High Yield Pulp From Jute Sticks

A. K. GUHA* AND A. K. SANYAL*

Our natural forest reserve in India is not at all sufficient to meet the ever increasing demands of the pulp mills for the production of paper, boards, and rayon. The estimated requirement of pulp for cellulosic products for the current year 1980-81) is 3 million tonns for paper and pulp boards and 1.2 million tonns for the newsprint and dissolving pulps (Table I). In the next term of Five years or so, the demand would increase by 40 40%. With the increasing gap between the demand and supply, pulp mills have to search for unconventional raw materials apart from the various types of wood or bamboo. Research to utilise different agrowaste is already in progress.

TABLE—I ESTIMATED DEMAND OF DIFFERENT CELLULOSE PRODUCTS

Sl. No.	Cellulose Products	Estimated demand for 1980-81 (thousand tons)
1.	Paper and paper boards	3000
2.	Newsprint	600
3.	Dissolving pulps	600

Jute stick, being an agrowaste, available in abundant quantity about 3 million tons annually, some amount is utilised as domestic fuel or fencing and the rest is wasted. Jute Technological Research Laboratories is being engaged in the study of jute stick pulping for a long time.

Compared to bamboo or wood, it is predominant in hemicellulose but different in lignin content to some extent, like hard wood jute stick hemicellulose is predominant in xylan. The fibre length of jute stick pulp is short 0.6—1.0 mm (Table II). In this respect it is more similar to hard wood pulp, whereas the fibre from bamboo pulp is quite long. From these considerations, pulping process of jute stick is similar to that of hard wood.

TABLE—II CHEMICAL COMPOSITION OF JUTE STICKS ALONG WITH SOME LIGNO-CELLULOSIC MATERIALS AND THEIR FIBRE LENGTHS

Sl. No.		Jute stick	Jute fibre	Bamboo	Indian hard-wood
1.	Alpha-cellulose, %	40	61	30 40	35 45
2.	Lignin, %	23	13	20-32	21-28
3.	Hemi-cellulose, %	34	22	15-26	11-20
4.	Fibre lengths, mm.	0.8 (approx.)	2.0 (approx)	1,0 2.5	0.7-1.8

In view of the existing shortage of raw materials, high yield pulping should receive a great attention. To attain this goal, Jute stick pulping processes are directed so as to utilise the major portion of the constituents of jute stick at the same time maintaining the quality of end product.

Mechanical Pulping Process : In the mechanical process, the jute sticks, cut to pieces was soaked in water for 24 hours, and pulped by means of Sprout Waldron disc refiner, beaten in a standard beater to freeness of 40° S.R. The yield of the pulp from this mechanical process was very high (80—95%). The paper was creamy white colour in the grey form but possessed poor strength, the breaking length being 580 metres only, and could not withstand any fold.

Chemi-mechanical : The mechanical process

*Jute Technological Research Laboratories, 12, Regent Park, Calcutta-700040

needed modification a bit. Instead of water used earlier, 5-10% caustic soda on the weight of raw material was used for softening the stick during soaking. The softened material was then defibrised by the disc refiner. The unbleached pulp yield was 80-85% with a creamy white colour. Though this process produced a slightly lower yield, compared to mechanical process, but it produced a superior product. The resultant paper possessed a breaking length of 5000 metres with a fold of 280, having acceptable properties for newsprint and different grades of paper. The jute stick pulp was found to be superior to bamboo pulp prepared by identical chemi-mechanical process. The yield of bamboo pulp was 80—85%, but difficult to bleach, the corresponding paper has poor properties. The yield was sacrificed a bit, to aim for improved end product, the semichemical pulp from jute stick was used in admixture with bleached sulphate pulp from bamboo for the manufacture of newsprint and quality grades of paper. Use of size and China clay produced upgraded paper with improved whiteness, capacity and smoothness, with somewhat loss of strength (Table III).

Chemi-mechanical process using lime : In the foregoing section, the jute stick was given cold caustic treatment, but here the stick was digested with a mild alkali (lime), to weaken the adhesive forces holding the aggregate fibres, consequently lowering the energy consumption in the subsequent refining operation. Jute stick pieces were digested (65 lbs/sq.in.) with 5% lime (CaO) in a stationary digester provided with circulating system. The cooked chips were washed and passed several times with gradual reduction in clearances through the disc-refiner. The refined material was beaten in Hollander type of beater and boards were made in a hand machine. The pressed board had satisfactory bursting strength and folding endurance suitable for use in manufacture of box, particularly suitable for shoe trade. The yield in this semi-chemical pulping was 75%. A slight modified process increased the yield to 82% at the expense of properties, (Table IV).

Semi-chemical pulping by neutral sulphite : In this process a quite satisfactory yield of pulp is obtained. The jute stick chips were cooked with a mixture of sodium sulphite and sodium carbonate

TABLE—III PROPERTIES OF JUTE STICK HIGH YIELD PULP PREPARED BY DIFFERENT METHODS

Sl. No.	Process	Pulp	Yield of unbleached pulp %	Breaking length of paper (metres)	Folding endurance	Remarks
1.	Mechanical	Jute stick	90-95	580	0	Creamy colour but poor strength.
2.	Chemi-mechanical	Jute stick	80-85	5000	280	Grey Creamy colour of accepted strength
3.	Same as 2	Bamboo	80-85	1500	2-3	Yellow pulp, difficult to bleach
4.	Chemi-mechanical (for jute stick) + Chemical (sulphate) (for bamboo)	Jute stick (70%) + Bamboo (30%) bleached	65 (average)	6040	316	Quality paper for use as newsprint etc.
5.	Same as (4)	Same as (4) + clay + size	—	4720	64	Good finish opaque, smooth and white for writing paper etc.

at 65 lbs/sq.in. using a stationary digester having a circulating system. The partially softened pulp was passed through the disc refiner. The pulp with an yield of 70-72% was processed into papers suitable for use as newsprint. By suitable adjustment of concentration of chemical, paper with a breaking length of more than 4000–5800 and a burst factor of 23–31 could be obtained, much higher value compared to that for newsprint of daily newspaper. Good quality of grey boards could be obtained by the NSSC process. This sheet comparable in thickness to post cards were also made by NSSC process. Their properties were at par to those determined for post cards, (Table IV).

Chemical pulping process : The chemical pulping process causes the removal of some of lignin and hemicellulose, with a sulphate process. The yield can be held 45–50% or slightly above, the permanganate number lies between 15–19. On bleaching the yield is reduced to 40% or so. It was seen that if the yield was sacrificed a lot, quality products could be produced. The grey pulp yielded good wrapping paper, file covers, the bleached one gave rise to writing papers. When a dissolving pulp from jute stick is aimed at, several steps as prehydrolysis, sulphate digestion and compulsory multistage bleaching process are followed. In such a dissolving pulp, yield is bound to come down. The yield might be held at a higher level when the dissolving pulp is impure with hemicellulose or some lignin. This pulp might be suitable for some cellulosic products such as carboxymethyl cellulose, or some types of acetate. But work in this laboratory had shown that even for carboxy methyl cellulose, the dissolving pulp should be of high grade to maintain the quality of end product. A pulp of rayon grade quality from jute stick was developed here which contained 99% alpha-cellulose. The yield was held at 26% or so, for this type of pulp yield the limit was set by the alpha-cellulose content of the original jute stick which was only 40%. Recently the above dissolving pulp was spun into rayon in this laboratory. Now the question remains whether further improvement in the yield was possible, maintaining the quality of pulp of the end product.

In the foregoing sections the pulping of jute sticks by mechanical, semi-mechanical and NSSC processes are described. In all these cases, high yield pulp was obtained. Use of jute sticks for chemical pulping for paper or dissolving pulp was also pointed out for comparison of yields.

If one has to restrict to very high yield pulp

TABLE—IV PROPERTIES OF JUTE STICK HIGH YIELD PULP BY CHEMI-MECHANICAL AND NEUTRAL SULPHITE SEMI CHEMICAL PROCESSES.

Sl. No.	Process	Yield %	Basis weight (g/sq.m)	Breakting length (meters)	Burst factor (Nos)	Folds	Remarks
1.	Lime digestion + Refining (4 passes)	75	530	—	28	464	Grey colour suitable for Box Board used in shoe trade etc.
2.	Lime digestion + Refining (1 Pass)	82	524	—	17	100	Product a bit inferior.
3.	N.S.S.C. (Sodium sulphate +Sodium carbonate)	70-72	34 44	4000 5800	23-31 11-12 (Daily newspaper)	—	Good quality for Newsprint etc.
4.	Same as (3)	70-72	370 458	5710-7550	22-33	—	Thick boards for different uses.
5.	Same as (3)	70-72	213-220 220-230	—	7-12 8-9 (Normal Post card)	—	This sheet may be used for post card for its quality and colour.

(85%), chemi-mechanical process using cold caustic can be advocated. Here in a creamy yellow product is formed, where bleaching is avoided. This can be used for newsprint. Again it is seen that jute stick responds well to the action of alkali due to its light and porous structure. On the other hand, bamboo does not respond well to the action of caustic. Again when the jute stick is softened with alkali, delignification occurs with consequent development of strength. With water alone, mechanical grinding is slow, whereas in case of chemi-mechanical process, refining of softened stick consumes less mechanical energy. In the case of chemi-mechanical process, the pulp has grey creamy colour and acceptable strength, so can be used for newsarint and cheaper variety of paper. The chemi-mechanical pulp does not require washing and there is no cost of recovery of chemicals. The NSSC high yield pulping of jute stiek has got attraclive white creamy colour, so does not require bleaching. The pulp can yield newsprint, grey board and post card type of materials. The chemi mechanical high yield pulping process utilising lime, yields quality board suitable for making boxes. Here the process is cheap and the chemical recovery does not effect significantly. In the NSSC process, the cost of chemicals with their recovery are involved. Still due to high yield of the pulp and useful end products this process can be recommended. Jute stick pulp has short fibre structure and characterised by its wetness. This should not be an hinderance to its utilisation either by small scale or large scale industries. In view of its capacity of contributing to the high yield pulping process. Cottage industry based on mechanical or chemi mechanical pulping of jute should be set up for development of village economy. When Japan and Australlia are preparing certain useful grades of paper even from 100% hardwood, so it appears that jute stick, being similar to hardwood should not create any concern to the pulp makers if they use 100% of jute stick.

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