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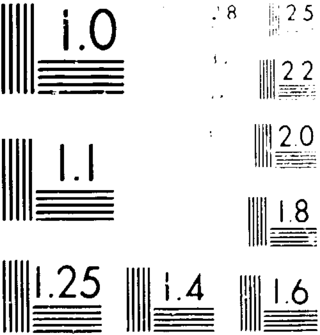
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A MODERN FIBRE LINE - ENERGY AND ENVIRONMENTAL ASPECTS*

by

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Technological innovations in the pulp and paper industry are rarely sudden or dramatic. New developments take considerable time for wide acceptance and adaptation. A modern fibreline and the fibreline of the 1980's will, therefore, contain concepts that today are already in advanced development stages or in commercial operation in some pioneering mills.

The new fibreline has to cope with the rapidly increasing investment costs, improve or at least maintain return on capital in an ever increasing inflationary environment. The operational efficiency has to be continually improved and costs reduced to allow a steady economical growth. Maybe the most significant single factor, determining the future of the pulp industry, is power consumption, and no effort can be spared to reduce the energy requirement of the pulping processes. Any of these improvements will have to be made not at the expense of the environment but, on the contrary, on the condition of preserving a non-polluted nature, which people of the new generation will demand.

The dominant pulp that will be produced during the 80's, and also further on, will be the kraft process or its modifications. In view of the intensive research activity in oxygen pulping, elimination of sulfur and use of various additives, the process will certainly be modified in the future, but this will have little influence on the basic equipment. Chips and fibre suspensions have still to be handled, and there will be delignification and displacement operations etc., typical for the pulp industry.

Unbleached Kraft Pulp

The majority of mills for manufacture of unbleached kraft pulp will no doubt be integrated. The raw material will be softwood and the main product liner-board, sack (bag) paper and other types of packaging products.

Fig. 1 The flow diagram in figure 1 shows such a fibreline. One of the features of this new system is its simplicity.

Following cooking in a Kamyr two-vessel continuous digester with Hi-Heat washing and cold blow, the chips are defibered in a disc refiner integrated in the blow line. The pulp is further washed in a continuous diffuser and finally washed and thickened on a wash press before high consistency refining in front of the paper machine. The system allows pulping to higher yields without jeopardizing the runability on the paper machine and the quality of the final product. This is of utmost importance for the economy when considering the scarcity and high prices of softwood in many areas.

Fig. 2 The digester system shown in figure 2 incorporates the fundamentals for a good result. You have the presteaming of the chips unavoidable for a good impregnation, followed by half an hour's impregnation with the cooking liquor at a hydraulic pressure of 1000 kPa. Then transfer to the digester for heating and cooking. Most of the heating is with indirect steam in the transfer circulation in order to minimize the dilution with condensate. Further, the alkali is controlled and, if necessary adjusted in this transfer circulation. This is often necessary when having a non-uniform chip quality.

This digester system is also very useful for two-stage processes, such as polysulfide for additional increase in pulp yield.

The digester is of course equipped with Hi-Heat countercurrent washing, characterized by its high efficiency. The pulp leaves the digester under "cold blow" conditions.

The black liquor extracted from the digester is flashed in three steps. The steam for the first step containing the main part of the malodorous gases and turpentine is used in the Hi-Heat exchanger and the condensate and non-condensables are sent to separate treatment. The second flash is used in the steaming vessel, and the third flash is sent to the chip bin. This system implies a simple and efficient heat recovery and odor control.

The refiner used for the fibre separation is normally a 42 inch diameter single disc refiner of Defibrator make, especially designed to suit this particular application. Power applied varies between 30 - 50 kWh per ton, depending on throughput and pulp yield.

The pulp is then washed in a continuous diffuser, a machine already well accepted in the industry.

Via a storage tower, the pulp is transferred to a wash press, where the pulp is finally washed and thickened before the high consistency refining and paper machine.

The blow line refiner must have the ability to defiberize the chips into a pulp with a minimum of fibre bundles and shives. However, too much refining may negatively affect the washing efficiency because of the increased drainage resistance of the pulp. Shive content and drainage must therefore be balanced against each other to optimize the in-line defibering. In order to ensure good washing and at the same time achieve low shive content, high consistency refining is necessary.

An inherent consequence of increased yield is that the pulp will contain fewer but heavier fibres. These heavier fibres are stiffer, which will influence the paper properties. High consistency refining is, therefore, the solution to compensate for the disadvantages of higher yields, not only in sack paper qualities.

As you may have noticed, there is no screening incorporated in this fibreline. The fact that screening is not necessary has already been proven in some mills.

The apparent advantages of this fibreline are: high yield, simplicity, high availability, low energy consumption and fulfillment of the most stringent environmental regulations.

Bleached Kraft Pulp

Fig. 3 The flow diagram in figure 3 shows a fibreline which in principle can be valid for both softwood and hardwood, market pulp as well as pulp for integrated paper manufacture.

The digester shown is of the same type as already described. After the digester follows a two-stage diffuser, placed on the storage tower. By installing a two-stage diffuser, the time in the Hi-Heat washing can be reduced to 2 hours.

This means a reduced digester height, resulting in a lower degree of packing in the lower part of the digester in the case of heavy wood or poor chip quality. In the case of hardwood pulp from e.g. eucalyptus, the digester could be further simplified. The pre-impregnation vessel before the digester can be omitted as hardwoods generally are easier to impregnate and delignify. After the washing follows the screening. This is here shown only by a symbol but should of course be of the closed type. After thickening on a combined thickener-washer, the pulp is transferred to the bleach plant, which is a five-stage displacement bleach plant, with medium density chlorination.

Displacement Bleaching

If bleaching agents are displaced through a pulp mat instead of being mixed into the pulp, very rapid bleaching can be performed. High bleaching rates are achieved through continuous displacement of the reaction products by fresh chemicals, and maximum active chemicals concentration is maintained at the fibre surface throughout the whole reaction period. This basic concept has been named "dynamic bleaching", and was proposed by Howard Rapson, Canada.

In the year of 1970, the idea to combine the continuous diffuser washer with the principles of dynamic bleaching was born, since it was proven that bleaching could be performed in 5 - 10 minutes. It was concluded that several displacement stages of the diffuser type could be built in one tower only. The liquid circuits could be completely closed, the demand for active chemical exhaustion in the stage could be eliminated and the chemical concentrations set at their optimal levels. The power consumptions would be considerably reduced, since the pulp transportation from tower to tower would be eliminated. Heat would be saved both through the closed circuits applied, which means less heat losses with effluent, and because intermediary contact with the atomsphere would be reduced.

The displacement bleaching concept has been intensively tested by Kamyr for three years in a 4-stage pilot plant, having a capacity of 120 TPD. The results from these trials showed that the pulp properties accomplished in the displacement bleaching process compare favourably with those obtained in conventional bleaching. The first commercial installation was started in the end of 1975 and the second unit in the end of 1976. Both these units consisted of a conventional chlorination stage followed by a 4-stage E - D - E - D displacement tower. The capacity of these units are each 500 TPD.

Fig. 4 Figure 4 shows a cut-away view of a 4-stage displacement tower.

A third unit was started in 1977 in Finland, with the sequence E - D - E - D for final bleaching after an existing prebleaching plant. The number four unit was delivered to Oji Paper Co., Japan, and was started in April 1978. The designed capacity is 500 ADMT/D of 86 GE brightness pulp with the sequence C - E - H - E - D. This bleach plant is of special interest, as it is the first one-tower five-stage bleach plant with the MD-chlorination.

Fig. 5 Figure 5 shows the flow diagram of a 5-stage displacement bleach plant.

For the moment there are two more displacement bleach plants in the engineering and manufacturing stage:

Tofte Cellulosefabrikk A/S & Co., Norway
500 ADMT/D softwood pulp with the sequence D/C - E - D - E - D. Scheduled start-up in 1980.

A. Ahlström Osakeyhtiö, Varkaus, Finland
450 ADMT/D hardwood/softwood pulp with the sequence D/C - E - D - E - D. Scheduled start-up in May 1980.

Both these plants are of the two-tower type, which means that the last chlorine dioxide stage is performed in a separate tower in order to have a longer retention time to reach 90+ brightness. Both these plants are going to manufacture market pulp.

The displacement bleaching process has now passed the commercial prototype phase. It has established itself as an attractive alternative, offering essentially the following benefits over its conventional competitors:

- less space
- less materials
- less energy
- less capital
- less manpower
- corrosion protection
- low effluent volume.

The process fits logically into the concept of the effluent free pulp mill and is as such directly applicable.

Oxygen Delignification

The bleaching plant is the biggest water polluter in the manufacture of bleached pulp. Various means to decrease this discharge have been proposed. One of them is to use oxygen for further delignification after cooking and thus replace part of the chlorination. This is today a commercially accepted process. What is done is that the lignin content in the pulp is reduced, normally by 50%, and the used chemicals and dissolved organics are recovered with the bleach liquor from the cooking by counter-current washing. This results in a corresponding reduction in chemical consumption and bleach plant pollutants. The oxygen delignification has come to stay. A drawback with the present technique is the high investment costs. The treatment is done at high consistency, under pressure and at high temperature.

Fig. 6

Figure 6 shows the flow diagram of the latest installation (Skutskär Mill, Sweden). The following steps are involved: After cooking and a certain, relatively high degree of washing, the pulp has to be concentrated to 30%, mixed with alkali and protector, fluffed and retained in oxygen atmosphere under a controlled time, diluted and washed carefully again. There is, however, intense work going on to simplify the oxygen delignification Such a simplified technique has been tried by Kamyr in pilot-plant scale (75-100 TPD).

The installation is based on the use of an inline defibrator to mix oxygen in fine disperse form into the Hi-Heat washed blow line pulp from a Kamyr digester just before a pressure retention tower, and thus creating foaming conditions. The consistency is around 10%. The results so far have been very promising and the system is now ready for full scale application

Fig. 7

(figure 7).

A Modern Fibreline for Bleached Pulp

Fig. 8

Based upon what has been mentioned above, a modern fibreline for bleached pulp will be as shown on the flowsheet in figure 8. This arrangement gives a production line that has inherent energy savings previously unheard of, low effluent volume and low pollution loadings. Further it requires a minimum of building space and volume.

The following table shows the difference in energy consumption between "A", a fibreline according to figure 8, and "B", a fibreline consisting of batch digesters, drum washers, high consistency oxygen and a drum washer bleach plant.

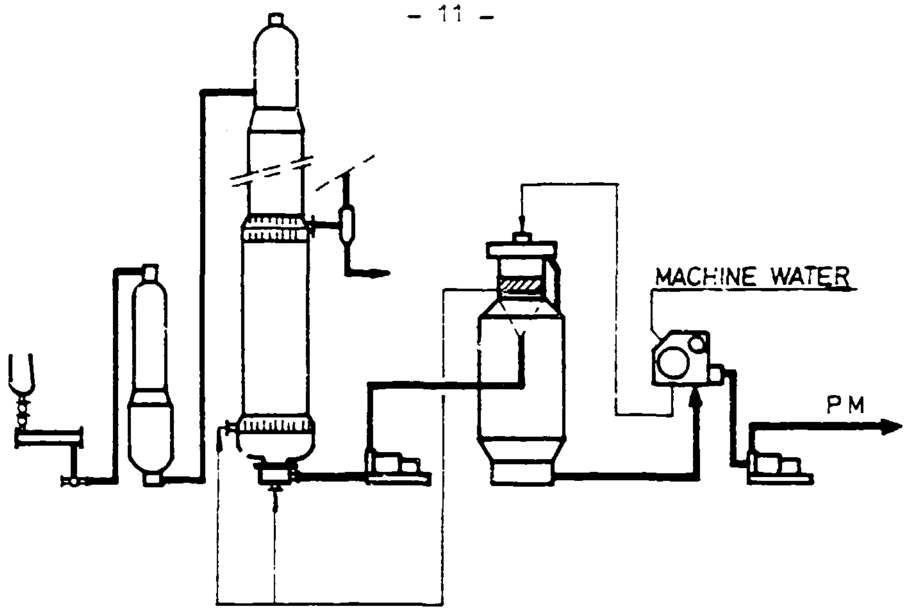
El. energy kWh/ton

	A	B
Cooking	50	40
Washing	-	35
Screening and thickening	55	60
Oxygen with washing	45	90
Bleaching	40	125
	190	350

Steam consumption GJ/ton

	A	B
Cooking	2.6	4.0
Oxygen	0.5	0.5
Bleaching	0.7	1.3
	3.1	5.8

Conclusively there are considerable energy savings with the low energy line alternative. Additionally the water consumption according to this alternative is low at approximately 14 ton/ton pulp compared to 35 tons for a conventional fibreline. Against a background of the ever increasing energy costs, this should be a **very** interesting and viable alternative to the more conventional process systems.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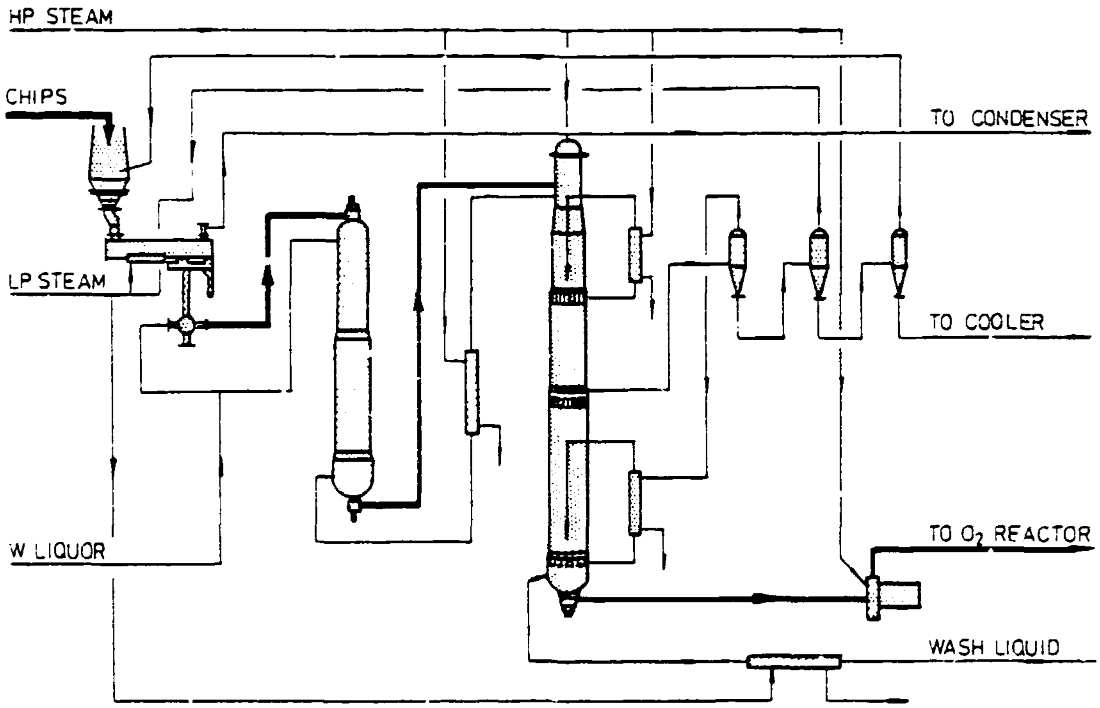
HP STEAM
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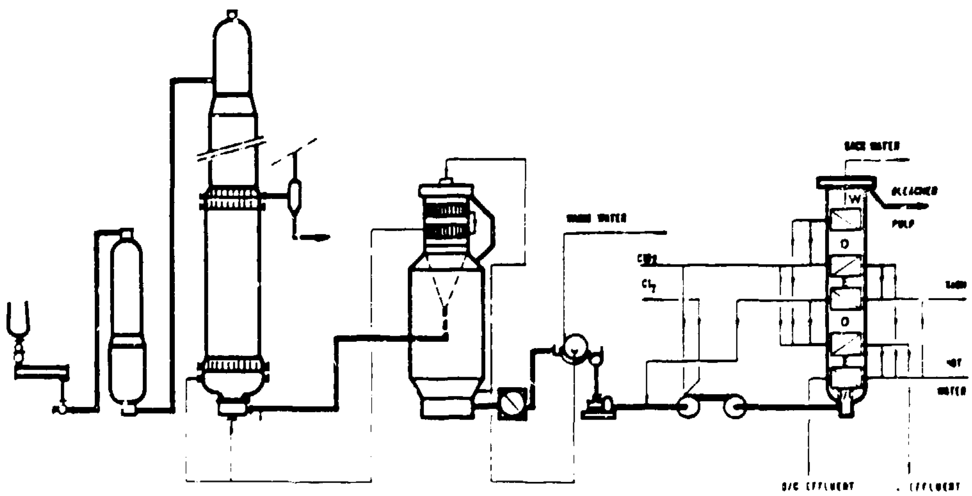

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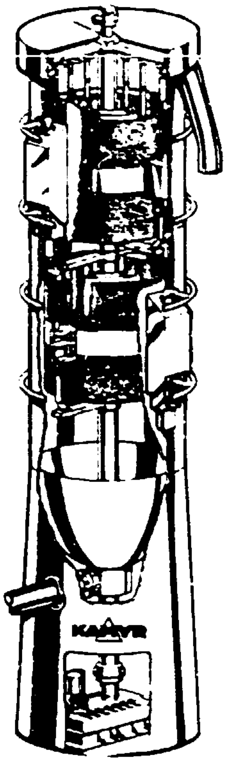

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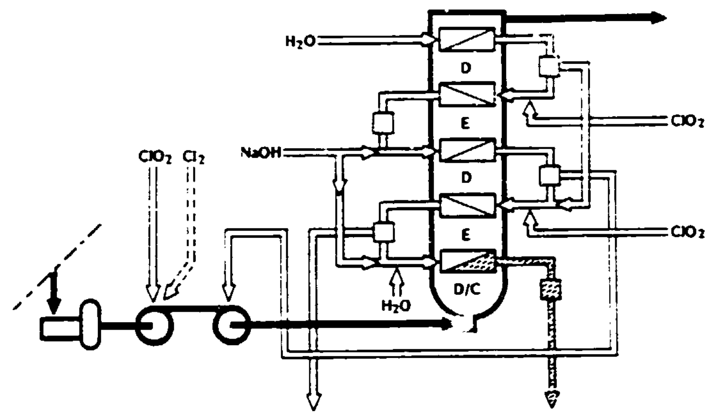

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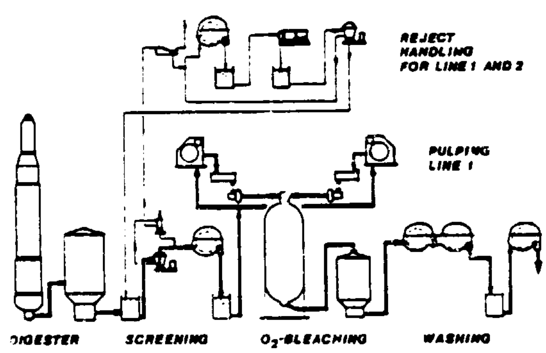

THE PULPING LINES AT SKUTSKÄR

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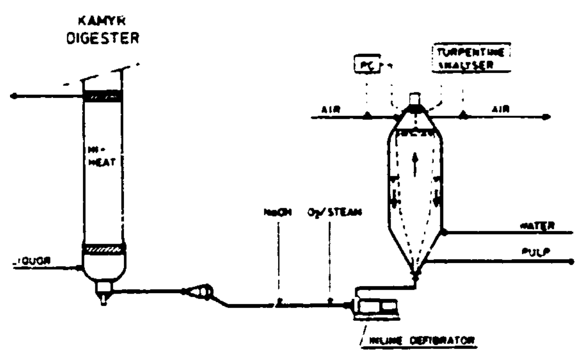

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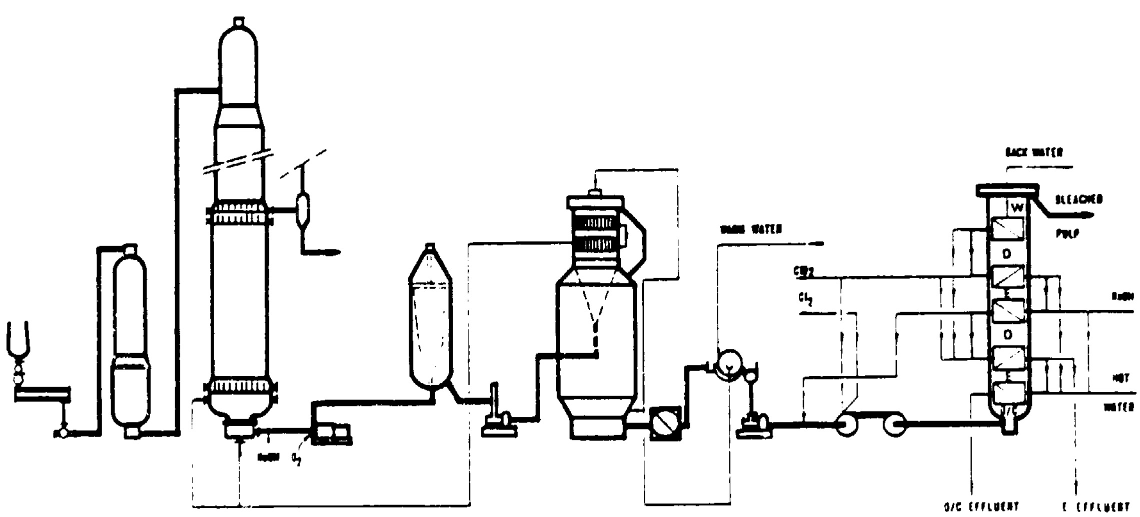

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