Technological Changes in Non-Wood Pulping Focusing on Emissions, Quality and Operating Costs

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ABSTRACT

In the last ten years, significant attention has been given to the effect of fiberline emissions, pulp quality and operating costs. As a result, dramatic changes have taken place in the process for manufacturing pulp, both from process and equipment perspective.

The main drive force for these changes has been the request to minimize the discharge of effluent fromt he fiberline due to increasingly tougher regulations lower capital costs and to lower operating costs compared with existing operation. The suggested non-wood fiberline design is based on the latest wood fiberline technology which is exemplified in this paper.

Technological changes in non-wood pulping can yield an improved quality and production while saving process chemicals, lower the investment costs compared with other available designs and reduce effluent.

INTRODUCTION

The ongoing development activities within Valmets fiberline technology area are based on three important corner stones, greater economy, production excellence and environmental protection.

The goal is to develop efficient machines and process solutions that make it possible for the industry to combine environmental-friendly technologies which are both cost effective and a quality assuring, without going beyond reasonable investment costs.

This challenge has been the lead star for Valmet in its fiberline design from woodyard to the baling line.

Valmet's modern fiberline

- is cost effective
- provide excellent pulp quality via highly selective process units.
- has a low environmental impact
- handles large production in a single line.
- uses the same type of washing equipment in all washing applications.
- uses identical screeing units in fine and rescreening.
- employs modularized building with all process

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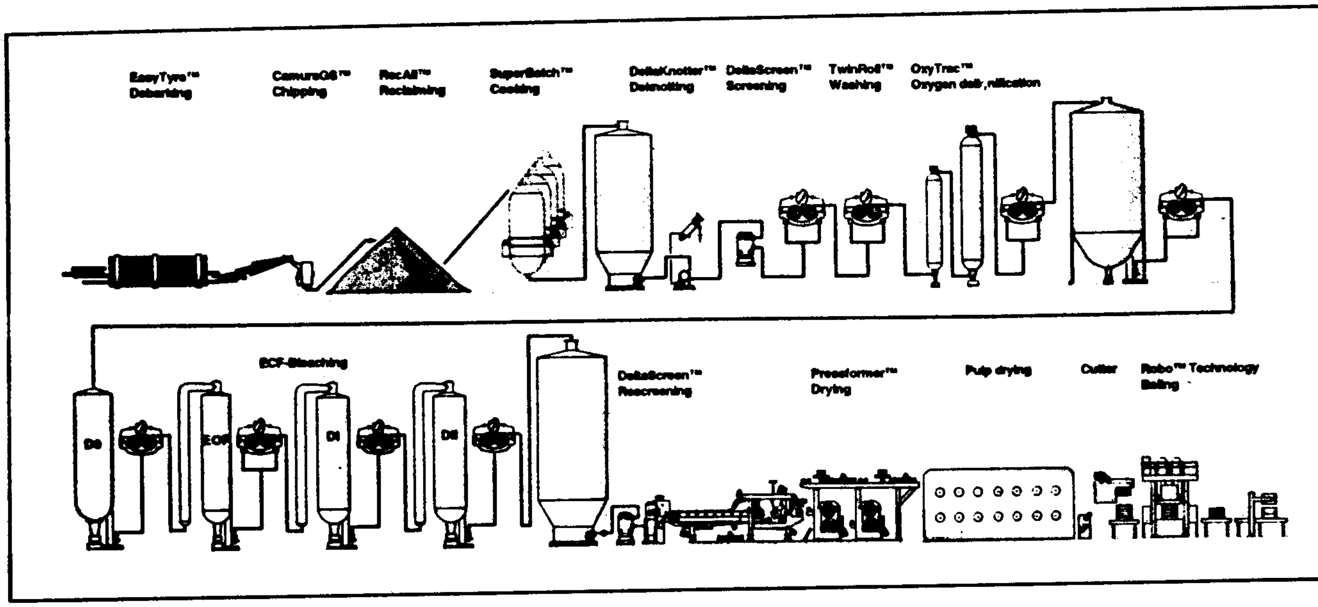

Figure 1. Valmet fiberline from woodyard to baling

areas in close proximity.

- has process flexibiliy for ECF. TCF, wood and non wood applications.

Modern fiberline technology delivers several possibilities to improve wood and non-wood fiberlines. The greatest potential for optimization and savings is in the field on non-wood pulping where modern wood fiberline technology can be applied, as described in this paper.

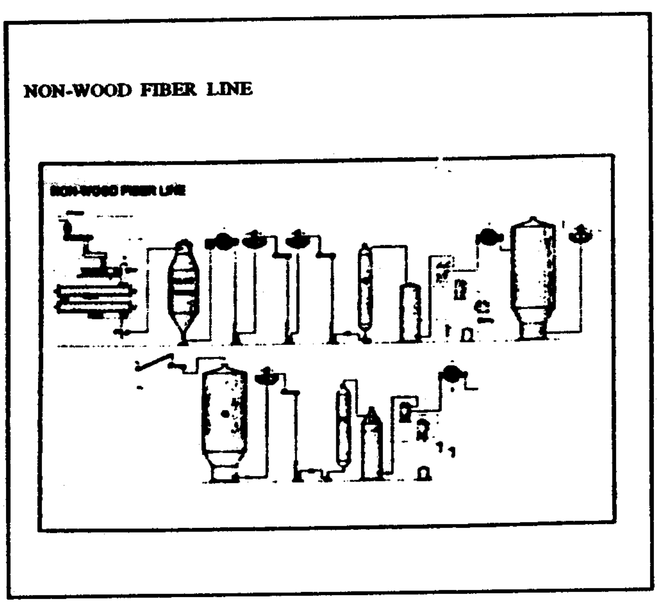

Figure-2 The Valmet fiberline for production of non-wood TCF pulp.

A MODERN WOOD PULP FIBERLINE

Valmet's latest fiberline technology is shown in figure 1. The overall process solution consists of several highly selective individual process units. Such as Super Batch cooking, Oxy Trac delignification and a bleaching sequence which preserve the high pulp strength delivery through the fiberline.

A well- designed fiberline from process, machine and building perspectives are the base criteria for a cost effective design with short pay-back, excellent quality, low energy demand and environmental - friendly production of pulp.

THE MODERN NON-WOOD PULP FIBER-LINE

The modern non-wood fiberline is very similar to the wood pulp fiberline because most wood fiberline technologies can be applied to non-wood fiber processing. The same process principles are applicable in non-wood pulping although the equipment can be different in some positions. See figure 2.

HIGH CONSISTENCY SCREENING

High consistency screening has become state of the art technology in the deknotting, fine screening and bleached stock screening. See figure 3.

The energy savings due to the higher pulp consistency and the improved pulp cleanliness at

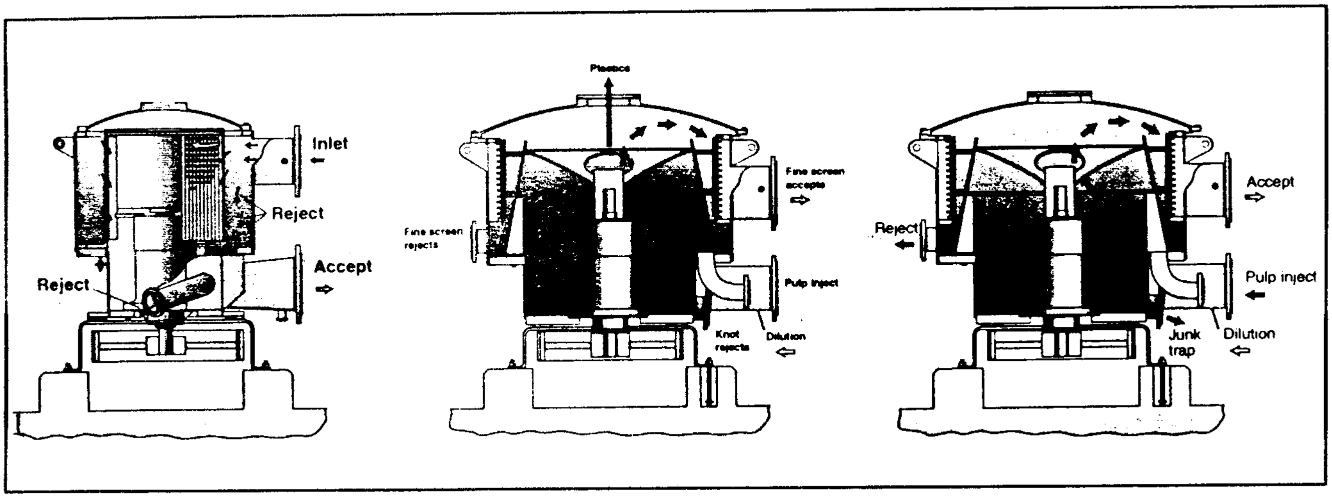

Figure-3 DeltaKnotter, DeltaCombi and DeltaScreen

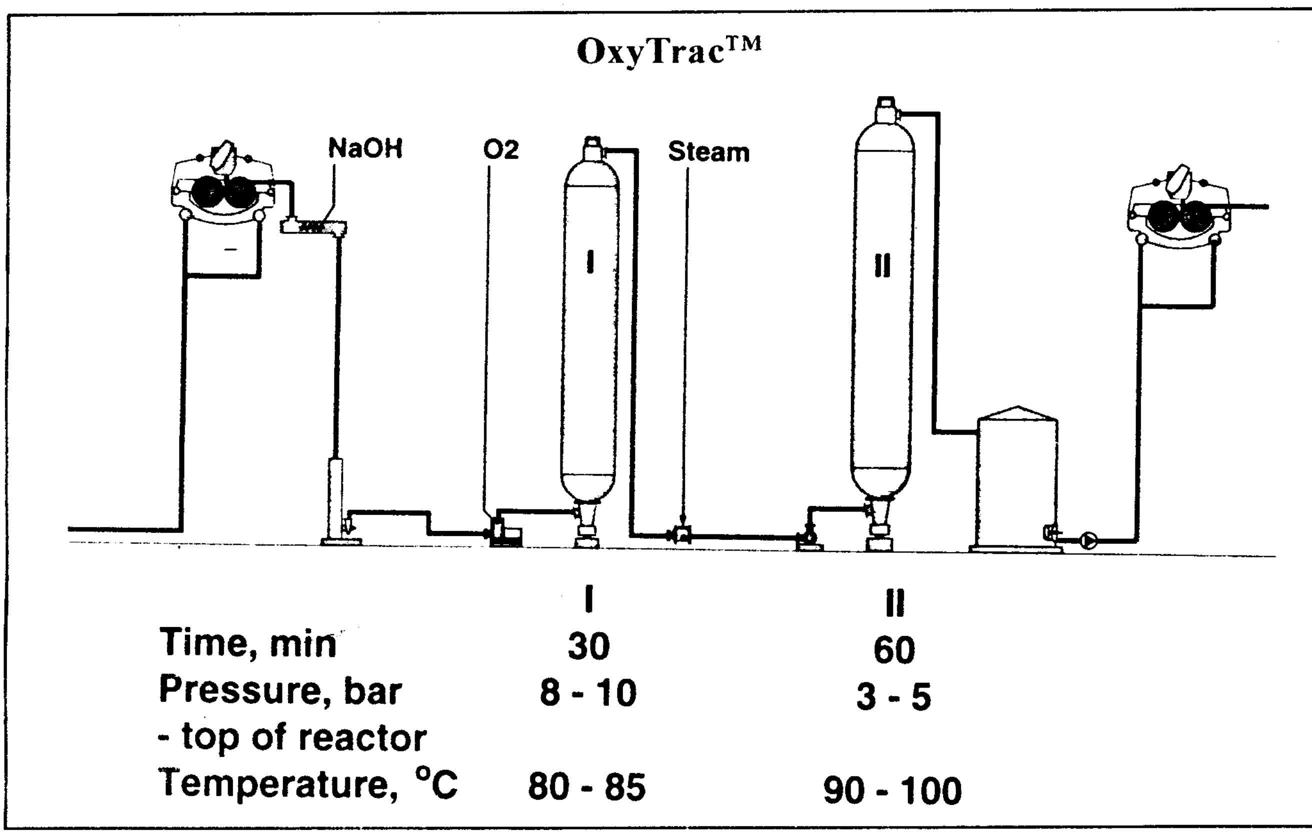

Figure-4 OxyTrac™

lower reject rates have been the major breakthrough factors for the operation.

In bleached stock screening the energy and investment cost savings are as high as 40-50% compared to a conventional cleaner system at the same pulp cleanliness. In fine screening the energy saving is in the range of 30% with improved shive removal efficiency (1). The overall shive removal efficiency for the Delta Screen fine screening system is typically 92-95% (2).

Valmet has developed a screen module concept where the same base components are used in the screening and deknotting equipment. This improves

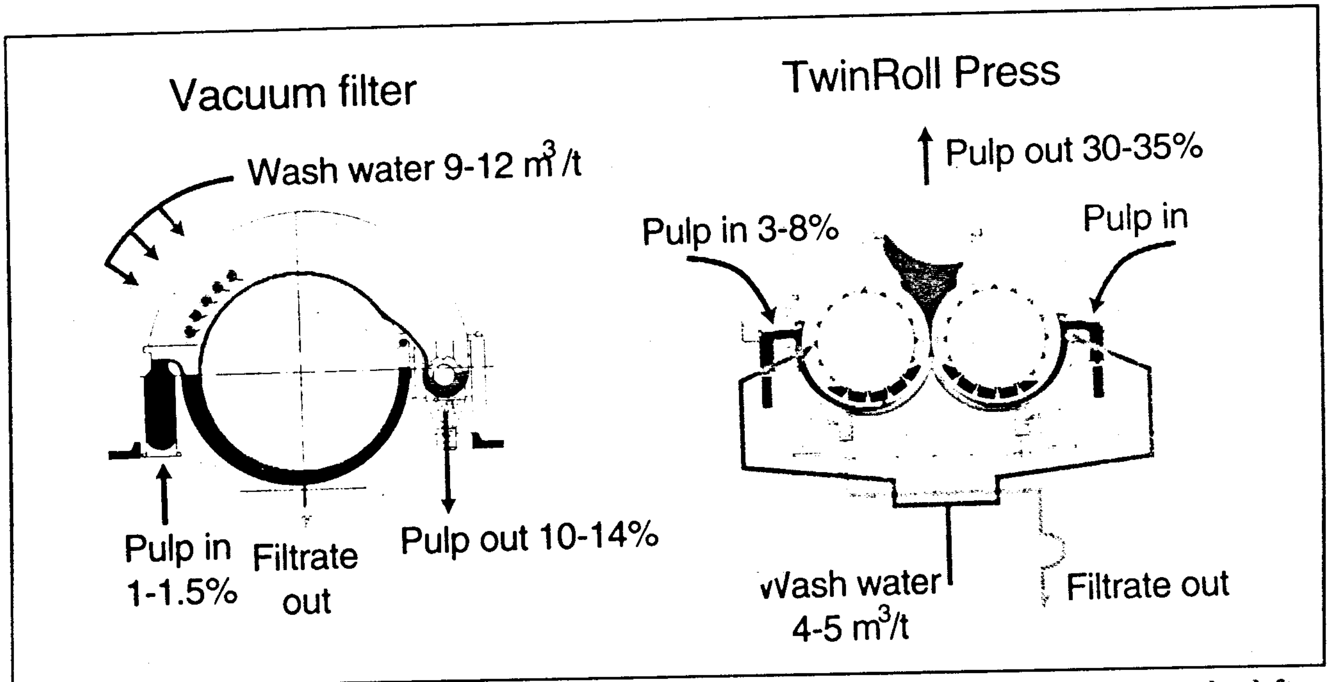

Figure-5 Simplified description of the washing principle on a vacuum filter shown to the left and on a TwinRoll Press to the right.

maintenance cost and minimizes spare parts required.

OXYTRAC OXYGEN DELIGNIFICATION

Valmet has developed and patented OxyTrac, a versatile tool for oxygen delignification with high selectivity up to very high degrees of delignification. See Figure-4.

The high selectivity makes it possible to reduce

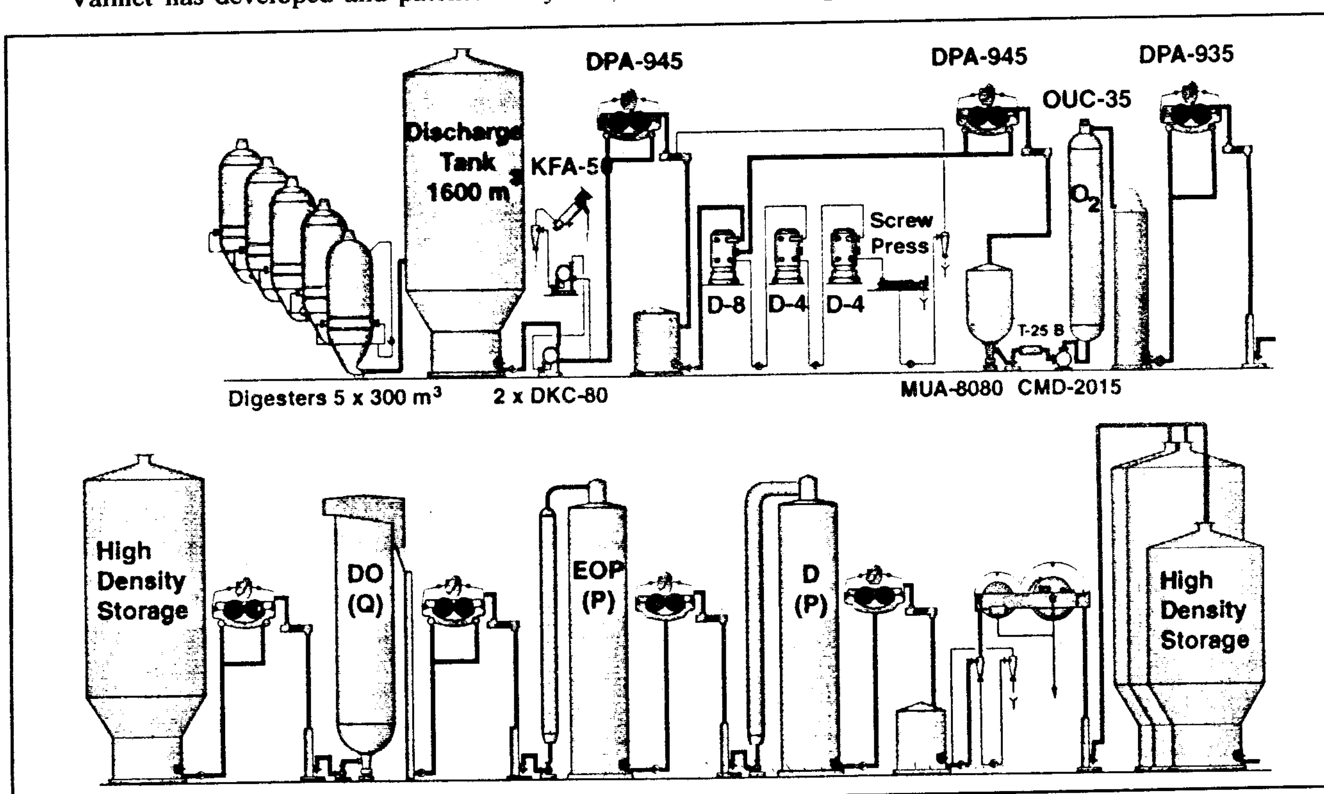

Figure-6 Advance Agro, Thailand

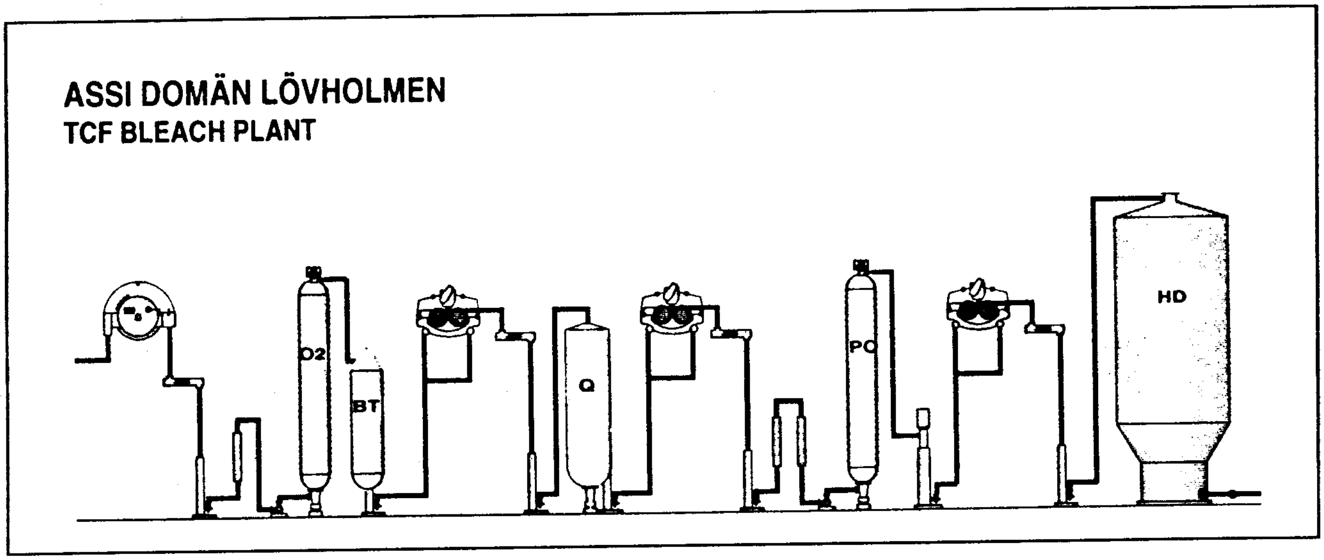

Figure-7 AssiDoman Lovholmen

the kappa number to very low levels and still improve the final quality of the pulp. The mill experience on degree of delignification is 60-75% for softwoods and 45-50% for hardwoods at maintained or improved final pulp quality (3). The high degree of delignification of the pulp has a strong impact on the chemical consumption and the environmental load of the bleach plant effluents.

Typically, a kappa number variation of around 3 units out from the digester has been reduced to 0.7 units to the bleach plant in mills where the OxyTrac system has been installed. This has a beneficial effect on process stability and runnability in the fiberline.

WASHING

Valmet uses a press-based washing technology

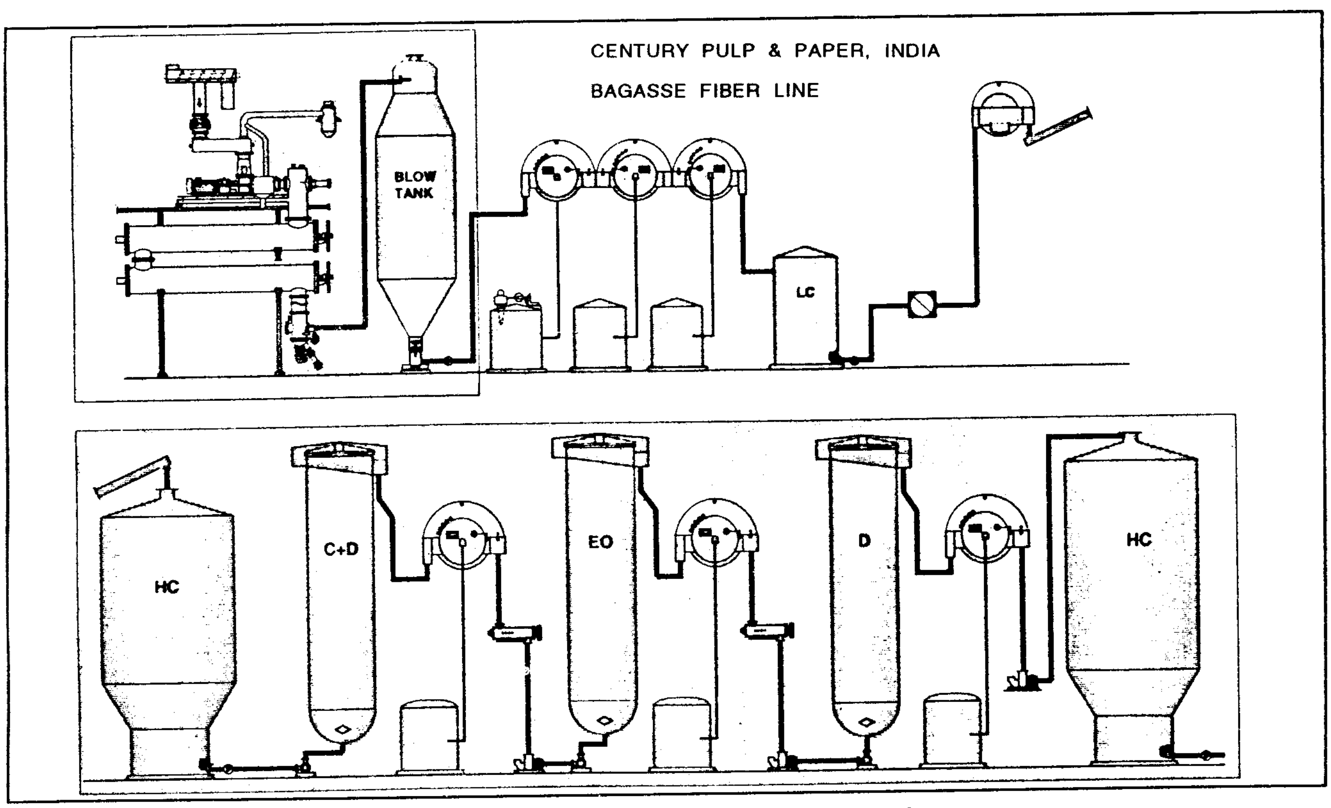

Figure-8 Century Pulp and Paper, India

in all positions in the fiberline. The all press washer line allows all existing mills to produce their total production in one single line, which thereby minimizing energy and labor demand per ton of product.

The principal differences between a filter washer and a displacement press are shown in figure 5.

The press based fiberline has several advantages compared to conventional filter fiberlines, such as.

- the ability to construct a low elevation, compact modularized building where all the process areas are in close proximity
- the press has higher washing efficiency than the vacuum filter
- a filter based fiberline has 50-60% larger building volume than a press-based fiberline
- the wash water demand for a press is less than 50% of a filter
- the filtrate tanks are smaller for a press compared to a filter

BLEACHING

A well-washed, oxygen delignified pulp can be bleached in a short sequence when the brightness target is 82-85% ISO (4).

Valmet's press based bleach plant is a strength preserving, low effluent process with low chemical consumptions for both ECF and TCF pulp production.

Typical mill data from a press based ECF bleach plant running on Eucalyptus pulp (5).

STATE OF THE ART HARDWOOD AND NON-WOOD FIBERLINES

Advance Agro, Thailand, was Valmet's first all press based fiberline. The mill that was designed for 560 adt/d. started up in January 96 and makes fully bleached Eucalyptus Camaldulensis pulp. See figure 6. A 90% ISO, ECF pulp is produced in three bleaching stages, D (EOP) D, using less than 35 kg act. Cl/adt and 3 kg H_2O_2/adt. The chemical consumption in the bleach plant is extremely low as a consequence of the efficient washing and low liquor amount carried over from the TwinRoll press. The mill has a low impact on the environment as the

Brightness	90	% ISO
ClO_2	35	kg act/ADt
NaOH	9-10	kg/ADt
H_2O_2	3	kg/ADt
Acid Effluent	3.7	m^3/ADt
Alkaline Effluent	3.1	m^3/ADt
Total COD	11.1	kg/ADt

bleach plant effluent is about 7 m^3/adt and the COD amount in the effluent is 11 kg/adt.

AssiDoman kraftliner, Sweden, is a press based TCF bleach plant designed for 480 adt of birch kraft pulp/d, that was placed in operation in December 95. See figure 7.

A kappa 17-19 pulp is bleached in the sequence OQ (PO) to 85% ISO brightness. This press bleach plant demonstrates that a pulp of 85% ISO brightness with good strength properties can be produced even though the manganese content is rather high.

The above mills are examples of Valmet hardwood fiberlines showing good water management and low polluting effluents.

The Century Pulp and Paper company in Lalkua, Uttar Pradesh, India owned by Century Textiles and Industries Ltd, has a bagasse kraft pulp mill comprising a cooking plant from Valmet followed by brown stock washing on three filters, screening and a decker. Bleaching of pulp is done in a (C+D) (EO)D bleach plant delivered by Valmet, which raises the pulp brightness to 82-84% ISO with a brightness ceiling of about 88% ISO. The fiberline was started up in 1995 and it has a capacity of 225 bdmt/d, see figure 8.

NON-WOOD PULPING

The nature of the non-wood raw material and favorable cooking conditions makes it possible to cook for example bagasse in a continuous tube digester during only 10-20 minutes. After passing through the digester the pulp is cooled down to 90-95^{0}C by chilled black liquor to avoid damage of the fibers during discharge.

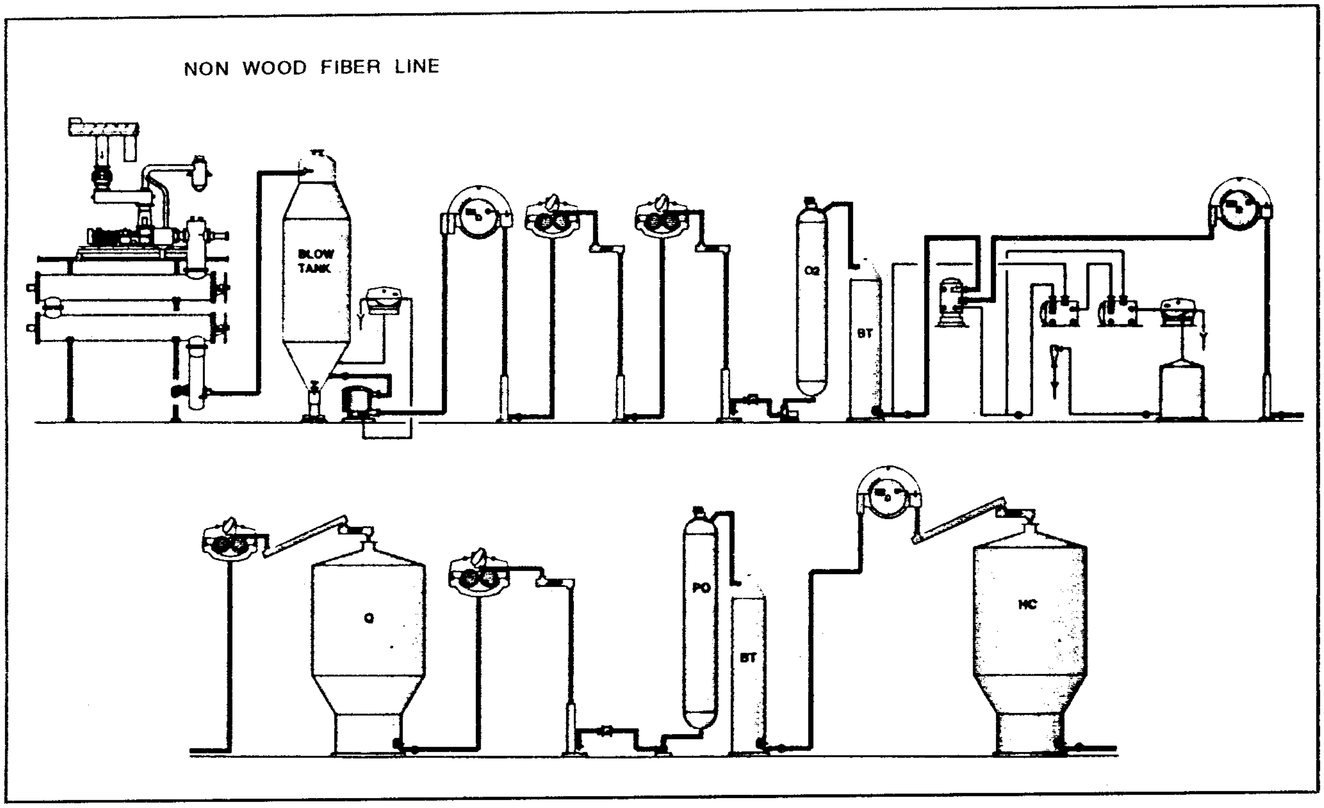

Figure-9 The Valmet fiberline for production of non-wood TCF pulp.

A continuous tube digester system has many benefits compared to a conventional rotary digester, such as :

- The cooking result can be followed and adjusted to improve the yield.
- high steam utilization with steam savings around 50-60%.
- high uniform pulp quality and better runnability
- higher pulp strength, if the cold blow is applied
- can operate at different production levels due to controlled retention time
- no separate blow condenser is required
- saving in building cost and man power

The closed part of the fiberline, brown stock washing and post oxygen washing, is strictly counter current and uses drum filters combined with dewatering presses.

The presses have several advantages over drum filters. A 20-25% lower energy consumption of each washing unit due to higher operating consistency and thus less filtrate volumes to pump. The high outlet consistency of the press washer creates an efficient washing and temperature barrier between each individual process stage. It is easy to maintain good dilution factor control when the press is located as the final washer in the closed part of the fiberline. The press has a washing efficiency that is 1.5-2 times higher than a drum filter.

The well washed pulp from the brown stock washing is further delignified in an oxygen stage operating at 40-45% degree of delignification, giving a corresponding saving in bleaching chemicals and effluents in the open part of the fiberline. The delignification occurs at 3-5 bars and 90-100°C in a pressurized reactor under alkaline conditions. The system is designed to feed the reactor with pulp which contains low carry over from the brown stock washing and to ensure efficient oxygen mixing in a mixer. Both these factors favor the selectivity for strength preservation.

A high consistency screen room is located between the blow tank and the first post oxygen drum filter. The high consistency screening room consists

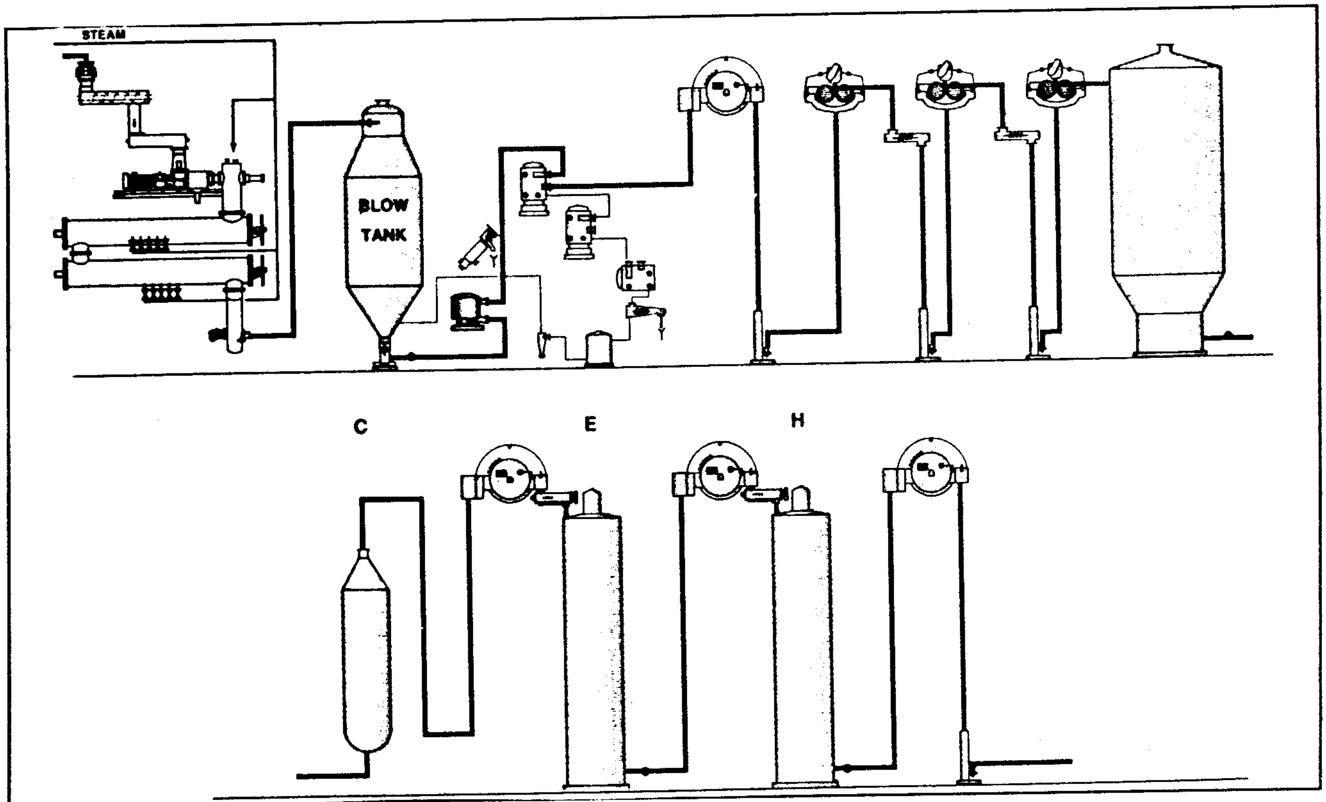

Figure-10 CEH Bagasse

of DeltaScreens with sloted Nimega baskets reducing the power consumption and improves the shive removal efficiency.

The well-washed oxygen delignified pulp is treated in a chelant stage to remove metal ions harmful for the subsequent peroxide stage. A press is used to efficiently remove the metal ions from the pulp.

TCF bleaching is a process solution for a greenfield mill as chlorine gas and hypochlorite plant can be excluded. The sequence OQ (PO) is an adequate sequence for a brightness of 80-85% ISO, and in some cases up to 88% ISO. The PO stage is an oxygen reinforced, pressurized alkaline peroxide stage. The pressure at the top of the reactor is 3-5 bar and the temperature around 90-100°C. Finally, the peroxide bleached pulp is washed on a drum filter.

COMPARISON CEH AND OQ (PO)

A comparison between a CEH and OQ (PO) sequence shows that it is possible to build a modern, cost effective. environmentally sound peroxide bleaching sequence which is able to produce and excellent pulp quality with the same total investment cost as for a conventional CEH sequence. This conclusion is based on two fiberlines which have identical digester systems and equally efficient washing ahead of the bleach plant, figures 9 and 10. It should be noted that the capital cost for the chemical plant has not been considered for the CEH alternative, which makes the OQ (PO) alternative more attractive.

The comparison (Table 1) shows about 14% higher operating costs for OQ (PO) sequence. However, the origin and pretreatment of the bagasse has a great impact on the bleaching result. This is well illustrated in figure 11 showing three bagasse samples similarly cooked and bleached in the laboratory.

Bagasse sample C was also bleached CEH and D (EO) D. figure 12. The better selectivity of the OQ (PO) sequence at higher brightness levels compared to CEH is presented in figure 13 showing the viscosity development. This is also reflected in the strength properties, figure 14, where the OQ (PO) sequence shows a better tear/tensile relationship than the CEH sequence. In this case the brightness was 82% ISO for CEH and 85% ISO for OQ (PO) meaning that the difference in tear/tensile relationship between the two pulps will be even larger at equal brightness. A 85% ISO bagasse TCF pulp can thus be produced with well preserved strength properties.

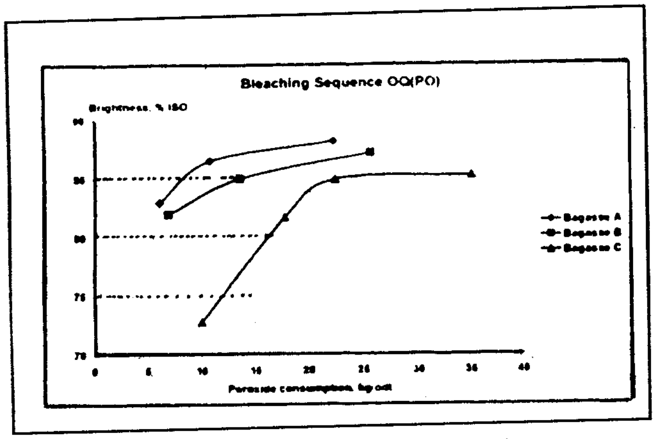

Figure-11 Bleaching graph

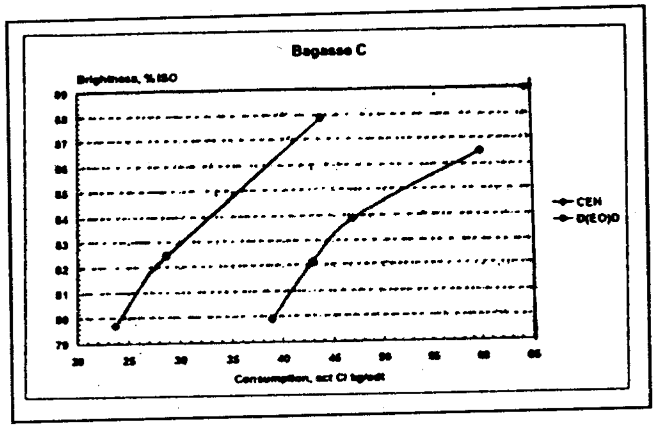

Figure-12 Bleaching graph

An OQ (PO) sequence has many environmental benefits. There are no toxic chlorinated organic compounds generated within the bleaching process. Hence the toxicity of the effluent is extremely low. The alkaline process makes it possible to close the major part of the bleach plant effluent and only 5m of the Q stage filtrate has to be purged from the process. A CEH sequence can not beclosed to the same extent, due to the high chloride content in the bleach plant filtrate.

CONCLUSIONS

Recent decades have brought great progress in the field of chemical pulping and bleaching of wood. That means higher efficiency at lower environmental load. These techniques are in most cases well suited for non-wood mills. As an extra benefit to those pulp mills, pulp quality will be improved by leaving the bleaching with chlorine and hypo chlorite behind and instead go for more environmentally sound TCF

Table-1. Operating and Investment Costs for a 200 ADt/d bagasse fiberline

Chemicals	USD/ton	CEH-1 Consumption kg/adt	CEH-1 Cost USD/adt	O Q (PO) Consumption kg/adt	O Q (PO) Cost USD/adt
OWL	37.0			12.0	0.4
Oxygen	210.0			14.0	2.9
Cl_2	156.0	30	4.7		
NaOH	333.0	25	8.4	15	5.0
NaClO	507.0	25	12.6		
DPTA	3000.0			2.0	6.0
H_2O_2	800.0			25	20
LP steam	2.0	700.0	1.4	500	1.0
MP steam	8.0	2000	16.0	2450.0	19.6
Electricity	USD/MWh	kWh/adt	USD/adt	kWh/adt	USD/adt
Fiberline	84.0	432.0	36.3	420.0	35.3
Total USD/adt pulp			**79**		**90**
Investment *fiberline cost			MU/SD/adt		SD/adt
Total USD/adt pulp			**1218**		**1230**
*Excluding chemical plant					

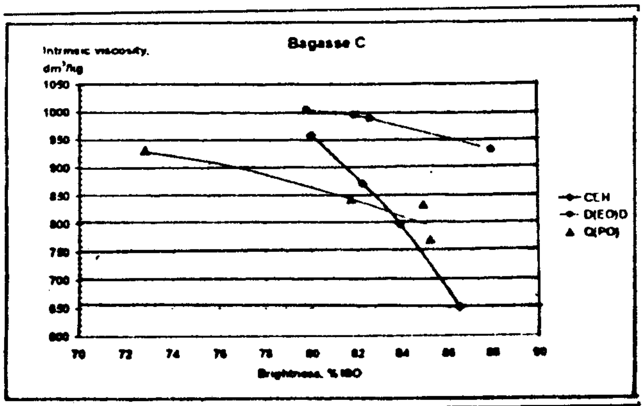

Figure-13 Bleaching graph

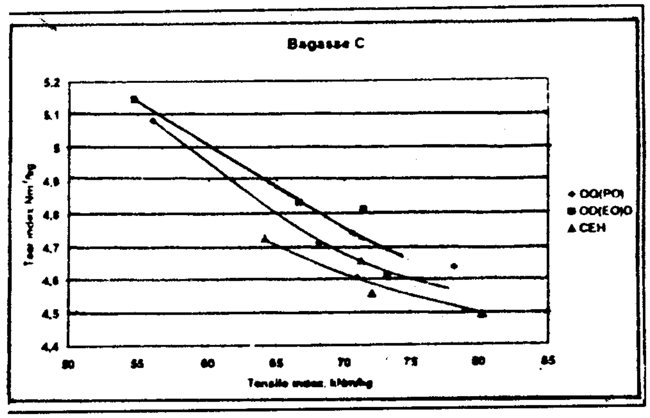

Figure-14 Bleaching graph

pulping technology.

This presentation has shown that it is possible to produce an 85% ISO bagasse TCF pulp at reasonable costs with well preserved strength properties. Why wait?

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