necessary to have bast portion alongwith stalk[6].

2. Research Work Carried out at CPPRI

Studies on newsprint from whole mesta plant were initiated in the early 83's,CPPRI's role was to find out the suitable process technology for obtaining newsprint of acceptable quality.The other collaborating agencies were JTRL (ICAR) of Calcutta and RIND, Madras. After extensive studies conducted by JTRL and other research aboratories and mesta research stations under ICAR, recommended whole mesta plant *(H. sabdariffa)* for the above studies.

3. RAw Material

About one tonne of chopped mesta received from Mesta Research Station at Amdalvalsa (AP). The plant was harvested after 50% flowering stage (130-140 days). Air dried plant was cut into 1-2" size manually. Care was taken to keep the bast portion intact during cutting. The measurement of bulk density, and basic density were carried out according to procedure mentioned in laboratory manual of CPPRI[7].

TABLE 1

PHYSICAL DATA OF WHOLE MESTA

Dryness, %	—	81.0
Bulk density, Kg/m³	—	88
Basic density, Kg/m³	—	205.5
Bast fibre, %	-	37.0
Dust, %	—	8.10

From the Table-1 it is observed that mesta plant contained appreciable amount of bast fibres (37%). The bast portion is characterised by relatively long fibres which varied from 2 to 3 mm in length and central woody protion had much shorter fibres (0.3–0.4 mm). In addition a small core of pith with colapsed parenchyma cells was observed. The bulk and basic densities were very low.

4. Optimization of High Yield Pulping Process

The physical and optical properties of mechanical pulp component are important factors which influence the quality of resultant newsprint. The mechanical pulp should have balanced fibre and fines proportion so as to enable to have good bonding and wet web strength. The fines proportion is an important factor which has strong influence on the scattering coefficient. Today the older mechanical pulping processes like ground wood pulping, processes like ground wood pulping, refiner mechanical pulping, have been replaced by modern processes like TMP, CTMP, CRMP etc., which are capable of producinmg stronger mechanical pulps. The important optimization strategies are

(i) low chemical inputs
(ii) maximum production rate
(iii) maximum energy consumption
(iv) improved pulp quality
(v) steady and uninterrupted operation etc.

It is very important to monitor the parameters like feeding rate, disc clearance, disc pattern and consistency during refining for achieving maximum production rate with better quality pulps. The feeding system of present TMP pilot plant (Fig. 1) consists of a rotary valve feeder prior to preheater. This type of preheater has limitations with low density raw materials like mesta/kenaf. In batch trial 20 Kg of chips were used and preheater temperature in TMP and CTMP was maintained between 120 and 123°C with 2 to 3 minutes retention time in preheater. The conditions maintained during TMP and CTMP were as follows :-

Refining Conditions

Pressurized Refining	TMP	CTMP
Preheater^{0}C	120-123	120-123
Disc clearance, mm	0.3	0.25
Disc pattern	5821	5821
Atmospheric secondary stage refining		
Temperature^0 C	80-90	80-90
Disc clearance mm	o.15	o.15
Disc Pattern	5811 G	5811 G
Total specific energy consumed kwh/t	888	1065

In TMP and CTMP although satisfactory quality pulps were obtained, but it was not possible to attain desired feeding rate resulting in low production rate nd frequent clogging of refiner plates. The defibrator CMP pulping system has twin screw transportation system in metering bin and even with minimum speed the quantity of raw material entering the raw material entering the raffinator was more than what it could take, so it was decided to feed manually keeping production rate around 30 Kg/hr which was found optimum. However, considering limitation of feeding system it was decided to choose chemirefiner mechanical pulping process.

5.(a) Chemirefiner Mechanical Pulping

About 200 Kg of raw material was processed and around 150 Kg of CRM pulp was produced under following conditions :-

Pulping Conditions

Prehydrolysis		
Material to liquor ratio	—	1:6
Steaming temp.	—	120° C
Time	—	30 min.
Chemical Impregnation		
NaOH, % applied on raw material	—	5-4 % (18g/1)
Temp.	—	80° C
Retention time	—	60 min.
I Stage refining		
Disc Pattern	—	5811 G
Disc clearance, mm	—	0.5
II Stage refining		
Disc Pattern	—	5811 G
Disc clearance, mm	—	0.25
Temperature	—	around 80° C
Pulp Properties		
Initial freeness,ml, CSF	—	710
Initial Brightness, % ISO	—	36.0
Pulp yield, % *	—	86.0

* Pulp yield calculated from mateiral dissolved during prehydrolysis and refining.

TABLE - 2

STRENGTH AND OPTICAL PROPERITIES OF BLEACHED MESTA HIGH YIELD PULPS

Particulars	Pulp		
	TMP	CTMP	CRMP
Strength properties			
Freeness, ml, CSF	150	155	145
Tensil Ind.(Nm/g)	29.0	39.0	41.5
Tear ind. (mNm^2/g)	3.60	4.40	6.50
Burst ind.($kpam^2/g$)	0.95	1.75	2.30
Optical prperties			
Sp. scatt. coeff. m^2/kg	42.6	35.3	36.4
Brightness, ISO,%	53.4	49.1	52.1

TABLE - 3

LABORATORY EVALUATION OF CRMP USED FOR NEWSPRINT

Properties	Pulp-1	Pulp-2	Pulp-3
Chemical pulp %	Nil	Nil	10
Filler (Talcum),%	Nil	2.0	Nil
Freeness, ml (CSF)	150	140	205
Burst ind, kpam^2/g	1.50	1.60	1.85
Tensil ind., Nm/g	24.5	30.5	31.0
Tear ind, mNm^2/g	7.40	8.10	8.00
Brightness,%, ISO	34.5	34.1	—
Opacity,%	99.4	98.9	—

In high yield pulping higher discharge consistencies are preferred but in the above run it was not possible to attain consistencies over 10% due to lower production rate. The initial freeness was kept on higher side, in order to preserve the long fibre fraction, as refining was done at relatively lower consistencies.

5(b). Bleaching of high yield pulps

150 Kg CRMP pulp produced was bleached with single stage hypochlorite to a brightness level around 50%. The bleaching was done with 7.5% hypochlorite in open chest. The quantity of the pulp was small and the conditions of temperature and consistency during bleaching could not be maintained. Initially the consistency was maintained at 8% and was reduced to about 2% due to mixing and steaming problems. The final brightness obtained was around 52% ISO. The bleaching losses were around 5%

5(c). Strength properties

Strength properties of mesta CRMP pulp have been given in Table-2 and are compared with TMP and CTMP belached pulps. Mesta CRMP pulp was relatively stronger as compared to TMP and the difference between CRMP and CTMP was only marginal. The strength properties of Mesta CRMP were much better than those compared to *E.tereticornis* CMP pulp[6]. the results of strength properties indicate that mesta high yield pulps possess properties suitable for newsprint. The tearing strength in particular was on par with TMP from southern pine[8].

The pulps produced for newsprint on pilot plant scale were initially tested in the laboratory to optimize post refining conditions, blending of chemical pulp, filler etc. The results are recorded in Table-3.

It was observed that with just marginal change in freeness from 150 ml to 140 ml and addition of 2% talcum there was improvement in strength characteristics of the pulps. Appreciable increase in tensile and tear indices was observed. the 90% bleached CRMP pulp blended with 10% commercial bamboo pulp with slightly higher freeness value (205 ml,CSF) showed satisfactory strength properties.

TABLE - 4

PROPERTIES OF DIFFERENT NEWSPRINT SAMPLES

Properties	Mesta Newsprint produced at CPPRI	Mill* (Indigenous)	Mill** (Indigenous)	Imported
Physical				
Substance, g/m²	50.8(Avg.)	56.1	51.5	51.7
Thickness, microns	100	108	100	96
Apparent density, g/cm³	0.51	0.52	0.51	0.54
Tensile index, Nm/g, MD/CD	28.0/14.5	19.0/11.5	29.0/10.5	32.0/13.5
Stretch, % MD/CD	1.3/2.6	0.7/1.3	1.1/1.4	1.1/1.3
Burst index kpam²/g	0.25	—	0.50	—
Tear index, mNm²/g MD/CD	6.20/7.10	3.20/3.80	3.10/4.30	3.50/5.80
optical properties				
Brightness,% ISO	51.3	42.7	55.2	57.5
Opacity,%	90.8	96.1	95.3	95.7
Sp. scatt Coefficient, m²/g	37.9	45.1	45.0	55.1
Printing characteristics				
Print surf, roughness (micron)	MD/CD7.15/7.60	5.0/5.40	3.60/3.76	3.70/3.95
Ink demand (Ink layer) micron	9.8	10.0	8.0	7.6
Print through (Macbeth density)	0.41	0.33	0.37	0.20
Pin holes	Excessive	Present	Exessive	Nil

* Furnish containing ground wood chemimechanical and chemical pulps.
** Furnish containing chemimechanical pulp from Eucalyptus and chemical pulp.

5(d). Production of Newsprint

About 150 Kgs of bLeached and screened mesta CRMP pulp was taken to storage chest. Bleached commercial bamboo pulp refined to a freeness level of about 165 ml CSF in Defibrator raffinator was blended with mesta pulp with an average freeness of 385 ml CSF so that the resulting pulp furnish had 90% mesta CRMP and 10% bamboo chemical pulp. The pulp furnish was taken to wolf and banning beater followed by Jordan refiner. The final freeness of the pulp furnish was in the range of 100–140 ml CSF. About 20% filler was added and the newsprint was produced on Sandy Hill Fourdrinier pilot paper machine ilustrated in Fig.2 having 1 meter deckle. The runnability of the stock on the paper machine was quite satisfactory with minimum breaks. The grammage variation was in the range of 46–53 g/m^2. The strength and optical properties of the newsprint produced are given in Table–4.

The strength properties of mesta newsprint were quite satisfactory and were better than indigenously produced newsprint samples. Tearing strength, in particular was good and was on par with imported newsprint sample produced from pine. The mesta newsprint possessed acceptable optical properties. The scattering coefficient was on lower side presumable due to increased loss of fines during screening and paper making operations. The laboratory printing tests were satisfactory except surface roughness. Higher roughness was attributed to higher proportion of shieves due to limitation of screening equipment. The strengh and other properties are more or less conforming to recently laid ISI specifications. Further with improved screening and proper bleaching it is possible to obtain better strength and optical properties.

5(e). Printing Trials

The newsprint reel of about 130 kg. produced was printed on Japanese high speed Visa Offset press at the 'Hindu' press, Madras. The maximum speed of printing machine is 1,00,000 copies/hr. and generally printing is carried out at the speed of 30,000 to 45,000 copies/hr. which is sufficient to meet the daily circulation rate of newspaper. The mesta newsprint produced was also printed at various speeds, 20,000, 30,000 and 45,000 copies/hr. Printing at further higher speeds was not possible due to small quantity of paper. Runnability of the paper on printing press was quite satisfactory as the paper withstood the printing speed of 45,000 copies/hr. Printing experts felt that some minor defects like fluff generation, slight print through etc. can be rectified by controlled bleaching, refining and screening operations. Nevertheless the printing trails at 'Hindu' recorded a greater degree of confidence in the quality of the newsprint produced.

6. Problems and Prospects of Utilization of Mesta

i) Raw Material Handling & Availability

Raw material handling also forms an important operation of pulp and paper mills. Operations like collection, cleaning chipping etc. are important and these do have influence on pulp quality. Raw material handling particularly in case of low density raw materials, like mesta is a tedious one and labour involved in harvesting, collection, transportation and raw material preparation will have influence on the landed cost of the raw material. Form the refining studies conducted at CPPRI it was observed that the efficient refining and to achieve the maximum feeding rate, it is necessary that the bast portion should be intact with the stalk and length of chops should be around 20–25 mm. This can be achieved only by cutting green stalk. The bulk density of chopped mesta ranges between 80–120 Kg/m^3. and is very low compared to wood chips which have bulk densities over 500 Kg/m^3. Thus the transportation of chopped mesta would not be feasible one. Efforts to convert the chops into high density cubes have been made elsewhere. In a communication from Soldwedel, Publisher of the Yuma Daily Sun, Yuma, Arizona, he feels that cubing of chopped kenaf should be good answer for transportation problems. He suggests that the cubing machine could be taken to farms and chopped kenaf can be converted into high density cubes for transportation[8]. Tomber etal[5] have reported that feeding of kenaf cubes with densities as high as 640 Kg/m^3 was satisfactory in TMP unit. A mill in Arizona is using John Deere self propelled cubing machines and cubes of satisfactory quality and uniform size are obtained.

Unlike bagasse, where it requires an additional step of depithing involving additional equipments and requirement of substantial quantities of water, whole mesta plant does not require this additional step. In order to reduce the transportation costs cubing is suggested. However, it depends on the total hauling distance. For hauling distances more than 100 Km cubing may be necessary.

ii) Land Requirement

Mesta is grown extensively in Southern part of India and can withstand varying climatic conditions like less rain fall, less fertile land etc. It is estimated by ICAR that total land area under mesta cultivation is about 3.5 lakh hectares out of which 1 lakh hectare cultivation is in Andhra Pradesh. Considering the yield of mesta at 6 tons/hectare a newsprint mill with a consumption of 200 tonnes of mesta daily will require about 5000 hectare land with two harvests of mesta in August and November. The mesta available in 3.5 lakh hectare land will be sufficient to meet the demands of 4 to 5 newsprint mills.

iii) Economics

The economics of newsprint production would largely depend upon the cost of the newsprint pulp furnish. With increased proportion of chemical plps the cost of pulp furnish increases. Thus the newsprint pulp furnish cost would largely depend on the quality of mechanical pulp component and cost of its production. Preliminary economics, based on the cost of primary inputs like raw material, energy, chemical etc., was worked out and was compared with mill newsprint pulp furnish containing wood mechanical pulp and chemical grade pulp. The figures are given in Table-5. The details of the economics worked out are given in **Annexure-1.**

TABLE - V

COST OF BASIC INPUTS
(100 tpd capacity)
Cost (Rs.)

Inputs	Mesta Newsprint	conven-tional (Eucalypt)
Raw material	65,300	83,200
Chemicals	76,800	106,200
Energy	112,500	187,500
Total	254,600	376,900

Conclusion

1. Pilot plant scale research reveals that it is possible to produce satisfactory quality newsprint grade paper from whole mesta plant using chemirefiner mechanical pulping process, and the paper withstood the required printing speed on offset printing machine.
2. High yield pulps produced from whole mesta plant using CRMP process possess satisfactory strength and optical properties.
3. With controlled refining, belaching and screening operation it is possible to further improve the quality of newsprint.
4. Newsprint produced was conforming to acceptable standards and th preliminary economics indicate that the cost of the pulp furnish is relatively lower. compared to indigenously used newsprint pulp furnish.
5. The studies conducted clearly indicate that whole mesta plant is a promising and potential fiber source for newsprint mills.

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ANNEXURE-1

COST OF INPUTS FOR NEWSPRINT GRADE PULP PRODUCTION 100 TPD BASIS

		Newsprint pulp from mesta		Newsprint from eucalypt mechanical pulp and chemical pulp	
1.	Furnish	90% Mesta CRMP and 10% Bamboo Chemical pulp		70% Eucalypt CMP and 30% chemical pulp (Bamboo/Reed)	
2.	Raw materials	Mesta	113 t	Eucalypt	94 t
		Bamboo	22 t	Bamboo	67 t
	Cost of raw material	56,500/-		56,400/-	
		8,800/-		26,800/-	
	Total Rs.	65,300/-		83,200/-	
3.	Chemical requirements	NaOH	7.68 tons	NaOH	11.33 tons
		Chlorine	0.74 tons	Chlorine	2.21 tons
		Hypochlorite	10.0 tons	Hypochlorite	12.00 tons
	Cost of chemicals	NaOH	Rs. 46,080/-	NaOH	Rs.67,980/-
		Liquidchlorine	Rs. 740/-	Liquid chlorine	Rs. 2,210/-
		Hypochlorite	Rs. 30,000/-	Hypochlorite	Rs. 36,000/-
		Total	Rs. 76,820/-	Total	Rs. 1,06,190/-

1		2	3
4.	Energy requirement	150,000 kwh (to have about 150 ml CSF)	250,000 kwh (to have 150 ml CSF)
	Cost	Rs.112,500/-	Rs.187,500/-
	Total Cost of Inputs	Rs.254,620/-	Rs.376,890/-
	Inputs Cost/t Pulp	Rs.2546/-	
	Difference In Cost of Input	Rs.1200/- pulp can be saved in case of mesta.	Rs.3769/-

Fig. 1

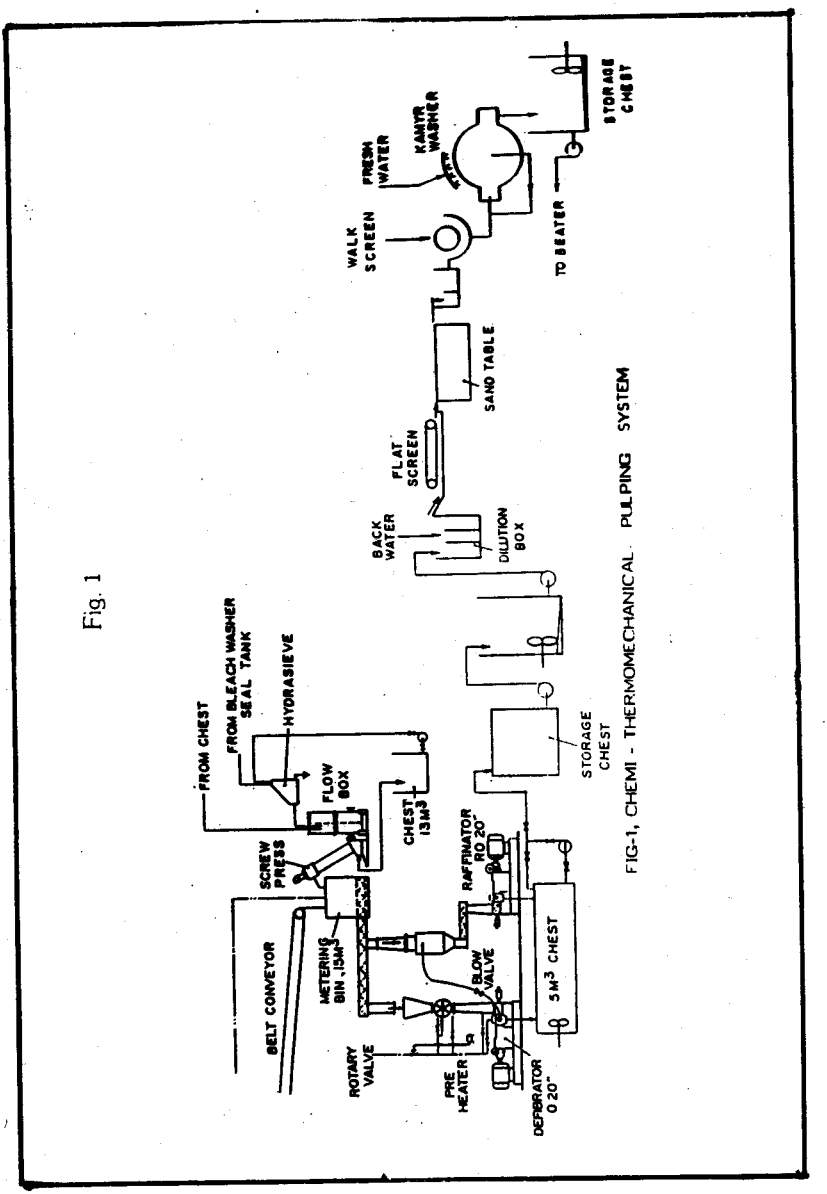

FIG-1, CHEMI - THERMOMECHANICAL PULPING SYSTEM

FIG 2

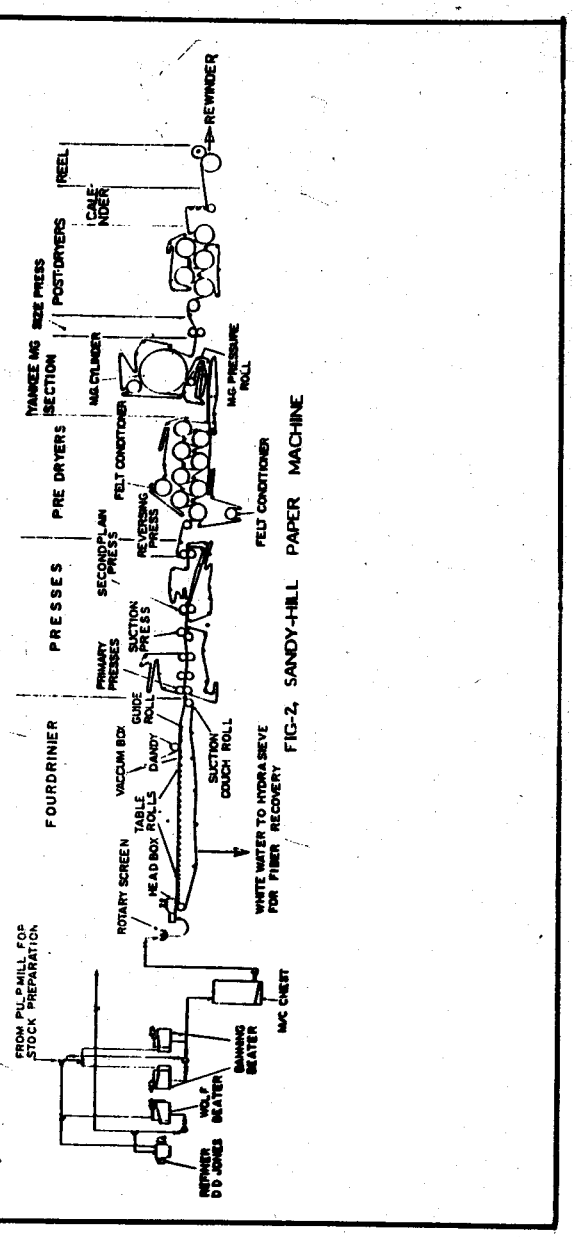

FIG-2, SANDY-HILL PAPER MACHINE