High Yield Pulping of Tropical Raw Materials

Maximum raw material utilisation for functional papers

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High yield pulping is increasingly being recognised as an important objective in modern profitable papermaking and as a means at the same time of helping forest conservation.

Aiming for high yields is, of course, not a new concept in papermaking, but in recent years the need for it has been emphasised by a number of factors including the importance of keeping water contamination under control, the basic desire to produce as much paper as possible from every ton of raw material harvested, the realisation that for some purposes a high yield pulp is functionally better than a lower yield pulp and the reduction of transport, chemical, steam and other costs.

Help for obtaining higher yields has come from technological advances in the important areas. The first is the modern equipment now available for preparing machanical pulp directly from raw materials in chip, sawdust and other forms; and the second the preparations of highr yield chemical pulps—arises from an increasingly detailed knowledge of the chemical and physical composition of raw materials enabling digesting conditions to be more exactly worked out to give minimum degradation of gcod papermaking materials. Between the highest commercial yields of over 95% and the lowest, ranging around 40%, the choice of materials and processes depends on local conditions, the product to be made and the all-important target of the highest yield attainable in the circumstances.

The planning af maximum economy in the use of available raw material can be helped substantially by a better recognition, through more intelligent quality assessement and testing, of the basic functional requirements of papers in their many different fields of use. Paper that is too good for its job represents a waste of both money and raw material.

INTRODUCTION

I suppose I must be one of very few people here to-day who met and heard in person William Raitt, that tough and persistent pulping and papermaking pioneer. Raitt worked in India for twenty-five years on the development and use of native fibres of all kinds, but his first love and his continuing primary interest was bamboo(1). Among my earliest recollections on first joining the paper industry is attending a lecture which Raitt gave in London in 1927, entitled "The bamboo hope". A year or so later, he gave a quite charming account(2) of what he called "The childhood of papermaking"; much of this discourse is centred around Srinagar. Thus my interest in India and in the Indian papermaking scene was aroused very early in my career by the enthusiasm and dedication of William Raitt.

A lot of water has flowed under the bridge since those early days some forty years ago, but Raitt's work, nonetheless, was a pioneering effort which undoubtedly helped to alert the world to the necessity for looking well into the future and ensuring that suitable raw materials for paper manufacture would be available indefinitely in quantities which could meet continually growing world requirements.

As we know, the picture has changed very much over the years, but the title selected for this three-day conference is a timely reminder of the importance of watching raw material situations in great detail and well ahead of requirements. I note, incidentally, that as recently as March this year your annual conference was centred around pulp yield improvement. There is no doubt, therefore, about the urgency of this matter.

Perhaps my own particular title may need a little amplification at this point. I have selected it because I believe raw material availability can be influenced substantially by a clearer understanding of the real functions of different kinds of paper and of the types of pulp that can best help to give the desired paper performance. Backing up these views, I have just read a statement concerning the fields of activity of the Norwegian Pulp and Paper Research Institute. Among these, they say they are concentrating on the optimal use of the raw materials in paper manufacture, based particularly on end-use requirements and value analysis. I think this coincides closely with the situation and objectives I have described. I shall refer to this question from time to time when considering some examples of high yield pulps and the types

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of paper in which they can be used advantageously. In my opinion we do not give enough attention to realistic studies of pulp properties in relation to the **essential** functions that papers have to fulfil. In consequence, we not infrequently use lower yield, i.e. more expensive, pulps than are necessary to attain a given quality. This statement perhaps applies with greater force to European and American conditions than to the Indian situation, but it is still a valid factor here and not to be overlooked by any means.

As many of my friends in the paper industry know, I have had the good fortune to travel very widely and I suppose I have covered in one way or another most of the world's papermaking countries. One of my outstanding impressions has been admiration for the ingenuity that one sees in papermaking operations, whether they are on a very small or a very large scale. I also admire the courage exhibited both in starting completely new and often pioneering types of small-scale paper manufacture, as well as right at the other end of the scale, the huge new machines we see coming into operation at wire widths close to 400 inches and production nudging the 500 ton a day mark. I make these points mainly to say that I believe there is a great deal to be learnt by exchanging information of all kinds whether our operations are on a huge scale or on a very modest one.

Most of my life, I have been connected much more with mass production papermaking than with medium and small machines, but I want to emphasise that the comments I am making are from the standpoint of my interest in looking for ideas and lines of progress at all levels. Certainly they are not made in the belief that experience with modern equipment can provide all the answers.

May I then as a reminder enumerate a number of facets concerning our high yield theme? All need consideration in aiming at maximum yields, whether they be from tropical or temperate source, and they are all inter-related.

There is, firstly, the obvious fact that the greater the production of the raw material that can be fully incorporated into the manufactured product the lower will be the transport and handling costs per ton of paper made. This of course, is a universal consideration, but perhaps in some areas in India it is of special importance because of the huge distances to be contended with — huge at any rate as compared with my own country.

Secondly, high yields mean less felling in the forests for a given paper production. Therefore, forests are better conserved. Alternatively of course, more paper can be made from existing felling rates.

Then, there is the very important consideration that high yield pulps can sometimes, provide a better finished product quality than would be given by lower yield pulps. This fact is too often overlooked because, in some way or other at the back of our minds, we seem inexorably to link quality with higher priced raw materials, almost irrespective of what the requirements are.

An outstanding example — if not the outstanding example — of the preferred use of a high yield pulp is mechanical pulp for newsprint manufacture. The qualities of this kind of pulp are such that printability, opacity, and other characteristics can quite definitely be superior to those of more expensive chemical pulps. Nevertheless, chemical pulps are added with the intention of upgrading the final product or of improving its runnability on the paper machine, or both. I have had the opportunity of expressing my strong views on these matters on several occasions recently (3) and later on I shall refer again to runnability and other allied questions. The last, but nonetheless significant, consideration is one which strangely enough is often either ignored or just not emphasised nearly enough. It surely is very obvious that the higher the yield the fewer the worries there will be about effluent problems. It is much more sensible for the economic health of the paper industry, and also to preserve the amenities of paper making locations, to strive to incorporate into the finished product the largest possible proportion of the starting raw material.

In practice, the waste that positively has to be discharged must be governed by the properties needed in the final product, but even then a review of the situation from time to time may well throw up some way in which so-called waste material can be turned to a useful purpose. It really does seem rather crazy that we have to spend so much time, money and skilled effort in endeavouring to avoid pollution of our waterways, and also of our air, when perhaps a similar effort directed towards incorporating more of this material in the paper might prove to be practicable and so very much more profitable.

To conclude this general introduction to my subject, I may recall that during the last war we had to devise means of using all kinds of substiute raw materials because of acute shortage on all sides. On one occasion, I had a hand in the procurement and use of a shipment of very dry and dirty bamboo poles, some 20 ft. in length by an average diameter of, perhaps, 6 inches. Although it looked most unpromising, we were able to use all this material, at a yield close to 100%, by passing it, firstly through an ordinary wood chiper, then through one or two Miracle attrition mills and finally, it was treated in a very early type of Asplund defibrator. I must confess that the resulting filthy coloured shivey stock was not put into paper, but we used it as part of our hardboard furnish with, in the circumstances, quite reasonable success and, of course, it gave us no effluent problems and improved the gross tonnage availability which we so desperately wanted at that time.

HIGH YIELD MECHANICAL PULP

For many years now, I have been closely involved in the investigation, production, and use of mechanical pulps. This is partly because many of the mills with which I have been concerned during most of my papermaking career have made and used great quantities of this type of pulp, but it is also because I have much enjoyed studying and helping to improve both the methods of manufacture and the testing procedures by which to assess the quality of this very important raw material. Within the last decade, there has been the rather spectacular development of the new form of this pulp, refiner mechanical pulp.

As is well-known, the refining method of production is a distinct step forward in the upgrading and better control of quality, and although it is now well and truly launched as a commercial method of manufacture, it is still actively being worked upon as a development project. I for one believe strongly that we are on the threshold of further important advances, both in quality and in the reduction of the energy requirements for preparing this kind of pulp.

So far, the experimental work and the commercial installations have been confined mainly to the treatment of softwoods, but there would appear to be no basic reasons why types of wood (and perhaps other raw materials too), in addition to those conventionally used for grinding, should not be developed as suitable raw material for refiner mechanical pulping.

There is, of course, the problem of the naturally poorer colour of tropical hardwood, an example of which, used commercially here in India for newsprint manufacture, is salai.

It is interesting to note, in this context of the removal of unwanted materials from mechanical pulp, that good progress has been made in reducing the pitch content of pine chips by high pressure squeezing, in equipment such as pressafiners for instance, prior to refining. Undoubtedly, further developments along these lines may be expected, and this, together with the ability to exercise better control over the papermaking quality of the product, should give high yield refiner mechanical pulp a definite advantage over conventional groundwood for flexibility in application and improved quality.

So here is an area in which important contributions can be made to the whole question of developing high yield pulp. Obviously, it will call for research and development into the particular requirements of those varieties of tropical woods and other fibrous raw materials which appear, on preliminary examination, to stand a reasonable change of being converted into pulp in this way.

To sum up the advantages of high yield refiner pulping we have:

1 Almost 100% of the raw material can be used in the paper

2 The use of chips, in place of the logs or bolts normally required for conventional grinding, enables slabs, off-cuts, small diameter wood, and irregularly shaped wood, to be pulped by the mechanical refining process. In effect, this still further increases the already very high yield obtainable.

3 There is the added merit that in some locations, notably on the West Coast of North America, quite appreciable percentage of sawdust can be incorporated in the raw material being mechanically pulped.

Quantities as high as 60% of sawdust refiner pulp have been mentioned to me recently as being regularly used for newsprint. But the proportion and usefulness of sawdust will, of course, be greatly influenced by the kind of wood and the kind of sawdust produced.

4 Preparing mechanical pulp by refining provides a longer fibred, product, and it is better fibrillated. It also has a higher freeness than normal groundwood, but this may or may not be an advantage depending on the circumstances under which the paper is made. These qualities certainly add up to an exciting high yield pulp which has greater tearing strength, a higher breaking length, improved stretch and a better burst factor as compared with groundwood made in the conventional way (4).

Thus there are many attributes of refiner mechanical pulp that can make it a strong contender for use in the important objective of raising the yield of our raw materials. Not only does one get a direct improvement because of the near 100% utilisation of the raw material as harvested, but also there is the indirect but no less important consideration that the high quality of these pulps can enable them to displace more expensive and much lower yield chemical pulps, such as those in newsprint for instance. As will be seen later, I have strong reservations anyhow about the need for using chemical pulps in this way, even where conventional groundwood is concerned, but this is a controversial matter which requires further ventilation.

These comments are inevitably rather heavily loaded by experience with softwoods. Nonetheless, it is well to remember that for very many years excellent conventional groundwood pulp has been made from aspen and other hardwoods. Thus, I would suggest that, in view of the way you yourselves have struggled with the very difficult problem of turning salai into a useful groundwood, there may well be good cases to be made out in favour of using other raw materials of these kinds that grow naturally already or can be cultivated for making refiner groundwood in your country. I know that you are very active in these matters and, indeed, I have seen some of your nurseries. I look forward to hearing more about your man-made forest endeavours at this meeting.

Another example of a hardwood which is now used successfully for mechanical pulping purposes, is, of course, eucalyptus. The pioneering efforts of the Australians have done wonders with this difficult raw material and it is certainly here to stay as a groundwood furnish for newsprint and other printing papers.

As you will have gathered, I am not familiar enough with the current scene in India, or with the latest programmes in the development of the technology of eucalyptus and other hardwood mechanical pulping, to discuss from practical knowledge the applicability of refiner techniques. What I do know, however, is that my involvement with the refining of softwood chips, through investigations with which I have been personally concerned and also through close contacts with the Pulp and Paper Research Institute of Canada in Montreal, has made me a great enthusiast for this method of pulp production. I would certainly like to see its wider application to softwoods and to tropical raw materials as a means of providing your much needed additional sources of pulp.

It will be realised that, so far, I have omitted to do more than just mention one of the drawbacks of high yield refiner pulping and that is the question of energy consumption. The history of the development of this pulping system has been closely associated with energy reduction problems and, although great strides have been made since the early investigational work was undertaken ten years or so ago, energy usage still tends to be a little high compared with conventional groundwood. I believe, from the ingenious small-scale laboratory studies undertaken by Attack and May at PAPRIC, that the future possibilities of substantially reducing the energy needed to refine wood chips are bright. Even now the industry is in the happy position that, because waste wood, and therefore cheaper wood, can be used in making refiner mechanical pulp, this can more than offset the small extra cost needed for meeting the present rather higher energy requirements.

Of course, to promote the use of refiner mechanical pulp more fully and profitably, the question of colour and brightness, their levels and their reversion tendencies, are of great importance.

In my contribution in Atlanta to the Sixth International Pulping Conference, I referred with some emphasis and enthusiasm to the important high-priority task of developing a groundwood bleaching procedure, which must be non-delignifying (to maintain the high yield), commercially acceptable, and be able to provide a product of reasonable stability. This is, of course, a tall order, even for softwoods of the types we are considering in Atlanta. Nonetheless, by way of illustrating the possibilities, I referred to the work of Howard Rapson, who, at the preceding International Pulping Conference in Vancouver (the Fifth) displayed hand-made mechanical pulp sheets which he had bleached with peracetic acid upto a brightness as high as 88% G.E.

In correspondence I have had subsequently with Professor Rapson on this subject, he had endorsed his hopes of achieving high brightness figures without removing lignin but he does not underestimate the toughness of the task. He has research workers studying the reactions involved in bleaching groundwood, and his is by no means the only school active in this field. An important facet is to determine how peracetic acid and other bleaching agents are being used effectively, and what happens when they are consumed wastefully, by reacting with colourless groups to produce other colourless groups for instance. Like many problems of this nature, there seem to be no obvious short cuts, but I am a great believer that success will come in due course, at any rate for the less heavily discoloured woods and, of course, at prices which must be economic. In a very recent publication (5), Rapson gives a useful review of the current state of groundwood bleaching knowledge.

Functionally, mechanical pulp is such a desirable constituent of mass product printing papers that the incentives to work on the further improvement of its qualities are tremendous. This, then, is one of the most important ways of working towards higher yield pulping.

HIGH YIELD CHEMICAL PULP

I have realised increasingly, as I have progressed with the preparation of this discourse, what a very wide field there is to be covered. It obviously is impossible to explore anything like the whole subject, but it is hoped that I may throw up one or two pointers which, in one direction or another, will help to catalyse further progress towards higher yield goals.

The purposes of incorporating into the title the question of functional papers was to emphasise how, by bearing in mind and reassessing from time to time what job it is that the ultimate product really has to do, it may be found possible and even advantageous to use higher yield pulps than are conventionally considered desirable.

The mention of functional papers does not mean that all paper is not in some way or other functional, but there is a distinction to be drawn between aesthetic aims and the more severely utilitarian purposes for which paper may be required. In utilitarian qualities, colour for example and brightness may in reality be of secondary importance, and, provided customers can be convinced that the colour to which they are accustomed is not a necessary part of the functioning of the paper, higher yields can be worked upon.

It is difficult to avoid mentioning newsprint repeatedly — even in this chemical pulping section — since, on our functional basis, it is a strong contender for higher yield operation. The tonnages involved, and therefore the potential savings in money and raw material, are very large. I realise, of course, that the problems associated with newsprint manufacture in India are particularly severe and that you have been disappointed with your 1968 figures despite an all-time record. You have a very tough challenge in endeavouring to eliminate your currently imported tonnage, but perhaps higher yields, based on dispensing with chemical pulp, plus additional machine capacity may whittle down your import needs sooner than you think.

I was able to emphasise, at the Atlanta meeting, that, if only greater recognition would be given to the functional and economic importance of mechanical pulp in newsprint, greater quantities could be used, even up to the 100 per cent mark, thus substantially improving the overall yield from the raw material supply. Those of us who are favoured with good long fibred softwood supplies are naturally in a privileged position compared with mills having to use hardwoods — and poor hardwoods at that. Nevertheless the challenge is still there, even if it is considerably more difficult to accept. But the rewards are there also. I speak with some knowledge of these matters, as we had first-hand experience of shortages and the need for developing substitute fibres and higher yields during and immediately following the last world war.

In retrospect, perhaps the title of this section is to some extent misleading, since I believe that in discussing high yield chemical pulping we really should take the mechanical pulping process as our starting point. Not only can it be produced, as I have said, with quality characteristics that enable it to vie with chemical pulp, thereby still further enhancing the yield situation, but also there are good prospects for upgrading its use in better quality papers, notably by developing improved fibre quality (probably through continuing progress in refiner techniques) as well as by attacking the bleaching and colour reversal problems as discussed above.

Moving lower down the yield scale, a prominent example of success in using high yield pulp functionally for making an excellent quality product is the production of semi-chemical pulp for making fluting medium. This combines a good yield of raw material with an excellently functioning finished product. It is certainly by this kind of approach that forest conservation can be helped significantly, matching the process to the product as well as to the raw material.

And so we have a wide choice from conventional groundwood and refiner mechanical pulp through chemi-groundwood, mechano-chemical pulping and cold soda to semi-chemical NSSC pulps and on to high yield chemical pulp and then normal lower yield conventional chemical pulp.

Turning, rather abruptly now, however, from the high lignin containing materials, I would like to refer briefly to a new development, which, although long-term, looks to me to be promising. This concerns the preparation of pulps in such a way that the procedure is highly selective. The yield is high, not due to lignin retention, but because damage to the potential papermaking constituents is minimal. In fact only the non-cellulosic material is removed, and the product is then available for making the highest classes of bright, white-papers. The name given to this process is 'holopulping'; it is under development at this time by an organisation with which many of you in this audience are very familiar — the Institute of Paper Chemistry(6) in Appleton, Wisconsin. Indeed, you may already know about the process but I feel nonetheless that I should refer to it here.

The essential feature of the procedure, which, as I say, still has a long way to go to become commercial, is to separate the attack on non-cellulosic materials into a number of carefully planned stages, using for each step the most appropriate reagent and pulping conditions. In this way, the whole process is optimised rather on the lines of the old Cross and Bevan procedure for determining the cellulose content of fibrous raw materials.

As it stands at its present stage of development, the first step is to prepare finer chips than is normally the case so that selective delignification can occur. The second step consists in modifying the lignin in situ with a mild oxidant. The most practical reagent found so far seems to be chlorine dioxide. Under favourable conditions, this step can be accomplished in a matter of minutes at temperatures below 100°C. The modified lignin is then extracted by a solvent which can be caustic soda. Bleaching may be done with hypochlorite in the usual way. The bleached pulp retains the high yield, with improvements in its properties. Finally, after extraction and bleaching, the residual chemicals are removed by countercurrent washing. By these means, which incidentally, it is said, are readily adaptable to continuous operation and automatic control, the yield of bleached pulp may be raised from a normal below 50 per cent to a figure approaching 70 per cent, depending, of course, on the nature of the raw materials.

The preliminary presentation of these results, which were made public as recently as May this year at the 33rd Executives Conference, includes, even at this stage, a useful indication of costs. Although the power, steam, water and material costs are higher, the wood and chemical costs are lower, the overall result being that the total production costs of holopulping will be about the same as those of conventional chemical pulping. Bonus advantages include; very little odour, only atmospheric equipment required, the regeneration of chemicals is relatively simple, the basic chemicals required are produced by electrolysis, and the chemical system is nearly self-sufficient. This, of course, is only the very briefest sketch of this new development, but it could be an important contribution to high yield pulping on a rather grand scale, which is that, since only unwanted material is removed, the holopulp remaining is available for all kinds of high-class paper and board manufacture. Thus, this could be a major way to conserve raw material without the need for retaining lignin to give a high yield. It offers the possibility of a rather remarkable combination of high quality with high yield.

I hope I have not given too much prominence to holopulping at this stage, but there is wisdom, I suggest, in keeping your sights well up for future consideration provided, during the further development, you view the eventual possibilities from a firmly practical stand point.

INFLUENCE OF MACHINE RUNNABILITY

The use of high yield pulps will almost inevitably cause some differences in the way the paper machine runs, both so far as the drainage properties are concerned and also in the effect on the draws. The chances are that, except for holopulping, the fibres will be somewhat shorter and less flexible, and therefore the wet strength between the various papermaking sections, especially at the wet end, will be reduced. Furthermore, the desire to gain higher yield in newsprint, for example, by reducing if not eliminating the chemical wood pulp content, can also have an effect on drainage and draws.

There is no basic reason, however, why these characteristics should necessarily cause a drop in papermaking speeds and efficiencies. On the contrary, provided the problems are faced with intelligence and a recognition, that, by using modern equipment and modern systems. not only can these disadvantages be offset but also, through the need to look into the new conditions more closely, improved overall running can be established. There is a lot of leeway that can be made up between current ways of running paper machines and ways in which they should be run. It has seemed to me for some years that most papermaking organisations have not taken full advantage of the help that can be gained from the use of modern instrumentation and I am convinced that, in the hands of really capable physicists and engineers, it should be possible to tract down and to prevent most of the causes of paper machine breaks that occur today. A colleague of mine some years ago made the comment that, if we can run a paper machine satisfactorily for an hour without breaks or significant variations in the properties of the paper made, there really is no reason why, with proper control, that same machine should not carry on for a day or a week, or more, without breaks occurring. These views are becoming all the more realisable through the intense interest there now is in the computer operation and control of paper machines.

It happens that two months ago, at Oxford, we held the Fourth Fundamental Research Symposium. These conferences, as you may know, are held every four years and, on this occasion, we decided to break away from our previous general pattern, which concerned the fundamental physics of fibres and papermaking, in favour of what we believed, when we started our planning four years ago, would be a highly topical and important area of study. We called our subject "Papermaking systems and their control".

The week was, I believe, a first-class success and one of the contributions I found of particular interest, in connection with this visit of mine to India, was the story of a very enterprising and successful application of a computer system to a small paper machine, installed at the Grove

Mill Paper Company Limited, located in the midlands of England. Mr. G. F. Beecroft, the Managing Director of the mill, was kind enough to send me a written account of some comments he made at the symposium concerning the successes they have achieved at Grove Mill. His comments are as follows :-

'Five years ago in 1964 we wondered how to simplify our operation and to reduce costs. Primarily we wished to simplify, and we considered that automation of a shortened system should not be too costly an affair. However, no electrical company in the computer process field considered our thoughts to be viable economically until English Electric made a study in depth and thus the present system was evolved. The economics of controlling our 84" machine proved fascinating when it became apparent that we were going to be successful and nowadays we have ceased to be amazed. In fact, we consider full computer controlled paper manufacture to be ready for discussion, bearing in mind that whilst full control would be economical for newly built mills, older mills may be selective with regard to parts of the process that should be automated or perhaps only instrumentated in a sophisticated manner. The day is here when the equipment can become a package deal and in such a highly capitalised industry as ours the price will hardly be noticed.

'We believe that our system is one of the shortest in the world, if not the shortest, and we would like to issue a friendly challenge. From starting up with an empty system and wired bales of pulp we can be in full production of highly beaten paper in 35 minutes. Who can do better? Our computer produces controlled conditions so far as the wet end is concerned, and width of the machine and speed are immaterial. Computer control of drying conditions, the wetting process, and draw tensions can all be added if they can be shown to be economic. In our opinion it may be unwise to computer control certain parts of the process if there is a machineman still employed. Our present benefits are better running conditions, faster change over times, and a sales edge over our competitors.

'Our computer has been the key which has unlocked our mind—for example, we foresee an end to effluent problems in mills such as ours. This is the most exciting part of the whole affair; this unlocking—where will it lead? So strongly do we have these thoughts that we say if you only wish to control basis weight then do not purchase a computer controlled process — it would be like casting a pearl.

'Naturally, we are enthusiastic and we want to see the system copies. The reason for this apparent benevolence is that we want a feed-back of information. Our system is a Mark 1 — the sooner a Mark 10 Model is developed the greater our own development will have become. We invite visitors to pay us a visit — our only stipulation is that a return visit be permitted, and we would hope that all round knowledge had improved.'

Thus it is, I feel, quite a godsend that at this time, when most of us are anxious to conserve raw materials by increasing yields through better functional pulp preparation, we can obtain solid help in the running of these pulps on our machines by the use of modern instrumentation and by the computerisation of paper machine operation. By these means, breaks, effluent, quality variation, and the time needed for grade changing, are all reduced, and, in the case of George Beecroft's 84" machine at Grove Paper Mill, the capital cost was less than £20,000, in hard cash (7).

In mentioning these matters, I hope I am not being too repetitive concerning information and programmes that you may well already have under consideration, or perhaps already in operation. Nonetheless, I think it is worth quoting one or two further points of considerable economic interest that have been published by the Grove Mill Paper Company.

The automatic control system installed there enables the operator to set all the controls — thick stock valve, main flow valve, breast box head, slice opening and the machine speed — at their optimum positions, whereupon the control system will implement the new running conditions at the correct settings as well as in the correct sequence. All this is done by merely resetting three dials on the control desk and operating a pushbutton switch. When this is done, the computer causes the controls to be automatically adjusted to the new instructions. This ensures that each grade is made in the same way by all operators and in such a way that the machine is used to its optimum capacity.

A lot more could be said, but fuller details are in the original publication, and, indeed, the subject is referred to in Indian Pulp and Paper (8). Suffice it to mention here that a system of this kind offers a wonderful way to use paper machines, however old and narrow they may be, in such a manner that at all times the best speed and performance are maintained and the conditions such as efflux ratio, basis weight, breast box consistency, and drying conditions are at all times operating to give uniform paper quality under optimum operating conditions of the machine.

To add to this impressive list of advantages, it must be emphasised that the Grove cost was very moderate, particularly in relation to the capital cost of the machine. It enabled the project to make sense even for an old and narrow width machine with a maximum speed of 800 fpm, making substances ranging from 30 to 130 gsm.

As a final comment concerning this question of the influence of machine runnability on the use high yield pulp, perhaps a paragraph from the introduction to the Oxford Symposium (9), by H. W. Emerton, the Chairman of the Fundamental Research Committee, would not be out of place. It further emphasises how such things as down-time, which might be excessive when using high yield pulps having indifferent running properties, may well be offset by using a modern computer approach. Here is what Mr. merton says :

> 'It is perhaps not entirely naive to ask why control is necessary. More precisely the question should be formulated as "what is the incentive for a greater degree of control than that hitherto exercised?" In the last resort and speaking quite generally, it is of course financial incentive, which may be ex-expressed in terms of savings in labour, in raw materials, in down-time on the process, and the usually unquantifiable benefits of customer goodwill arising from improved and more consistent quality. As we gain confidence and experience in control we eliminate the inertias from the system; for example, we reduce the capacities of machine chests of the process; the stocks and inventories of a commercial system; the delay in customer feed-back in a commercial system. Finally, of course, advanced control permits operations which would otherwise be quite impossible'.

CONCLUSION

We have seen that, to produce high yield pulp and make the fullest use of it (which means that we want the largest possible amount of paper from every ton of raw material the country can provide), we need to have not merely high yield pulping capabilities, but a whole series of inter-related considerations. These include :

1 Intelligent selection of the highest yielding pulping process consistent with the true functional requirements to be built into the paper (or board).
2 Wherever possible (to help the economy and minimise effluent problems) the high yield system chosen should be a non-delignifying one, or at least a minimal delignifying one.
3 Paper machines must not dictate and therefore place limitations on the properties of the pulp to be used. Ideally, the requirements of the finished paper, both from the quality and economics points of view, must be the sole consideration.
4 Thus paper machines must be highly flexible and controllable in operation, and of course they must maintain high efficiencies. Modern instrumentation and computer application can greatly help. George Beecroft has reported a 15 per cent increase in production as a consequence of his instrumentation and computer control (8).
5 Much more attention must be paid to the true quality requirements of the paper to be made. Testing instruments should be viewed with the greatest suspicion until they have been proved beyond all reasonable doubt that they are able to provide measurements that are really signifificant in terms of paper behaviour in commercial use.
6 Looking further into the future the possibility, for high quality bleached papers of producing high yield delignified pulp, such as holopulp, should be kept in sight.

In addition to high yield aims in a country such as yours here, and my own at home, in which the paper industry is very short of home-produced raw materials, there are the questions of increasing the supplies, and the associated problems of improving accessibility to raw materials and markets. This calls for intelligent site selection and a really enlightened afforestation policy.

I would like to finish up with a final note about the question of functional papers. The problems arising in devising and using tests for true functionality have greatly interested me for many years, and I came across a practical example of the difficulties only two months ago. I think it is worth recounting.

At the Oxford Symposium (9), to which I have already referred, a contribution to the discussion was given by R. H. MacClaren concerning what he termed the 'guide-line approach' when specifying paper which must have critically accurate properties. He gave, as an example, the following figures for a quality he buys in large amounts:—

Thickness	— 3.8 ± 0.25 mils.
Basis Weight	— 75.2 ± 5% gsm
Moisture	— 4.7 ± 0.8%
Stiffness	— 2.0 machine direction
TaberV5	— 1.0 cross direction

All these tests are carried out under standardised atmospheric and temperature conditions. There is also, incidentally, a smoothness test, the validity of which I queried and which, I gather, may be modified. I recommended the PRINTSURF as being a far better scientifically designed and practical instrument then the one he was using.

The crucial point, however, is that, recognising the inadequacy of these fairly simple but reliable tests and the impossibility at present of measuring and specifying fully has more complex requirements. MacClaren links these simple tests with carefully selected paper machines known to be capable of providing the required quality. The machines he needs are not easily found, but, having located them and arranged for paper to be made according to his guide-lines, he insists that once they have settled down to the right quality the papermakers are prohibited from making any adjustments whatsoever. He is so insistent on this that he has representatives watching the machines twenty-four hours a day to ensure continuity of the quality. MacClaren believes that in this way he gets a distinct edge on his competitors, who try to tie everything up by a specification using tests, some of which are of very questionable validity.

This example illustrates two things: firstly, the great difficulty of describing quality adequately by means of test specifications (this is not really an admission of defeat, it is a sensible recognition of current limits in our test capabilities); and secondly, there is the need for matching and maintaining unvarying of end product quality uniformity to suit customer requirements.

Our testing difficulties must therefore be recognised, and I come back to my starting point, which is that the raw material must be matched as economically as possible to the requirements of the ultimate consumer. I am sure this can be done much better than we do it now; and, at the same time, by developing improved pulping techniques and making more realistic judgments of quality requirements, we can gradually move closer to higher yield targets.

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consumption of pulp and paper

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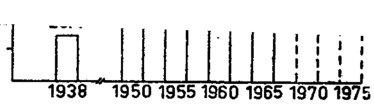

Fig. 1. The World Consumption of Paper and Paperboard.
The years 1970-1975 acc to FAO

	[illegible]	[illegible]	[illegible]	[illegible]
India	20	41	16	23
West Europe	21	20	24	25
USA	20	16	23	41