Degree of Closure of Swedish (Nordic) Bleached Kraft Pulp Mills, 1990 and 2000 - 2005

Meeri Puukko

ÅF-Process, Flemminggatan 7, P.O. Box 8309, S-104 20 Stockholm, Sweden
Tel: +46 8 657 1311; fax: +46 8 657 3757
E-mail address: meeri.puukko@afconsult.com

Key words: Degree of Closure, Bleached Kraft Pulp Mills, Sweden

Abstract

The topic of this paper is to indicate how and how much the Swedish (Nordic) bleached kraft pulp mills have been closed up during the last ten-fifteen years. Emphasis is put on how water usage has decreased and changed in the different mill areas and how they are related to each other. In these aspects the paper is quite detailed.
In average the process effluent flow has decreased from about 100 -110 m^3/ADt to approximately 50-(60) m^3/ADt in Swedish bleached kraft pulp mills during the period 1990 - 2000/2005. There are large differences among mills. The most closed mills have process effluent flows of about 30 m^3/ADt.
The consequence of increased closure is increased concentrations of organic and inorganic substances. An overview is given of what problems the increased concentrations may give rise to in different mill areas.
This paper mainly deals with different ways to close up the bleach plant, as it is primarily the bleach plant that has been closed up during the period discussed. The main reason to increase the closure within the bleach plant is to decrease the water usage and the process effluent flow. The foremost reason to close up the bleach plant with the rest of the fibre line and the recovery areas is to decrease the discharges with effluent. Examples are given of both these main methods.

Introduction

During the last ten to fifteen years the degree of closure of Swedish kraft pulp mills and kraft pulp mills in most other countries have increased significantly, resulting in decreased amount of process effluent per ton of pulp. Process effluent flows do not include clean water flows from the mill, as cooling and sealing water flows etc.. World-wide the consumption of fresh (raw) water has also decreased. Swedish kraft pulp mills have, however, not decreased the fresh water consumption as much as kraft pulp mills located in countries with limited water supplies.

Regarding Swedish mills the process effluent flow has decreased from about 110 m^3/ADt in 1990 to about 50-(60) m^3/ADt in 2000/2005. These are average figures for mills, producing only or significant amounts of bleached kraft pulp in addition to other pulp qualities and/or various paper products (NV 1990 & 2000; Skogsindustrierna 2005). Some mills have reported dramatic changes, while other mills have reported smaller changes. Södra Cell Mönsterås has e. g. reported a decrease of the process effluent flow from 52 to 33 m^3/ADt during this 15 year period. The corresponding figures for Aspa Bruk (Munksjö) are from 120 to 29 m^3/ADt and for Korsnäs from 120 to 89 m^3/ADt, ***Table 1***. In this context it should be mentioned that some mills have reported the total effluent flow, process plus clean water effluent flows, why the average and some individual figures per ton of pulp are rather high.

Table 1 *Process effluent flows from Swedish kraf pulp mills producing mainly bleached pulp. Some or several mills have reported the total effluent flow, i.e. including clean waters as cooling water etc., why the average figures as well as several individual figures are high (NV 1990 & 2000; Skogsindustrierna 2005). In this table the average figure of 15 mills is given as well as a few mill specific figures.*

		1990	2000	2004
Average	m^3/ADt	108	58	52
Mönsterås	m^3/ADt	52	36	33
Aspa Bruk	m^3/ADt	120	42	29
Korsnäs	m^3/ADt	120	91	89

Greenfield kraft pulp mills for bleached pulp qualities are usually designed for a total effluent flow of 20-30 m^3/ADt, which corresponds to a fresh water consumption of about 23-33 m^3/ADt. In these mills cooling water and other clean waters are reused after cooling in cooling towers or alike. In principle it means that the total effluent flow equals the process effluent flow.

The main reason to increase the degree of closure is to decrease the releases of various substances to the receiving waters. Often the fresh water consumption will then also decrease, but not always. Decreased water consumption may be a stand-alone goal, especially in areas and countries with restricted water supplies.

In this paper the discussion will be limited to increased degree of closure of process streams. Process streams then relate to streams containing wood, chips or pulp or streams that have been separated from wood, chips or pulp, like e. g. bleach plant filtrates, condensates and spent liquors. It is mainly the closure and water consumption of the fibre line that will be discussed, as this is the area in which much of the water is consumed and the process effluent flow evolves from.

The consequence of increased closure is increased concentration of the liquid streams in the bleach plant, the brown stock and digester areas as well as the recovery areas. This will give rise to various problems as risk for scaling, deposits, increased corrosion etc..

Fibre line in Sweden/Nordic Countries in 1990

In the kraft pulp mill fresh (process) water is consumed in:

- The wood yard;
- The brown part of the fibre line including the digester plant, the screening plant, the brown stock washing area and the oxygen delignification plant;
- The bleach plant;
- The drying machine including the final screening plant (unless the pulp goes to directly to a paper machine);
- The causticizing/white liquor preparation

Dry **debarking** was applied in most Swedish and Nordic mills by 1990. Typically the consumption of water was 2-4 m^3/ADt, and usually as warm water. Somewhat less water was released as process effluent, 1.7-3.7 m^3/ADt.

In the **brown part of the fibre line** it was common to use hot water or clean condensate from the evaporation or a mixture of both as wash liquid on the last washing unit. Having a wash press as the last washer a common liquid flow was then 4 m^3/ADt, ***Figure 1***. With a filter as the last washer a usual wash liquid flow was 8.5 m^3/ADt.

The wash liquid was led counter currently through the whole brown fibre line. The liquid extracted from the digester includes the excess liquid from washing (dilution factor), chemicals used at cooking (white liquor) and oxygen delignification (oxidized white liquor and/or NaOH) and added steam as well as wood water. The black liquor, including dissolved wood substance and spent chemicals, was extracted to evaporation and further recovery.

The amounts of condensate from cooking respectively evaporation are approximately 1 and 8-10 m^3/ADt. The clean fractions from evaporation, often called the secondary condensate, were often used for washing on the last washer in the oxygen delignification plant. The amount of secondary condensate varies with the concept of the evaporation plant, but is usually in the range 2-5 m^3/ADt. The dirty condensates from cooking and evaporation were sewered or used in causticizing for white liquor preparation.

A minor amount of liquid was also leaving the brown part of the fibre line together with the screening rejects. This liquid, 0.1-0.3 m^3/ADt, was sewered.

Using a wash press as the last washing unit after the oxygen stage it was usual to dilute the pulp with temperature controlled water before storage in the HD storage tower. Typically 5.5 m^3/ADt water would be needed, *Figure 1***.** With a filter in this position dilution was sometimes also required before storage of the pulp. In this example the required amount of water is then 1 m^3/ADt.

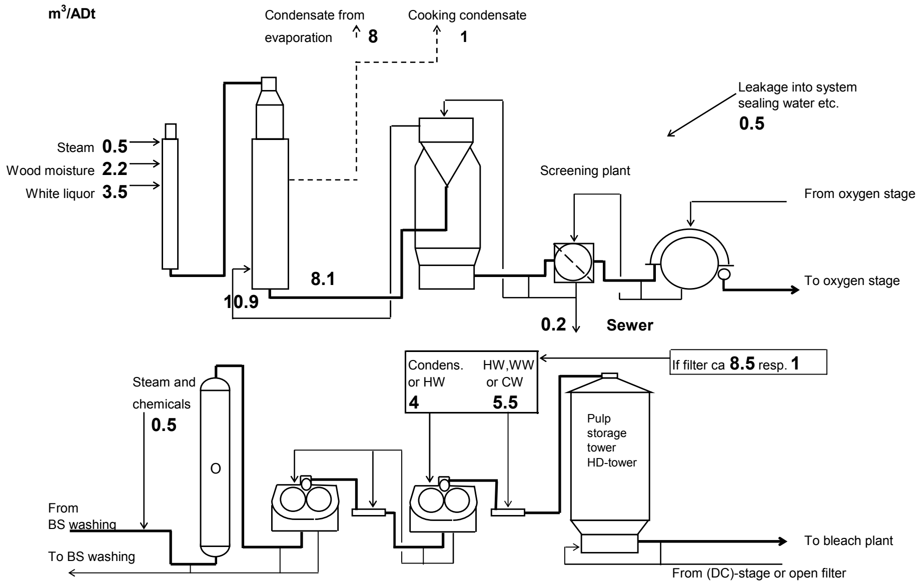

Figure 1 *Principle diagram of a brown fibre line in Sweden/Nordic countries in 1990, an example*

Five-stage ECF **bleach plants**, D(EO)D(EP)D, with filters as washing units were very common around 1990, ***Figure 2***. A usual effluent flow from this type of bleach plant was 25-35 m^3/ADt and in this specific example the flow is almost 30 m^3/ADt. The bleach plant is open - no filtrate/effluent is recycled to the brown part of the fibre line. Hot and warm water as well as white water from the drying machine are used as wash liquids, the amounts being 16.5, 2.5 respectively 6 m^3/ADt in this specific case. Liquid is also added to the pulp with the bleaching chemicals and as steam.

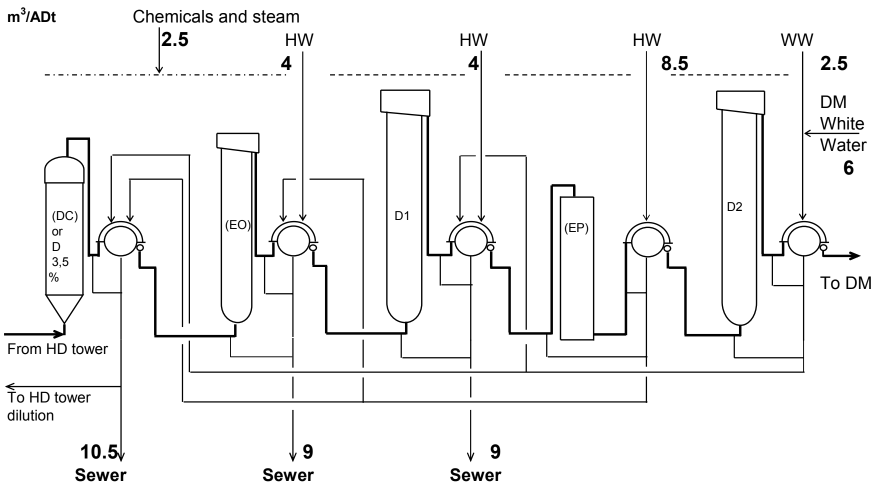

Figure 2 *Principle diagram of a 5-stage bleach plant in Sweden/Nordic countries in 1990, an example*

It was also quite common to have an open filter just before the bleach plant, ***Figure 3***. The wash liquid, mostly fresh water, used on this filter was sewered and increased the effluent flow from the bleach plant by 10 m^3/ADt, which means about 40 m^3/ADt in this case. These filters were introduced in the 1980-ies. The purpose was to wash out as much organic substance as possible before the bleach plant, to avoid "chlorinating" it. In the 1980-ies most bleached kraft pulp mills in the Nordic countries, if not all, bleached their pulp or some of their pulp qualities with chlorine and chlorine dioxide in the first bleaching stage (DC).

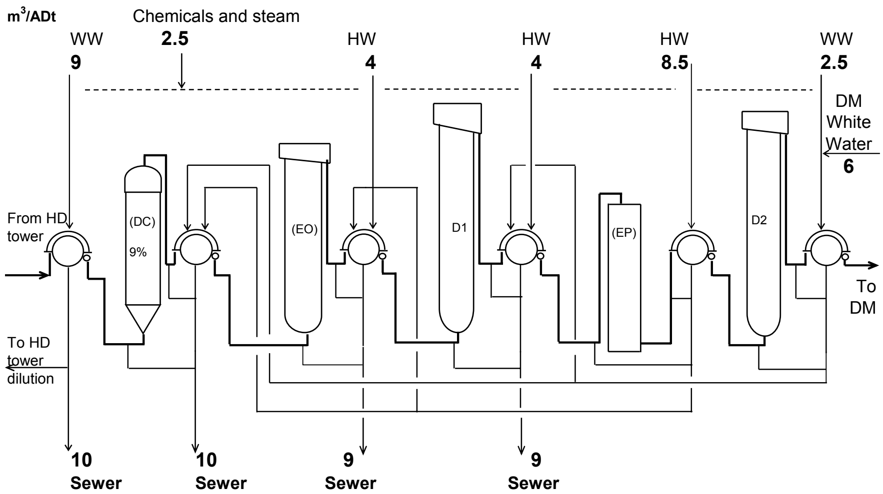

Figure 3 *Principle diagram of a 5-stage bleach plant in Sweden/Nordic countries in 1990, an example with an open filter before the bleach plant*

In the **drying machine** area, including the final screening, the amount of hot and warm water added to the pulp stream were about 4 m^3/ADt, ***Figure 4***. The usual amount of effluent sewered was 3-4 m^3/ADt and came from the press section. The rest of the white water was often used as wash water on the last bleach plant washer and for dilution of pulp between the bleach plant and the final screening plant.

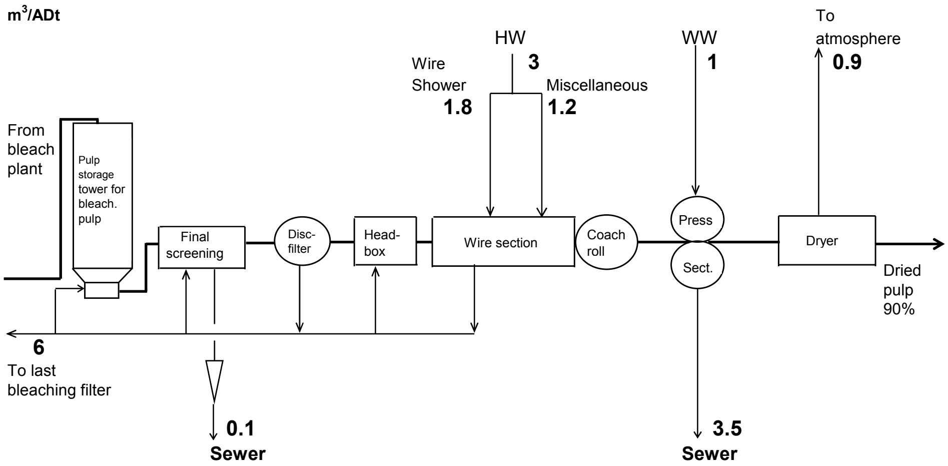

Figure 4 *Principle diagram of a final screening and drying machine area in Sweden/Nordic countries in 1990 and 2000-2005, an example*

In the **causticizing plant** typically 4 m^3 of liquid/ADt was used for the preparation of white liquor from the recovered cooking chemicals, ***Figure 5***. Mostly the liquor used was a mixture of hot water, cooking condensate and the dirty fractions of the evaporation condensate. Any excess of condensates were sewered. It should be mentioned that in several mills all or a great share of the condensates were sewered. In principle the causticizing plant does not generate any process effluent.

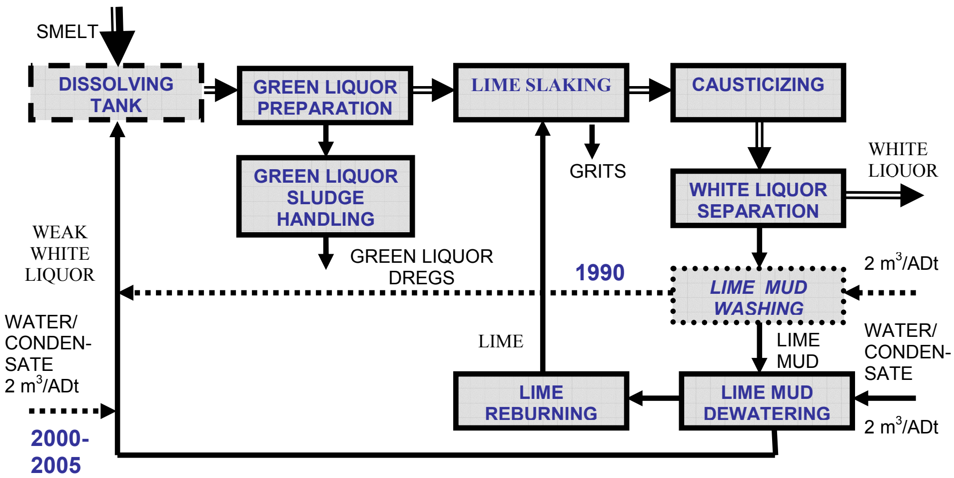

Figure 5 *Block diagram and principles of white liquor preparation, 1990 and 2000-2005*

Summarizing the above example the fresh water consumption of the 1990 year fibre line (including white liquor preparation) is almost 40 m^3/ADt without an open filter and almost 50 m^3/ADt with an open filter, *Table 2*. In this summary we have assumed that half of the cooking and evaporation condensates are reused, while the other half is sewered. We have also added another 10 m^3/ADt of water representing various spills and leakages of the whole mill. This process water did partly dilute all process streams. The amount of fresh water used within the mill processes and the amount of process effluent released from the kraft pulp mill then amount to about 50-60 m^3/ADt, ***Table 2***.

The largest consumer of fresh water is the bleach plant. In the example summarized the consumption is 19 m^3/ADt without an open filter and 28 m^3/ADt with an open filter.

Table 2 *Bleached kraft pulp mill of 1990, summary of the water consumption in different process areas according to examples presented above*

Consumption of fresh water	m^3/ADt
Wood yard	3
"Brown fibre area"	8
Bleach plant	19 (28) [a]
Drying machine	4
White liquor preparation	2
Chemicals (O + bleach plant)	2.5
Spills and leakages	10
Sum	**48 (57) [a]**
Process effluent flow	**Ca 50 (60)**

Assumptions: half the amount of condensate is sewered. Steam is incl. in the effluent flow, but not in the water consumption. There is 10 m^3/ADt of water as spills to effluent. Clean waters as cooling water and sealing water etc. are not incl. either in the water consumption or the process effluent flow.

a) 19 without an open filter and 28 with an open filter

Fibre line in Sweden/Nordic Countries (Europe) in 2000-2005

During the 1990-ies and the early 2000-ies it is mainly the bleach plant that has been closed up. Presenting a fibre line of year 2000-2005, we therefore mainly discuss the bleach plant.

Since the mid 1990-ies there are not really any typical bleach plants, but several bleach plant concepts. We therefore present a few examples.

Let us first deal with areas of the fibre line, which we may consider rather equal no matter of how the bleach plant is designed.

Within the wood yard we consider dry debarking to be standard, but with a somewhat lower consumption of water than in the mill of year 1990, 0.7-1.5 in place of 2-4 m^3/ADt. The effluent flow from the wood yard would then be 0.4-1.2 instead of 1.7-3.7 m^3/ADt.

The brown part of the fibre line is closed, which was standard also in a mill of year 1990. However, the degree of closure has increased around the last washer in the brown stock washing chain, including the oxygen stage washers. This is illustrated together with examples of different bleach plant concepts.

The drying machine, including the final screening, usually has the same degree of closure as 1990, *Figure 4*.

The causticizing plant (white liquor preparation) consumes the same amount of liquid as in 1990, about 4 m^3/ADt, but of which a larger part usually is condensate than fresh water. The distribution is, however, dependant on how clean the condensates are and to what extent they are used in the fibre line. New or retrofit systems do usually not include any lime mud washing, why the required make-up liquid is added to the weak white liquor, *Figure 5*.

ECF 1, increased recycle of filtrate within the bleach plant

In ***Figure 6*** a fairly closed ECF bleach plant is illustrated. It has four stages, D(EPO)DD, and is equipped with filters as washers. The bleaching towers are omitted in the figure to elucidate the mode of filtrate recycle. In this case the last post oxygen stage washer is located after the storage tower for oxygen delignified pulp. The effluent flow is approximately 15 m^3/ADt. Bleach plant filtrate is used in place of hot water for dilution of pulp in the screw after the last post oxygen washer, why the bleach plant can be considered as partly closed up with the rest of the fibre line. This measure decreases the water consumption in the brown part of the fibre line by about 5.5 m^3/ADt and consequently decreases the effluent flow from the bleach plant by the same amount. This bleach plant consumes about 12 m^3/ADt of water, which is considerably less water than the 19 m^3/ADt used in a typical bleach plant of year 1990 (the case without an open filter).

This type of closure does not decrease the discharge of organic substances from the bleach plant, but is rather a method to decrease its process effluent flow. In most Swedish pulp mills the “obtained excess” of warm and/or hot water is discharged as clean effluent in place of being cooled and reused.

A usual reason to this type of closure is that the effluent flow per ton of pulp has to be decreased to the effluent treatment plant in connection with a capacity increase.

In a fibre line with a bleach plant according to *Figure 6*, we assume that only condensate is used as wash liquid on the last post oxygen washer, 4 m^3/ADt. Further, we assume that equal amounts of water and condensate are used for white liquor preparation, 2 m^3/ADt of each. The excess condensate, 3 m^3/ADt, is released as process effluent.

Assuming that 5 m^3/ADt of extra water is required due to spills and leakages, the total fresh water consumption amounts to ca 27 m^3/ADt and the process effluent flow leaving the mill will then be about 28 m^3/ADt, ***Table 3***.

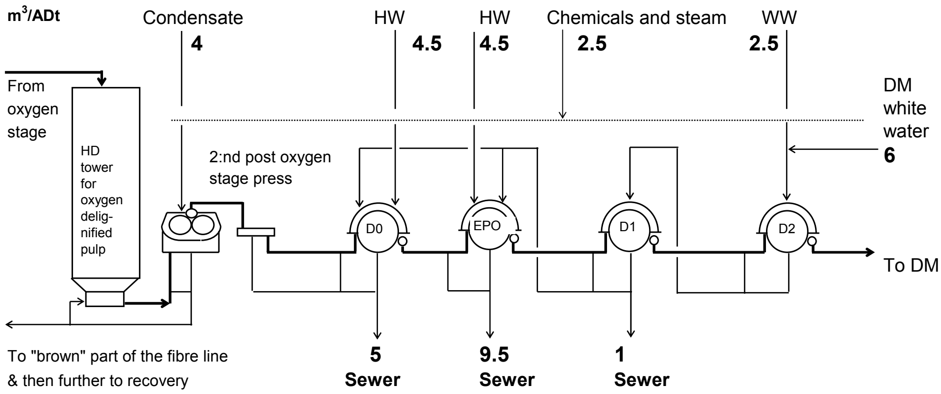

Figure 6 *Principle diagram of a an ECF bleach plant in Sweden/Nordic countries in 2000-2005, an example with increased filtrate recycle (closure) within the bleach plant*

Table 3 *Bleached kraft pulp mill of 2000-2005, summary of the water consumption in different process areas according to examples presented*

Consumption of fresh water	**m^3/ADt**			
	ECF1(a)	**ECF2 (b)**	**TCF (c)**	*Condensate to sewer: (a) 3, (b) 7, (c) 7 m^3/ADt. Steam is incl. in the effluent flow, but not in the water consumption. There is 5 m^3/ADt of water as spills to effluent. Clean waters as cooling water and sealing water etc. are not incl. either in the water consumption or the process effluent flow.*
Wood yard	1	1	1	
”Brown fibre area”	0.5	6.0	0.5	
Bleach plant	11.5	14.5	9	
Drying machine	4	4	4	
White liquor preparation	2	2	2	
Chemicals (O + bleach plant)	2.5	2.5	1.5	
Spills and leakages	5	5	5	
Sum	27	35	23	
Process effluent flow	28	37	24	

(a) Increased filtrate recycle (closure) within the bleach plant
(b,c) Alkaline bleach plant filtrate recycled to BS washing and further recovery

ECF 2, recycle of alkaline filtrate to the "brown" fibre line and further recovery

In ***Figure 7*** another fairly closed ECF bleach plant is illustrated. Also this one has four stages, D(EPO)DD, and is equipped with filters as washers. Like in the previous bleach plant the last post oxygen stage washer is a wash press and is located after the storage tower for oxygen delignified pulp.

Almost half of the alkaline bleach plant filtrate, about 4 m^3/ADt, is used as wash liquid on the last post oxygen stage washer; while the rest of it is used as wash liquid in the bleach plant together with hot and warm water and white water from the drying machine area. The bleach plant has partly been closed up with the brown stock washing and the recovery areas. The process effluent from the bleach plant is about 20 m^3/ADt. In this case hot water is used to dilute the pulp in the screw after the second post oxygen stage wash press - the amount being about 5.5 m^3/ADt. This bleach plant consumes about 15 m^3/ADt of water, which is less water than the 19 m^3/ADt used in a typical bleach plant of year 1990.

This type of closure decreases the discharge of organic substances from the bleach plant. Talking about COD (chemical oxygen demand) the release is usually 20-30 % lower than from a corresponding bleach plant operated open, but otherwise having equal conditions. As already indicated this type of closure also decreases the consumption of fresh water. In this example the hot water used in the screw dilution could be exchanged for D0-filtrate, and hence the water consumption as well as the process effluent flow could be decreased by about 5 m^3/ADt. This measure, however, significantly increases the risk of deposits of calcium oxalate ($Ca_2C_2O_4$) and organic substances in the D0-stage (Sävelin et al 1997) and does not decrease the releases of organic substances.

Korsnäs Mill in Sweden is a mill equipped with a D(EO)DD filter bleach plant. They have been recycling and recovering about half of their alkaline (EO) filtrate since 1995-1996 (Sävelin et al 1997) and in a similar way as illustrated in *Figure 7*. The mode of recycling and recovering the (EO)-filtrate has not changed since then.

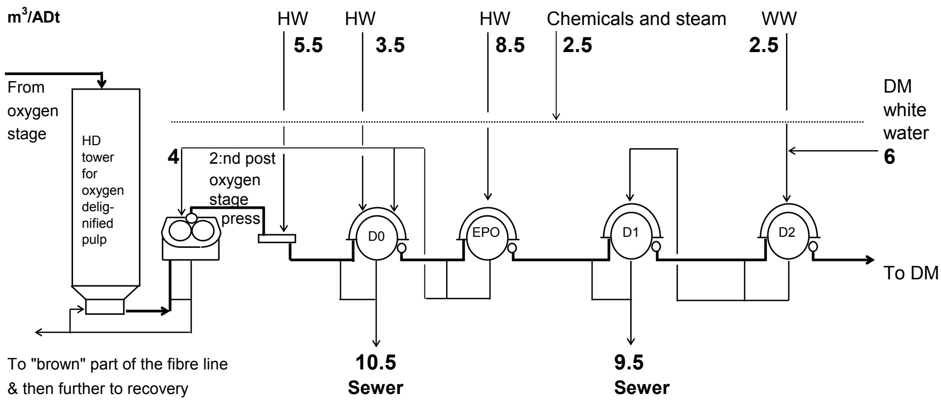

Figure 7 *Principle diagram of an ECF bleach plant in Sweden/Nordic countries in 2000-2005, an example with recycle of alkaline bleach plant filtrate to BS washing and further recovery*

In a fibre line with a bleach plant according to *Figure 7*, we assume that condensate is only used for the preparation of white liquor. Further, we assume that equal amounts of water and condensate are used for white liquor preparation, 2 m^3/ADt of each. The excess condensate, 7 m^3/ADt, is released as process effluent.

Assuming that 5 m^3/ADt of extra water is required due to spills and leakages, the total fresh water consumption amounts to ca 35 m^3/ADt and the process effluent flow leaving the mill will then be about 37 m^3/ADt, ***Table 3***.

TCF, recycle of alkaline filtrate to the "brown" fibre line and further recovery

In ***Figure 8*** an example is given of a TCF bleach plant, Q(OP)(ZQ)(PO), with a high degree of closure. It is further an example of a bleach plant with presses as washing units. In this case the HD storage tower for oxygen delignified pulp is also used as a Q tower. In principle the bleach plant of the SCA Östrand Mill in Sweden has this configuration and filtrate recycle and these approximate liquid flows (Morin 2000, Hjärpe 2005).

Mainly alkaline bleach plant filtrate (about 4 m^3/ADt), is used as wash liquid on the last post oxygen stage washer. This filtrate is recycled from the (PO) stage via the (ZQ) and (OP) stages. Fresh water is applied as wash liquid on the Q1 and (PO) presses. The Q1 stage is operated open, which means that metals and other dissolved substances will be bled out from the system; i. e. the concentration of these substances will decrease. To cool the pulp ahead of the high consistency Z stage cold water is introduced to the dewatering press preceding the ozone "reactor". The addition of water in this position also means that an extra dilution and out-bleeding of metals and dissolved substances will occur. The effluent flow from the bleach plant is as low as 7-8 m^3/ADt most part of the year. The bleach plant then consumes 9-10 m^3/ADt of fresh water, which is considerably lower than the 19 m^3/ADt typically used in a bleach plant of year 1990. During summer and especially during hot days more cold water is needed to cool the pulp ahead of the Z stage, and hence the water consumption and effluent flow then increases by another 2-3 m^3/ADt (Morin 2000, Hjärpe 2005).

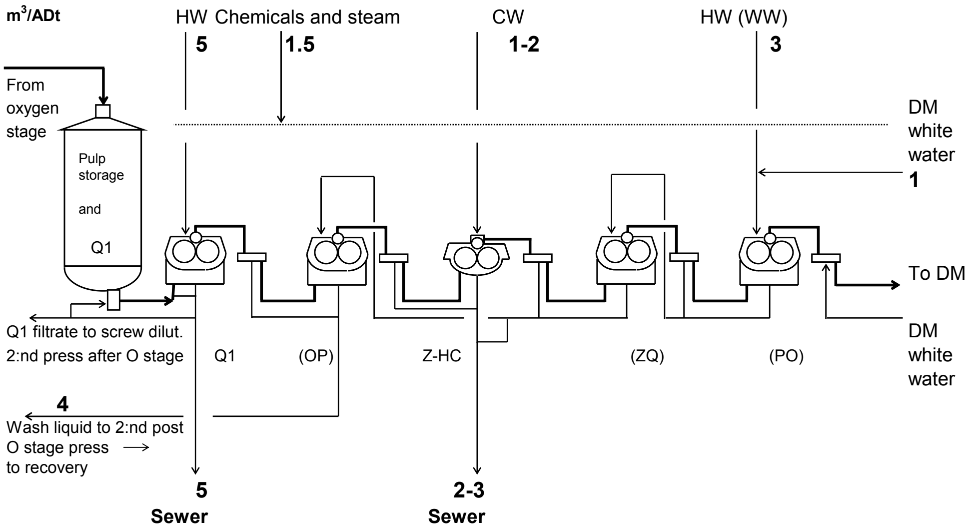

Figure 8 *Principle diagram of a TCF bleach plant in Sweden/Nordic countries in 2000-2005, an example with recycle of alkaline bleach plant filtrate to BS washing and further recovery. In principle the SCA Östrand Mill in Sweden has this configuration (Morin 2000, Hjärpe 2005).*

This mode of closure both decreases the discharge of organic substances from the bleach plant as well as its process effluent flow.

In a fibre line with a bleach plant according to *Figure 8*, we assume that condensate is only used for the preparation of white liquor. Further, we assume that equal amounts of water and condensate are used for white liquor preparation, 2 m^3/ADt of each. The excess condensate, 7 m^3/ADt, is released as process effluent.

Assuming that 5 m^3/ADt of extra water is required due to spills and leakages, the total fresh water consumption amounts to ca 23 m^3/ADt and the process effluent flow leaving the mill will then be about 24 m^3/ADt, ***Table 3***.

Shortly about other types of TCF bleach plants

Frövi, AssiDomän, is an example of a kraft pulp mill with a TCF bleach plant with no process effluent from the bleach plant. However, only 40 % of the total pulp production is bleached. The pulp is bleached in a sequence, in which the main bleaching chemicals are oxygen and hydrogen peroxide, OOQQ(PO). The alkaline filtrate is recycled through the brown part of the fibre line to black liquor evaporation and further recovery. The acidic filtrate is pre-evaporated separately, before being mixed with the black liquor and final concentration. In the bleach plant the liquids used for pulp washing are white water from the drying machine and chemically treated water, about 9 m^3/ADt of each. In Frövi all evaporation condensates (cleaned/stripped) are sewered. During the years Frövi has had some problems with scaling and deposits in the bleach plant, but mainly in the evaporation plant (Frövi personnel, 1998 and 2005). Through hard work they have, however, learnt to handle these problems.

There are another few bleach plants in Sweden, in which the main bleaching chemicals are hydrogen peroxide or hydrogen peroxide and per acetic acid. In most of these bleach plants it is mainly the alkaline bleach plant filtrate, which is recycled and recovered. The acidic filtrate and sometimes part of the alkaline filtrate is sewered. The bleach plant effluent flow is usually in the range 15-20 m^3/ADt.

Consequences of increased degree of closure

In addition to the increased closure of the fibre line liquid flows, the losses and the releases to air from the recovery areas have also decreased. The result of these measures is increased concentrations of various substances in all process streams and a build-up of so called non process elements (NPEs). These elements are mainly introduced with the wood raw material, but also with the chemicals used and the raw water.

Other changes that contribute to increased concentrations are the cooking methods of today, which generally means higher alkali concentrations than earlier, and a higher dry matter content of the thick liquor from evaporation.

In ***Table 4*** we have shortly summarized a number of consequences that may arise due to increased concentrations of various substances and specific elements.

Table 4 *Overview of consequences that may arise due to increased concentrations of various substances and specific elements in process streams*

	Digester plant	Bleach plant	Evaporation plant	Recovery boiler	Caustic-izing	Lime cycle	Pulp
Organic substance dissolved from wood	Scaling	More chemicals Deposits/ scaling	Scaling Corrosion		Plugging/ Inferior dewatering		Often negative
Alkali (OH)	Corrosion						
K, Cl ECF closed up with re-covery areas				Sticky dust/ plugging Corrosion			
Ca	Scaling	Scaling/ deposits Ca-oxalates D0 och Z	Scaling				
Mg		Deposits, Mg hydroxides			Inferior de-watering	Dead load	
Si			Scaling		Inferior de-watering		
Al			Scaling				
P						Dead load	
Mn, Fe		More H_2O_2					Lower brightness
Ba		Scaling/ deposits					

Increased concentration of organic substance increases the risk of scaling in the digester plant, bleach plant and evaporation plant. It often causes increased consumption of chemicals in the bleach plant (0-10 %) and may result in increased content of lignin and extractives in the pulp. It may also contribute to increased corrosion in the evaporation plant. If condensate with a "high" content of organic substance is used in white liquor preparation, it may result in increased plugging of the green liquor filter and deteriorated dewatering in the lime mud filter.

Higher concentrations of alkali (OH^-) in cooking contribute to more extensive corrosion in digesters.

Increased concentrations of chloride (Cl^-) become a problem, when recycling filtrate from an ECF bleach plant to the recovery boiler. Having a "traditional" ECF bleach plant, D(EPO)DD, it is only possible to recycle part of the filtrate (usually alkaline filtrate) to avoid problems with corrosion in the boiler and sticky dust resulting in plugging of the boiler flue gas side. Despite "moderate" recycle of filtrates, it is often necessary to purge chlorides. Korsnäs, e.g. purge chlorides through HCl scrubbing of the flue gases (1997 Sävelin at al). Some mills in Sweden purge precipitator ash to control the chloride content of the white liquor and hence the whole recovery system. Purging of precipitator ash is, however, not a long-term solution. Methods, which mean selective purging of Cl^- and K^+ from precipitator ash, are studied world-wide.

Increased concentrations of calcium mean a higher risk for scales ($CaCO_3$) and deposits in digesters, in evaporators and in bleach plants. Regarding bleach plants deposits of calcium oxalate ($Ca_2C_2O_4$) is a "major" problem. This compound primarily precipitates in and around D0 and Z stages. In these stages the concentration of both Ca and oxalate is high. As long as the pH is kept below 3-4 precipitation is usually avoided. In some cases the bleach plant has to be opened up somewhat, even if the pH is kept low in and around these stages. Barium (Ba) and magnesium (Mg) may also precipitate as $BaSO_4$ respectively Mg hydroxides in bleach plants.

Bleaching pulp with hydrogen peroxide (H_2O_2) high concentrations of manganese (Mn) and iron (Fe) will increase the decomposition of H_2O_2. Hence more hydrogen peroxide is required to attain a certain brightness level.

Increased concentrations of Mg and silica (Si) may result in deteriorated dewatering in green liquor filters. Magnesium and phosphorus (P) also increase the dead load in the lime cycle.

Increased concentrations of Si and aluminum (Al) increase the problems with scaling in the evaporation plant.

Conclusion

During the last 10-15 years kraft pulp mills in Sweden and in other countries have increased the degree of closure on the liquid side. The main reason has been to decrease the discharges to receiving waters in terms of organic and inorganic substances, at least in Sweden.

The increased closure and other process changes have led to higher concentrations of organic and inorganic substances. Consequences from that are increased corrosion in digesters, evaporators and recovery boilers, problems with scales and deposits in bleach plants, digesters and evaporators, increased consumption of bleaching chemicals, changed pulp quality etc..

There are different ways to close up the bleach plant. The main reason to increase the closure within the bleach plant is to decrease the water usage and the process effluent flow. This method does not decrease the discharges with effluent. The main reason to close up the bleach plant with the rest of the fibre line and the recovery areas is to decrease the discharges with effluent. This method may also decrease the bleach plant water consumption and effluent flow, but not necessarily.

Lately the trend has been to aim at a more moderate recycle and recovery of bleach plant filtrates than 5-10 years ago because of problems with scaling, deposits, chemical consumption, pulp quality etc.. The same applies for both “ECF and TCF” kraft pulp mills. If the goal was 0-10 m^3/ADt of effluent from the bleach plants 5-10 years ago, the goal is rather (10)15-20 m^3/ADt of effluent from the bleach plant today, at least in Sweden.

References

Hjärpe M. (2005). Personnel communication with Hjärpe M at the Östrand Mill, SCA

Morin R. (2000). Högbelastad biofilmrening av blekerifiltrat och kondensat, Roine Morin, Östrand Mill, SCA. Presentation at SPCI’s fall meeting in Sundsvall ; 2000. SPCI = Swedish Pulp and Paper Association.

NV 1990, Skogsindustrins emissioner till vatten och luft 1990, Naturvårdsverkets rapport 3925. NV = Swedish EPA

NV 2000, Skogsindustrins utsläpp, avfallsmängder och energiförbrukning, 2000, Naturvårdsverkets rapport 5154. NV = Swedish EPA

Presentation by Frövi, AssiDomän, personnel. (1998). Presentation at SPCI’s fall meeting at Frövi Mill and in Örebro in 1998. SPCI = Swedish Pulp and Paper Association. Personal communication with Frövi personnel (2005)

Skogsindustriena 2005**, www.skogsindustrierna.org**. Skogsindustrierna = Swedish Forest Industries Federation

Sävelin P. and Bergkvist L. (1997). Closure of the (EO) stage in the ECF Bleach Plant, TAPPI Minimum Effluent Mills Symposium, San Francisco 1997. Personal communication with Sävelin P. (2005)