# Optimising runnability and harmonising paper quality by means of continuous clothing oscillation

## Theoretical influences and practical experiences

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## 1. SUMMARY

If wire and press felt running is too uniform streaky wearing will be caused on the clothing, rolls and dewatering elements. Streaky contamination is also caused to the same extent on the clothing and rolls. Both of which cause defects in the paper density cross direction profile and paper moisture as well as its basis weight. The irregular wear and tear on the clothing may also lead to considerable runnability problems.

Streaky wearing and contamination may be prevented by controlled clothing oscillation in the cross direction of the machine. Press-related sheet breaks are reduced, also the feared following-up of the tail.

The theoretical influences of clothing oscillation and practical experience with forming wires and press felt oscillation are illustrated. The influences may be divided into various sectors and assessed, machine runnability in particular is increased.

Practical experience on the PM 5 of the Zürich Sihl paper mill the use in the wire and press section. The potential that exists even on slow-running paper machines is demonstrated.

## 2. INTRODUCTION

Very stable guiding leads to streaked wear of the clothing and dewatering elements, contamination of wires, felts and rolls and to defects of the cross direction profile.

The fully automated oscillation of the clothing prevents the streaky nature of wearing and contamination whereby a corresponding influence on the formation of the paper, the basis weight and irregular paper web moisture profile are also reduced.

The oscillation of the clothing may be performed manually by offsetting the guide edge sensors. In the majority of cases this achieves only a minimal improvement as web offsetting is not performed with sufficient frequency and uniformity.

Modern edge sensors permit the required oscillation to be performed fully automatically whereby in most cases both the stroke – i.e. the amplitude - and the time – and thus the frequency –may be variably set so that oscillation may be optimally adjusted to every machine, its speed, paper type and also felt conditioning.

Regular and continuous offsetting of the clothing prevents on the one hand defects becoming impressed in the felt or wire and on the other hand the clothing edge is prevented from damaging stationary dewatering elements, rolls or other clothings.

Erhardt + Leimer GmbH has developed the ElectroPalm electro-mechanical edge sensor. Here, an oscillation of the sensor zero position overrides the guiding signal.

*III. 1.: ElectroPalm in the felt of a crescent former with oscillation to avoid damage caused by edge trimming.*

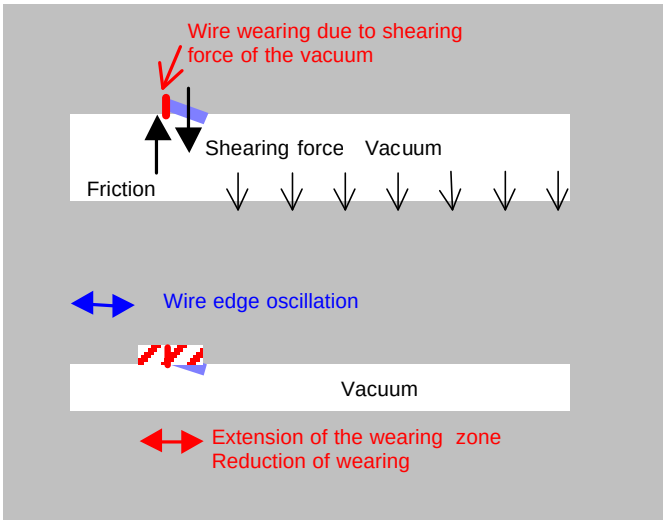
In comparison to manual edge sensor offsetting this has the advantage that the „human factor“ influence is dispensed with. Above all, the parameters for each paper type and clothing may be optimally adapted via the process control system.

At the Swiss Sihl special paper mill an ElectroPalm was retrofitted in 1996 in the forming wire, mainly to increase the service life of the suction box covers - an aim that was exceeded by far in the doubling of the latter's service life. In 1998 an ElectroPalm was retrofitted in the pick-up felt. The aim was to reduce streaky contamination and to harmonise so that paper web moisture on the calender should produce as few variations as possible in the machine cross direction and thus lead to a

uniform result after calandering. The advantages achieved will be illustrated and discussed.
This paper does not deal with oscillation on the paper web itself. This also leads on the pope reel, felt rolls and rewinders, calandering units and coaters to a considerable improvement in paper quality. This topic must be dealt with in a separate paper.

# 3. PRINCIPLES

In the paper machine wire and felts generally run at the same position with a very slight lateral displacement. This results in the streaky nature of wearing and contamination that increases with the clothing service life.. The more precise guiding is the narrower the wear or contamination zone will be.
At the individual clothing positions this leads to different problems in paper machine runnability and paper quality.




*Ill. 2.: Wearing in the Wire at the vacuum edge zone. Extension of the wearing zone via filter oscillation*

If clothing is now moved back and forth the critical area is extended. Wear and contamination are spread over a larger area, specific wear will then be considerably reduced.
Oscillation is performed slowly. A stroke period in the wire section of 15 to 60 min is typical, for the press felt periods of between 30 and 90 min are selected. The size of the stroke depends on the machine construction features such as roll length, bearing center-to-center spacing and clothing width. Typical strokes are 10 to 40 mm, in a few special cases oscillation strokes of up to 70 mm are known.
Oscillation must not be confused with imprecise wire guiding. While the latter has a similar effect it is unstable. In particular when accelerating or slowing down the paper machine speed, imprecise guiding frequently results in damage to or loss of clothing. Oscillation on the other hand always assures a precise and highly stable guiding of the clothing.

The influences of clothing oscillation may be regarded under various aspects:
- runnability improvement,
- harmonisation of contamination,
- reduction of wear and tear,
- harmonisation of paper quality.

## 3.1 RUNNABILITY IMPROVEMENT

If clothing running is too stable, streaky, very irregular contamination of the clothing itself and also the rolls is caused. This contamination impairs paper machine runnability. Defects may be specifically reduced by means of programmed oscillation.

### Wire oscillation

Wire oscillation reduces fluctuations in the cross direction moisture profile. These minimal fluctuations lead to a reduced, more uniform contamination of the pick-up felt.

### Press felt oscillation

If press felt running is too stable, two borders will be formed. The first separates felt with and without paper contact, clean from contaminated felt. The second marks the border to conditioned felt which is also sharply delineated. If the felt is oscillated the sharp demarcation of the two areas is softened.

### Tail following-up

If, after a short pick-up felt run time, a sharp separation between felt with and without paper contact occurs, the very slight displacement of the felt will lead to the tail no longer following up the wire but the pick-up. This frequently leads to serious defects in the press through to total loss of clothing. Felt oscillation achieves a gentle transition to the edge area of the felt. Following-up of the tail is excluded.

### Edge tears

If the felt runs underneath the paper web the latter will run on the contaminated edge areas of the felt. In the majority of cases this leads to edge tears. These cause problems, above all in the coaters and converting side.
These edge tears also arise if, towards the end of the felt run time, the operating width of the web is increased. If the felt cannot be run wider again by cocking the felt at this point, tears will be caused automatically.
Continuous oscillation extends the transition zone, edge tears are avoided. If the machine conditions permit it, oscillation should be set as wide as possible. As such the web may be widened at any time without disrupting production.
Ideally felt oscillation is supported by an oscillation of the cleaning showers. The borders between individual felt areas are thus faded so considerably that under

normal conditions disruptions in production due to tears may be avoided.

**Sheet Breaks**

Edge tears in the press frequently lead to sheet breaks in the press and dry section. In the case of high speed paper machines and lightweight papers in particular this leads to serious runnability problems. In these cases oscillation pays off very quickly.

| | |
|---|---|
| **Runnability** | |
| Sheet breaks | + |
| Edge tears | ++ |
| Follow-up of tail | +++ |
| Flipping of Center roll | ++ |
| Press felt contamination | ++ |
| Dryer felt contamination | + |
| **Paper quality** | |
| CD Moisture profile | + |
| CD glazing profile for online calanders | ++ |
| CD Gloss profile for online calanders | ++ |
| Streaky starch absorption in size/film press | + |
| CD coating film profile in online-coater | + |
| **Clothing and covers life** | |
| Edge damage due to felt conditioning | + |
| Plastic covers life | +++ |
| Ceramic covers life | O |
| Wire life | ++ |
| Felt life | + |

*Table 1: Wire and press oscillation influences*

## 3.2 CONTAMINATION HARMONISATION

Stable felt running leads to streaky contamination. The streaks are caused in the stock preparation as well as in the headbox and are transferred to the pick-up via a stable-running felt. This contamination leads to a higher level of paper moisture which with the increasing run time of the felt will also be transferred to the dryer screen. The individual press felts hereby deposit part of the accumulated contamination along on the felt rolls which then multiply the effect. Oscillation on the one hand leads to a more uniform distribution of contamination, on the other hand a reduction of the deposits on rolls and re-contamination of the felts. Over an extended lifetime the felt will retain a more uniform profile.

## 3.3 REDUCTION OF WEAR AND TEAR

Various factors contribution to wires and felt wear and tear due to stable guiding:

**Wire wear and tear**

In the wire excessive wear and tear is particularly caused by the transition to the suction zone. The wire is pulled into the apertures and thus damaged by the shear forces. Wire wear and tear is critical above all in the case of

- Highspeed machines,
- Paper grades with high fillers content, especially those with abrasive fillers,
- heavy paper grades that require a high degree of vacuum
- paper grades made of slimy stock or waste paper from which it is relatively difficult to extract water.

**Wear and tear on dewatering elements**

Nowadays dewatering elements made of plastic are still used very frequently. These are subject to a greater degree of wear and tear than ceramic covers. At the wire edge in particular pronounced wearing occurs on the covers. Here, continuous oscillation extends the wearing zone and thus wear and tear is harmonised so that a gentle transition between worn and non-worn areas occurs. In critical application cases the lifetime of the covers may be more than doubled. The costs of covers may thus be halved in favourable circumstances; in addition, production time is gained as less downtimes are required for replacing covers.

**Press felt wear and tear**

There are different reasons for guiding-related wear and tear on press felts.
One critical factor is the wearing of the felt edge by the wire edge. Here, both wire and felt oscillation reduce wear and tear. In the event of simultaneous oscillation it must be ensured that the frequencies are different and no harmonious multiples occur in order to prevent simultaneous oscillation of both clothings. In the case of crescent formers the tissue as well as the tail can be trimmed on the press felt. In order to assure reliable trimming at high speeds of 2,000 m/min a very high water pressure on the nozzle is used. When guided precisely the felt is first compacted by the water jet, later the edge can be trimmed off. The felt must be removed from the machine at an early stage. If the felt is oscillated the wearing zone is extended and as such the felt may achieve its lifetime. In addition trimming with blind forming wire edges leads to streaks on the felt, where the blind edges are contacting the felt. Uneven trimmed edges with the risk of sheet breaks as well as problems at the creping doctor can occur.

## 3.4 PAPER QUALITY HARMONISATION

**Moisture profile disturbance**

Cross direction profile defects in the headbox are intensified by streaky wearing and contamination thus caused during the wire lifetime. If the wire is oscillated from the beginning the structures of the headbox no longer leave their mark on the wire but are harmonised. Dewatering and formation are more uniform during the wire lifetime and thus the moisture, density and basis weight profiles are preserved. Streaky contamination of the press felt also leads to moisture profile defects in the web. These leave their mark on the dryer screens so that as the lifetime of the press felts and dryer screens increases the $\Gamma_2$ values will deteriorate. Filter and above all press felt oscillation permits the minimisa-

tion of cross direction profile defects until the end of the clothing service life.

**Glazing and gloss profile defects**

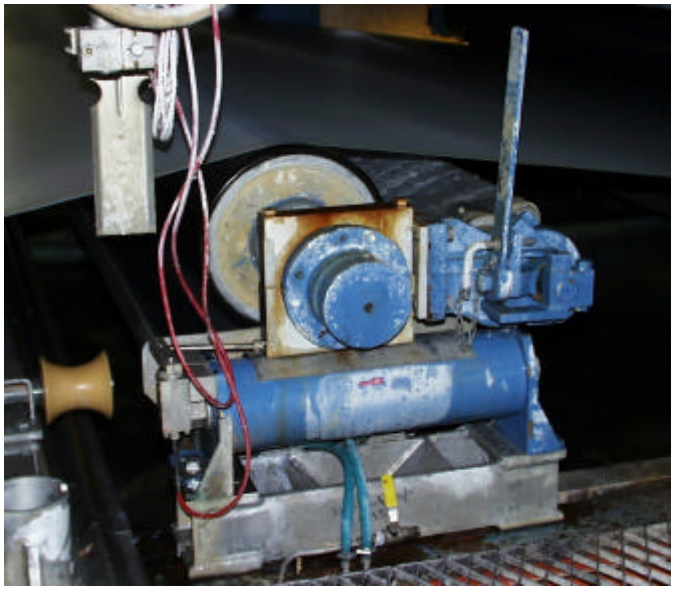
On online calenders moisture fluctuations in the machine cross direction lead to defects in the glazing and gloss profile. Damper paper streaks are easier to glaze and compact, dry areas will display less glazing and gloss. In the case of modern offline calenders the dampness may be compensated during the reel drum storage period. On modern online machine concepts the moisture may no longer be compensated. Oscillation, above all of the pick-up felt, leads to reduced fluctuations of the glazing profile.

# 4. PRACTICAL EXPERIENCE

In Zürich the Sihl paper mill operates 2 paper machines for producing special paper. With an operating width of 3.4 m and a maximum production speed of 100 m/min the PM 5 produces tracing paper for technical drawings, in particular however for digital printing. In 1998 oscillation was built into the froming wire, 2000 in the pick-up felt.

## 4.1 FORMING WIRE (FOUDRINIER)

In 1998 an ElectroPalm with programmable oscillation was installed on the forming wire guide. The oscillation amplitude of the longitudinal filter is 15 mm with a relatively short cycle time of 15 min.



*Ill. 3: Wire guide with ElectroPalm in the forming wire of the PM 5*

This oscillation considerably improves the runnability of the paper machine. The following were observed in detail:

- wire service life
- service life of the suction covers
- streaky wear and tear of wire
- cross direction profile defects
- edge wear and tear of the pick-up felt
- streaky contamination of the press felts
- streaky contamination of the dryer screens

**Wire service life**

In the case of the wire service periods no prolongation could be noted. Both with and without oscillation the wire service periods amounted on average to 100 days. Due to the very low machine speed of less than 100 m/min and the low degree of wear and tear on the edge of the vacuum no improvement in wire service lives occurred. The mechanical strain on the wire is here in comparison to other paper machines so minimal that no premature wire replacement is required.

**Service life of dewatering elements**

The paper machine is still fitted with plastic covers. These are worn down to a relatively high degree at the wire edge. Due to oscillation the service life of the suction covers could be doubled.

**Streaky wearing of the wire**

Due to precision wire guiding irregularities in the stock preparation and above all, the headbox were transferred to the wire. Streaky wearing and contamination occurred. This influenced dewatering and formation.
Due to oscillation the streaks were spread and harmonised so that both the streaks on the paper and the transfer of the streaks to the following clothing elements were considerably reduced.

**Cross direction profile defects**

Due to the streaks on the wire the paper was marked by a cross direction profile defect in the machine cross direction cd, both with regard to basis weight, moisture and formation. This was transferred to the press and dryer section clothing and increased the streaks on the paper there. Since the machine has been fitted with online calenders the problems of profile fluctuations in the cross direction of the paper machine have intensified. Previously the reel drums were taken to an intermediate warehouse and could be harmonised there to such an extent that on calendering no streaks arose. Since the mounting of a double calander after the dryer section as substitute for the super calender the moisture profile can no longer be compensated. Differences in density and moisture are intensified by the calander. These differences could no longer be measured by the process control system scanner but could only be detected on the finished reel drum. The cause could only be established in detail by means of thermographical measurements. Following oscillation of the forming wire the streaky wearing of the wire and thus also formation, moisture, density and basis weight were harmonised.

**Edge wear and tear of the pick-up felt**

Due to precision wire guiding the pick-up felt wore to an excessive degree in the edge area. By oscillating the

wire the wear area was extended by 15 mm so that felt wearing was harmonised to a considerable extent and longer service periods could be achieved. Runnability defects due to edge wearing caused by the wire were eliminated.

**Streaky contamination of the pick-up felt**

In the wire a structure was formed that led to streaky dewatering. These formation differences in the machine cross direction led to streaky contamination of the press felts. By oscillating the forming wire this contamination was harmonised and led to a more uniform moisture extraction behaviour of the press felts.

**Streaky soiling of the dryer screens**

The streaky contamination of the pick-up was reduced by forming wire oscillation. Originally the streaky soiling of the press felts led to an increased water content in the web. Soiling was transferred from the press felts to the dryer screens via the damper web. Once the forming wire and press felts were fitted with ElectroPalm oscillation system streak formation was reduced and harmonised for the press felts and, as a result for the dryer screens.

### 4.2 PICK-UP FELT

Since oscillation in the wire section achieved above all an improvement of the covers service life, in the year 2000 an ElectroPalm was retrofitted on the pick-up felt. The felt was typically oscillated by 20 mm, the duration of an oscillation cycle being 15 min.
The following aspects of press felt oscillation will be considered in detail:

- Streaky contamination of the press felt
- Sheet breaks
- Following-up of the tail

**Streaky contamination of the press felt**

The streaky contamination of the press felt has been reduced.

**Sheet Breaks**

The number of sheet breaks has not been reduced. Due to the very slow speed of maximum 100 mpm this is not a critical factor either in the press or dryer section. While presumably edge tears do occur runnability on the paper machine is not however impaired.

**Following-up of the tail**

The following-up of the tail is not a critical factor either as the maximum machine speed of 100 mpm is only reached at very low basis weights and even then only uncritical following-up of the tail occurs in isolated cases. At average to high basis weights no danger at all exists due to the lower machine speed.

## 5. COST EFFICIENCY ASSESSMENT

Even on a very slow-running special paper machine such as the Sihl paper mill PM 5 the implementation of wire and felt oscillation very quickly pays for itself without the full potential of the benefits being wholly exploited. The increase alone in the service lives of the dewatering elements in the wire section as well as the reduced and harmonised contamination of the press felts effect a considerable increase in runnability with significantly improved cross direction profiles for paper with regard to glazing, gloss and moisture.
In the case of highspeed paper machines such as newsprint paper machines the benefits of reductions in sheet breaks due to pick-up oscillation in particular are additionally achieved. Furthermore damage to the machine is avoided that might occur due to the following-up of the tail.
From various applications ranging from tissue to cardboard and special paper through to newspaper and printing paper with production speeds of between 40 and 1.800 m/min a R.O.I. of a few weeks to under 3 months is achieved if the machine is fitted at critical positions with wire oscillation.
Oscillation of the dryer screens also produces an improvement in runnability and paper quality, not however to the same extent.

## 6. CONCLUSIONS

By oscillating wires and felts the service life of clothing and dewatering elements may be increased. Machine availability is improved so that together with the reduced costs for clothing and dewatering elements output may be significantly increased.
Simultaneously paper quality may be improved and harmonised, in particular for online caladering and coating units.
Investment in clothing oscillation pays for itself within a few weeks as in the majority of cases only a few key points in the paper machine need be retrofitted and thus costs may be minimised.

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# Benefits of forming wire, press felt and dryer screen oscillation

1. Increase in **wire service life:** wire wear and tear at edges in the suction zone is spread over a larger area. The specific wear and tear may be reduced to such an extent that the wire may remain in the machine until it reaches the end of its normal service life.

2. Increase in the service life of **suction covers:** suction **covers** made of plastic in particular wear in the wire edge area. Due to oscillation wear and tear is spread over a wide area. In practice a doubling of the service life could be established.

3. Use of **lower cost suction covers:** due to the spread of edge wear and tear plastic **covers** may continue to be used, expensive ceramic **covers** need not be implemented solely because of edge wear and tear.

4. Reduction of **edge wear and tear** of the pick-up due to the wire edge.

5. Avoidance of **tail** following-up by the press.

6. Reduction of **edge tears**

7. Reduction of **sheet breaks** due to edge tears on the pick-up.

8. Prevention of **flipping** on the central roll

9. Reduction of **streaky contamination** of the press felt

10. Improvement of **felt conditioning** in the edge area

11. Prevention of streaky **deposits** on dryer sceens

12. Improvement of the **moisture** $\Gamma_2$ value,

13. Improvement of the **density** $\Gamma_2$ value,

14. Improvement of the **basis weight** $\Gamma_2$-value,

15. Improvement of the **glazing** $\Gamma_2$ value on online calanders

16. Improvement of the **gloss** $\Gamma_2$ value on online calanders

17. Avoidance of irregular **compressing** by online calanders due to moisture fluctuations

18. Streaky **starch pick-up** on the size press due to damp streaks