Updating the bleach plant for non-wood fibrous materials

*Olof Simonson.

Changing the conventional bleaching sequence CEH to (C+D) ED, (C+D) (EO) D or D(EO)D would greatly improve the environmental situation and at the same time improve the pulp quality.

Further steps towards a low pollution mill involve the installation of an oxygen stage prior to the bleach plant and increasing the substitution of chlorine in the first stage with chlorine dioxide.

To take full benefit from such actions, optimal cooking and thorough washing are necessary.

These items will be demonstrated as well as the necessity to include careful laboratory trials in the overall feasibility study.

The bleaching sequence normally used in the processing of materials like straw and bagasse is CEH, (fig. 1). That sequence will cause a severe load of chlorinated compounds on the recipient. The use of more than 100 kg active Cl per tonne of pulp is not uncommon. At the same time the attack on the cellulose is considerable by the chlorine in the relatively warm C-stage and by the hypochlorite in the H-stage.

This means an inferior quality even if the brightness target is kept at a moderate level e.g. 80-83%. Fig. 2 and 3)

It is not uncommon that mills are striving against lowest possible Kappa number from the digester. This is done in the good intention of saving bleach chemicals. The consequence is shown in fig. 4.

There is an optimal kappa number around 17 over and under which the final, bleached viscosity will be inferior.

Fig 5 shows that there is some relevance to use the viscosity to indicate the strength potential. The tear index at a given tensile index is higher for the bleached pulp with the highest viscosity and with the intermediate kappa number.

Cooking and oxygen bleaching :

One possibility to improve the quality with less environmental impact is to apply chlorine dioxide in the bleaching. Another one is to install an oxygen stage, or to use both techniques. (Fig 6, 7, 8, 9, and 10) The oxygen stage will reduce the chemical consumption and the polluting materials in proportion to the Kappa-number reduction over the stage.

The oxygen stage is a much more effective way to reduce the kappa number than to prolong the delignification in the digester which is illustrated in fig 11. At the same time the yield will be preserved (fig. 12).

It is necessary to be aware of the fact that there are differences in raw materials. (Fig 13) The consumption of alkali is depending on species and pretreatment. The diagram shows the difference in delignification of three equally pretreated samples of bagasse. It is a worthwhile investment to start any feasibility study with reliable laboratory trials.

Washing :

Before sketching on a fibre line for the production of high quality pulp from agricultural waste I will draw your attention to one more important aspect: washing.

*Sunds Defibrator AB, Sweden.

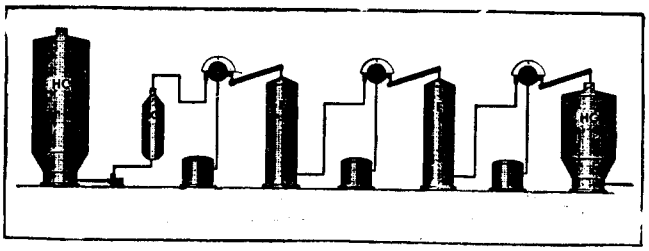


Fig. 1

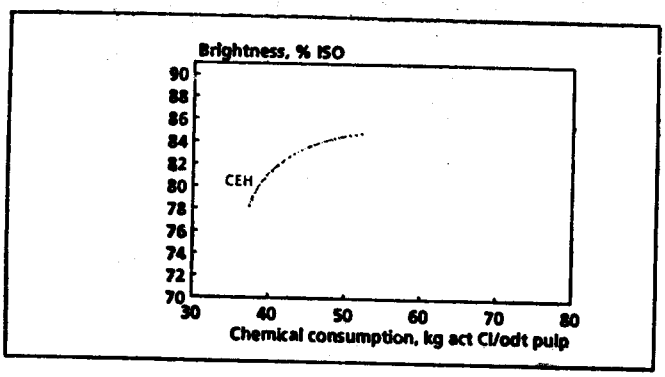


Fig. 2

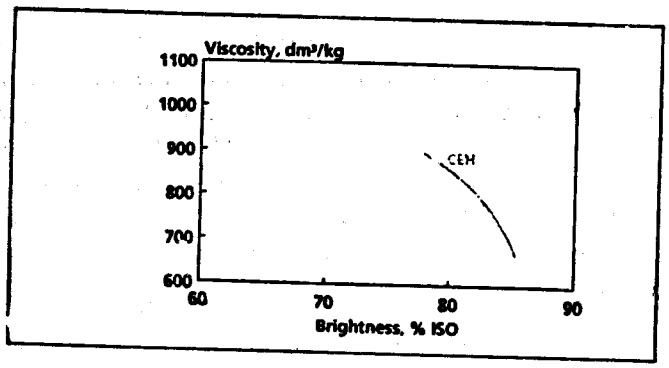


Fig. 3

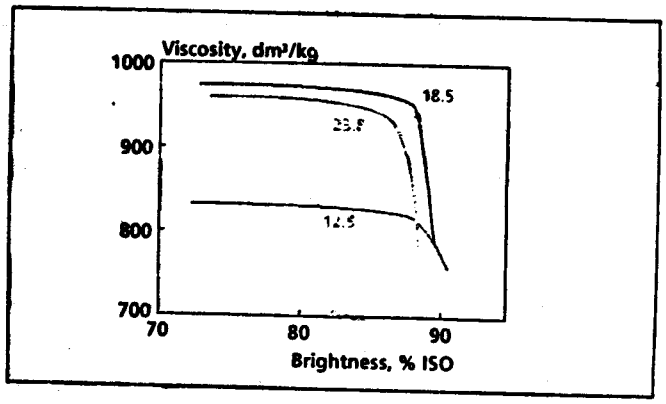


Fig 4

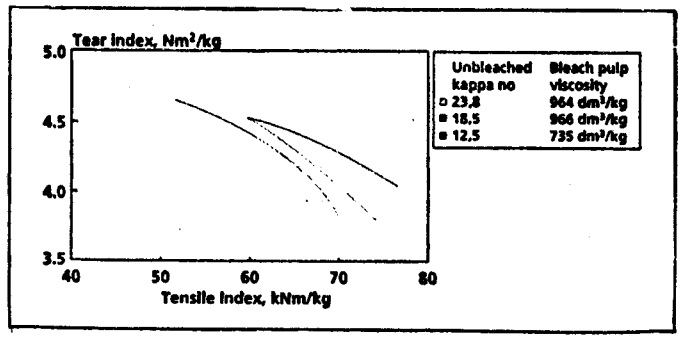


Fig. 5

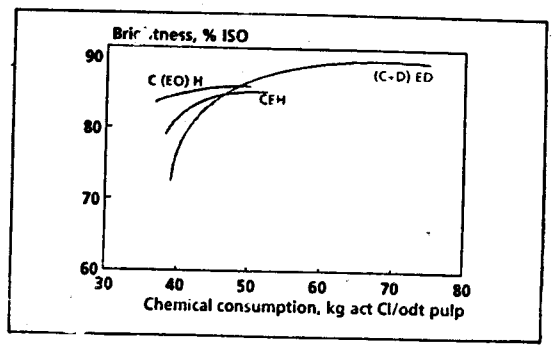


Fig. 6

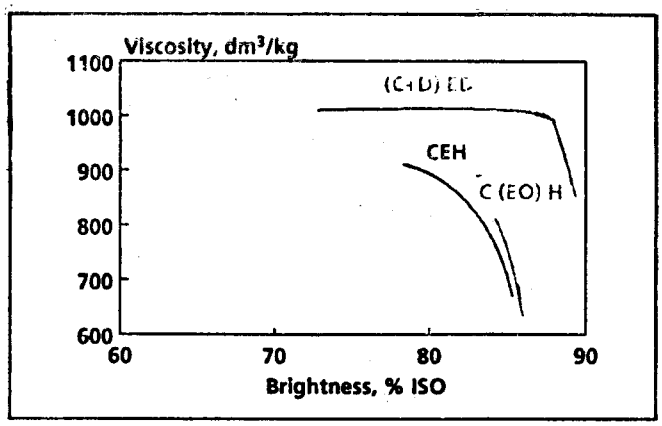


Fig. 7

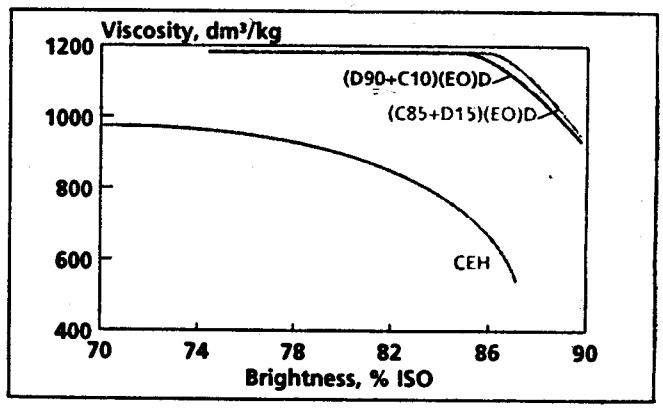


Fig. 8

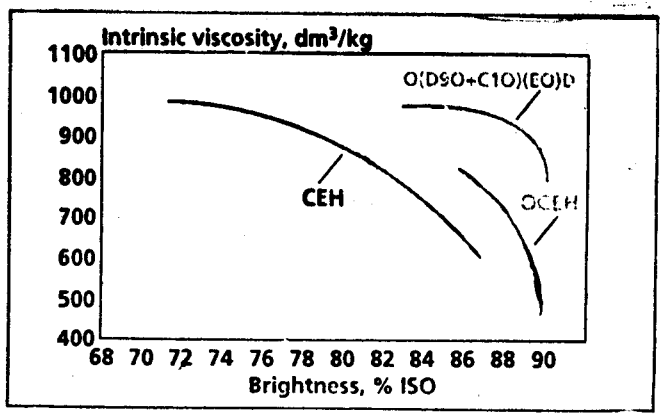


Fig. 9

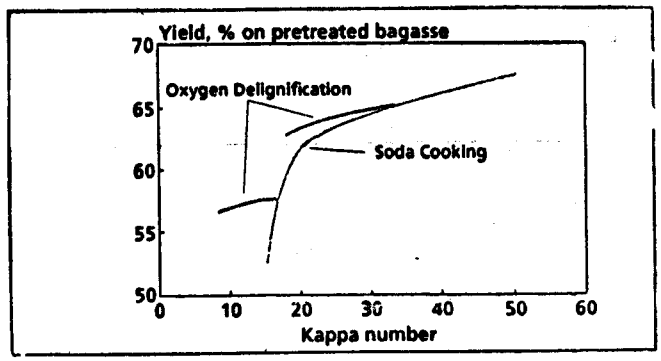


Fig. 12

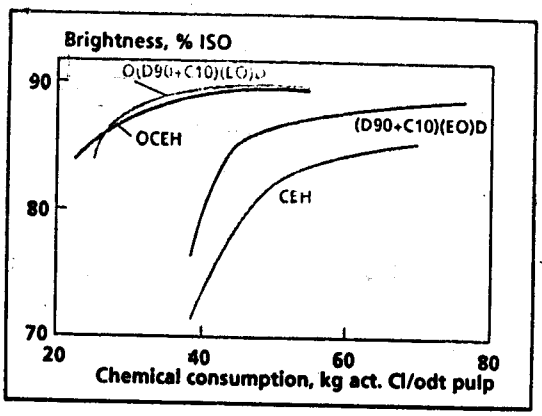


Fig. 10

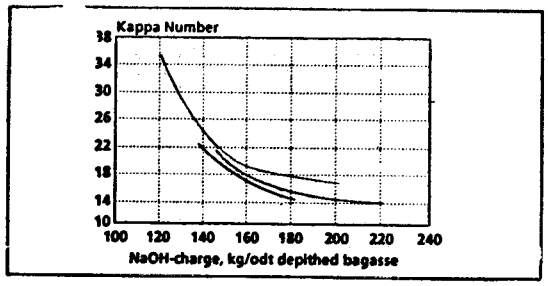


Fig 13

The dissolved organic material entering the bleach plant with the pulp will increase the consumption of chemicals and contribute to the emission of chlorinated compounds. 10 kg of COD will consume 3-5 kg of active chlorine

Therefore, the choice of washing equipment is essential. (Fig. 14)

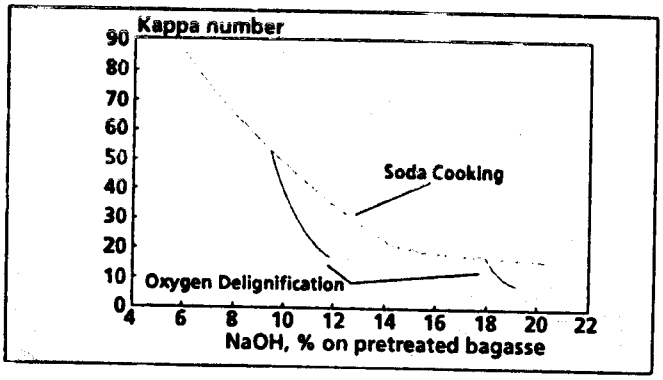


Fig. 11

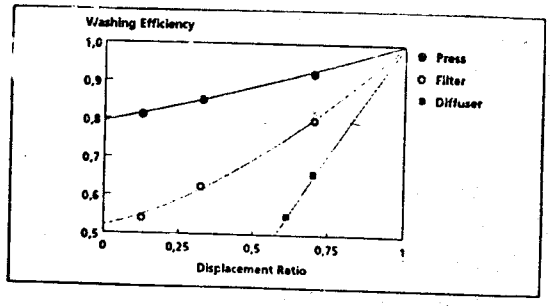
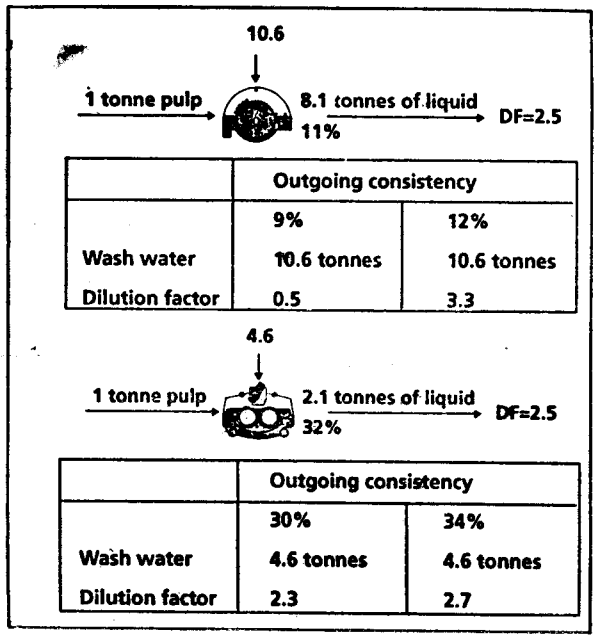


Fig. 14

kg ClO_2/tonne (act. Cl)	Production tonnes/day	Rupees/kg ClO_2 (act. Cl)	days/year	Rupees/year
5	150	20	350	52.5 lakhs

There are three main types of washing equipment: diffusers, filters, and presses.



	Outgoing consistency	
	9%	12%
Wash water	10.6 tonnes	10.6 tonnes
Dilution factor	0.5	3.3

	Outgoing consistency	
	30%	34%
Wash water	4.6 tonnes	4.6 tonnes
Dilution factor	2.3	2.7

Fig. 15

A diffuser washer is working basically without thickening and entirely on displacement of the dissolved material by a cleaner liquid. Therefore, it needs a high displacement ratio-close to ideal displacement–to recover most of the dissolved matter. As a contrast a wash press is working mainly by thickening the pulp–also at a low displacement ratio the washing efficiency will be high discharge consistency. A wash filter will take an intermediate position regarding both pulp thickening and displacement ratio.

The press is an effective means of controlling the dilution factor, that is the dilution of the black liquor to the evaporation. This is shown in fig 15. One more circumstance is talking to the advantage of the press: It has been observed in mill practice that the COD/ saltcake-ratio is lower in the pulp leaving a press than in pulp from a filter or a diffuser. (Fig. 16) This is a reflection of the circumstance that the large organic molecules are pushed out from the pores of the fibres by the substantial hydraulic forces in the press nip.

COD/Na_2SO_4-Ratio for various Washing units	
Displacement Washer	1.5-2.5
Filter Washer	1 0-1 5
Press Washer	0.5-1 0

Fig. 16

Oxygen Stage :

Fig 17 shows the implementation of an oxygen stage in an existing fibre line. The screening is put between the second and third wash filters. The oxygen stage consists of a pump, an oxygen mixer and a reactor. The post-oxygen washing is done by a press. As the press gives a high and reliable consistency something like 5 tonnes of wash water will be saved compared with a filter at the same dilution factor. That amount can be used on an open wash stage ahead of the first bleaching stage which would substantially reduce the carry-over to bleaching.

A less expensive solution which we have used in a number of mills from 350 to 1600 tonnes per day is shown in fig 18. The reactor is exchanged for a mere pipe without distributor and discharger The residence time is only 20-30 min compared with 45-60 min. in an ordinary reactor. The delignification is typically 30%. The fairly good result is explained by the leaching that takes place with the chemicals present in the storage tower.

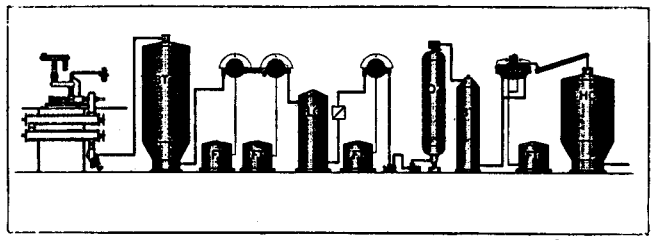


Fig. 17

Bleaching :

Whatever the target is for updating the bleach plant it seems wise to foresee the running of elemental chlorine free (ECF) or totally chlorine free (TCF) pulp

in the future For this reason up-flow towers are used in all stages, fig 19.

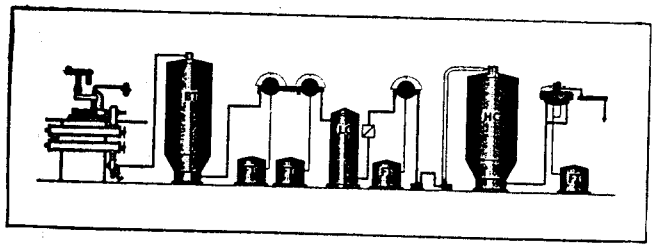


Fig. 18

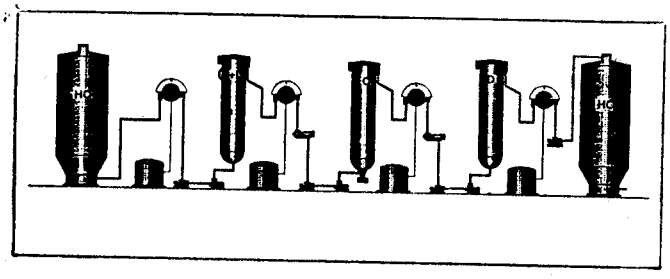


Fig 19

An open wash stage in front of the first stage will reduce the carry-over of dissolved matter with 50%. Furthermore, the filter will deliver the pulp at medium consistency which will be necessary to have if the stage is to be run with chlorine dioxide as the major chemical. The residence time is 30 min. for chlorine dioxide substitution up to 80%; at the higher degrees of substitution the temperature should be elevated. When basically pure chlorine dioxide is used the residence time will be 45 min , also at elevated temperature.

The extraction stage should be high enough at least 25m to give adequate counterpressure for the oxygen reinforcement of the reaction. At an existing tower a pressurized up-flow pre-tube is an alternative. The residence time will be 90-120 min.

The residence time of the dioxide tower will be 180-240 min depending on raw material and desired brightness.

In all stages the need for thorough mixing should be observed.

Conclusions :

Before starting a modernization three important aspects should not be forgotten: A reliable laboratory study is necessary to compare the present situation with future possibilities.

The role of adequate washing for saving expensive and polluting bleach chemicals. Building the new bleach plant with consideration to future demands on quality and environmental concern.