Increased Loading in Paper as a Means of Conservation of Fibrous Raw Material

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Scarcity of Fibrous Raw Material for Indian Paper Industry is reviewed. As a means of conservation of fibrous raw material, development of potential strength of fibres and increased loading is considered in this paper.

Work carried out on the pulp blends of Bamboo, Eucalyptus and hardwoods has shown that there is strength potential to give normal strength properties with increased loading. A 60% increase in filler content was possible by optimising the refining, without impairing the paper properties, giving a saving of 11% in fibrous raw material. However, in course of refining, drainage problems are encountered affecting production rate. Possibility of overcoming this is shown by the use of drainage aids.

This means of conservation of fibrous raw material has great economic consequences for paper industry and nationl economy.

Introduction

Indian Pulp and Paper industry is poised to take a big leap forward to meet the growing needs of the country. Production target for the Vth Five Year Plan (1974-75 to 79-80) is 2 million tpa. In comparison with the production in 1973 of 0.77 million tonnes, the target of Vth Five Year Plan is a great challenge and poses several problems. Among other things, availability of adequate fibrous raw material is perhaps one of the most critical way limiting factors. For the production of 2 million tonnes of paper, paperboard, newsprint and allied products, about 6 million tonnes of airdry fibrous raw material is needed (1). Bamboo constituted about 60% of the total fibrous raw material consumed during IVth Five Year Plan (1964–65 to 68-69) followed by pulp wood 15%, bagasse 8%, waste paper 7%, grasses 6%, and straw 4% (2).

Right from early sixties, paper industry is facing difficulty in getting sufficient bamboo. Over the years, with increase in paper production, the consumption of bamboo has been steadily increasing and at present about 2.7 million tpa are used by the industry (1). Hardwoods were not in use prior to sixties, and their use was started in 1962 to augment the production in the face of shortage of bamboo. It is estimated that bamboo availability is about 4 million tpa, whereas the requirement of fibrous raw material is of the order of 6 million tpa. Even the hardwood resources of our forests are not very encouraging. While the estimated industrial wood requirements for 1975 and 1985 are around 13.3 and 32.0 million m^3, the annual yield in 1985 is estimated to be only about 12 million m^3 (2). This leaves a big gap of about 20 million m^3 between requirement and availability industrial wood in the country

Scarcity of fibrous raw material, of late, has become a worldwide phenomenon. Even those countries, which are endowed with rich forest resources are no exception and every paper producing country is required to conserve its raw material. Man-made forests, high-yield pulping, whole-tree concept and recyling

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are some of the aspects which have received world-wide attention and attempts are being made to maximise the utilisation of the resources which are fast dwindling. "Conserve fibrous raw material" is perhaps an apt slogan for the paper world.

Fortunately, there seem to be increasing awareness of the problem in the country and several development plans are envisaged. One of the projects planned is the development of "man-made forests". It is reported that in the Vth Five Year Plan about 240,000 ha/year is to be planted under man-made forests with Eucalyptus, tropical pines and other fast growing commercial broad leaved species (3). On the part of the industry, intensive efforts are being made to develop technology for the utilization of new species of woods, improvement in productivity and conservation of raw matetials. Among the various means for the conservation of fibrous raw materials, one of the means, in the papermaking process, of refining and loading is considered here.

Pulp Refining and Loading :

Each type of pulp has its own characteristic strength development as related to refining. Some of the properties improve with refining and some others decrease. A balance is struck, in an ideal situation, to arrive at a compromise, where all properties are at their optimum level. This may, perhaps, indicate as to the potential strength of a given pulp. Generally, in practice, the ideal situation is not to be seen, nor is the potential strength of pulp fully utilized. Refining of pulp is normally, dictated by several factors. Rate of production is perhaps the most important factor governing all operations in a situation as obtained in the country where there is a big void between paper requirement and the industry's installed capacity. Of necessity, paper machines have to be speeded up and maximum output achieved. Refining has a direct bearing on the drainage properties on the wire, drying properties of the sheet and ultimately production. The trend has been towards lower refining, and free stock as far as the resultant paper properties do not fall below the tolerance limits. This has given good dividends to the industry and the country by way of higher production.

Now the industry is faced with the problem of scarcity of fibrous raw material. Paper mills have to work with limited supply of raw material and yet keep up higher production. All possible means have to be adopted to conserve pulp; for any fraction conserved is, indeed, a fraction produced. This situation calls for a greater utilization of the potential strength of pulp. With the tapping of higher strength of pulp, a fraction of the pulp can be substituted with a non-fibrous component in the paper as fillers, consistent with paper properties. This involves higher refining, greater loading, and changes in the behaviour of stock on wire, dryers and finally paper properties. Some work was carried out at the Research Centre in this direction and the details are given in the experimental part of the paper.

Experimental

Experiments were carried out in Research Centre to study the effect of refining and loading at various levels of treatment. For this purpose unbleached and bleached pulp from pulp mill was collected. Using Sprout-Waldron 12" Laboratory disc refiner pulp was refined, single pass, at 4.0 to 4.5% consistency keeping plate clearance at 4 different levels. Filler (talc) addition was at 4 levels, in each case. After the addition of rosin and alum, handsheets of 8" x 8" size were made on Noble and Wood sheet making machine, consisting of white water return system, 2-roll press and sheet drying cylinder. The results of the experiment on unbleached pulp are given in Table I.

Similar experiment was carried at using bleached pulp. In this case pulp was refined to two levels of freeness and sheets were made at two levels of basis weight. The results are given in Table II.

With higher refining the stock gets slow on the wire and drainage problems are encountered. To obviate this effect, drainage aids are recommended. To study the extent of improvement

Table I

Effect of Refining & Loading on the Properties of Unbleached Pulp* Handsheets

Refining**															
Plate clearance, microns	381				254				203				102		
Freeness***, °SR	19.5				20				24				31		
Additives**															
Loading (Talc), %	0	10	20	30	0	10	20	30	0	10	20	30	0	10	20
Freeness, °SR	19.0	18.5	16.5	16.0	19.0	18.0	17.0	17.0	22.0	21.0	22.0	21.0	26.0	26.0	26.0
Drainage time, Sec/700 ml	8.5	9.0	8.0	7.5	9.0	7.8	7.5	7.6	12.2	12.2	12.2	11.0	17.6	17.5	17.4
Handsheet Properties* ***															
Ash, %	2.1	7.2	13.4	18.5	2.4	7.3	13.4	19.1	2.1	7.1	12.7	18.1	2.2	7.2	13.6
Bulk, cc/g	2.14	2.06	1.93	1.90	2.15	1.99	1.97	1.89	2.02	1.90	1.85	1.94	1.83	1.75	1.73
Breaking length, km	3.40	2.73	2.50	2.36	3.85	3.33	2.83	2.75	4.86	4.26	3.74	3.40	5.81	4.50	4.30
Stretch, %	1.9	1.9	1.7	1.6	2.0	1.8	1.6	1.8	2.1	2.1	2.0	1.8	2.8	2.5	2.5
TEA, J/m^2	39.8	35.6	33.4	23.4	43.0	37.1	24.8	22.1	55.0	51.0	38.4	29.3	96.2	61.0	57.4
Burst factor	16.4	15.2	13.0	11.8	17.1	14.8	18.0	10.9	23.2	19.3	16.6	14.1	29.4	24.0	23.1
Tear factor	75.2	66.4	55.5	56.6	91.3	84.0	73.4	74.3	88.8	80.5	69.7	65.8	75.8	69.3	68.4
Folding Endurance, DF	5	4	3	2	4	4	2	2	8	5	4	3	16	7	7
Cobb test, g/m^2	20.3	18.1	18.8	17.5	19.2	19.7	18.1	17.2	20.0	19.5	19.2	17.8	21.7	21.9	20.6

Note :—

* Bamboo, Eucalyptus & hardwoods sulphate mill pulp having 30 0 Kappa No.

** Sprout-Waldron 12" Lab. Disc refiner was used. Pulp consistency was 4.0 to 4.5%

*** Initial freeness was 15°SR & drainage time was 4.0 Sec/700 ml

**** Additives used %—Rosin 0.6, Gum 1.0, Alum 3.5 in all treatments

***** Pulp handsheets of 90 g/m^2 were made on Noble & wood sheet making m/c. having WW return system.

Table II—Effect of Refining And Loading on the Properties of Bleached Pulp (*) Handsheets

Refining (**)	(a)		(b)	
1. Freeness, °SR	25.0	35.0	19.0	35.0
Additives (***)				
2. Loading (Talc), %	30	60	37	55
3. Freeness, °SR	21.5	30.0	—	—
4. Drainage time, Sec/700 ml	12	21	—	—
Handsheet properties (****)				
5. Basis weight, g/m²	61.9	64.5	240	240
6. Ash, %	16.6	29.6	24.5	33.0
7. Bulk, cc/g	1.61	1.40	1.38	1.26
8. Breaking length, km	3.14	2.95	1.83	2.22
9. Stretch, %	2.0	2.0	1.7	1.9
10. Burst factor	15.4	14.4	9.00	12.0
11. Tear factor	69.4	46.5	66.0	64.0
12. Folding endurance, DF	6	7	—	—
13. Opacity, %	87.8	89.0	—	—

Note : (*) —Bamboo, Eucalyptus & hardwoods sulphate bleached mill pulp having 78% brightness (Elrepho) & 9.0 cp viscosity (CED).

(**) —Sprout–Waldron 12" Lab. Disc Refiner was used–pulp consistency was 4.0 to 4.5%.

(***) —Additives used %—Rosin 0.6 & Alum—3.5

(****) —Pulp handsheets were made on Noble & Wood sheet making machine having white water return system.

by the use of drainage aid, experiment was carried out on unbleached pulp. The results are given in Table III.

Discussion

As seen from the data in Table I, higher refining produces slower stock and addition of loading and other additives makes the stock free to some extent at a given level of refining. An increase in the addition of loading to a free stock has greater effect on the freeness, making the stock more free than a slow stock where the effect is almost negligible. Drainage time also shows similar trend. This indicates that increased loading alone cannot take care of the increased slowness of the stock resulting from higher refining. To keep the drainage properties of the stock within acceptable limits. use of drainage aids seems to be a necessity when higher refining is considered.

Regarding sheet properties, it is seen that higher refining within the range covered shows an improvement in breaking length and burst factor. While tear factor shows an initial improvement and later has a downward trend, the folding endurance has an initial drop and later shows improvement.

Overall properties of unbleached pulp sheet show improvement even with increased loading when higher refining is done compared to lower refining, within the range studied.

In the case of bleached pulp also, as shown in Table II,

Table III—Effect of the use of Drainage Aid on Pulp* & Pulp Handsheet Properties

Refining**		
1. Plate clearance, micron	102	
Additives**		
2. Loading (Talc), %	20	20
3. Drainage aid****, %	0	2.0
4. Freeness, °SR	24.0	19.0
5. Drainage time, Sec/700 ml	15.4	9.5
6. Improvement in Drainage time,%	—	38.0
Handsheet properties***		
7. Basis weight, g/m²	86.6	86.4
8. Ash, %	13.5	14.7
9. Breaking length, km	3.12	3.78
10. Stretch, %	2.2	2.1
11. TEA, J/m²	26.4	27.2
12. Burst factor	17.9	16.8
13. Tear factor	64.0	64.8
14. Folding Endurance, DF	6	7
15. Cobb test, g/m²	21.3	20.3

Note :

* Bamboo, Eucalyptus & hardwoods unbleached sulphate mill pulp

** Sprout–Waldron 12" Lab. Disc Refiner was used 4.0 to 4.5% pulp consistency

*** Additives used, %—Rosin 0.6, & Alum 3.5

**** Drainage aid used was a liquid containing 2% solids

***** Handsheets were made on Noble & Wood sheet making machine with white water return system.

properties of sheet at both low and high basis weight, are maintained with increased loading and higher refining. About 60% increase in filler content is seen possible without impairing the properties. This gives about 11% saving in fibrous raw material.

The use of drainage aid to overcome the effect of higher refining was studied and as seen in Table III, an improvement of 38% in drainage time was possible, while the sheet properties were maintained.

From the above work and discussion, it is clear that there is very good possibility of conservation of fibrous raw material to the tune of about 10–12%. by the means suggested in this paper.

Conclusion :

Scarcity of fibrous raw material is a serious problem to the paper industry. Conservation of fibrous raw material has assumed great significance. In this paper, it is shown, that by refining the pulp to a higher degree, substitution with non-fibrous material such as fillers is possible within some limits without impairing the operational conditions and paper properties. This means of conservation of fibrous raw material has great economic potentiality and the industry may well be benefited.

References :

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(3) Ghosh, R.C., PPI 16 (5) : 19 (1974).