Fiberline Technology in Harmony With Nature

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INTRODUCTION

Concern about our environment is the main reason why pulping technology is rapidly changing. International environmental organisations are pushing consumers, as well as pulp producers, towards the philosophy that the Precautionary Principle shall rule, i.e. no effluents of which the environmental consequences are unknown shall be permitted.

The common opinion in the industry, has been that changes in the pulping process are not only troublesome, but also inevitably lead to increased production costs and reduced quality in the end product.

We at Sunds Defibrator, feel that a development towards reduced environmental impact is in line with reduced production costs and an improved quality. This principle has guided us in our development of new processes and machinery.

Today, we would like to present the concept that Sunds Defibrator has developed for producing a cost effective pulp with minimal impact on the environment, while still maintaining a high pulp quality.

An example of a fiberline capable of meeting these demands is shown in figure-1.

The Fiberline is designed for maximum flexibility. This concept provides possibilities to run ECF-(elementary chlorine free) as well as TCF-(totally chlorine free) fully bleached market pulp with a minimum of effluents.

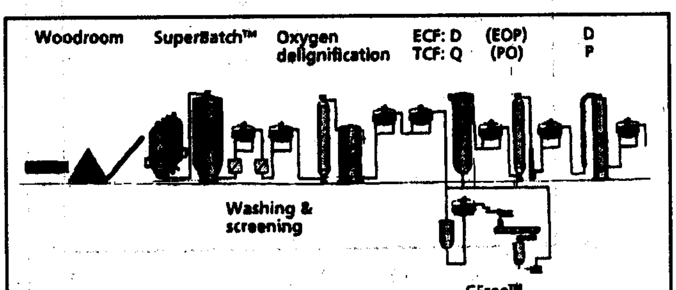

Figure-1. Sunds Defibrator's Fiberline 1996

In combination with Super Batch™, oxygen- and ozone- delignification, followed by a bleach plant, leads to an effluent volume less than 5 m^3/ton. Effluents characterized as COD and AOX respectively are shown in figure 2 and 3.

These figures show the comparison between the effluents from a modern mill, built in 1996, and a typical European mill at the end of the 1980s, with an oxygen- and five-stage bleaching plant.

The proceeding development work is now aiming for a more closed fiberline, and to recirculate

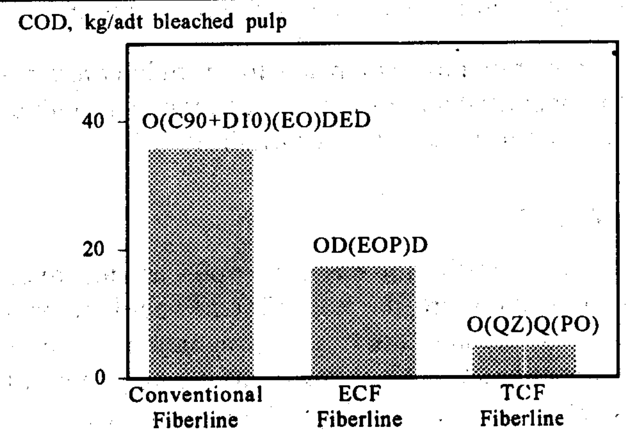

Figure-2. Emissions of COD

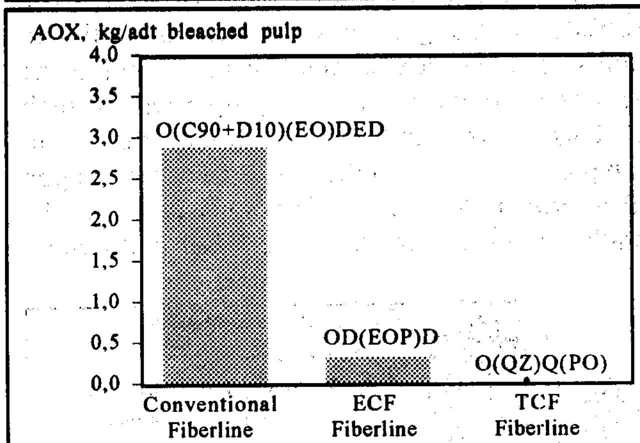

Figure-3. Emissions of AOX

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liquor from ECF- and TCF-bleaching plants mainly to the recovery boiler and secondarily to a separate destruction.

What differentiates the new fiberline from the traditional fiberline? The first thing that comes to mind is the absence of filters, which in all positions have been replaced by presses.

MODERN WOODHANDLING

Using modern woodhandling technology, combined with the right operating methods and raw material sorting by dimensions, it is possible to achieve substantial raw material savings in woodhandling. This also ensures a homogeneous, high-quality chip flow to the pulping process. High quality chips benefit pulping in terms of higher yield, less reject and a lower chemical consumption.

Higher quality also means lower pulp consumption in papermaking, or higher quality paper, both of which increase paper mill profitablilty.

COOKING

Sunds Defibrator has developed an improved cooking technology, the SuperBatch™ cooking process. It is characterized by impregnation of chips with warm and hot black liquor at the beginning of the process. The principle is shown in figure-4.

The significant characteristics of the SuperBatch cooking process, is the possibility to delignify to a very low content of lignin and at the same time maintain the strength properties at a high level. This is shown in figure-5. Sulphate pulp from Eucalyptus has been cooked to a very low kappa number, around 8-15, in one of our installations. The strength properties for the SuperBatch pulp show the advantages compared to conventional pulp cooked in batch digesters.

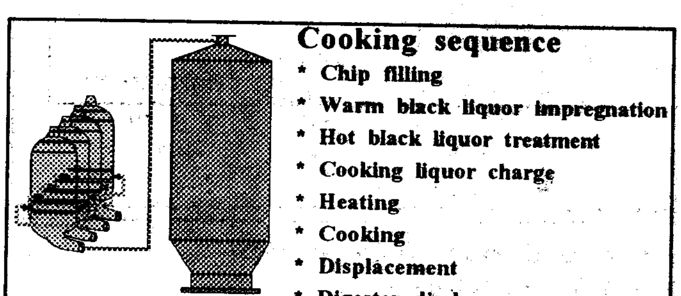

Figure-4. Super Batch cooking sequences

The steam consumption of the SuperBatch system is extremely low, approximately 0.8 ton/odt. Normally in conventional batch digesters, the steam consumption is 2.0-3.0 ton/odt.

Sunds Defibrator has a well proven continuous tube digester for annual fibers. The main advantages of this process are:

- thorough chemical impregnation, ensuring uniform, high quality pulp.
- optimum heat economy
- low investment costs

Some of the companies in India we have supplied with continuous tube digester are Tamil Nadu, Century Pulp & Paper and Satpuda.

EFFECTIVE WASHING AND SCREENING

Washing

There are mainly two issues, cost and efficiency, that have guided us in the development of washing and screening systems. Let us start with washing.

Traditionally, washing has been looked upon as a means to recover inorganic chemicals for the preparation of fresh cooking chemicals. It has also been important to recover the fuel value of dissolved wood substances. In recent years it has become evident that pollution abatement is of paramount

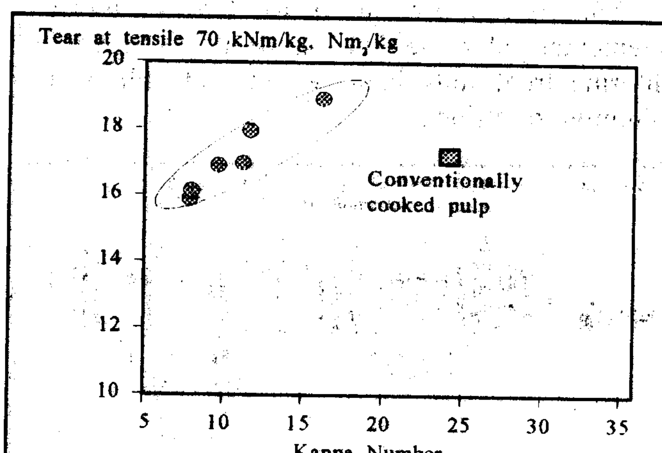

Figure-5. SuperBatch™ pulps-Good strength at low kappa consideration for a sustainable production of pulp and paper products. In view of this, the efficiency of the washing process has become more important, as carry-over of dissolved organic material can severely increase the content of polluting material in the effluent from the subsequent bleaching stages.

This has resulted in the need for highly efficient washing systems, in order to minimize carry-over of dissolved organic material (COD) to the bleach plant. Figure-6 shows results representing a simple laboratory simulation of multi-stage washing according to three different washing principles: displacement washing, filter washing and press washing. The same batch of poorly washed pulp was used. The washing performance was followed by measuring the content of Na_2SO_4 (SCAN) and dissolved organic material (COD) after each stage of washing.

The TwinRoll™ press shown in figure-7, uses three washing methods, dewatering, displacement and pressing. Compared with displacement wash and a wash filter, the TwinRoll™ press is much more effective in washing out COD. Another advantage is the controlled outlet pulp consistency of about 32-35%, which gives a controlled dilution factor. Extensive development work with presses has resulted in TwinRoll presses now being used throughout the fiberline. TwinRoll presses have also replaced filters in the bleach plant.

Screening

The DeltaScreen™ was developed by Sunds Defibrator in the late 80's. The DeltaScreen is a pressurized screen with a specially designed rotor unit, that allows operation at higher pulp consistencies, 3-5%, without reject thickening, which is shown in figure-8. The higher operating consistency, means higher capacity and a substantial reduction of the investment and operation costs.

The DeltaScreens are equipped with slotted wedge-bar type of screenbaskets, as can be seen in figure-9. The screening system is characterized by:

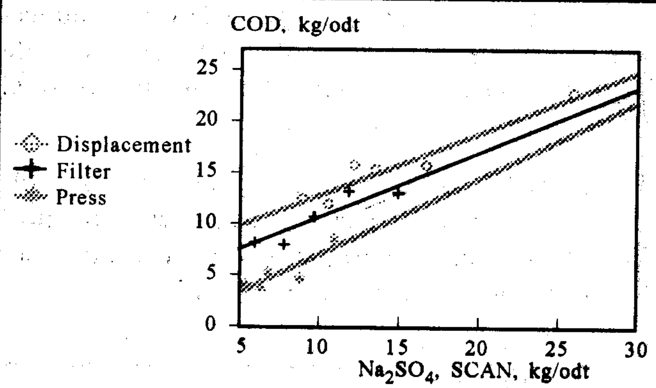

Figure-6. The relationship of COD to Na_2SO_4 in pulp samples of different degrees of washing. The results correspond to washing according to the displacement, the filter and the press principles.

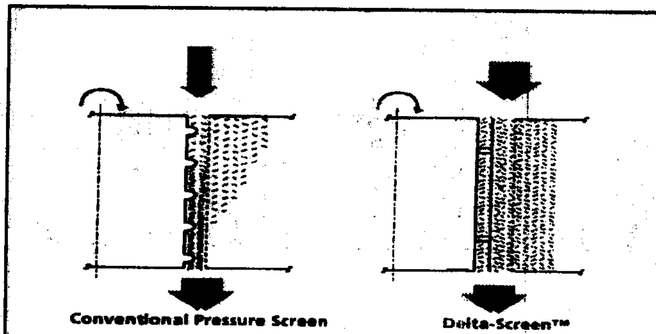

Figure-8. Screening conditions in a conventional pressure screen compared to a DeltaScreen. The Delta foil generates long suction pulses that recover some of the filtrate from the accept side back to the feed side of the screen plate. This keeps the consistency on the feed side constant and consequently the screening conditions are kept constant.

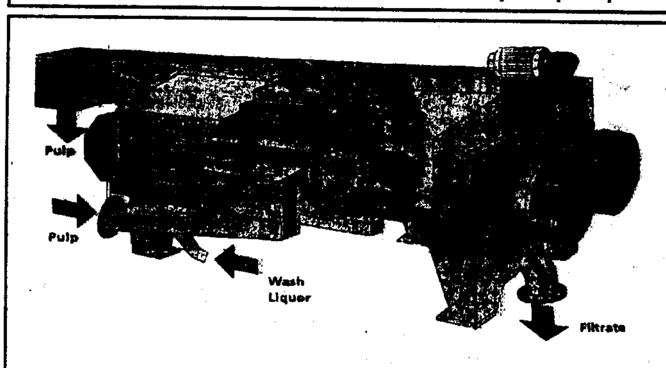

Figure-7. TwinRoll™ press

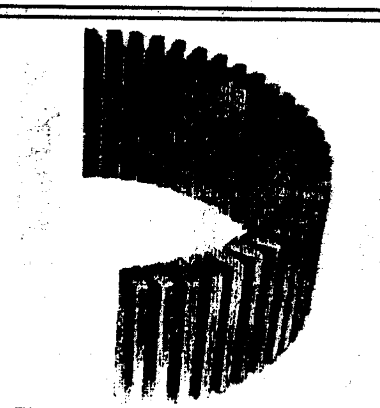

Figure-9. The slotted, wedge-bar type of screen basket

- Efficient barrier screening, selectively removing shives and fiber bundles.
- Mechanically stable slots, that enable screening in one single primary stage, i.e. eliminates double stage screening.
- A larger open area compared to conventional, slotted baskets.

The advantages of a screening system based on DeltaScreens, are high pulp cleanliness, which reduces the chemical consumption in bleaching as shive bleaching is not necessary. A reduced power consumption is also obtained, as the pulp consistency of 3-5% means less amount of circulating water.

Oxygen Delignification

Oxygen delignification is today a well established bleaching technique. Figure-10 shows Sunds Defibrator's medium consistency oxygen stage. More than 50% of the World's sulphate pulp production facilities use oxygen delignification. To achieve more than 50% delignification, a good prewashing is necessary. Recovery of liquor from oxygen stage is uncomplicated.

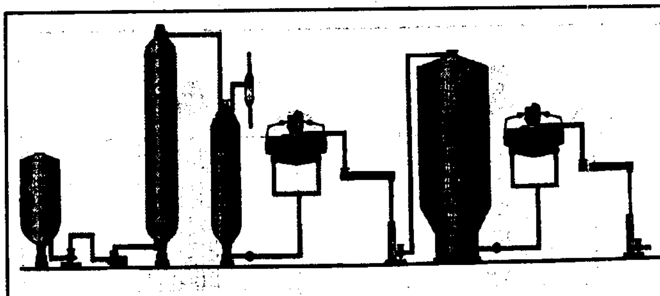

Figure-10. Sunds Defibrator's medium consistency oxygen stage

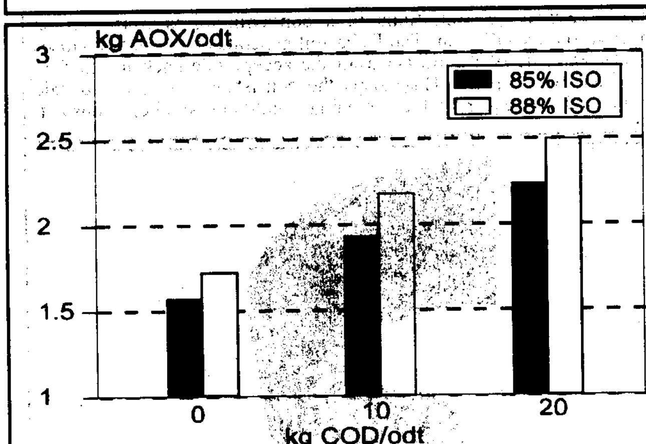

Figure-11. Influence of COD carry-over on AOX-formation in a O(C50+D50)(EO)D sequence

A high degree of delignification ahead of the bleach plant, in combination with good washing, reduces the amount of organic material, and which is subsequently chlorinated in the chlorine or chlorine dioxide stage, thereby promoting AOX formation, figure-11.

The chlorine consumption in a bleach plant is reduced in proportion to the kappa number reduction.

The most important factors in order to reach a high degree of delignification in the oxygen stage are:

- low carry-over of COD into the oxygen stage
- efficient mixing of oxygen gas
- proper final pH
- stable operation and a pulp consistency >11%

ECF Bleaching

In the chlorination stage, AOX is produced when chlorine reacts with the pulp and with the organic material carried-over from the brown stock or post oxygen washing.

To reduce AOX formation, higher ClO_2- substitution is one viable way. There is a clear relationship between the chlorine dioxide substitution and the formation of AOX, see figure-12.

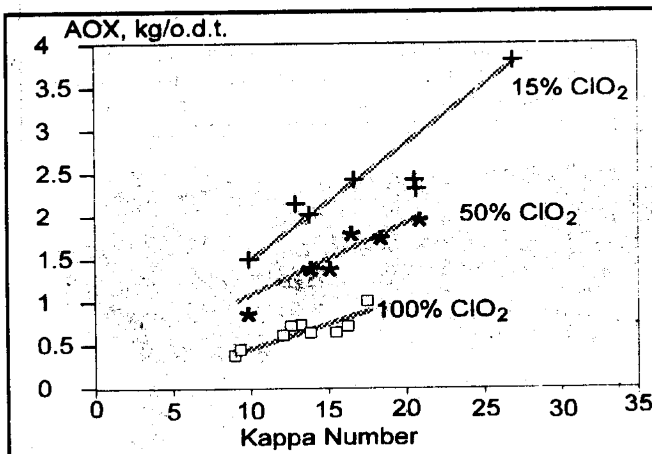

Figure-12. The AOX-formation in DC(EO) DED bleaching for softwood kraft pulps vs the kappa number prior to bleaching.

To reduce the consumption of chlorine dioxide in a modern ECF fiberline, extended delignification of cooking and oxygen delignification are useful tools. A modern Sunds Defibrator ECF-plant can produce a pulp with a kappa number as low as 6 out of the oxygen stage., The AOX level in the bleach plant effluents is thus bleow 0.3 kg AOX/odt before external treatment.

To minimize the consumption of ClO_2 in an existing bleach plant that is converted to ECF bleaching, the following modifications can be made:

- install an open washer ahead of the D0 stage to minimize COD carry-over
- convert a low consistency D0 stage into a medium consistency stage
- improve mixing efficiency

The consumption of chlorine dioxide can be reduced by 10-15% if the D0 stage is converted into a medium consistency stage.

Thorough mixing is crucial for savings of chemicals. The T-mixer, figure-13, represents the second generation high shear mixers, having the highest possible mixing efficiency at minimum investment and operating cost.

The T-mixer has been developed to supplement our old SM-mixer, which has been sold in almost 500 units. The target was to maintain the mixing efficiency, while reducing the size and the power consumption, and special attention was paid to the aspects of maintenance. A number of installations have shown that the targets was reached.

The initial distribution of the chemicals is of prime importance. This very important aspects has so far been neglected, in many mixers, the chemicals are simply added to the pipe ahead of the mixer.

TCF-bleaching

Total Chlorine Free (TCF) bleaching avoids the creation of AOX as chlorine compounds are eliminated from the porcess.

The biggest change in bleaching technology, is the introduction of peroxide in combination with oxygen at high pressure and high temperature. The advantages with this combination was shown more than 20 years ago. But it is not until today, it has become technically and commercially interesting to adapt this technology at full scsale. Figure-14 shows Sunds Defibrator's pressurized peroxide stage.

A powerful, pressurized peroxide stage reduces the peroxide consumption and increases the brightness, compared to a conventional atmospheric peroxide stage. A combination of high temperature and pressurized oxygen is the key to good results.

Pulp consistency is also an important process parameter. A high, even pulp consistency to the pressurized peroxide stage, provides a stable residence time and a reduced peroxide consumption for a certain brightness.

In TCF bleaching, harmful metal ions must be eliminated from the process if hydrogen peroxide is

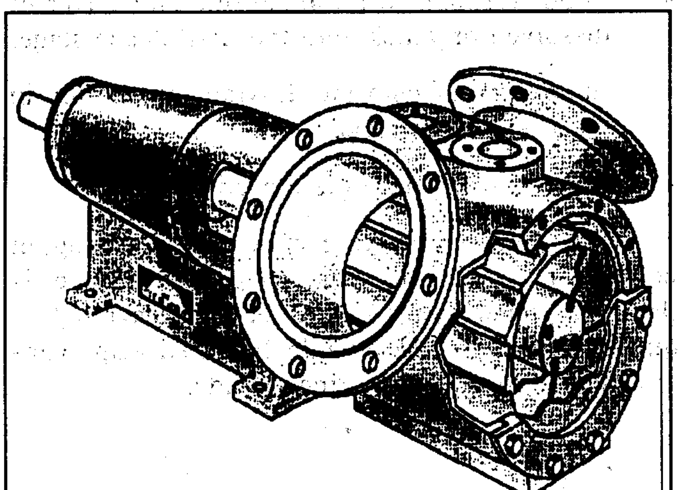

Figure-13. T-Mixer

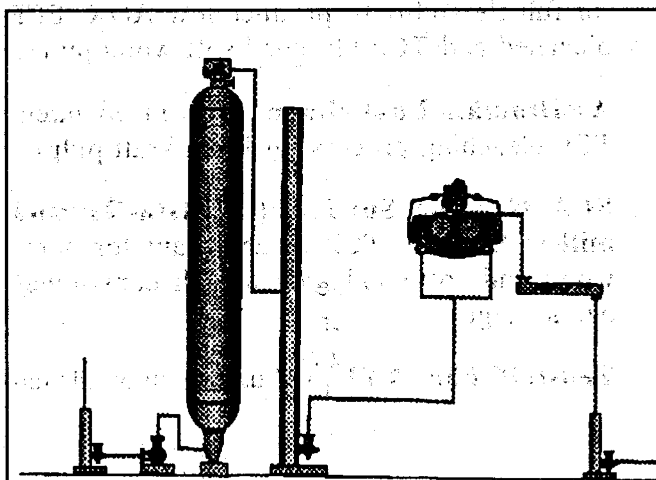

Figure-14. Sunds Defibrators pressurized peroxide stage used as bleaching agent. The most detrimental metal ions are manganese, copper and iron. These metals are removed in a chelating stage ahead of the peroxide stage. The chelating agent is either EDTA or DTPA.

The pressurized peroxide stage is also beneficial in a conventional bleach plant if a high brightness is required and the pulp is close to the brightness ceiling. The pressurized peroxide stage can then be used to reduce the total active chlorine consumption and to improve the pulp quality.

REFERENCES

The need during the nineties for the industry to drastically reduce the effluents of organic material from bleaching, and to minimize resp. eliminate the usage of chlorine based chemicals, has put a great pressure on the suppliers to develop a new fiberline technology.

We have briefly introduced to you how this has effected the development work for new processes and machinery in our company. During the last years we have delivered a number of installations based on the concepts presented in this paper. These installations are:

- **Advance Agro Mill** in Thailand, complete fiberline with only TwinRoll presses for dewatering and washing, ECF or TCF bleaching.
- **SEPAP Steti Mill** in the Czech Republic, rebuilt in several steps in the 1990s to allow for full flexibility to produce low AOX, ECF bleached and TCF bleached soft wood pulps.
- **AssiDomän Lövholmen Mill** in Sweden, TCF bleaching process for birch kraft pulp
- **SCA Graphic Sundsvall, Wifsta-Östrand mill** in Sweden, TCF bleach plant for hardwood and softwood with a high consistency ozone stage.
- **Zellstoff Pöls Mill** in Austria, new bleach plant producing primarily ECF pulp with TCF production in campaigns.
- **Stora Billerud Skoghall Mill** in Sweden, new bleach plant capable of producing ECF and TCF pulp.

CONCLUSIONS

Were it not for our customers's demands for changes, and their participation in the development work, these changes would not be possible. The development work is proceeding towards an increased close-up of the fiberline. A big effort is made to further improve the processes, machinery and systems, to reach even lower production costs and better product quality, and at the same time reduce the environmental risks that are linked to the manufacturing of bleached chemical pulp.

Careful attention to the whole fiberline process, from the woodyard to the baling line, is important if an environmentally friendly, cost effective, high quality pulp is to be produced.

In a modern fiberline, with a high degree of delignification, it is possible to lower the COD and AOX in the bleach plant effluent. It is possible in a ECF blach plant to emit only 0.3 kg AOX/odt and 20 kg/odt before external treatment.

The AOX formation and the reduction of COD in a chlorine based bleach plant depends basically on:

- good washing, to minimize the carry over of dissolved organics, into the first bleach stage.
- the degree of chlorine dioxide substitution in the first bleach stage.
- kappa number into the bleach plant.

Oxygen delignification and ozone bleaching, in combination with a pressurized peroxide stage, is the most powerful and cost effective bleaching sequence today to produce a fully bleached pulp, without using chlorine or chlorine dioxide.