OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

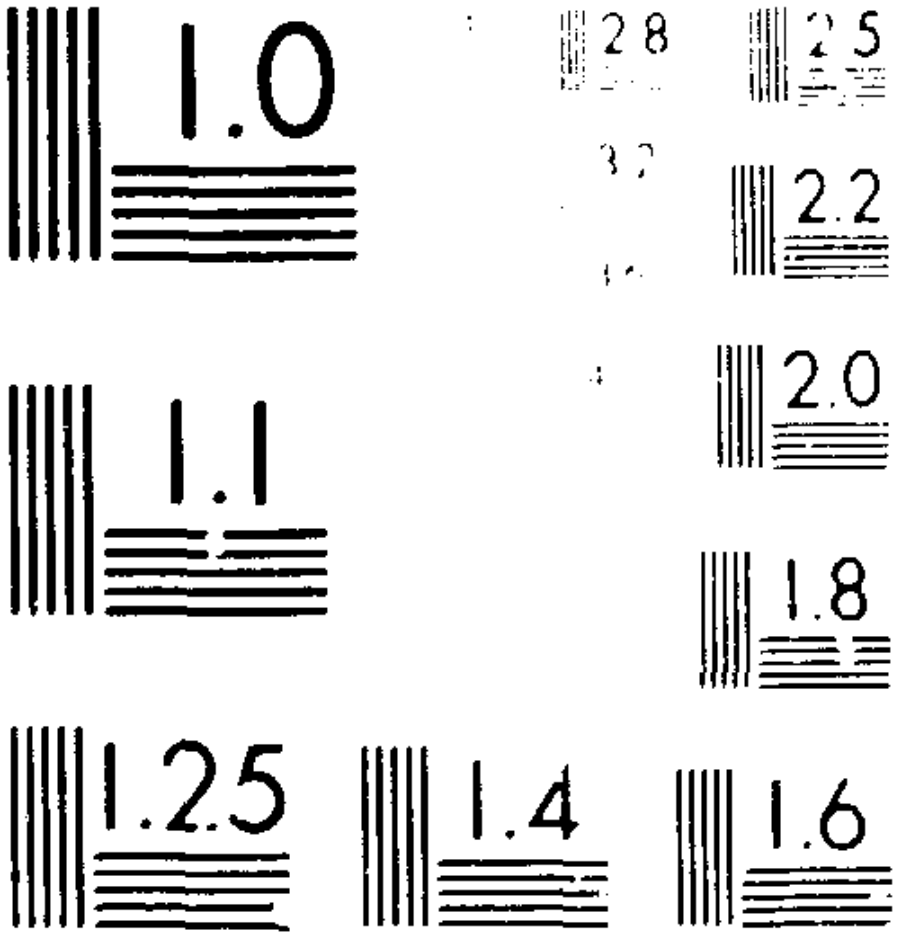
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

10534

Distr.
LIMITED

UNIDO/IO.446
13 August 1981

ENGLISH

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

SO YOU WANT TO BUILD A PAPERMILL?*

US/GLO/79/121

A conversation prepared by D. Attwood**

* This document has been reproduced without formal editing.

** Director, Paper and Board Division, Pira (National Technical Centre for the Paper and Board, Printing and Packaging Industries), Leatherhead, Surrey, United Kingdom.

INTRODUCTION

A world without paper is almost inconceivable and yet there are still many countries who produce no paper at all. In 1981 there are exactly 50. Governments of those countries are naturally interested in encouraging paper manufacture both to improve literacy and to save foreign exchange. It generally, however, requires an entrepreneur to take the first step (with or without government encouragement). The internationally famous papermakers and/or consultants mostly from developed countries who might be turned to for advice are often incapable of conceiving of the scale which is appropriate for a country new to papermaking and often schemes which are too grandiose are proposed.. Even if the proposal could be funded it often turns out that the finished product is more expensive than can be bought on the open market.

It is the present author's opinion that the solution lies in very small scale pulp and paper plants. What follows is an imaginary conversation which takes place in the author's office with an entrepreneur from a developing country with no papermaking history.

A. Well now that you have seen the laboratories and seen paper made on a very small scale lets have a talk about your interests. Have you been visiting papermills on your visit? Which countries have you visited so far?

E. I have been travelling through Europe on business.

A. I believe that you wish to discuss papermaking opportunities with me. Do you have any particular aspects in mind?

E. All the paper used in my country is imported and so I thought this presented me with a good business opportunity to build a papermill and serve local needs. However, in reading the financial papers it seems that most major papermaking companies in the world are having difficulties in making profits at present.

A. Well that is not strictly true. World paper demand and hence manufacture does tend to be cyclical, but even now the major companies are investing in new plants. Such new plants these days are often so large that when they come on-stream there is suddenly an oversupply situation for a period. But, world demand is insatiable.

E. What sort of increase in capacity is planned?

A. If all the planned expansions materialise, more than 29 million tons of paper and paperboard will be added to world capacity by 1984 bringing the total to 222 million tons per annum. If you would like further details, I suggest that you consult FAO's publications, in particular their recent Pulp and Paper Capacities 1979 - 1984 report.[1]

E. I am afraid these figures are almost meaningless to me. The consumption in my country is so small as to be insignificant. Nevertheless, perhaps you do reassure me when you say demand is insatiable and that capacity continues to be increased. Even though I have not told you from which country I come, can you be certain that demand there will increase?

A. As near certain as anything in this world. Paper consumption goes hand in hand with increased disposable income. I do not believe the European countries will necessarily approach the per capita consumption of the United States and I do not think the developing world will approach the consumption of Europe. But these consumptions are probably one hundred to two hundred times the consumption in your own country so that if your country develops further it will consume more paper. But, of course, you do not have to build a mill on the expectation of an increased demand, although this would be reassuring. You should almost certainly plan on satisfying existing demand.

E. So you believe in the future of paper. In that case what sort of paper should I make?

A. How long is a piece of string? It all depends upon what you mean by paper. There are literally hundreds of different types of paper all with in built properties to suit their end use. I can provide you with a list if you like[2]. It would be difficult to conceive, for example, of two more different papers than newsprint and banknote paper. The first to be used once and then disgarded and the second to be in circulation for many years.

E. Yes, I quite see that, but then the prices obtained for the products will be very different. Newsprint is made from cheap materials, is sold in bulk, is not very demanding technically.

A Nothing could be further from the truth than your last statement. That it is made from cheap materials is true and that it is sold in bulk almost always true. It is, of course, manufactured in bulk but

even in the developed world there are small local newspapers, which buy newsprint in relatively small tonnages. However, newsprint is a commodity product usually made on fast wide machines and sold in bulk.

E. What do you mean when you say that it is not true to say that the manufacture of newsprint is not very technically demanding? It is just a cheap disposable paper.

A. I make this comment based on two aspects firstly, the fact that newspapers are produced to a very tight production schedule and, therefore, newsprint must have sufficient strength to run on high speed presses.

Of equal importance is the quality of the print. In many countries the advertising in a newspaper produces as much revenue as the cover cost. It is very true that a newspaper reader could cope with a much lower quality of paper than is currently being used but a soap advertiser for example, is looking for a bright clean advert. It is not very convincing saying Brand X washes whiter if the accompanying picture is a dirty grey. Neither does one advertiser want another advert showing through the other side.

Secondly, just because the paper is a bulk commodity the paper machine itself, usually embodies very high papermaking technology. The machines are usually dedicated only to the manufacture of newsprint at high speed.

E. What you say may be true, but I do not think you understand the problems in a country like mine. We produce no paper at all, we could do with much lower qualities of paper than would be necessary in a developed country.

A. I agree with you. Provided you are not going to compete on the open market. The commodity grades can be shipped very cheaply all over the world. It is most unlikely that you could make them cheaper than the mass producers and if you have a quality disadvantage than you will suffer. That is, of course, unless you have protective tariff barriers.

E. I am certainly not contemplating banknote paper but I must say that I thought newsprint was a possibility but as I understand it you are advising me against all commodity grades. Just what are these commodity grades?

A. I mean all those papers and indeed certain pulps which are more or less internationally standard products and consumed in large quantities in a limited number of grades. Typically I am referring to such papers as newsprint, liner board, sack kraft and market pulp. These are standard mass produced products which can be shipped over large distances and sold relatively cheaply anywhere in the world. Plants being installed to manufacture these grades get bigger and bigger so as to take advantage of the economy of scale.

E. Just what is this economy of scale?

A. Well put very simply it is the case that it is found in practice that a new paper machine producing 100 tonnes of paper per day may only cost 50 - 60 per cent more than a machine with a capacity of only 50 tonnes per day. Thus as the size of the plant increases the "capital element" in each ton decreases.

E. If this is the case then why do you recommend to me that I put in a small plant. What evidence have you that they can be viable?

A. Look. I happen to have on my desk a magazine[3] describing a host of new mini mills being built in India. This particular one to make 26 tons/day of printings and writings from rice straw, wastepaper and rags is particularly interesting. It is about the size I might recommend to you.

E. Is the printings and writings an area you would recommend and is 26 tons/day about the right size to start?

A. You should be aware that legislation in India favours mills of less than 30 tpd and that might have influenced this particular choice but, yes I do think this is about right. Without knowing the precide details of your requirements I believe 20 tpd is about right to start with and

I recommend that you consider either printings and writings or the cheaper packaging papers. In fact, in balance I think the packaging papers offer the best chance of an early commercial success.

E. Why what have you got against printings and writings?

A. In one respect they are a good choice since they have a higher added value. You will, however, have to bleach the pulp and probably go in for producing pulp by a full cook. Both these aspects can give rise to effluent problems and associated losses.

E. I am not sure that I understand what you mean by "producing pulp by a full cook".

A. Let me try to explain. To all intents and purposes all the fibres used in papermaking come from plants of one sort or another. In the vast majority of cases these plants will in fact by trees. In the raw state that is to say when a papermaking fibre is on a tree it is adulterated with binding materials such as lignin, resin and other substances.

The lignins cement the fibres together to form the skeleton of the plant and they also penetrate the fibre wall themselves. It forms the main constituent of the dry plant after cellulose which is what the fibres are made of. The other chemicals are only minor constituents. For example, a tree may be 66% useful fibre, 30% lignin, 3% resin and 1% inorganic material. In the process of pulping wood by chemicals, lignin is degraded so that it is soluble in the pulping liquid so that by filtration relatively pure fibres are obtained. When chemicals are used to separate fibres from the other the process is termed "Chemical Pulping". Large portions of the plant are dissolved away so that only a low yield is achieved perhaps as low as 40%. Such fibres, however, are very strong and easily bleached.

The other main type of pulping is Mechanical Pulping where only physical force is used to break up the structure of the wood. Although the yield

can be as high as 99% this method produces coarse weak pulps and these are commonly used, for example, as the major constituent in newsprint.

These days there are many combinations of the two processes one known as Chemi-mechanical pulping involves pretreatment with chemicals followed by mechanical defibering.

When I used the words "full cook" I mean that as much of the lignin as possible is removed and that very pure fibres are left.

E. Do your comments apply to plants as well as trees and what exactly happens to the "lost" yield.

A. Yes, of course, straw for example, also contains lignin as well as fibre and a full cook on straw might give a yield of only 36%. But agricultural wastes like wood need not be subjugated to a full cook. Typically, the cooking can be done with chemicals like milk of lime, soda, ash and caustic. Usually, just sufficient chemical treatment is given so that supported by a mechanical defibering method the organic chemicals holding the fibres together can be removed.

Unless these chemicals are recovered and this is not normally viable with a small pulp mill then the effluent from a mill can cause problems in small rivers or irrigation channels, but they can be used to advantage. In Indonesia for example, they have been used for improving the fertility of the soil for rice growing.

E. You seem to have very strong views about the paper I should not make.

A. Yes, if I were you I would reject all the mass produced paper but I would chose from products where there is a large sub-division of grades which customers take off in small lots. You see a large mill cannot maintain a sufficiently large stock to give an adequate service at a distance. Even in the developed world, small (by their standard) mills exist to serve local markets. In fact, if

this were not so then market pulp mills would not exist. It costs very little more to produce paper than to produce dry pulp for sale, the processes are so similar. Market pulp is, however, a commodity - the small mills buying it transform it into virtually a speciality product serving local markets. Proximity to a market is, therefore, one of the very important factors which can lead to a small mill being viable.

E. So you mean the mere fact that I want to make paper near the consumer gives me an advantage over the importers.

A. Of course, not only will you be able to satisfy small orders, but you should have considerable savings on freight charges.

E. So you see the proximity to market as being the most important factor?

A. By no means. I would think that market size is probably the first consideration. Undoubtedly your new mill will stimulate demand (especially if this has been artificially restrained because of import restrictions) but you must first of all satisfy yourself as to what the demand is.

E. You are right to remind me to look at market size - that after all is the first requirement in any business but to return to the nearness of the mill to the market - this must surely be a compromise with nearness to raw material?

A. It goes without saying that raw materials must be available at an acceptable price so that if the freight costs of those are too high then the total profitability will be affected. Perhaps I can ask what raw material is available.

E. As yet, I have not studied that, but I understand that any fibrous material can be turned into paper.

A. That is true. In general all paper is made from fibres derived from plants. There are literally thousands of different species ranging from grass to the largest trees. The vast majority are capable of yielding a usable fibre but in rea ity there is only a relatively small number of species which are economically suitable as a source of fibre for papermaking. In general it is the coniferous soft-woods which produce the most desirable fibrous raw material but these trees mostly grow in temperate latitudes.

We should not forget,of course, that up to 90 years ago trees were not used for papermaking. Papermaking fibres were only non-woody fibres from agricultural products such as wool, linen flax, cotton, straw etc. and the prime source was to a large extent recycled rags. It is a comparatively recent innovation for softwoods and even more recently for hardwoods to be used for papermaking, although today these fibres have taken over the market so that about 94% of the world's paper is based on wood.

It is very relevant I believe that the old tradition to use recycled products such as rags has been continued in many countries by recycling waste papers.

Technologies exist for pulping non-wood fibres for papermaking although these tend not to be applied anywhere anymore in the industrialised world. They still do exist, however, in Europe and the developing countries of Asia and Africa.

There is no shortage of non-woody fibrous raw material in the world. Recent information from the People's Republic of China indicates that 60% of the fibres used in the production of 5,000,000 tonnes/year of paper in their 1,000 mills, are also non-woody fibres. FAO estimate that around the world about 500 million tonnes of fibres could theoretically be produced.

The pulp industry in a number of countries such as Algeria, Morocco, Tunisia, Eygpt, Iran, Iraq, Burma, Cuba and Sri Lanka is mainly based on non-woody materials. Pulp production in many other countrie

such as the People's Republic of China, Colombia, Peru, Turkey, Romania, Hungary, the Philippines and Indonesia is partly based on these fibres.

So you see paper can be made from non-woody plants and these should be one of your first considerations.

E. Is it not possible to plant trees? I thought that eucalyptus were being planted which could be harvested in seven years.

A. I would say that it is uneconomic today to contemplate forestry or any other activity solely to produce papermaking fibres. It is usually residues or waste material which are used for papermaking.

E. You mean in those parts of the world which have no softwood forests?

A. No it is becoming true everywhere. Even in America and Canada, it is usual to exploit the forest by saw milling so that the bulk of the tree goes for lumber and it is the sawmill wood waste that is used for pulping. With small trees, of course, this is not possible.

E. But I have heard about all kinds of plants being used for papermaking, like bamboo, rice, straw, jute sticks, hemp, sisal, different grasses etc.

A. As I have said all will produce pape of a sort and I would probably advise you not to ignore such raw materials, but can you also obtain waste paper? In fact, if paper is used in your country you must have waste paper.

E. It is all very well for you to suggest recycling paper. That may be acceptable in an affluent society where paper is used only once but where paper is short it may be used many times before it is finally discarded.

A. Nevertheless, discarded it finally is and there are, for example,

some small paper mills in India which are based on waste paper. Have you seen this book on small scale papermaking by A W Western, together with these case studies[4]. Look here is a 30 tonne a day plant based on straw and waste paper. In this case the waste paper is from printers' off-cuts a very high quality but of little further use than for recycling. I have an article here[5] on the Kibo Board Mill in Dar-es-Salaam in Tanzania which was planned to produce 10 tonne/day and is now producing 14 tonne/day. This was originally based on an expectancy of 10 tonnes/day of waste paper arising from the local printing industry and office waste from governmental and local community administrations.

E. Agriculture is very important in my home country and I know there is a lot of straw surplus to requirements. Should this be my first choice?

A. Do first of all reassure yourself that it is available. Farmers are noted the world over for being conservative and they will always give preference to their own farm requirements as opposed to supplying a mill. But certainly straw is an ideal material, if somewhat bulky and, excellent papers can be made from it. Look at these examples on my desk which come from Greece. They are fully bleached banks and bonds and compare favourably with anything we can make.

E. Would you only use straw for high quality papers then? Could it not be used for packaging papers?

A. It could be a major constituent of packaging papers and you would not have to bleach it in that case. But it has very little strength. It gives quite a stiff paper but not a very strong paper.

If you can get hold of a lot of straw then you could consider a mill based on say 80% with 20% of waste for strength.

E. You surprise me when you say use waste paper for strength. I would have thought waste paper would produce a very weak fibre.

A. That is one of those questions for which one has to answer "it all depends". It does all depend upon what you mean by waste paper. It can vary from the very high qualities such as printers' off-cuts which are virtually pure pulp substitutes and can be used as such and command an almost equivalent price, to the very low qualities often called mixed waste which are only suitable as fillers for the middles of multiply boards. Let me show you the European list of the standard qualities of waste paper[6].

E. Which of these would you recommend combining with straw to make packaging papers?

A. Some compromise is possible but it would be a quality such as "Corrugated Containers".

E. You said earlier that if we used paper in my country then there must be waste paper available. I can get hold of government statistics to find out how much paper comes into the country. Some of it must be destroyed in use or go on to library shelves or into files. What would it be realistic to recover?

A. It has been calculated that about 80% of the paper and board produced worldwide could be potentially recoverable. Recovery rates as high as 50% have been spoken of but in all honesty 25% would be a very high figure.

I would only use the overall figure to give me an upper limit and say that this was 20% of the paper consumed in the catchment area of your mill.

E. You mean I could rely on having 20% of the paper consumed in the area available for recycling.

A. By no means. I said it was an upper figure. It will give you some idea of your area's potential. There is no substitute for a proper survey to see what local firms can sell you.

E. What other materials should I consider in addition to straw and waste paper?

A. Well, as an aside almost, do not ignore rags. Cotton rags that is. They have a tremendous potential for adding strength. If there are any local textile mills that can provide cuttings, uncontaminated with synthetics, then these would be a valuable source of raw material.

E. They sound so good, why do you say "as an aside"?

A. Primarily because they are never likely to be in sufficient supply to be a major constituent. Nor would you want them to be a major constituent, unless you were making very special kinds of paper such as banknotes, electrical papers etc.

E. Very well I will remember that, then what other raw materials can I consider?

A. The other waste material is bagasse that is the fibre derived from sugar mills. If you have a well run, modern sugar mill in the area of any size then you should find surplus bagasse to run a pulp/paper mill. I suspect this cannot be the case, otherwise you would not be talking to me. There is a fair knowledge of bagasse papermaking in existence and any competent consultant can work out for you whether a mill would be viable. Of course, it may be that a small supply of bagasse is available in which case you could consider a small plant.

E. And as for wood ...?

A. Again, I suggest that if you did have sufficient wood available we would hardly be having this conversation. No, if we are discussing a small integrated pulp and paper mill we probably have in mind non-woody fibres, wastepaper and bagasse. You could consider wood waste if you know it is available.

E. I begin to see certain restraints.

A. Yes, if you accept my argument about no commodity grades and if we are going to use the raw materials I have just outlined and if I am right about an upper limit of say 30 tpd to avoid effluent problems then an ideal mill is probably going to be:

1. 20 tpd based on waste paper, probably producing cheap packaging grades.

or

2. 20 tpd based on unbleached straw plus waste paper for strength again producing cheap packaging grades.

or

3. 20 tpd printings and writings possibly based on straw.

E. Are these the only alternatives?

A. Oh no, I have left out rags, bagasse and endless permutations. Much will depend upon what you have available.

E. The magazine article about small mills is really very general. Have you any other information?

A. I showed you earlier this publication[4] Small scale papermaking by A W Western. They contain many case studies of successful small mills. Have you enquired of UNIDO? They have a comprehensive list of publications aimed at advising on new projects. We, ourselves, could soon dig out of the files details of mills close to what you might want to build.

E. What is the simplest mill of all?

A. Undoubtedly, based on 100% waste, but let me stress again Intermediate Technology's Small scale papermaking - if you are looking for ideas it is there that you will find them. Let me read them out to you and you can decide which comes nearer to your requirements:-

1 tonne per day (Hand made).

5 tonnes per day, printings and writings based on waste and market pulp.

5 tonnes per day, tissue and lightweight papers based on waste paper and rags.

7 tonnes per day, printings and writings based on waste paper, wood pulp, rice, straw and gunny waste.

10 tonnes per day, printings and writings based on straw, waste paper and some bought in pulp.

12½ tonnes per day, producing soft and hard tissues and other lightweight papers.

25 tonnes per day, printings and writings based on bagasse and straw.

30 tonnes per day, packaging grades based on rice straw in the winter and wheat straw in the summer together with sabai grass.

30 tonnes per day, printings and writings based on straw and waste paper.

30 tonnes per day, printins and writings based on straw and wood waste.

I will get my secretary to Xerox this flow sheet[7] of a chemi-mechanical straw pulp mill of 10 tonnes/day to give you some idea of what a straw pulp mill looks like.

E. Wait a minute I must write these down ... but none of these in only waste paper?

A. True. But look at these diagrams[8] taken from one of our reports. It shows the very simple way in which waste paper is fed to a paper machine. Basically, all that is required is a hydrapulper and some form of cleaning. In all three diagrams you will see that waste paper is fed via a conveyor belt to the hydrapulper; in the most complicated it will pass through centricleaners, pressure screens and deflakers all of which clean up the stock - but your choice of equipment will depend on the quality of paper you are trying to produce and, of course, on the quality of waste paper.

E. Suppose I wanted to start in a very simple way.

A. Well you cannot dispense with the hydrapulper - a 20 tpd hydrapulper is a fairly common size and you should be able to pick one up second-hand fairly simply.

E. Secondhand? I meant to ask you about that - could all the equipment be bought secondhand?

A. Reconditioned secondhand paper mill equipment is a vital source of plant. In fact it is commonplace in the developed papermaking countries to rebuild and rebuild papermachines. Many components in very modern looking mills can be many years old. In fact, in the UK many of the coating base and/or printings and writings machines are based on the newsprint machines of yesteryear. Obviously bearings wear out and pumps suffer from corrosion but carefully maintained paper machines have a very long life. Drying cylinders and framework for example almost last for ever. In fact it is very instructive to note which parts of a papermachine are replaced when a papermachine rebuild takes place. Almost certainly a new flowbox will be called for and if you buy a secondhand machine you should ascertain which parts you will need to replace.

Most secondhand machines come on the market as paper mill owners seek wider and faster machines. I would certainly seek out second-hand equipment, although, of course, new small-scale pulp and paper

equipment can also be bought in countries like India and Taiwan.

You know there is one major decision you are going to have to make when you chose a paper machine and that is whether to choose a Fourdrinier or a Cylinder machine.

E. Just a minute - choose between a what and a what?

A. These are the two main divisions of papermaking machinery. There are new developments which do not strictly fall into these categories but I would advise you to ignore them for the time being. The Fourdrinier machine is commonly used for all printings and writings, tissue, newsprint etc, in fact all the single ply sheets. Basically a dilute suspension of fibres is poured on to a moving wire gauze and when sufficient water has been drained away or removed by suction the single web is transferred to a press section and then a drying section.

Multiply products on the other hand commonly used for boards and packaging papers are made on multi-vat or cylinder machines. In these a cylinder mould is immersed in a vat of dilute fibres and the sheet is formed on the surface of the mould as the stock flows through it. The sheet is picked up by a felt which traverses all the cylinders so that a multiply sheet is formed. Any decent papermaking text book will explain the workings of these machines. It is important, however to understand the advantages and disadvantages of both systems, although in general it will be the Fourdrinier that will be used for what a layman calls paper and the cylinder machine for what he calls board. When board is made on a Fourdrinier it is, of course, made as one thick ply and the machine speed has to be held back to allow the water to drain away. On the other hand a Fourdrinier does produce a very uniform sheet.

The cylinder machine is far more flexible although cumbersome. Up to nine plies might be employed and all kinds of permutations and combinations are possible with high quality pulps on the outerplies for example, and much cheaper furnishes in the middles. Whilst the forming of each individual ply is much simpler than a Fourdrinier nevertheless, separate pipework and chests will be required for each furnish.

That mill I mentioned earlier in Tanzania for example is a three vat machine. This mill might well be taken as a model if you do contemplate a waste based plant.

By the way I would not recommend that you buy second hand pulping equipment. You remember how I explained pulping to you. Pulping liquors are corrosive and after a useful life it is unlikely that much can be recovered from a pulp plant. In any case it you want a small plant you may just be pulping in an open tank at atmospheric pressure and in all honesty little actual plant is required.

E. In fact, if I take your suggestion and concentrate on waste based packaging grades I shall not be pulping as such?

A. Indeed not, all the "work" has been done on the fibre and you will be merely recovering it. You will, however, have to clean it.

E. How exactly does the waste paper get to the hydrapulper?

A. These diagrams show a conveyor belt but that could certainly be dispensed with to begin with. If waste paper was brought to a large shed and just dumped on a clean floor you would arrange for a group of say women to fill baskets from the waste paper and carry them to the hydrapulper. The very act of filling a basket from the waste would act as an efficient screening operation. Provided the women only put paper into the baskets all the pernicious contraries would be left on the floor to be disposed of later.

E. But could a labour force handle that quantity of waste?

A. I suppose in round figures we are talking of one tonne per hour which is 50 baskets of 20 kg each or 100 baskets of 10 kg each. I think that is a containable problem.

E. In that case which of these cleaners is dispensable.

A. I am sorry but that does depend what you are going to make. It takes us into the realms of consultancy. If you go along this line, however, and start to have a clear idea of what sort of plant you want then I do suggest that you contact UNIDO.

they have extensive knowledge of small scale pulping and papermaking and can put you in touch with the appropriate consultants.

Incidentally we have not so far touched upon services, that is to say water, steam, electricity, compressed air etc. These are just as important as having a secure supplier of fibrous raw materials.

The importance of adequate water supplies of acceptable quality cannot be over emphasised. Water is required both in the papermaking process and for steam generation. No matter what the source of the water it is likely to require treatment. This again is a very technical area, see here are the standards for process water which have been set by TAPPI (The Technical Association of the Pulp and Paper Industry, USA)[9].

These limits are only indicative and in using waste paper water with much higher limits can be used. Do not forget that as much as 40 - 50 m^3/t paper might be required. Careful design could get this down to say 10 m^3/t but it would indeed be careful design.

Water is also required for Boiler feedwater and the treatment of water for such purposes is again a highly technical matter.

When I first joined the paper industry I remember being taught that it required one ton of coal to make one ton of paper and in energy equivalence that is not so far off the mark even now. Most modern paper mills would have a combined heat and power system that is to say a boiler powered by either oil or coal could be used to generate steam, which is then used to generate electricity, but the passout steam from the turbine is used to dry the paper. Thermal efficiencies of over 85% can be obtained whereas 30% is typical for a conventional power station.

Again I have to say "that it all depends" it may be that the best solution is the use of package boilers for steam generation and the purchase of electricity from the grid. Continuous operation will be vital for your viability and you must investigate thoroughly the question of an uninterrupted supply of power.

You might also think it a minor matter if I mention compressed air, but in a paper mill with even the minimum instrumentation the air must be clean and free from oil and water. Do be sure to install at least 100% standby capacity preferably by having a standby compressor.

E. And if I do go ahead, you have stressed at times during this discussion the high technology required. How shall I train my staff? We have some excellent highly qualified young scientists and engineers in my country - should I encourage them to go abroad and obtain higher degrees in papermaking?

A. Certainly not - what you really need are technologists. You will almost certainly need expatriates to start up the plant and you should then arrange for on the job training. If you have got a bright engineer he could be sent for a period to an overseas mill but not to one of the large papermaking companies. It is not only in your country that there is a lack of skilled technicians - almost universally there is a lack in the middle, ie, between the operatives and the higher management both technical and commercial. For my money, however, you must have "on the job training" we have run many courses in mills and I believe it is the best way of upgrading anyone's skills and not losing them to a competitor or overseas country.

Of course, if you are going to buy secondhand equipment it is far better that your own personnel should dismantle it and then erect it on your chosen site. You would do well to send them abroad for training in dismantling although your maintenance crew can be trained in your own country to recondition equipment.

I firmly believe that your first step once you have identified the size and type of mill you are contemplating is to visit at least one and preferably two or three similar operations. Paper makers are usually very open and free with their advice.

Once you have a clear idea of the personnel you require you can think about their training. Do not forget that you are likely to lose a certain percentage of trained staff so you must plan for wastage.

Start up is a difficult time and the experts you import to start the mill will be too busy to undertake training during start up, but it is an excellent time for your own staff to learn by doing. They should have been prepared, however, by their pre-start up training which needs to be a judicious mixture of practical and theoretical work.

E. Thank you for your help. I can see that I have got some reading to do and then some preliminary calculations.

A. Right, I suggest you go away, do your homework, and then write to UNIDO.

This is the address:

United Nations Industrial Development Organisation
Vienna International Centre
PO Box 300
A-1400 Vienna
AUSTRIA

REFERENCES

1. Pulp and Paper Capacities 1979 - 1984, FAO 1980

2. Papermaking and Manufacture of Paper Products by Dr J Ben Lieberman, published by Technical Aids Branch, Office of Industrial Resources, International Co-operation Administration, Washington 25 DC

3. Pulp and Paper International, December, 1980 page 26

4. Small Scale Papermaking by A W Western, published by Intermediate Technology Industrial Services

5. Annexe One - Description of Kibo Board Mill - Dar-es-Salaam

6. Annexe Two - list of European Standard Qualities of Waste Paper

7. Annexe Three - Chemi-mechanical straw pulp mill 10 tonnes/day

8. Annexe Four - three diagrams from Pira report

9. Annexe Five - Tappi Process Water Quality Standards.

ANNEXE ONE

THE FIRST PAPERMILL IN TANZANIA

Translated from: WOCHENBLATT FUR PAPIERFABRIK, 18. 1980 p 769

In 1976 the company P J Wolffe & Sons GmbH, machine makers in Duren, received an order from Messrs Kibo Paper Industries Limited, Dar-es-Salaam, Tanzania, for the supply and erection of a complete paper mill in Tanzania.

Kibo Paper Industries is a paper converting company, responsible to the NDC (National Development Corporation). They manufacture cartons, corrugated board, cement sacks and paper bags entirely from imported paper and board, drawing on the management experience and know-how of their partners in Pakistan.

Naturally this operation created its own waste paper which was not re-usuable within the country. The local printing industry and office waste from governmental and communal administrations also produce waste paper and in total a daily supply of 10 tonnes of waste paperwas expected. This was to form the basis for the new paper production. The anticipated products were fluting medium, kraft-liner and dulplex carton board in the weight range 100 - 250 g/m^2. The machines were to be modern but simple to run and planned in such a way, that future extensions of the plant would be able to treble production. The machine width was set by the existing corrugator as 1550 mm trimmed width. The stock preparation was arranged for two stock lines, one of mixed waste, the other for virgin pulp and sorted waste paper.

Each line is equipped with pulpers, cleaning equipment, deflakers and beating refiners all with the necessary stirred chests. The paper machine consists of three modern semi-dry cylinder sheet formers and normal couch press, one plain and reversing press of the usual construction, followed by ten dryers of 1500 mm diameter, clothed with dryer screens and one pope-reel.

The machine is driven by a lineshaft with five sectional drives and a thyristor controlled DC motor. A twin carrier drum is also supplied.

The required steam is raised by a package boiler. Electrical power comes from the town grid. The town of Dar-es-Salaam also supplies the fresh water. The water system is largely closed, all piping is stainless steel, so that only a small quantity of effluent flows into the Indian Ocean via a simple clarifying basin.

The installation was ready for start up in May 1978, after one years construction and only six months erection time aided by skilled labour from Pakistan.

Start up of the paper machine was highly successful and after only 20 mins corrugating of 130 g/m^2 was being reeled up, of good quality.

The guaranteed production of 10 tonnes/day was achieved immediately and was subsequently raised to 14 tonnes/day.

The local employees watched the production of paper with tremendous awe and respect, because only 6 Tanzanians had been trained for six months as papermakers in the Pakistan mill. Of these three took other employment and, therefore, only three trained Tanzanians were present at the start up of the first paper mill in Tanzania.

The main burden of start up was borne by the experienced crew members from Pakistan. The co-operation between Wolff and its Pakistani counterparts deserves much praise and the relationship continues to do well.

The successful start up of the first Tanzanian paper mill was celebrated in the local manner with much beating of drums and excellent local lamb.

The project "Papermill" was thus wholly successful. The President of Tanzania, Dr Julius K Nyerere has seen this for himself during a visit to the mill. The waste paper collection in the whole country has been organised and increased. There are now 30 tonnes of waste paper available per day. On the basis of this fact the Governmental administration has given permission to extend the paper mill.

Wolffe & Sohne have during the past month received an order to enlarge the production capacity to 30 tonnes/per day. The machine will be given an additional suction couch and further water removal units at the wet end; a MG cylinder and after dryers; a hood over the whole drying section and a broke pulper.

The pulpers of the stock preparation will be fitted with a bale transporter band.

The waste paper stock line was enlarged by a secondary pulper and further cleaning units, also more refiners.

The freshwater carries too much sand and, therefore, the piping and machines have to be protected from increased wear by hydrocyclone cleaning.

The converting mill will be able to take the whole of the production since new machines have here also been installed.

ANNEXE TWO

European List of the Standard Qualities of Waste Paper

The following Specifications are for Standard Qualities of Waste Paper, which are technically perfect in principle, but which may include exceptions if agreed between both parties.

Group A - Ordinary Qualitities

Mixed Paper and Boards No 2 consist of a mixture of various grades of paper and board, without restriction on short fibre content.

Mixed Paper and Boards No 1 consist of a mixture of the various qualities of paper and board and containing less than 15% short fibre papers, such as newspapers and magazines.

Board Cuttings consist of new shavings or cuttings of pressed board or of mixed board free of strawboard.

Mill Wrappers consist of packing papers, called reel wrappers such as are used as the outer wrappings for reels, parcels, or reams of new paper, free of bitumen, waxed or plasticised papers.

Corrugated Containers consist of used cases or sheets of corrugated board, with or without Kraft covers, and a middle of straw or wastepaper, free of bitumen, waxed or plasticised paper.

Mixed Pamphlets and Magazines consist of pamphlets, magazines, catalogues, printed matter and old newspapers, mixed, with or without staples, free of cardboard bound books.

Overissued Pamphlets, Brochures and Magazines in Bundles consist of unused pamphlets and magazines, coloured printed mater, free of latex and insoluble glues, in bundles.

Coloured Letter (or Coloured Records) consist of copy and writing paper with or without print in mixed colours.

Light Coloured Letters (or Light Coloured Records) consist of copy and other writing paper, printed or not, mixed light colours with an allowance of 5% of dark colours. The allowance of papers with a mechanical pulp base shall be agreed between tge buyer and the seller

White Pamphlets, without Cardboard consist of books or white sheets o paper for printing and may include mechanical pulp, with black print, no colours, free of book covers, linen, synthetic or latex glues.

White Pamphlets without Cardboard, Wood Free consist of books or of white sheets of paper for printing, free of mechanical pulp and of coated papers, with black print, no colours, free of book covers, line synthetic or latex glues.

Group C - High Qualities

Mixed Light Coloured Shavings (Printers Shavings) consist of shavings of pale coloured writing and printing paper, made up mostly of white chemical pulp.

Printers Shavings of Very Pale Mixed Colours consist of mixed pastel shade shavings of writing and printing paper, made up of white chemica pulp, free of dark colours.

Coloured Shavings, sorted in Colours with Mechanical Pulp consist of shavings sorted according to shade, bulk coloured, without print, with mechanical pulp.

Coloured Shavings, sorted in Colours, free of Mechanical Pulp consist of shavings sorted according to shade, bulk-coloured, without any print and free of mechanical pulp.

Overissued Pamphlets, Brochures and Magazines in bales or palletised consist of unused brochures and magazines printed in colour, free of latex or insoluble glues, in bales or on pallets.

Cuttings of Duplex or Multi-ply Board with a White Liner (grey-white) consist of new cuttings or other waste of Duplex or multi-ply board, with as least a white liner over a grey interior, or back, with or without print.

Group B - Middle Qualities

Old Newspapers consist used newspapers which contain less than 5% of coloured booklets or of publicity pamphlets, free of crumpled paper.

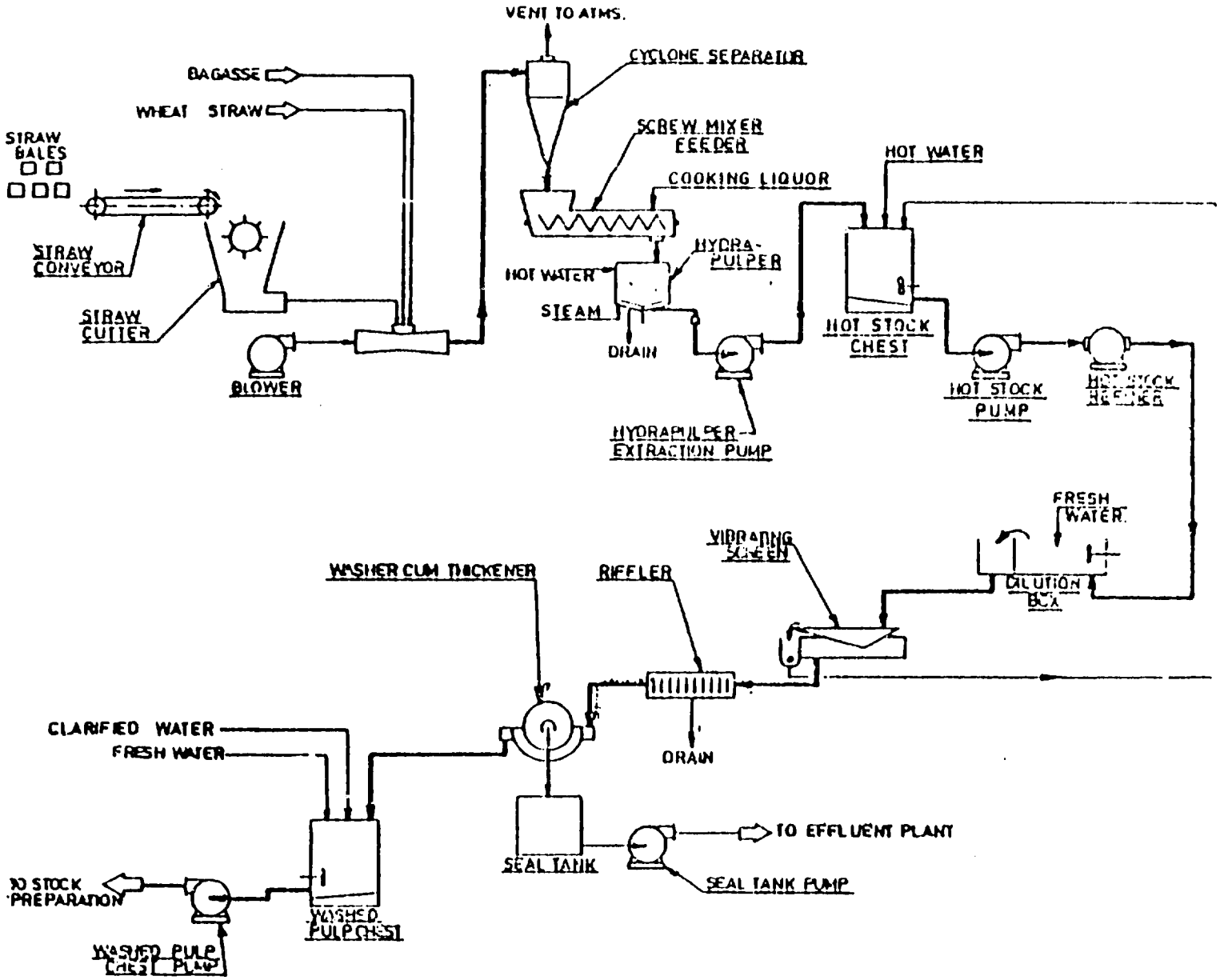
Overissued Newspaper in Bundles consist of unused daily newspapers printed on white newsprint and which do not contain more than the normal percentage of coloured illustrations, without staplesm and in original packed bundles.

Overissued Newspapers in Bales or Palletised consist of unused daily newspapers printed on white newsprint which do not contain more than the normal percentage of coloured illustrations, without staples, and in bales or on pallets.

Mixed Coloured Shavings consist of shavings of magazines or similar printed matter, without restrictions as to colour and of the containt of short fibre paper or of coated paper.

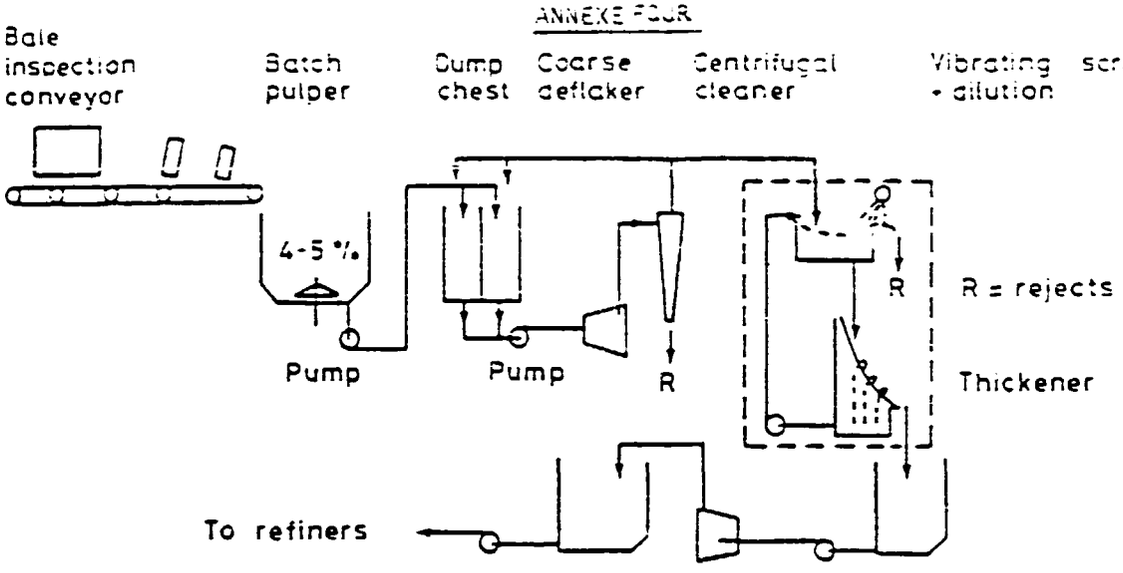
Light Coloured Bookbinders Shavings consist of white shavings, without beater-dyed papers printed in mixed colours, made up for the greatest part of mechanical pulp with a maximum of 20% of coated paper, unless stipulated otherwise and of a generally bright clear appearance.

Specially Light Coloured Bookbinders Shavings consist of white shavings, without beater-dyed paper, printed in mixed colours, made up for the greatest part of mechanical pulp with a maximum of 20. of coated paper, unless otherwise stipulated and of a specially bright appearance.



ANNEXE THREE - Chemo-mechanical pulping process for pulping agricultural residues for small paper mills - A case study by Dr S L Keswani presented at the 8th World Forestry Congress, Jakarta, Indonesia 16th-28th October, 1978

ANNEXE FOUR

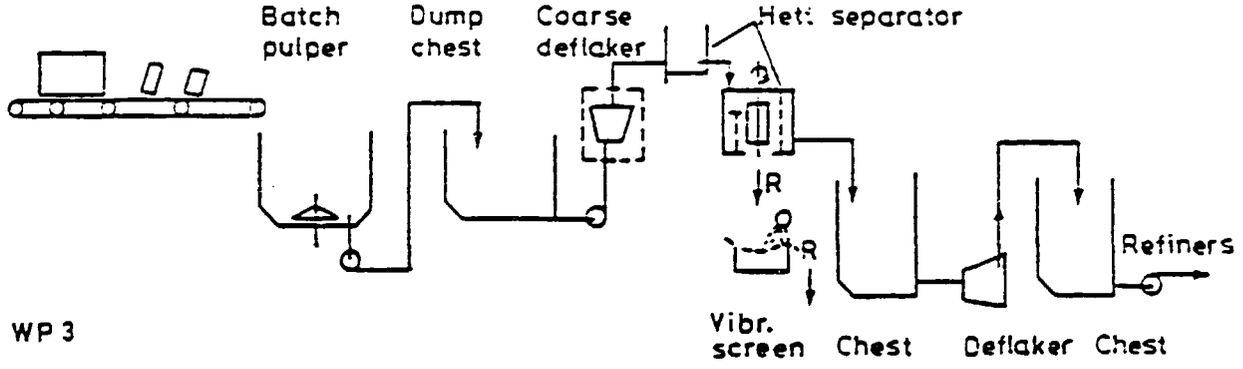


WP 1

Inspection deflaker Pump. Chest.

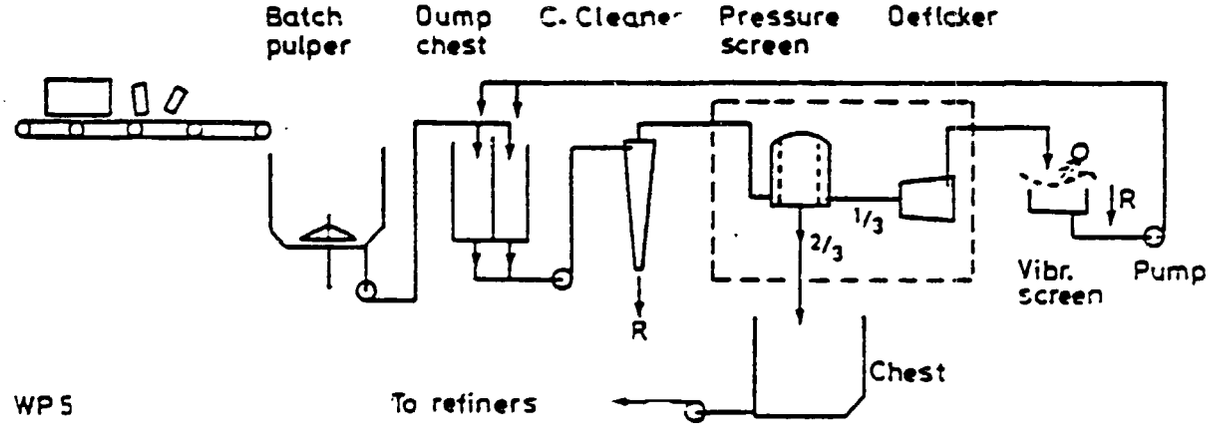
Pump Chest

IN WP2 THESE UNITS ARE REPLACED BY A 'HETT' SEPARATOR FIG 1



WP 3

IN WP4 A COARSE DEFLAKER IS LOCATED AFTER THE DUMP CHEST FIG 2



WP 5

IN WP6 THE PRESSURE SCREEN AND DEFLAKER ARE REPLACED BY A COMBINED DEFLAKER - SORTER FIG 3

WASTE CLEANING SYSTEMS WP1 TO WP 6. FIGS 1, 2, 3,

ANNEXE FIVE

TAPPI Process Water Quality Standards

	FINE PAPERS	GROUNDWOOD PAPERS	KRAFT PAPERS	
			BLEACHED	UNBLEACHED
Turbidity	10	50	40	100
Colour (Platinum units)	5	30	25	100
Total hardness	100	200	100	200
Calcium hardness (as CaO)	50	---	---	---
Alkalinity to methyl orange (as $CaCO_3$)	75	50	75	150
Iron (as Fe)	0.1	0.3	0.2	1.0
Manganese (as Mn)	0.05	0.1	0.1	0.5
Residual Chlorine (as Cl_2)	2.0	---	---	---
Silica, soluble (as SiO_2)	20	50	50	100
Total dissolved solids	200	500	300	500
Free carbon dioxide (as CO_2)	10	10	10	10
Chlorides (as Cl)	---	75	---	---