OxyTrac™ process

Monica Bokstrom*, Yngve Lundahl* and N.K. Jain**

Metso Paper, Sundsvall AB , Sweden

Mechano Paper Machines Ltd., Kolkata, India

ABSTRACT

The OxyTrac process for extended oxygen delignification has been shown to be a very efficient process making it possible to extend the delignification significantly for softwood pulps. For hardwood pulp, it has been found that the delignification can be extended, to a smaller degree only compared to the delignification in a conventional single stage. The OxyTrac process has however always given an improved selectivity for hardwood pulps. Lately it has become clear that mills running the OxyTrac process on both softwood and hardwood pulps have experienced other important benefits of the process, as improved bleachability and bleached pulp strength, which are more important especially for hardwood than the extension of the delignification as such.

INTRODUCTION

Oxygen delignification was in commercial operation early 1970s and have since that time become an important stage in the pulp mills. Developments have further improved the process to todays Oxytrac™. The oxygen delignification reduces the environmental load. Further advantages are improved yield and savings of bleaching chemicals.

Fibreline

Metso have focused on research and development to make an efficient fibreline producing excellent pulp quality for last many years. The following goals have been met:

- Producing high quality pulp
- Meeting the environmental norms
- Flexible, TCF and ECF bleaching in the same equipment
- Improved washing with presses in all positions
- Improved screening with DeltaScreens

In India, ITC Bhadrachalam has selected the new fibreline concept. Furthermore, Valdivia in Chile have placed an order from SuperBatch™ cooking to baling this year. A green field mill at Stendal in Germany is under construction where Metso has supplied the fibreline from woodyard to baling.

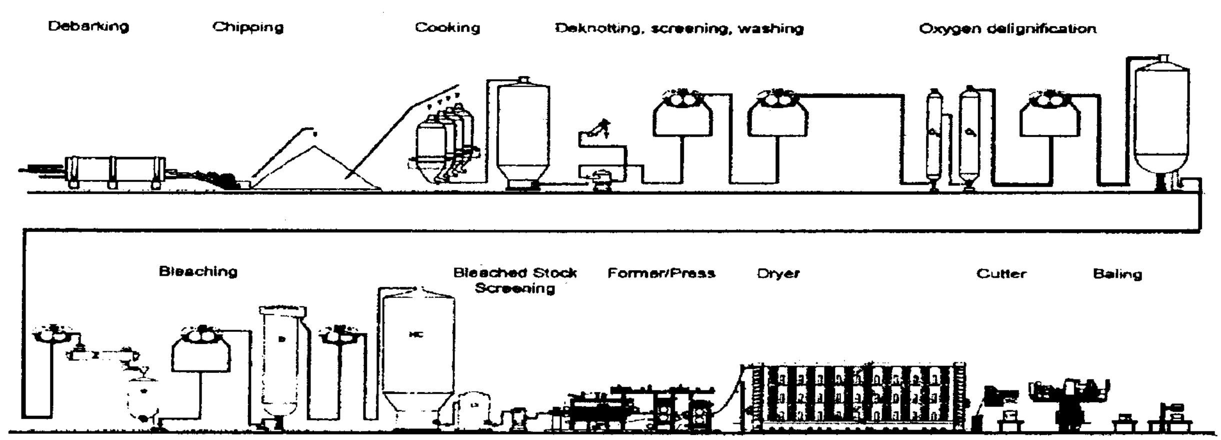


Fig. 1 The Metso Paper Fibreline.

Oxygen delignification

Oxygen delignification involves the use of oxygen and alkali to remove a substantial fraction of the lignin remaining after cooking. Both the chemicals applied and the materials dissolved from the pulp are compatible with the chemical recovery system. This process has been developed considerably since its commercial introduction in the early 1970s. It is conducted under elevated temperature and pressure, at high or medium consistencies and in single or multiple stages. The process can be applied to all types of pulp. While both high and medium consistency stages are in operation today, the perceived advantages of medium consistency for lower capital cost, ease of pulp transport and improved selectivity have made medium consistency as the dominant technique. The most efficient oxygen delignification process for chemical pulping uses two stages and medium consistency. Metso Paper has supplied oxygen delignification stages since the 1970s and has a world market share of more than 50%. The development of the oxygen delignification is going on to further improve the lignin removal efficiency.

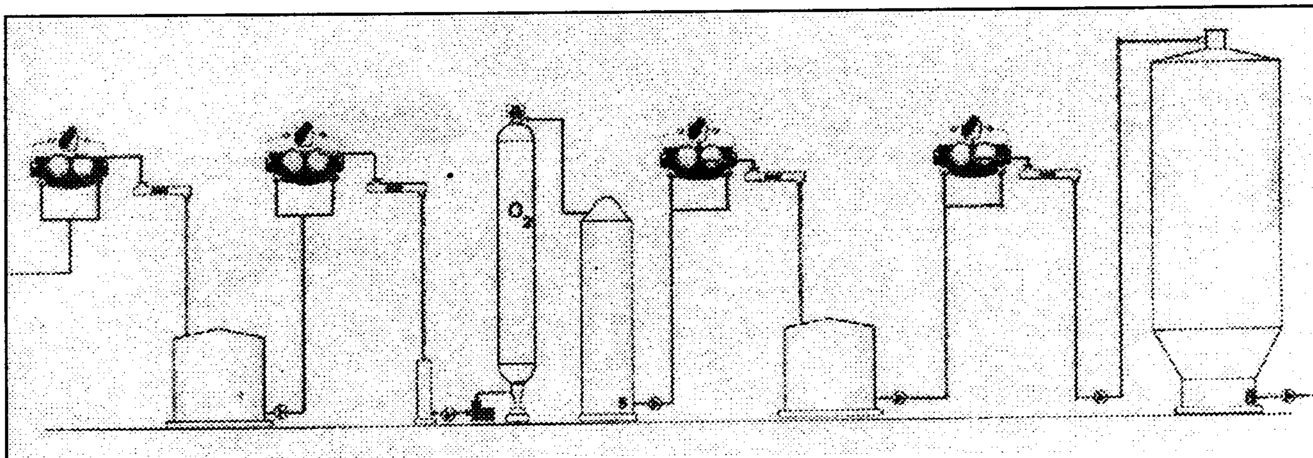


Fig. 2 A conventional oxygen delignification system

Why oxygen delignification?

Extended delignification by oxygen results to a lower kappa number of the pulp entering the bleach plant. As a consequence, the effluent load from the bleach plant will be reduced.

Other objectives of extending the delignification are to reach to a higher brightness of bleached pulp to save bleaching chemicals and to facilitate bleach plant closure. A higher yield of bleached pulp is obtained if the extended delignification by oxygen replaces a part of the residual delignification by cooking.

Oxygen delignification system

A conventional single stage oxygen delignification system (Fig. 2) consists of a pump, a mixer, an upflow pressurized reactor and a blow tank (Fig. 1). Conditions in the bleaching stages are adapted according to the individual requirements but are for hardwood pulps usually in the ranges of 90-105°C, about 3 bar at top of reactor, 15-20 kg NaOH/adt and 15-20 kg O_2/adt.

Two important factors required for an efficient delignification are that the pulp should be washed well

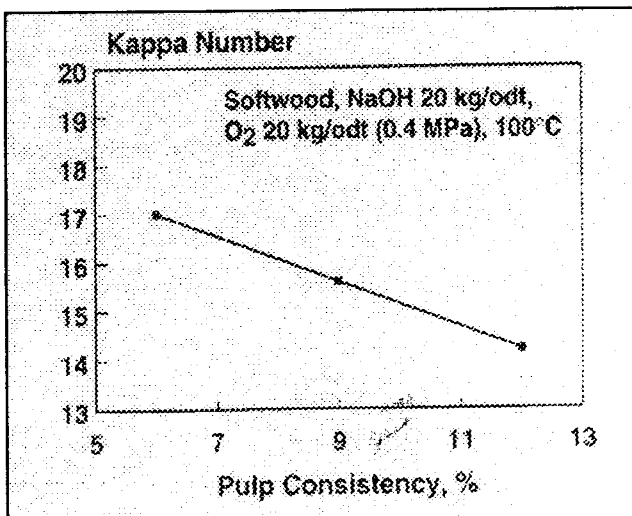


Fig. 3 The influence of the pulp consistency on the kappa reduction. Laboratory oxygen delignification on softwood pulp. The retention time used for the separate points corresponding to the retention time available at the pulp consistency in a reactor designed for one hour at 12% pulp consistency.

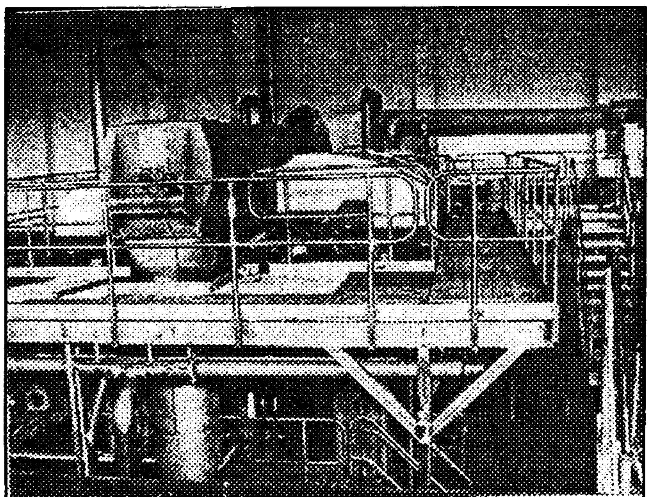


Fig. 4 The TwinRoll™ Press

ahead of the stage and that a high consistency pulp (but still in the medium consistency range) is fed to the system. The carry-over of unoxidized COD (from the cooking) means that the consumption of alkali and oxygen is increased and that the selectivity is impaired. The recycled carry-over with the, the oxidized COD, has a much smaller impact on the oxygen stage. If the carry-over of unoxidized COD is around 20 kg /adt or below, washing ahead of each stage is sufficient for a well performing system.

The influence of the pup consistency on the kappa reduction based on the Laboratory oxygen delignification of softwood pulp is given in Fig. 3. The retention time used for the separate points corresponds to the retention time available at the pulp consistency in the reactor designed for one hour at 12% pulp consistency.

The pulp consistency should be as high as ≤ 11%, for proper and stable running of the system. A higher pulp consistency means that the delignification rate is increased because of the higher alkali concentration at a given charge of Kg NaOH/adt. It means also that the residence time in the reactor increases at a given reactor volume (Fig. 3). Another important reason for having high consistency in the stage is that the risk for gas channe ling decreases at higher pulp consistency. The best and most assured way to be able to keep a constant and high consistency in the system is to have a press as washer ahead of the stage.

OxyTrac oxygen delignification in two stages

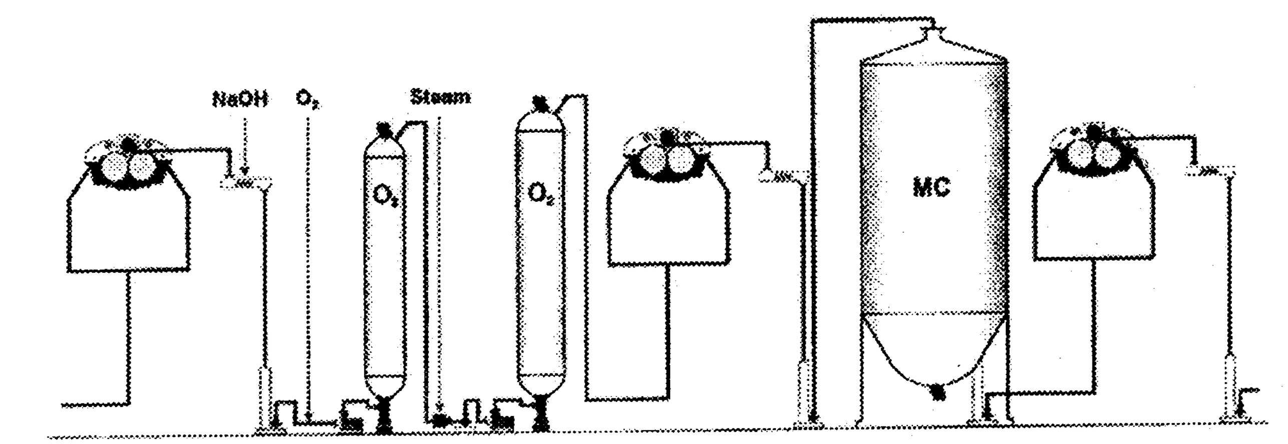
Metso Paper has developed a two-stage process for extended delignification, called the OxyTrac process, (Fig. 5). As extended delignification can only be interesting if the selectivity is very good, this system is developed to give both high delignification and good selectivity. The most dramatic effects have been obtained for softwood pulp with very high delignifications, up to 70-75%. As the delignification by oxygen is lower for hardwood pulps, the effects on the delignification by the OxyTrax system are smaller. The delignification can, for example, increase by about one kappa unit. As both the selectivity and the bleachability of the pulps are improved, the effect of lower chemical consumption, higher yield and better pulp strength make the system very attractive with short pay-back time also for hardwood pulps. With the proper control of the system, very stable outlet kappa numbers are obtained even at large variations in digester kappa number.

The Oxytrac process

The development of the OxyTrac system is based on the kinetics for oxygen delignification as well as. Laboratory tests and our experience of running oxygen stages in fullscale, single stage as well as two stage systems. The basis of the process is that the delignification rate should be high and the rate of cellulose degradation should be relatively low. In one study of the oxygen delignification kinetics, it was shown that the delignification in the initial phase is more dependent on the alkali and oxygen concentration than of the cellulose degradation. The delignification is thus favoured by a high chemical concentration. At the same time we all know that the cellulose can be severely degraded by keeping a high alkali concentration when the temperature is high. This severe degradation can, however, be avoided by keeping the temperature on a relatively low level.

In the second stage where the final delignification takes place, we have found that the variables that can improve delignification are increased temperature and increased retention time. For the selectivity it is however better to extend the time rather than to increase the temperature. There is obviously no improvement of the selectivity by changing the chemical concentrations as shown by kinetics studies. This is, however, only true if the alkali concentration is high enough to avoid significant reprecipitation of lignin.

The recommendations for the OxyTrac process which have emerged are shown in Fig. 4. The first reactor is operated at a temperature of 80-85°C, which usually means that the pulp has to be cooled to the first stage. All the alkali and all oxygen are charged to the first reactor, where a pressure of 8010 bars is maintained at the top. With the high pressure more oxygen is dissolved in the liquor to give a higher



Time' min	**30**	**60**
Pressure, bar -top of reactor	**8-10**	**3.5**
Temperature, °C	**80-85**	**90-100**

Fig. 5 The OxyTrac system.

concentration of oxygen. At a higher pressure the gas volume at a given charge of oxygen in kg/adt is smaller. This facilitates the mixing and decreases the risk for gas channeling in the reactor.

The second stage is operated with a longer retention time than the first reactor as the final delignification is slower. To have a reasonable retention time of about an hour the temperature of the pulp usually has to be somwhat higher in the second stage. A pressure of about 3 bars is required in the second stage. Depending on the raw material, digester kappa number and the washing stages before the system the chemical charge factors can differ. For a softwood pulp a typical value for the alkali charge is about 1.7.-2.3 kg NaOH/ Δ kappa, adt, the oxygen charge is usually 18-25 kg/ adt, and magnesium sulphate is added for dellulose protection. For hardwood pulps the charge factor per Δ kappa is usually somewhat higher, 2.4-3.0 as charge factor, the oxygen charge 13-18 kg/adt.

The press as the last washer ahead of the OxyTrac system is an important feature of a stable and efficient system as it makes it possible to keep a stable and high pulp conistency which is important for the mixing and to keep the residence time controlled, and to avoid gas channeling. The high pulp consistency from the washer also makes it possible to cool the pulp to the proper temperature with dilution liquor only.

Mill data

The implementation of the OxyTrac system in full scale has shown that high quality pulp is produced with this system and that the pulp bleachability develops favourably with the process. The first mill which installed OxyTrac was Ostrand mill in Sweden. They are running both softwood and hardwood production of softwood is 1150 tonne/day and hardwood 1240 tonne/day. Ostrand produces TCF pulp, with a brightness of + 90% ISO, using ozone. Closing up of

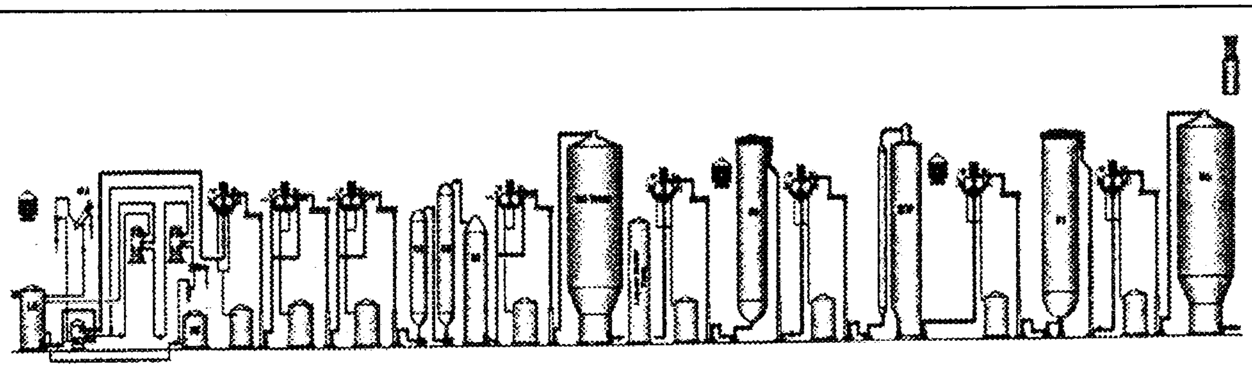


Fig. 6 ITC Bhadrachalam

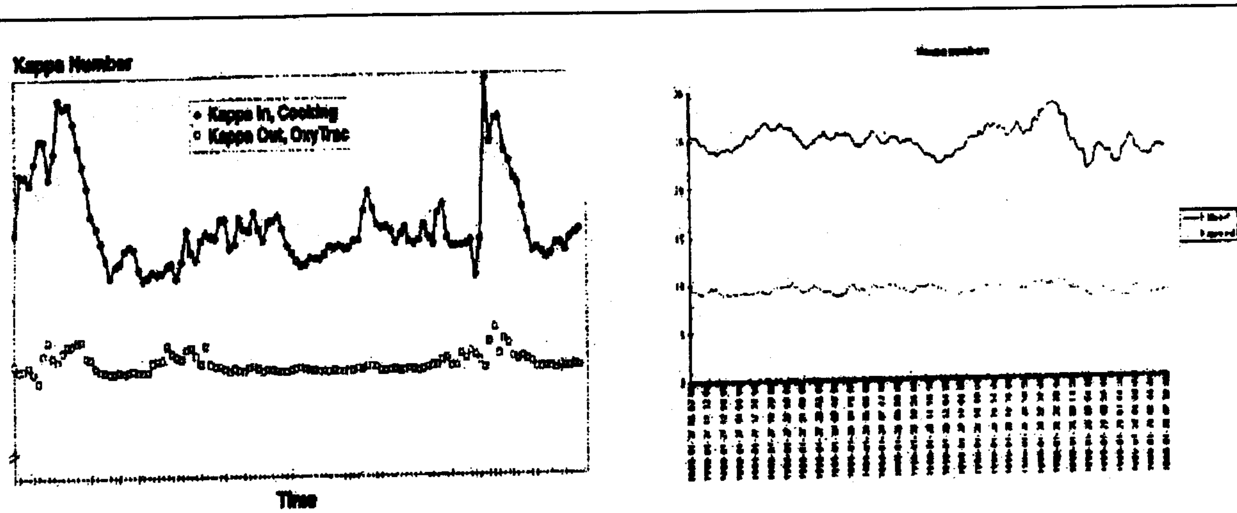


Fig. 7 Kappa numbers before and after OxyTrac delignification. Two examples from two different mills, softwood pulps

the mill is of importance and the discharge is about 5m^3/tonne. Other mills using OxyTrac are Potlatch in USA and Rosenthal in Germany. Further five OxyTrac stages will be started during 2002 and 2003. The fibreline in ITC Bhadrachalam has also the OxyTrac in the new pressbased fibreline.

Control of the process

One of the most important features of an oxygen delignification system is its ability to level out variations of the incoming pulp to decrease, the variations in the bleaching demand and thus to lower the risk for overcharging chemicals. With the development of the OxyTrac system and when implementing it in fullscale we have developed a control system for it as well. The control is mainly based on feed forward control based on online kappa number measurements, and has proven to give very stable kappa numbers out from the process, as can be seen in Fig. 7.

Operating parameters

The table below shows different bleaching sequences. all ECF, with and without oxygen delignification. The filter bleach plant is compared with presses as washers between the stages.

As you can see, the highest chemical cost has the sequence without oxygen stage. The highest discharge values are of course also found in this sequence. OxyTrac with ozone stage shows the lowest bleaching costs and has the lowest impact on the environment. This sequence can be an attractive solution in many installations. Many studies and data from mills have shown that the best strength can be obtained with the sequences having OxyTrac delignification. The yield

Table 1. Bleaching of Indian Hardwood pulp to 88% ISO. Production 300 odt bleached pulp/24 h.

Sequence	D(EOP)DD	OD(EOP)D	OD(EOP)DD	(OO)D(EOP)D	(OO)D(EOP)D	(OO)(Ze)D
Kappa Number	23	13.5	13.5	12.5	12.5	12.5
Washers in bleach plant	Filters	Presses	Filters	Presses	Filters	Presses
Bleach chemical costs US$/adt	47	29	32	28	31	25
ClO2 capacity, t/d	11	6	6.5	5.5	6	2
AOX, kg/adt	1.0	0.5	0.6	0.45	0.55	Non detectiable
COD, kg/adt	50	28	28	26	26	14

is also higher as the kappa number can be higher from the digester plant.

The payback have been less than one year in most of the mills by implementing OxyTrac from a single stage oxygen stage. It is mainly the increase of yield and reduction of chemicals which has reduced the production costs. The pulp quality related to brightness and strength properties has been kept after the rebuild. The AOX and the COD levels are much lower when using oxygen stage compared to the sequence without. With the OxyTrac process the effluent load can be minimized.

CONCLUSION

In the paper a process for extended oxygen delignification, the OxyTrac™ process, is presented. It has proven in full scale running to give both high delignification and high selectivity compared to conventional oxygen delignification. It seems to be especially attractive to use the process to both raise the digester kappa number and to decrease the kappa number of pulp for bleaching. With such an application improved bleachability with maintained or improved pulp strength can be obtained.