

TAMPERE POLYTECHNIC  
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FINAL THESIS

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## **Control of dusting in BCTMP drying**

Thesis Supervisor  
Commissioning Company

Tampere 2005

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M-real Tako Board. Lielähti BCTMP Mill  
Supervisor: Petri Vuorijärvi (MSc)

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## ABSTRACT

Changes in the pulping process in the Lielähti BCTMP mill have lead to dusting problem in the dryer section. Excessive amount of dust inside the dryer decreases the drying capacity.

The aim of this thesis is to study the factors that cause the dusting problem and how to reduce or eliminate it. One part of the study is to follow the effect of retention aid addition on dusting on dryer section.

Based on the measurements and other findings the retention aid chemical has no effect on dusting in the dryer section. Although, improved drainage enables to increase basis weight of dried pulp which reduces calculated amount of dust per produced pulp ton.

There is a lot of work to be done to decrease dusting in the dryer section. Based on this study the problem cannot be solved by making modifications in pulp drying machine. The source of this problem occurs earlier in the process.

## TABLE OF CONTENTS

ABSTRACT.....	2
1. Introduction.....	4
2. CTMP process in Lielahiti Mill .....	4
3. Background information .....	5
3.1. Lielahiti BCTMP mill .....	6
3.2. Switch from SGW raw material to BCTMP in Tako Board .....	6
3.3. Changes in Lielahiti BCTMP mill pulp production.....	6
3.3.1. Lower refining rate.....	7
3.3.2. Higher refining intensity .....	8
3.3.3. The new plate design .....	9
4. Lielahiti BCTMP mill pulp drying machine .....	11
4.1. General.....	11
4.2. Wire section.....	11
4.3. Press section.....	11
4.4. Dryer section .....	11
4.4.1. Pulp drying with airborne web .....	11
4.4.2. Internal air circulation system.....	12
4.4.3. The nozzle design .....	13
4.4.4. Maintenance and service .....	14
4.4.5. Cleaning .....	14
5. Consequences of excessive dusting in dryer section .....	15
6. Retention aid research.....	17
6.1. Retention aid .....	17
6.2. Preliminary laboratory research.....	17
6.2.1. Laboratory tests.....	17
6.2.2. Laboratory results.....	18
7. Measurements and results .....	22
7.1. Introduction.....	22
7.2. Fiber length distribution .....	22
7.3. Monitoring dusting inside the dryer.....	23
8. Conclusion.....	24
8.1. Increase of basis weight .....	24
REFERENCES .....	26

## 1. Introduction

The purpose of this thesis was to study the dusting problem in Lielahiti BCTMP mill drying section. Excessive amounts of dust inside the dryer cause drying capacity decrease. The aim was to search the solution to reduce or eliminate this problem.

The second chapter introduces briefly BCTMP process on a general level. The third chapter of this work clarifies the background of this problem from a theoretical point of view. The main emphasis is on the issues that changes in production process have caused. The fourth chapter is the description of Lielahiti BCTMP mill pulp drying machine concentrating on the dryer section in which the actual problem appears. Chapter five sums up the consequences of the excessive dusting problem.

The experimental part is based on retention aid research and the measurements on dryer section which were performed in Lielahiti BCTMP mill pulp drying machine at the same time with retention aid research made by Eka Chemicals AB. The last chapter presents the conclusions.

## 2. CTMP process in Lielahiti Mill

The chemi-thermo-mechanical process is a modification of the TMP process. The most significant difference compared to TMP process is the chemical treatment for chips. The used chemical for this treatment is sodium sulphite ( $\text{Na}_2\text{SO}_3$ ). The main raw material of Lielahiti mill is spruce chips. Mixture of spruce and birch chips is also used. Utilization of this 50%/50% spruce/birch mixture has increased lately. As seen on Figure 1, the chemical processing is performed before the refining stage. Preheating the chips together with sodium sulphite softens the wood matrix. In this way the defiberation process is more gentle and detached

fibers are in a more intact state than without chemical treatment.  
[7]

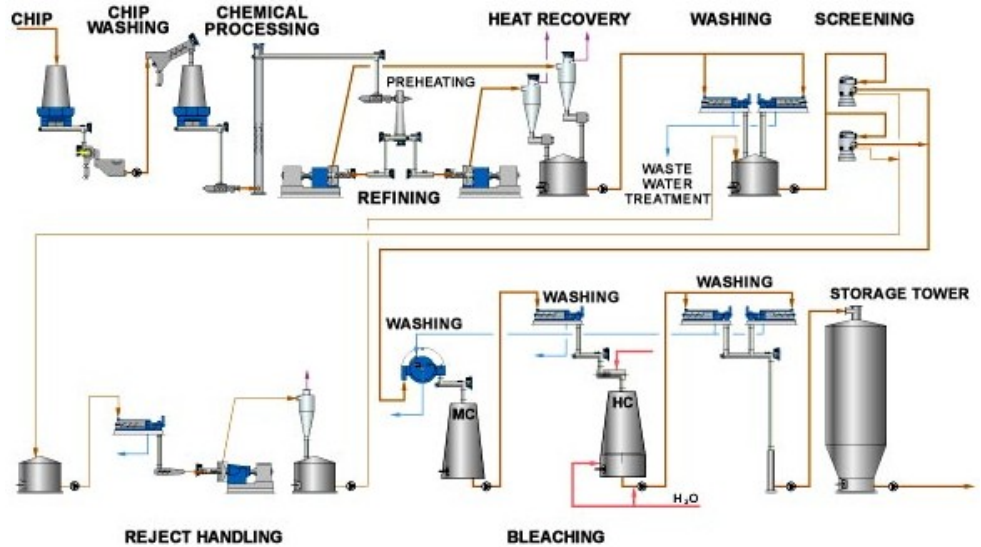


Figure 1. Diagram of general CTMP process. [7]

Refining is performed in single a stage by two Metso RGP 60 types of single disc refiners. Main refiners are installed parallel and those can be controlled independently. After washing stage the pulp is screened. The pressure screening removes shives and bundles of unrefined pulp to reject treatment. Rejected pulp is refined in Metso RGP 46/50 type of reject refiner. Peroxide bleaching can increase the brightness level up to 80% ISO. Mainly 70% and 80% ISO brightness levels are used. From bleaching the pulp is thickened and pumped into storage tower.  
[7]

### 3. Background information

M-real closed Lielähti BCTMP mill market pulp production in summer 2004. So far Lielähti Mill had been producing fluff pulp for hygiene products. Freeness (CSF) level of fluff pulp for hygiene products was around 650ml. In July 2004, the integration of Tako Board mill and Lielähti BCTMP mill was completed. Since then

Lielähti have focused on the production of BCTMP as raw material for Tako Board. Tako Board utilizes BCTMP in middle layer of paper board production. [1]

### 3.1. Lielähti BCTMP mill

Lielähti BCTMP mill is part of M-real Tampere Tako board mill. Lielähti mill produces approximately 110,000 t/a Bleached-Chemi-Thermomechanical pulp as raw-material for paper board production. Lielähti mill BCTMP is used in middle-layer of paper board. The pulp is dried in airborne dryer and cut in sheet cutter to bales in Lielähti mill. The BCTMP bales are delivered from Lielähti mill to Tako mill in the center of the town by lorry transport.

### 3.2. Switch from SGW raw material to BCTMP in Tako Board

Before the integration of Tako board mill and Lielähti BCTMP Tako used *stone ground wood* (SGW) from own SGW-plant and little amounts of BCTMP from Lielähti pulp mill to middle-layer of folding boxboard. Now the Tako board SGW plant is closed and BCTMP is the only raw material used for FBB middle layer. The present quality standards for consumer packages set high requirements for FBB. Cleanliness is an important factor especially in foodstuff board. This restricts usage of chemicals in the production. For this reason any additional chemicals are not added to Lielähti BCTMP. Advantages of BCTMP in board products are high stiffness, good dimensional stability, and a low content of extractives. [5]

### 3.3. Changes in Lielähti BCTMP mill pulp production

The switch to pulp production for board grades instead of fluff for board grades caused changes in the production process. Most of

the changes took place in pulping department. The main wood raw material is spruce. The new requirements for produced pulp is average fiber length <1,6mm and freeness value targeted to 470ml (CSF). The way of refining was adjusted to meet new specifications of end product.

After these changes in production the dust amount in drying section have been increased significantly. Presumption is that energy saving defiberation process is harsher for fiber than conventional method.

### 3.3.1. Lower refining rate

The refiner output and the used mechanical energy determine the refining rate. The refining rate is indicated as the *specific energy consumption (SEC)* per each ton of air dry pulp (MWh/t). External fibrillation of the fiber needs high refining energy. Lower specific energy refining leaves fibers more intact and level of fibrillation is lower. Therefore the bonding ability of fiber is also decreased. [5,7]

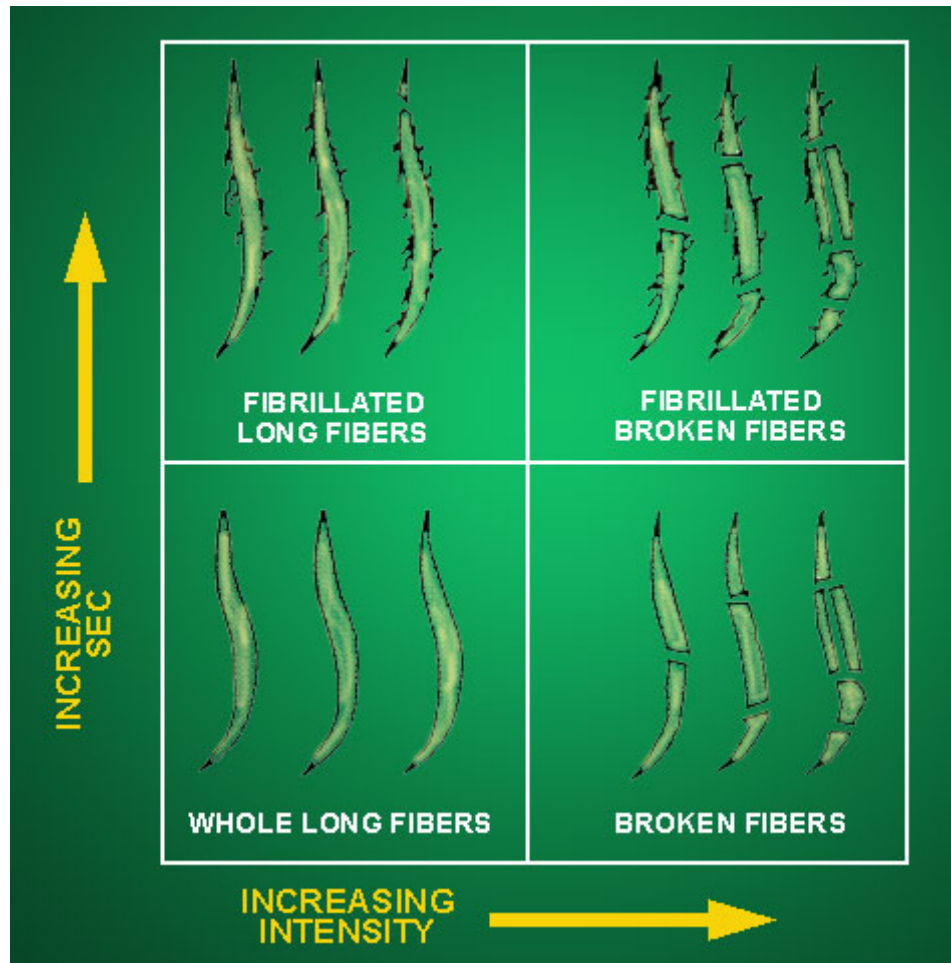


Figure 2. High refining intensity together with low SEC produces more broken fibers. [7]

### 3.3.2. Higher refining intensity

Refining intensity is defined as the average energy of the impacts directed to fibers. Higher refining intensity means harsher refining with a narrow disc clearance. High radial pulp flow in narrow disc clearance gives short residence time of the fiber in the disc gap. A short residence time reduces the amount of pulp in the gap. However, one must notice that there are only a few empirical tests made concerning the residence time, and the refining intensity is still a theoretical quantity. Increased refining intensity has a tendency to reduce the length of the fibers. Therefore, high intensity refining can be described as a cutting type of refining.



This type of refining weakens the bonding ability of fibers and fiber fractions [5,7]

### 3.3.3. The new plate design

The plate design has the most significant impact in the refining intensity. Plates of the both main refiners and reject refiner are now equipped with low energy segments (LE™) which are developed and manufactured by Metso Paper. Using low energy segment design on refiner plates makes it possible to save measurable amounts of energy. A pilot plant scale trials have shown that it is possible to decrease the refining energy by 20 % [6, 7]

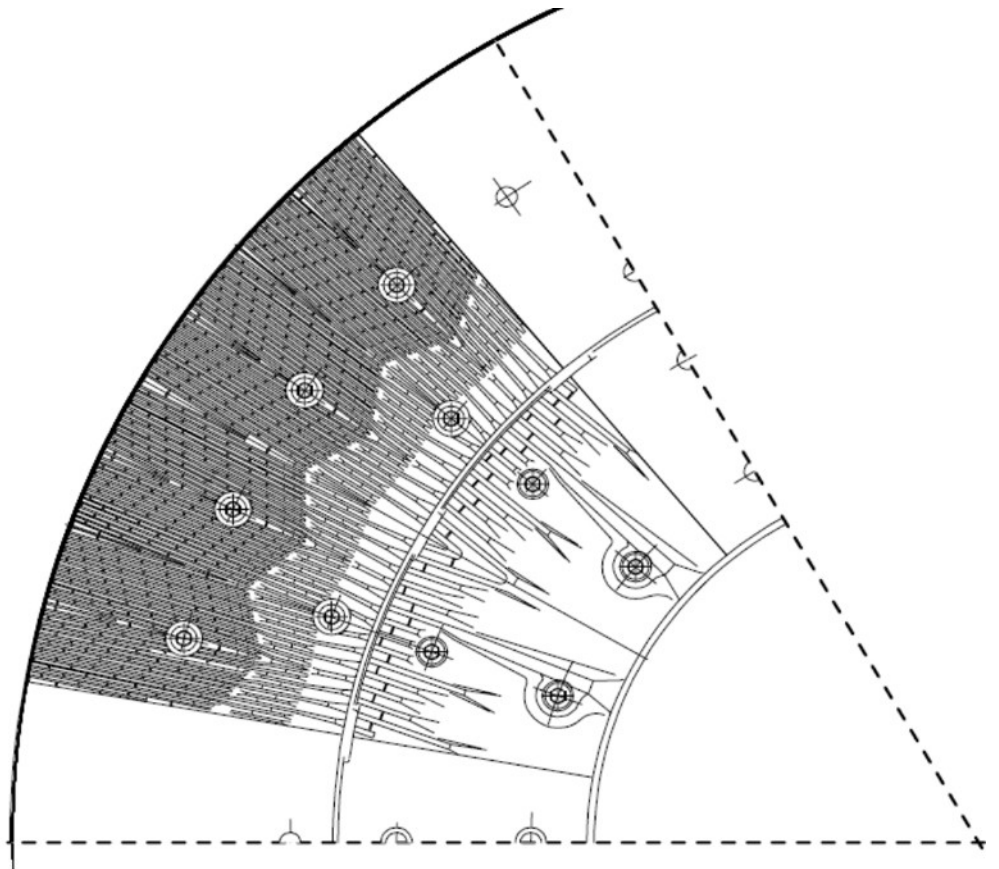


Figure 3. Conventional refiner segments with radial tooth pattern.

[5]

In the low energy segment tooth angle deviates from radial direction compared to a conventional refiner segment. The angle of teeth forms a pumping effect in the disc gap. The result of this feature is a faster feed of pulp into the refining zone and a shorter residence time in refining. In this way the intensity of refining is increased. Higher intensity effectively refines coarse fibers and reduces shives especially in the reject refining. This type of geometry in tooth pattern reduces the turbulence at the inlet section of the refiner which leads to reduce of specific refining energy consumption. Low energy segments are also used to change the fiber length distribution of the pulp. [6]



Figure 4. Basic operating principle of the low energy segments.  
[6]

## 4. Lielahiti BCTMP mill pulp drying machine

### 4.1. General

The pulp is dried in a drying machine that consists of wire section, press section, drying section and sheet cutter. Basis weight is approximately  $600 \text{ g/m}^2$ , line speed 90 m/min and desired dry content 85%. Trim width at the sheet cutter is 378 cm.

### 4.2. Wire section

The stock is fed from a rectifier roll head box onto a wire equipped with a hybrid former, where Fourdrinier section precedes the twin-wire nip. The wire section is equipped with forming rolls, foils and four suction boxes for dewatering downwards in Fourdrinier section and three suction boxes in hybrid former for upward dewatering. [2]

### 4.3. Press section

The press section is equipped with a two-nip press and a suction roll to pick-up web from wire to press section. The dry content of web after press section is around 50%.

### 4.4. Dryer section

#### 4.4.1. Pulp drying with airborne web

Airborne pulp drying is a non-contact drying method. The pulp web never touches any heated steel surfaces. The dryer utilizes heated air to dry and support the pulp web. The moist web enters at the top of the dryer. The airborne web then makes 11 horizontal passes back and forth before it leaves the dryer at approx. 15% moisture. The delay time of the web inside the dryer

is approximately 5 min when the line speed is 90 m/min. The hot and dry supply air enters at the bottom of the dryer. It is re-circulated and reheated several times in the internal circulation system. [3,8]

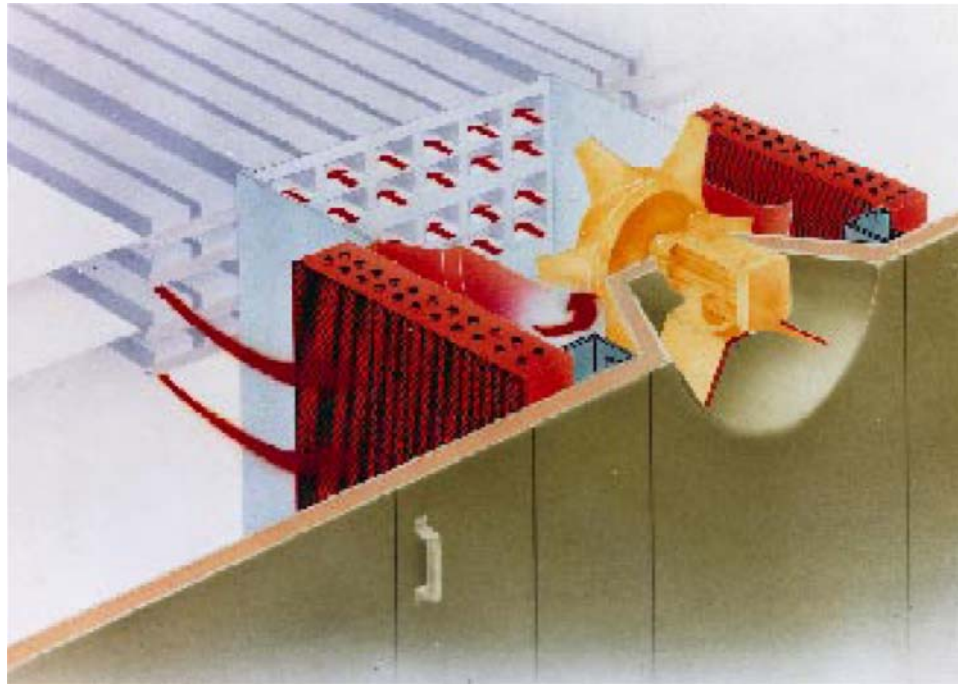


Figure 5. Fläkt dryer internal circulation system [3]

The wet web entering the first blow box deck on the top of the dryer is impinged by air with the highest moisture content. At the bottom of the dryer, where the web has a high dryness, it is impinged by air with lower moisture content. This type of drying results in high capacity and decreased heat consumption. [3]

#### 4.4.2. Internal air circulation system

The circulation air fan, steam coils and blow boxes build up the internal circulation air system. The dryer consists of 26 identical vertical sections. To maximize the heat economy, only a small percentage of circulation air is exhausted. Approx. 95% of the air is re-circulated in this system. The circulation air is reheated by the steam coils and impinged through blow boxes with nozzles on both

sides of the web. As the air circulates upward in the dryer, its humidity increases. [4, 8]

#### 4.4.3. The nozzle design

The nozzle geometry and configuration are essential for reliable function and for a high efficiency of the two side blow box system. The distance between blow boxes and pulp web must also be very short in order to have a high drying efficiency. The web tension in the machine direction is low because it is only the air friction for web transport that has to be overcome. In cross machine direction the drying takes place under tension free conditions. Flutter free web transport at a low web tension results in a high runnability. [4]

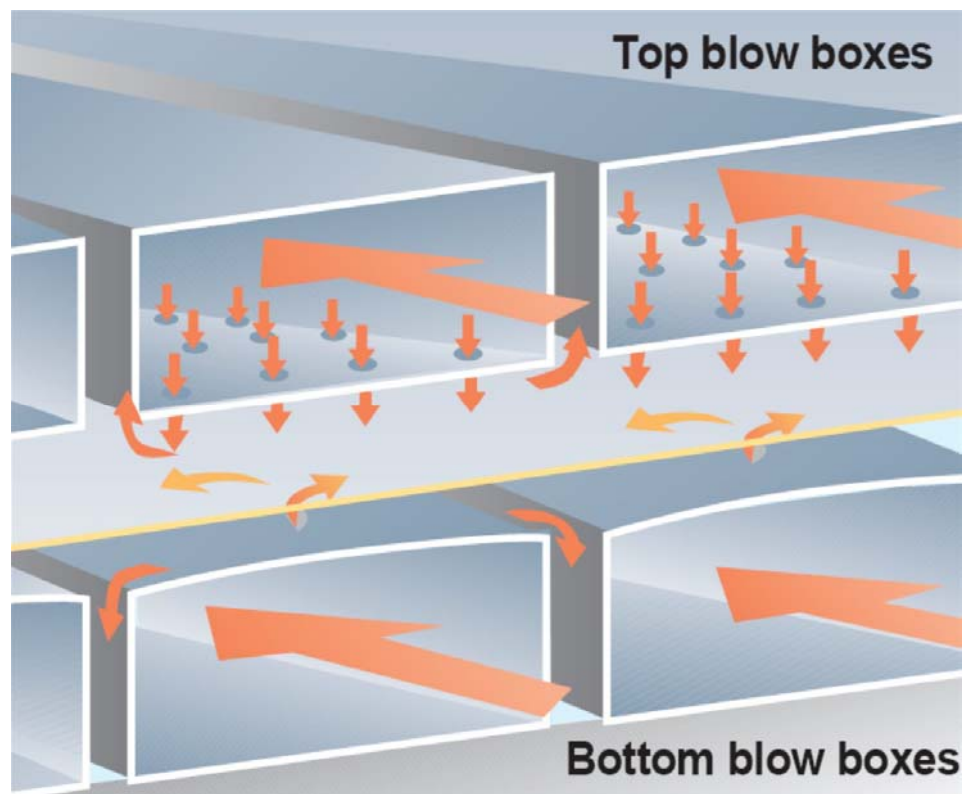


Figure 6. Fläkt dryer blow box deck with airborne web. [3]

#### 4.4.4. Maintenance and service

The dryer with airborne web has few moving parts and this minimises the need for maintenance. All bearings are located outside the heated part of the dryer. During normal operation, only circulation air fans and one drive motor is in function. The rolls are freewheeling and the transmission and threading tape are stopped.

Platforms at the inlet and outlet ends and inspection doors give full access to the dryer. Blow boxes are liftable and built in light make inspection and cleaning of the blow box deck easy [4].

#### 4.4.5. Cleaning

The steam coils are equipped with fine mesh wire screen frame. The wire screen works as a filter before the circulating air flow moves through steam coils. To maintain the whole drying capacity the dryer must be cleaned at regular intervals. The wire screen frames are cleaned three times a week. This can be done without machine shutdown during normal production running. The wire screen frames are cleaned with vacuum cleaner through inspection doors from both sides of the dryer. Each work shift cleans one third of the frames. In all, it takes three shifts to clean all the screen frames of the whole dryer, which means that all the screen frames are cleaned during 24 hours.



Figure 7. The wire screen frames are cleaned with vacuum cleaner.

The blow boxes can not be cleaned during production running. To clean the blow boxes the dryer must be stopped and the inside temperature must cool down to a safe level. Cleaning is performed with a long suction hose inside the blow box. This cleaning operation is done 2-3 times per year during planned maintenance shutdowns. This operation is very time-consuming because each of the blow boxes must be cleaned separately.

The dryer needs to be checked from inside before tail threading, because there might be ripped pieces of pulp web inside the dryer between top and bottom blow boxes after web break.

## 5. Consequences of excessive dusting in dryer section

An excessive amount of dust forms a very thick layer on wire screens inside the dryer. This makes the cleaning with a vacuum cleaner very difficult. When the wire screen is clear the finest

fraction of dust goes through it with air flow. It takes some time before the fibrous material in circulated air forms a filtrating mat on the wire screen surface. When the mat is formed the filtration level of screen increases. In that case if the cleaning is performed more often the more fine material goes through the wire screen filter.



Figure 8. Thick layer of dust on one of the wire screens of dryer.

The finest fraction of dust accumulates inside the blow boxes starting from the tip of the sealed end. This is a more serious harm because the blow boxes can not be cleaned during production running. When the whole diameter of blow box gets full of dust the air nozzles are blocked-up. This is very problematic, especially in the bottom blow boxes whose task is to keep the web airborne with an air flow. The lack of support makes the pulp web flutter or even get on contact with the blow box. This will increase the intensity of mechanical stress onto the web surface. If the web starts to flutter too much horizontally it might cause a web break.



## 6. Retention aid research

### 6.1. Retention aid

Since early days, retention aids have been commonly used in papermaking. In pulp drying machines where the mechanical retention is significantly higher than in paper machine utilization of retention aid is very rare.

In the beginning of 2005 Eka Chemicals was interested to try the effect of retention aid chemical on retention and drainage in Lielähti BCTMP mill pulp drying machine. Especially better drainage on wire section was a desired feature, because this makes the drying process more efficient. Surely, improved retention also develops the process towards a better direction. In addition to this, it was assumed that a slightly improved dry strength can lead to decrease of dusting on drying section. However, according to Eka Chemicals any guarantees of this kind effect with this retention aid can not be given.

### 6.2. Preliminary laboratory research

In February 2005 Eka Chemicals did laboratory research with two different retention aid polymers in Lielähti BCTMP mill laboratory. The tested polymers were Eka PL 1510U and Eka PL 2610U. Both of them are cationic charged polyacrylamides. The effect on retention was tested with both polymers alone and also in conjunction with two different Eka NP colloidal silica sols.

#### 6.2.1. Laboratory tests

Effect of retention aid on Lielähti BCTMP mill stock was tested by Eka Chemicals sales engineers Seppänen Hanna and Haulivuori Sami. The Dynamic Drainage Jar (DDJ), also called The Britt Jar,

permits direct measurement of first-pass retention of solids under turbulent conditions independent of mat formation. [9]

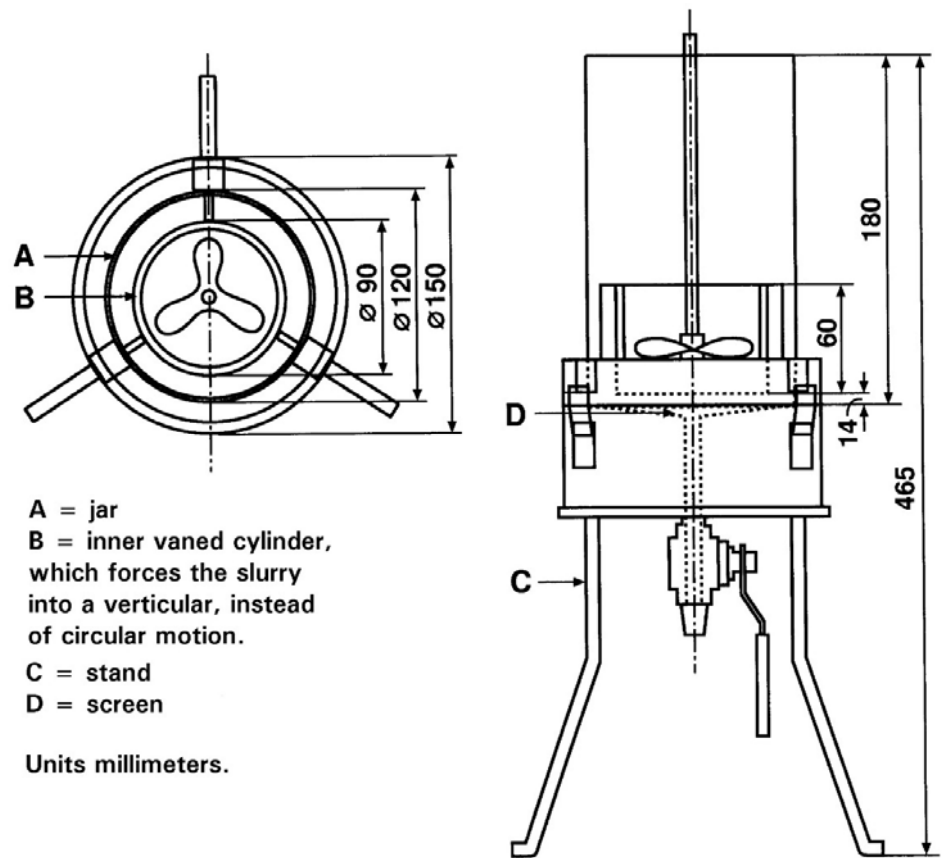


Figure 9. The Dynamic Drainage Jar. [9]

### 6.2.2. Laboratory results

The effects of five different dosage levels 25, 50, 75, 100 and 125 g/t on retention were tested. As the graph of Figure 10 shows the DDJ-retention is doubled with fairly low dosage of polymers compared to situation where no chemicals are used as retention aid. It is possible to reach very high level of retention with dosage from 50 to 75 g/t. However, these results are not directly proportional on mill scale wire retention values. [10]

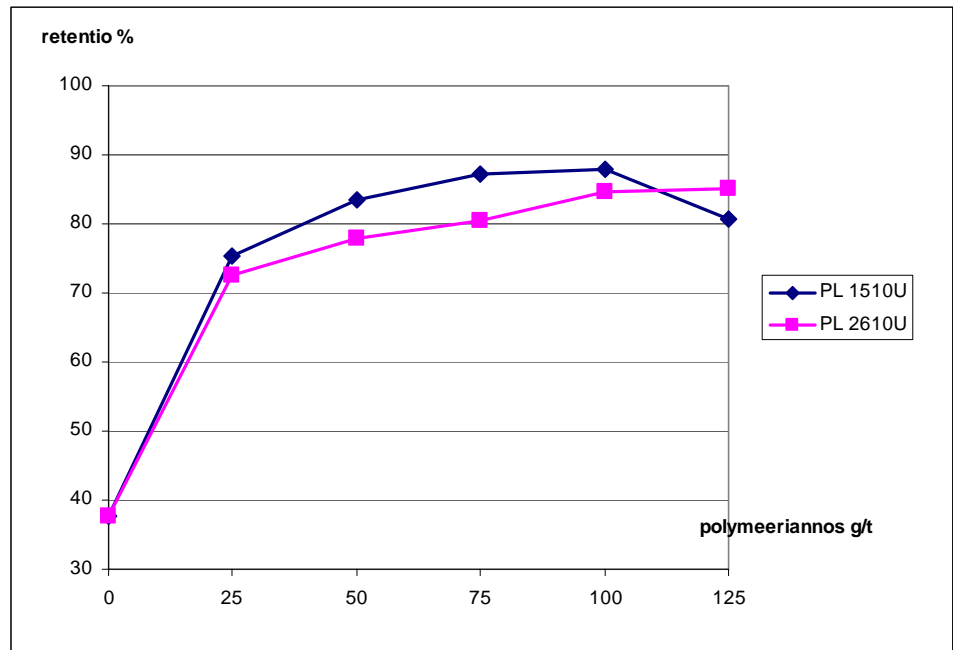


Figure 10. DDJ-retention for different dosage levels of PL 1510U and PL 2610U polymers. [10]

The conjunctions with Eka NP colloidal silica sols were also tested. Increase on the level of retention was not noticeable from the level that was achieved with polymers. It is more beneficial to use only polymers to improve retention.

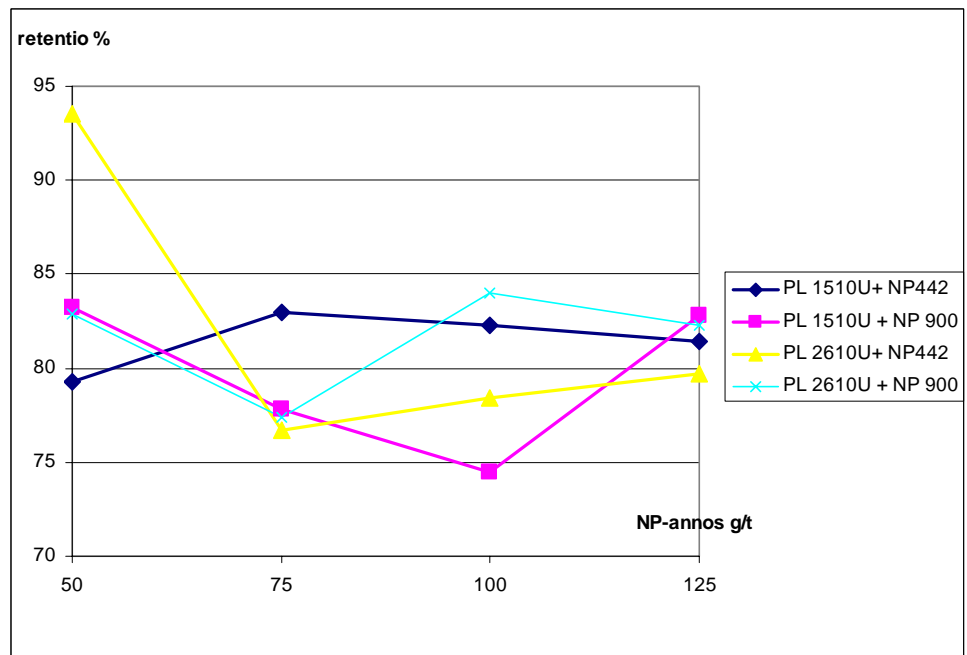


Figure 11. DDJ-retention for colloidal silica conjunctions with polymers. [10]

### 6.3. Mill scale trial run

The decision to perform a mill scale trial run on drying machine was made because of good results. The chosen polymer for the trial run was Eka PL 2610 U without colloidal silica sol. This alternative was easier to carry out. Addition of polymer in stock was possible to do without any major alteration in process or process equipments. [12]

Eka PL 2610 U is supplied in 1050kg containers in form of emulsion where the active content is 43 – 46 %. Before adding into stock the polymer emulsion must be diluted. This can be done with automatic dissolver that prepares the solution. [12]



Figure 12. Polymer dissolver equipment.

After dissolving the solution is transferred to a feeding tank. From this tank solution is drawn off with positive displacement pump. The solution is diluted 10 times before the feeding point, in order to ensure good distribution throughout the stock. Typical addition

point would be in the thin stock between the fan pump and machine screen. In Lielähti drying machine there is no machine screen after fan pump, so the addition point is before the fan pump. Fan pump provides necessary distribution for polymer throughout the stock. [12]

Normal dosage for retention and drainage improvements will range from 500 to 2500 g/t in paper machines. In this case, for pulp drying machine dosage level can be lower. Three different dosage levels were tested. Based on the laboratory results the chosen dosages were 30, 125 and 250 g/t. The presumed optimal dosage is from 100 to 125 g/t. The lower and higher dosages were tested to get clearly noticeable retention level difference on measurements. [11]

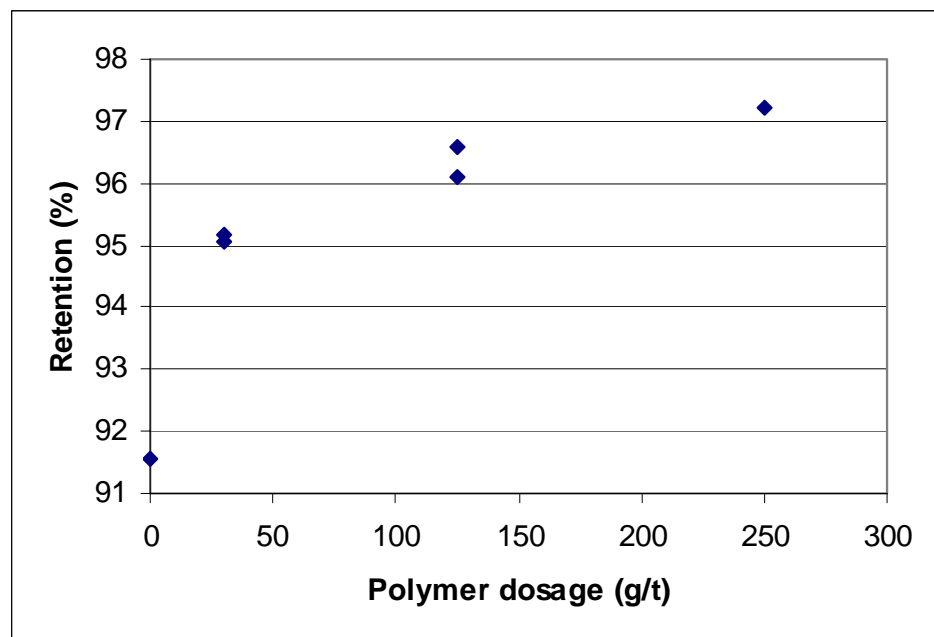


Figure 13. Retention increase with polymer dosage. [11]

Retention increased significantly as seen on Figure 13. Lower energy consumption of suction pumps in wire section indicates that drainage was improved as well. Also the lower use of heating energy in dryer section was observed.

## 7. Measurements and results

### 7.1. Introduction

Measurements of this work were concentrated mainly on the dusting phenomenon in the drying section. Monitoring of dusting level inside the dryer was executed before and during the polymer addition in the stock.

### 7.2. Fiber length distribution

The measurements were started with fiber length distribution analysis. Presumption was that the dust in the dryer mainly consists of fine material that breaks loose from the web surfaces during airborne drying. Samples of dust were collected from the surface of dryer wire screens. Dust samples were analysed with Kajaani FS-200 fiber analyzer.

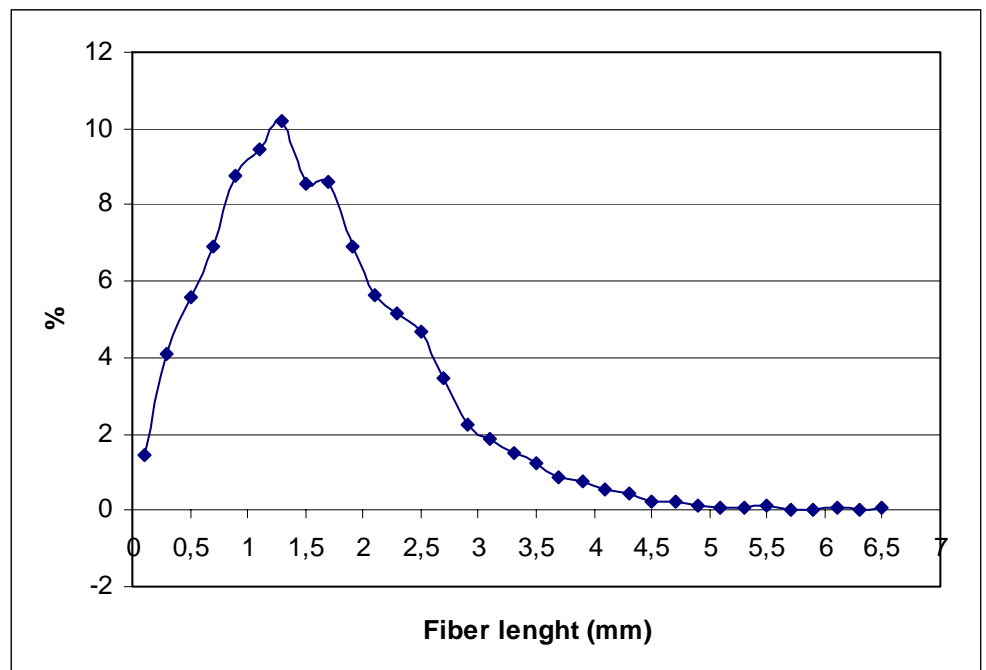


Figure 14. Weighted fiber length distribution of dust measured by Kajaani Fs-200.

The analysis proved that presumption of high fine material content was wrong. Actually, the fiber length distribution of dust is practically identical with fiber length distribution of the produced pulp. Average fiber length is 1,54 mm when the target fiber length is <1,6 mm.

### 7.3. Monitoring dusting inside the dryer

The selection of method and device to determine the level of dusting in the dryer was problematic. Steamy and hot conditions set limitations for measurements. The absolute amount of dust inside the dryer is impossible to measure when machine is running. The decision was to select fixed measuring point from inside the dryer. The chosen method was to observe the amount of dust that filtrates on the specific area of one wire screen of dryer in certain period of time. This way it is possible to observe the variation of dusting during production running. Specified area was two wire screens of the dryer. Height of the screen is 370 cm and width 100 cm. Total observed area was in that case 7,4 m<sup>2</sup>. Specified period of time for dust filtration measurements was 4 hours.

The industrial vacuum cleaner turned out to be the most reliable device for collecting the filtrated dust from the surface of wire screen to container of vacuum cleaner. The container was equipped with a detachable dust bag. The weight of the collected dust was rather simple to weigh when the weight of empty dust bag was known.

Table 1. Dusting level measurements before and during polymer addition.

Dust amount measurements (g)			
sample	Before polymer addition	sample	During polymer addition
1.	508	7.	511
2.	507	8.	508
3.	521	9.	517
4.	535	10.	531
5.	516	11.	519
6.	513	12.	522
Average	516,67	Average	518

The measurements during polymer addition were made when the dosage level of polymer was 125 g/t. As the figures shown on Table 1. the polymer addition has no effect on level of dusting.

## 8. Conclusion

Unfortunately, total solution for dusting problem was not found. The addition of retention aid polymer into stock did not have any reversal effect on fibers that break loose from the web surfaces. However, retention aid improves drainage in wet end which makes it possible to increase the basis weight of dried pulp or increase the machine speed.

### 8.1. Increase of basis weight

The increase of basis weight decreases calculated dust amount per produced ton of pulp. This statement is based on the hypothesis that the amount of dust that breaks loose is constant



compared to certain area of web surface. So, if the basis weight is increased from  $600 \text{ g/m}^2$  to  $700 \text{ g/m}^2$  this means that approximately 16,7 % more pulp can be pass trough the dryer with same web surface area.

If the volume of production is held in the same level it is possible to run the drying machine with a slower line speed. This can decrease the mechanical stress on the web surface.

## REFERENCES

[1] M-real year 2004: *Annual review*

[2] PAULAPURO, HANNU (ed.). *Papermaking science and technology: Book 8 Papermaking Part 1, Stock Preparation and Wet*. Papermaking chemistry Helsinki: Fapet Oy 1998.

[3] VTT INDUSTRIAL SYSTEMS. *KnowPulp 2.4* (CD-rom). Espoo. Last modified 27.05.2003.

[4] GULLICHSEN, JOHAN (ed.). *Papermaking science and technology: Book 6 Chemical Pulping*. Papermaking Chemistry Helsinki: Fapet Oy 1998.

[5] SUNDHOLM, JAN (ed.) *Papermaking science and technology: Book 5 Mechanical Pulping*. Papermaking Chemistry Helsinki: Fapet Oy 1998.

[6] VUORIO, P; BERGQUIST, P. "New refiner segments technology to optimize fiber quality and energy consumption of refiner mechanical pulp." 2005 African Pulp and Paper week conference. TAPPSA Archive. (cited 14.5.2005) Available in World Wide Web: <http://tappsa.co.za/archive/>

[7] VTT INDUSTRIAL SYSTEMS. *KnowPap 5.0* (CD-rom). Espoo. Last modified 28.05.2003.

[8] FLÄKT Oy. *Fläkt Compact Dryer*. sales brochure. 1989

[9] NEIMO, LEO (ed.) *Paper making science and technology: Book 4 Papermaking Chemistry*. Papermaking Chemistry Helsinki: Fapet Oy 1998.

[10] HAULIVUORI, S; SEPPÄNEN, H. *Lielhti BCTMP retention aid laboratory research report*. Eka Chemicals AB. Tampere. 22.2.2005.

[11] SEPPÄNEN, H. *Lielhti BCTMP retention and drainage measurements*. Eka Chemicals AB. Tampere. May 2005.

[12] EKA CHEMICALS. *Eka Facts: Eka PL 2610 U*. Data sheet. Rev. date 1.10.2004.