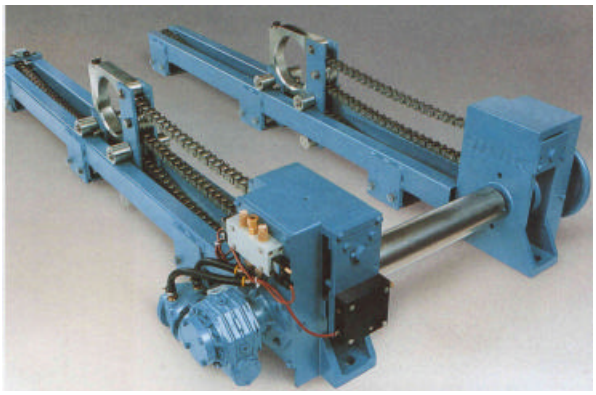
# INCREASED PRODUCTIVITY AND IMPROVED QUALITY WITH AUTOMATIC STRETCHGEAR IN THE DRYERS

**Theoretical Influences and Experiences from Practice**

Wolf Heilmann

## 1. Summary

Nowadays both in new machines and rebuilds fully automatic chain stretchgear is frequently installed to control the tension of the clothing. Depending on the grades produced, the machine concept and the raw materials used differing influences become apparent.



*Ill. 1: Automatic stretch gear with integrated load cell*

The theoretical and practical influences of automatic dryer fabric tension control are investigated. These influences can be divided into different areas:

- Reduction of production costs per tonne
- Increase in volume of production
- Improvement and consistency of the product quality

The first part of the article highlights parts of the theoretical influences, independently of the relevant emphasis on different paper grades. In the second part practical experiences on a fluting machine after one year of operation are covered. The advantages obtained from the investment in automatic tensioning are highlighted, and the qualitative influences on the paper produced are summarised.

Through reductions in cost and increases in production the investment in automatic tensioning paid for itself within eight months.

## 2. Introduction

Automatic tension control for the machine clothing brings with it significant advantages in the production of paper. The more precisely the tension control can be applied, the greater is its influence on manufacturing costs, paper quality and increases in production.

These advantages substantially outweigh the higher purchase costs and therefore offer a rapid Return on Investment. In new machines and rebuilds the tension control of felts and fabrics is usually automated.

Erhardt + Leimer have developed chain tensioners with integrated measuring and control technology which guarantee precise and reliable control of felt and fabric tensions in the machine. The large number of influences and their advantages are outlined with the example of a dryer section installation and confirmed with data from practice.

In the case study of a fluting machine rebuild the whole dry end was equipped with fully automatic chain tensioners with integrated measurement and digital control of the dryer fabric tensions. The dryer fabric tension can now be held constant within very narrow limits and thereby achieve very fast reaction times. In contrast, the previously installed spindle tensioners with external measurement and control via the process control system showed a typical, large control hysteresis.

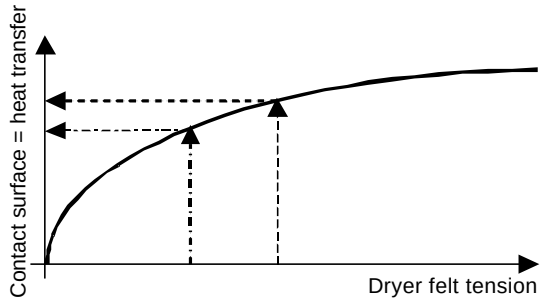
## 3. Fundamentals

### 3.1 Influence of Fabric Tension on Drying

This section explains the influence of fabric tension in the dryer section. There is a direct relationship between dryer fabric tension and the contact surface between the dryer cylinder and the sheet. This contact surface is directly proportional to the heat transfer from the cylinder to the sheet.

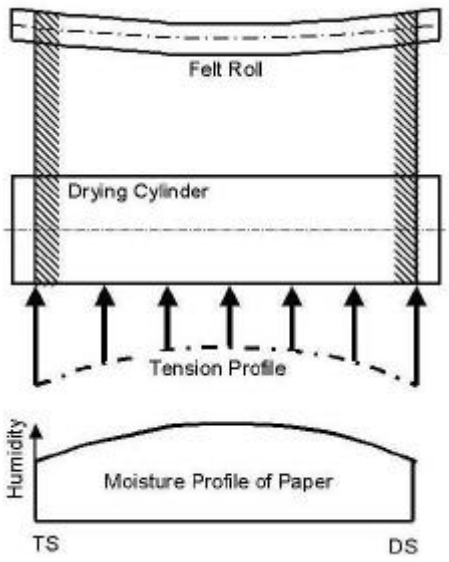
Therefore, drying and all the parameters related to it can be influenced. In addition to the fabric tension the fabric design, the paper grade and also the raw material have a role to play. Basically a higher fabric tension results in a better

heat transfer and therefore a better drying of the sheet.



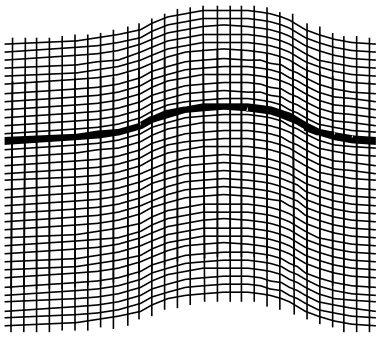

*Ill. 2. Influence of dryer felt tension on contact surface between cylinder and paper and heat transfer*

It is important to note that the fabric tension has additional influences. Especially the load on the felt rolls should be considered. With excessive tension the heavily wrapped rolls deflect. The fabric running length in the middle is reduced. As a result the fabric tension in this area is significantly reduced and a lower localised heat




*Ill. 3: Influence of deflected rolls on cd-moisture profile*

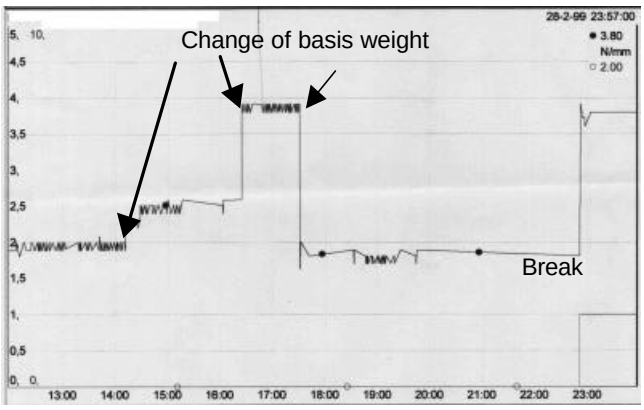
transfer occurs. The resulting CD moisture profile is characterised by a too wet middle and overdried edges.
The dryer fabric leads in the middle, producing the typical sinus form of lead in the seam. Only the fabric structure limits the degree of this lead.
At the edges and in the middle the open area is almost ideal, but in the intermediate areas the permeability is reduced by the distortion of the mesh. This results in normal evaporation at the edges and in the middle whilst the intermediate areas of the sheet remain wetter. A moisture profile in the form of an “M” is the outcome. This then overlays the moisture profile caused by the roll deflection and leads to problems in conversion. The sheet may not lie flat or have stable dimensions.



*Ill 4: Influence of fabric leading in the middle: in the distorted areas less moisture can be evaporated.*

### 3.2. Influence of Production on Fabric Tension

Moisture content and basis weight of the sheet have a powerful effect on the dryer fabric ension. The higher the absolute water content, the higher the energy requirement for evaporation. A relatively small proportion of drying energy heats up the fabric, so that a relatively low fabric tension results.



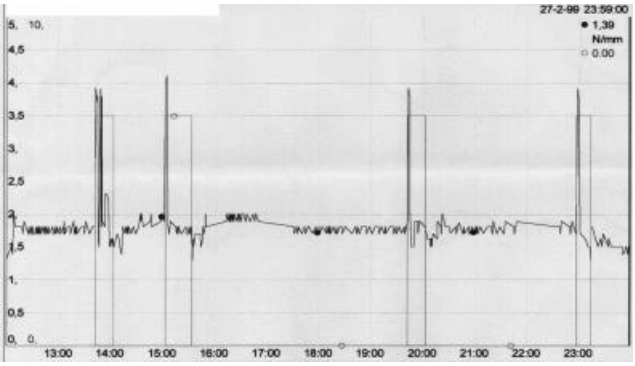

*Ill 5: Manual control of dryer fabric tension: change of basis weight leads to changes in tension as well as sheet breaks*

In absolute terms less energy is necessary to evaporate the water from low basis weight sheets. A larger share of the energy is available to dry and heat up the fabric which will shrink, thus increasing the tension.

A similar relationship exists with the stock composition, the degree of refining and the fines and filler content:

- Freer stocks allow themselves to be much more easily dried than heavily refined stocks
- Fines are more difficult to dewater than long fibres.
- High filler content sheets are easier to dewater

The most severe dryer fabric tension changes occur at sheet breaks or at grade changes when the sheet is sent to the pulper.
At grade changes of lightweights the variations in tension will be lower. In these cases the tension changes will be dependent on how quickly the machine speed is adjusted to the new production.




*Ill. 6: Semi-automatic control of dryer fabric tension: Breaks lead to severe tension variations: on restarting the machine fluctuations occur which take at least 10 minutes to settle down*

Manually controlled tensioners are unable to correct the tension increase resulting from grade changes. At breaks the increase in fabric tension can be up to three times that during normal operation.
Even with semi-automatic tensioning severe tension variations can occur. Their reaction is generally sluggish, since the dryer fabric itself must absorb the energy from the stretch roll movements. As a result of the damping characteristics, created by the modulus of elasticity, variations can be caused. Such fabric tension variations are only slowly evened out.
Automatic tensioners with external measurement behave similarly as in this case a magnification of the control hysteresis occurs. This is caused by the time delay between the position movement and the measurement.

## 4. Theoretical Influences

Fabric tension influences on paper production can be divided into two areas:

- Paper quality
- Production costs and volume.

### 4.1. Paper Quality

The fabric tension in the dryers is influenced by several parameters. These are mainly determined by the drying:

- CD Moisture Profile:
  The rolls deflect under excessive tension. This creates changes in the CD tension profile and the CD heat transfer.
- MD Moisture Profile:
  Without tension control the fabric tension is dependent on the moisture content. As a result wetter areas are dried less and drier areas are dried more effectively.
- Z-Direction Moisture Profile:
  The fabric tensions of the top and bottom dryer cylinders determine the heat transfer and therefore the drying of the wire side and top side of the sheet.

The following are some of the parameters which are affected:

- Flat Lying
- Curl
- Print Mark Stability
- Sheet dimensional accuracy
- Warp (fluting)
- Fingering (plasterboard)

| **Influence of fabric tension on paper quality** | |
|---|---|
| • md-moisture profile | • flat laying |
| • cd-moisture profile | • curl |
| • z-direction moisture profile | • dimension stability |
| **Influence of fabric tension on energy consumption** | |
| • dry content | • steam consumption |
| **Influence of fabric tension on runability** | |
| • sheet breaks | • downtime |
| • bearing damage | • fabric run off |
| • life of fabric | |

*Table 1: Theoretical influences of dryer fabric tension on fluting grades*

In addition the following quality characteristics can be affected:

- Damage to sheet surface as a result of too great speed differentials.

- Surface marking as a result of too high fabric tension.
- Blowing/de-lamination on multi-ply board grades.

### 4.2. Production Costs and Volume

Automatic tension control on dryer fabrics has positive influences on the following parameters:

- Dry content
- Reduction in steam consumption
- Breaks, caused by differential speeds between cylinder, sheet and dryer fabric within the individual sections
- Bearing damage caused by excessive fabric tensions
- Clothing life
- Reduction in downtime
- Risk to fabrics at breaks

## 5. Practical Experiences

In February 1999 fully automatic tensioners with integrated measuring for the precise control of tension were installed at the rebuild of a paper machine making packaging grades. Trim width was 2.45m and mainly 130 g/m2 fluting was being produced at an average speed of 304 m/min. The following advantages were confirmed after 12 months operation.

| | |
|---|---|
| **Bearing / Fabric Damage** | **4,08 Euro/to** |
| Reduction of Downtime for repairs by 80 % | |
| **Dryer Fabric Life** | **0,33 Euro/to** |
| Increase in average downtime by 36% through lower number of seam breaks and reduced stickies built-up | |
| **Reduction in Breaks** | **1,29 Euro/to** |
| Reduction Downtime of 40 h per year | |
| **Energy Savings** | **0,83 Euro/to** |
| Reduction in steam consumption from improved heat transfer and reduced fabric distortion | |
| **Efficiency Increase** | **3,66 Euro/to** |
| Increase in specific efficiency of 3,45 % | |
| Increase in machine speed of 4 m/min | |

*Table 2: Savings resulting from the installation of automatic stretch gears in the dry end*

The selection of the high value automation of the tensioning justified itself by a Return on Investment of eight months. This only accounted for the easily calculable advantages.
The influences can be listed under several headings:

- Improvement in the condition of bearings.
- Increases in dryer fabric life.
- Reduction in breaks.
- Energy savings
- Increase in machine efficiency
- Improvement in paper quality

### 5.1. Improvement in the condition of the felt roll bearings

Before installation the dryer fabrics regularly exceeded the maximum permitted tension with the result that the bearings were overloaded. Advantages of automation were:

- Shuts caused by bearing changes were reduced by 80%
- When bearings failed which occurred despite routine maintenance changes, fabrics were also damaged. These did not occur after the rebuild.
- The new possibility of maintaining a constant fabric tension reduced the risk of consequential damage from overheated or defective bearings. This is a very important but not easily calculable contribution to cost savings.

The costs of these items before automation amounted to 4.08 Euro/to.

### 5.2. Increase in Dryer Fabric Life

Before installation of automatic tensioning seam failure occurred frequently. This was caused by uneven tensioning and particularly by exceeding the permitted maximum tension. This excessive tension occurs, for example, at breaks or during the production of low basis weights. With the automatic tension control a maximum permitted value cannot be exceeded under any circumstances. Additionally, it was possible to optimize the dryer fabric run at the rebuild which was of particular benefit to the 1. Section.

- The avoidance of tension peaks reduced seam damage and increased fabric life from 110 to 150 days on average.
- Through the use of mixed waste in the stock there are problems of stickies build-up in the dryers. The stickies contaminate the roll surfaces and increase their diameter, which in turn increases the tension. The automatic tension control compensates for this and prevents excessive strain on the seams.

This saving amounts to 0.33 Euro/to.

### 5.3 Reduction in Breaks

Previously spontaneous and uncontrolled slackening or overtightening of the fabric could lead to uncontrolled slippage of the sheet against the cylinders and the dryer fabric. This slippage resulted from differential fabric tension between top and bottom cylinders and also between front and drive side. The differential speed between cylinder, sheet and dryer fabric is largely influenced by the fabric tension since the coefficient of friction remains largely constant. These varying differential speeds lead to sheet breaks. The automatic tension control significantly reduces the number of breaks. In total related downtime could be reduced by 40 hours per year.
This gave savings of about 1.29 Euro/to.

### 5.4. Energy Savings

The automatic tensioning of the dryer fabrics resulted in a more even fabric structure which ensured a more even evaporation. This saves 0.05t steam / t paper under the same production conditions. A further 0.05 to 0.10 t steam / t paper is saved by the more even heat transfer between cylinder surface and sheet.
Both factors together provide a saving of about 0.83 Euro/to.

### 5.5. Efficiency Increase

The reduction in the specific steam consumption led to an increase in the efficiency of the machine. Instead of previously 5.8 t/h it was possible to produce 6.0 t/h. This is an efficiency increase of 3.45% solely from better utilization of heat energy. The efficiency increase enabled the production speed to be increased by 4m/min.
This produced cost advantages of about 3.66 Euro/to.

### 5.6. Improvement in Paper Quality

In addition to the economic advantages there are influences on the paper quality. It may not be possible to evaluate them in terms of cost savings, but they can increase turnover by providing a product which is qualitatively better at the same price. By installing the automatic tensioning parameters could be improved which relate directly to the drying:

- CD moisture profile
- Z-direction moisture profile
- Curl
- Flat laying

There was no measurable improvement in the MD moisture profile. Also, no significant improvements could be established with smoothness, tear strength, or surface damage by stickies. Printability was not tested.

| Influence of Dryer Fabric Tension on Paper Quality | |
|---|---|
| cd - moisture profile | + |
| md - moisture profile | 0 |
| z - direction - moisture profile | + |
| flat laying | + |
| curl | + |
| smoothness | 0 |
| smoothness regularity | 0 |
| tear strength | 0 |
| surface damage by stickies | 0 |
| printability | n/a |
| warp | + |
| quality regularity | + |
| runability on corrugators | + |

*Table 3: Influence of dryer fabric tension on paper quality and properties*

At the convertors of the paper produced on this machine a significant reduction in warp on the corrugators was experienced, so that more economic production of the packaging products was achieved. The improvement in quality and particularly an evenly high quality with minimal variation improved the market opportunities for the papers produced.

### 6. Profitability Assessment

In total about 510,000 Euro per year were saved by the automatic tensioning in the dryer section. The production costs per ton of paper could be reduced by about 10 Euro. The cost of the tensioners was approx. 100,000 Euro plus duty, installation and downtime for the installation. Taking all costs into account the return on investment was less than eight months. In addition the improved and more regular product quality – leading to improved chances in the market – were not in the calculation.

### 7. Conclusion

It can be proved that the installation of automatic tensioning on new machines or at rebuilds can lead to a significant reduction in production costs with a simultaneous increase in production and an improvement in quality. This pays for the investment in record time.

# Advantages of Automatic Tension Control

1. Increase of **drying capacity:** higher dryer felt can be used without damaging the machine or the paper. In practice, production could be increased up to more than 10 percent
2. Reduction of **steam consumption** through better heat transfer from drying cylinder to paper. Reductions of up to 15 percent could be observed in practice, compared to manual tension control, and up to more than 5 percent, compared to semi-automatic or low-cost automatic tension control
3. Reduction of **energy consumption** with same production
4. More even and accurate **felt guiding** due to constant felt tension
5. No **loss of dryer or press felt** upon sheet break
6. More even **moisture cd-profile** as dryer felt rolls will not bend
7. More consistent **moisture md-profile** due to constant felt tension in time. With manual tension control, moisture changes are increased as felt tension is not adapted
8. Control of **twosideness of moisture** between top and wire side of sheet
9. Control of **cd-shrinking** and **md-elongation** of the sheet
10. Reduction of **slippage** between clothing, sheet and cylinders due to too low felt tension. This is extremely important in silent drive machine designs
11. Better **runability** of paper machine
12. Reduced **Flutter of sheet** in open draws caused by too low felt tension and uneven slippage
13. Reduction of **sheet breaks** through control of differential speed in each dryer group. This significantly increases the production and machine availability due to reduced downtime
14. Increased **lifetime of roll bearings**. In practice, production time could be increased by as much as 40 hours per year, as less downtime was required to change rolls
15. Longer **life time of clothing**. No damage to seam due to excessive tension. No damage to clothing due to jammed bearings
16. Reduction of **felt change time**, as the high speed of the tension carriages allows to move the roll more far faster than manual operation.
17. More even **drying** in the dryers as bended rolls and thus distortion of the dryer felt is avoided
18. Improved **flat laying** of the sheets
19. Reduction of **curl**, due to control of top and bottom side heat transfer
20. Improved **dimension stability**
21. Improved **print mark stability**
22. Improved **format stability**
23. Reduction of **Warp** on corrugators
24. Avoidance of **surface marking** due to excessive dryer felt tension
25. Improvement of **smoothness** resulting from high felt pressure on the cylinder surface
26. Avoidance of **surface damage** due to reduction of slippage. On silent drive machine designs, slippage between cylinder, sheet and felt can only be avoided using accurate tension control
27. Influence on **mechanical resistance** due to optimized wire tension in forming section
28. Reduction of **finger picking** at the converting of plaster board
29. Reduction of **de-lamination** or **blowing** at multi ply board caused by overheating at the first drying cylinders
30. Reduction of **cockling** at newsprint as higher pressure will keep the sheet consistently on the drying cylinders
31. Reduction of **edge waves** as overdryed edges are avoided and more consistent md-moisture profile is reached
32. Reduction of **sticky deposit** as first dryer groups must not be overheated to increase the drying capacity

More detailed information can be obtained at our local representative office or at:

Erhardt + Leimer GmbH
Sales Division 3 - Paper Manufacturing
Albert-Leimer-Platz 1
D-86391 Stadtbergen
Tel.: + 49 - 821 - 24 35 - 230
Fax: + 49 - 821 - 24 34 - 222
@: sales3@erhardt-leimer.com
www.erhardt-leimer.com