A Logical Approach to High Yield Pulping

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The importance of pulp yield can be illustrated by a simple example of a mill using 200 tonnes of bamboo to produce 100 tonnes paper per day. The paper contains, on an average, 80% of bamboo pulp. The margin of profit is Rs. 400 per tonne of paper but the net profit is not enough to pay any substantial dividend. It is interesting to speculate what could happen if the pulp yield could be increased by 5%.

100 tonnes of paper contains $100 \times 0.8 = 80$ tonnes of bamboo pulp obtained from 200 tonnes of bamboo. Therefore, the yield is $\frac{80 \times 100}{200} = 40\%$. If the yield is increased to 45%, $\frac{200 \times 10.45}{0.8} = 112.5$ tonnes of paper can be made from the same amount of bamboo and the net profit would increase by $12.5 \times 400 =$ Rs. 5000/- per day or Rs. 16.00 lakhs in a year of 320 working days.

If increase in production is not possible, the consumption of bamboo would be reduced by $200 - \frac{80}{0.45} = 22.22$ tonnes per day. If the cost of bamboo is Rs. 150/- per tonne, the saving in bamboo alone would be worth Rs. 3333/- per day or Rs. 10.67 lakhs in a year of 320 working days.

Thus an increase in yield by 5% may contribute very substantially towards the economy and financial success of the mill concerned. Although such an improvement cannot be achieved over-night, a systematic examination of the existing conditions may reveal sources of undue losses, prevention of which will be the first positive step towards the goal.

The shrinkage of 200 tonnes of bamboo to 80 tonnes in final paper occurs in successive stages as follows:—

Loss	Shrinkage		Balance Tonnes
	%	Tonnes	
Loss in storage	1	2.00	198.00
Loss in chipping and screening.	1	1.98	196.02
Loss in cooking chips for conversion to unbleached Pulp.	55	107.81	88.21
Loss in washing and screening of unbleached Pulp.	1	0.88	87.33
Loss in bleaching	5	4.37	82.96
Loss of bleached pulp in stock preparation, conversion to paper and finishing.	4	3.32	79.64

Losses in successive stages are not necessarily the same in all mills but the shrinkage follows more or less the same pattern. It is well worth to determine and investigate the losses in each stage over a number of months and then take adequate steps to minimise losses in each stage so as to maintain the best performance recorded during the period under review.

As the largest shrinkage of raw material occurs in pulping of chips, the scope of improvement is also the widest in this stage. If colour, purity and strength characteristics are of minor importance, most of the raw materials can be converted to pulp by mechanical disintegration alone. The loss in mechanical pulping can be confined to water soluble constituents and the yield of pulp may be as high as 95-97%. If better strength characteristics are required, the individual fibre need be protected from undue damage during the pulping process.

To attain these objectives, the lignin in the middle lamella has to be softened or removed by applications of suitable chemicals. But till the introduction of semichemical pulping process in comparatively recent years, the conditions of application of chemicals have been such that process of delignification proceeded much beyond the stage it was absolutely necessary. The strong chemicals used at high temperature and pressure, not only reacted with lignin in the middle lamella but readily attacked the lignocellulose complex in the fibre walls, dissolved a substantial portion of hemicelluloses and degraded a portion of the cellulose of higher degrees of polymerisation. The drastic process of bleaching applied to the resulting pulp caused further degradation of fibre simultaneously with the removal of residual lignin. The yield of such pulps has been naturally low, often considerably lower than the percentage of Alpha cellulose originally present in the raw materials. Curiously enough, the improvement in bleaching technique has preceded that in pulping and a stage has now reached that bleaching to a fairly high degree of brightness is no great problem once the

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fibrous raw material has been converted to a uniform pulp.

The semichemical pulping started with application of chemicals just enough to soften the raw materials so as to complete dissolution by mechanical means. The idea has now developed to such a stage that the extent of removal of lignin can be controlled at will and a compromise of chemical and mechanical processes can be drawn so as to obtain pulp with the least loss of material and physical damage to fibre.

Neutral sulphite semichemical, sulphite semichemical, sulphate semichemical chemimechanical, mechanochemical and chemiground processes are all designed to obtain the highest possible yield consistent with the quality of pulp desired. The chemical constituents of the raw materials are the only limiting factors. For example, excepting in the case of dissolving grade, yield of bleached pulp is limited by the holocellulose contents and not by the actual cellulose contents or even the Cross and Bevan cellulose.

The importance of protecting cellulosic components from damage and degradation cannot be over emphasised. Cutting, chipping or crushing of raw materials to suitable and uniform sizes, pretreatment to ensure uniform and quick penetration by chemicals, addition of wetting agents and various protective chemicals during the cooking and bleaching operations, and control of liquor ratio, concentration, pH, temperature, pressure, mixing, duration of treatment etc., are all essential pre-requisits of efficient pulping.

One of the latest developments in high-yield pulping has been the use of Hydrogen Sulphide in the initial stage of pulping. The chemical is applied in presence of water or mild alkali. The chips so treated are then cooked for a short while under high temperature and pressure and then further cooked either with caustic soda or a mixture of caustic soda and sodium sulphide. The cooked material is then disintegrated by a suitable refiner for conversion to pulp proper. The protective action of Hydrogen Sulphide has been found to be comparable to that of Borohydride which prevents chemical degradation of cellulosic material.

High yield pulping is the only logical approach to the solution of the problem of scarcity of raw materials in this country. There is no other way to narrow the gap between the availability and requirement of raw materials which is already on a steady increase. The prospect of increasing forest land is not too bright because the value of return from the forest land is less than that from the agriculture land and the scarcity of agricultural products is equally acute. Expansion in industry and commerce is also likely to enhance the value of land near industrial townships and cities much beyond the scope of using them for raising food crop and vegetables, not to speak of cheaper plants required for manufacture of pulp and paper. It is, therefore, imperative for the industries as well as Governments concerned to find ways and means to adopt improved methods of pulping so as to save raw materials for making more paper.