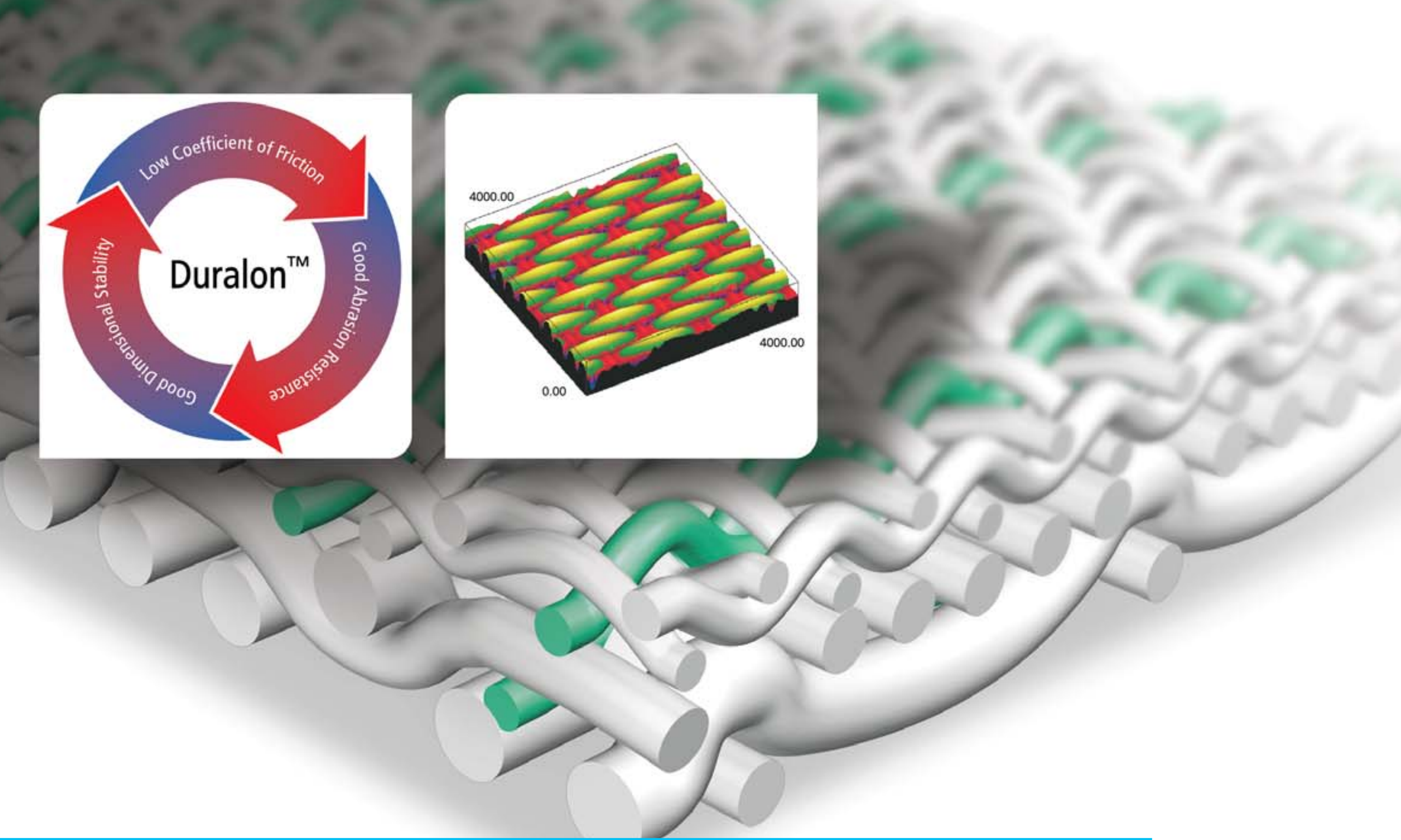


# Reducing Power Consumption and Increasing Lifetime due to a New Material in Forming Fabrics

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**Introduction**

The paper industry is facing numerous challenges as the worlds markets shift from the traditional markets of North America and Europe to the emerging markets of Asia which has brought with it numerous mill closures. Overall, demand is relatively flat in the traditional markets together with falling prices and increased costs. The situation and short term outlook will certainly remain challenging.

It is well known that the forming section consumes the least amount of energy when compared to the press section and the dryer section. However, with the correct choice of fabric design and constituent materials, quantifiable and significant cost savings are possible.

**Technical Background**

Currently, the most common material combination in use for the machineside wefts (CMD) in forming fabric designs is Polyester and Polyamide. The main advantages and disadvantages of these materials are described in Figure 1.

| | Advantages | Disadvantages |
|---|---|---|
| **Polyester** | Good dimensional stability (low moisture uptake) | Low abrasion resistance |
| **Polyamide** | High abrasion resistance | Poor dimensional stability (high moisture uptake) |

Fig.1 Advantages and Disadvantages of Polyester and Polyamide

Forming fabric manufacturers have looked to improve the abrasion resistance of forming fabrics by increasing the amount of Polyamide on the machineside.

Whilst this approach addresses the abrasion resistance the negative aspect is a (potential) increase in the power consumption due to the increased coefficient of friction of Polyamide compared to Polyester (see Fig 4).

Additionally, caused by the high moisture uptake of Polyamide, an increase in edge curl as well as a decrease in fabric dimensional stability are likely. Therefore the need to develop a new material, which would utilize the advantages of Polyester and Polyamide without any of the disadvantages, was the main design driver.

As a result of extensive laboratory analysis and fieled trials Heimbach has introduced a unique material (DURALON) into its PRIMOBOND SSB range of forming fabrics. Duralon fulfills the key criteria of today's (and tomorrow's) forming fabrics (Fig.2).

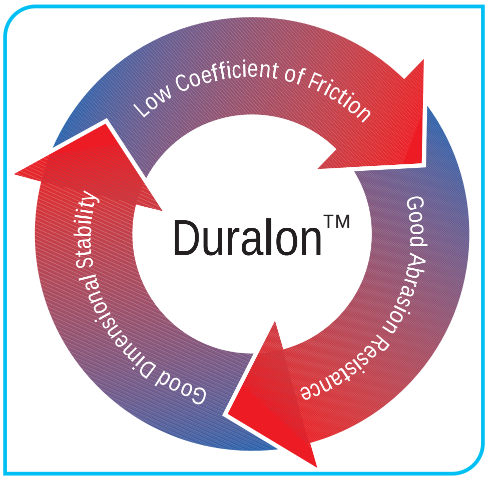



Fig.2 Main Design Drivers of Duralon

**Experimental Material Analysis**

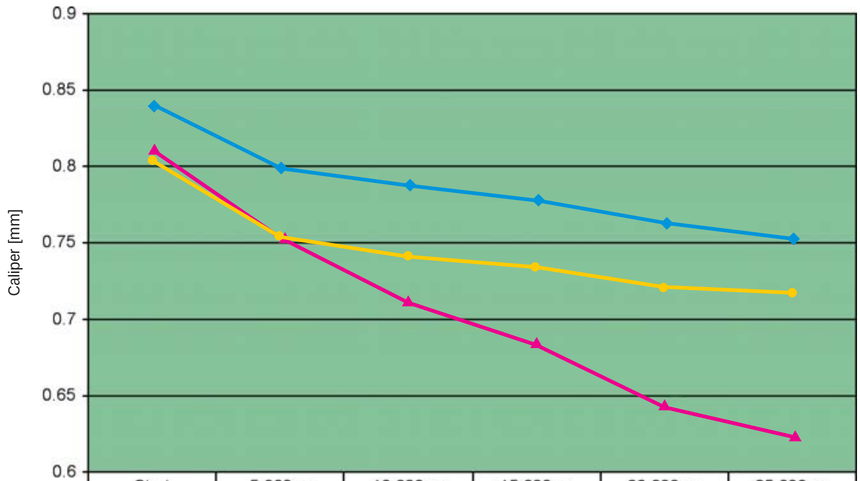
In order to characterize the constituent material, two main analysis techniques were used – abrasion testing which also includes the measurement of the frictional properties, and laser profilometry measuring the machineside topography of the fabrics. The analysis was conducted on PRIMOBOND.SF SSB fabrics. Three fabrics were analysed with different machineside material components – namely 100 % Polyester, alternating Polyester/Polyamide and 100 % Duralon. All other fabric parameters were unchanged.

Abrasion Testing

The equipment used was an industry standard Einlehner AT2000 which utilizes a rotating cylindrical ceramic body made from aluminum oxide. Filler concentration was 0.8 % Hydrocarb 50 BG from Omya. From the analysis, we can see in Fig 3 the caliper loss evolution after each 5000 m step. Fig.3 clearly shows that the wear rate of the Polyester is much higher with an overall caliper reduction of more than 23 %. This compares to the Polyester/Polyamide and Duralon samples which are both similar at around 10 %.

Measurement of Frictional Properties

In addition to the above abrasion analysis a detailed investigation was undertaken to look at the frictional properties of the three materials previously mentioned. Figure 4 shows the relationship between temperature (typical PM furnish temperature 45-55 °C) and “Coefficient of Friction” (CoF): It can be seen that the coefficient of friction of the Duralon fabric is much lower compared to the




| | Start | 5,000 m | 10,000 m | 15,000 m | 20,000 m | 25,000 m |
|---|---|---|---|---|---|---|
| Polyester/Polyamide | 0.84 | 0.800 | 0.788 | 0.779 | 0.765 | 0.754 |
| Duralon | 0.803 | 0.753 | 0.740 | 0.733 | 0.720 | 0.717 |
| Polyester | 0.812 | 0.755 | 0.713 | 0.686 | 0.645 | 0.625 |

Fig.3 Wear Rates

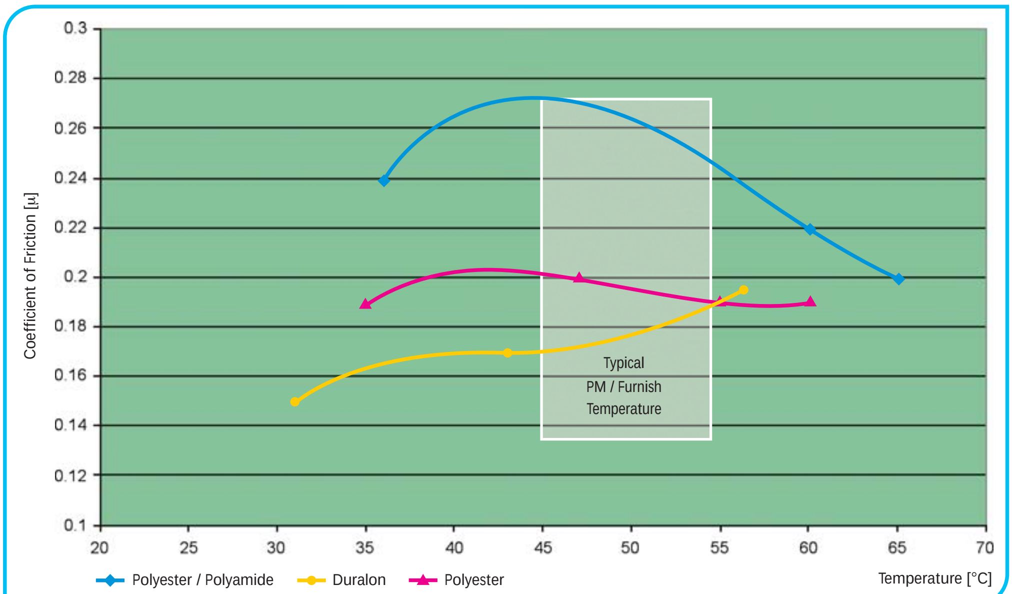



Fig.4 Comparison: Relation of Temperature and Coefficient of Friction

Polyester/Polyamide and the Polyester sample. A lower CoF will lead to less drag on the paper machine – meaning lower power consumption and potentially longer life.

Laser Profilometry

The NanoFocus µSurf® is a 3D optical measurement system based on whitelight confocal microscopy. Since it measures over the entire field of view of the objective, the NanoFocus µSurf® is especially suited for fast and easy measurement of microstructures – like forming fabrics.

The analysis looked at the machineside topography of the above mentioned designs but for ease of presentation of the results only the Polyester/Polyamide fabric and the Duralon fabric will be considered.

Figures 5 and 6 show the topographical profile of the machineside weft (CMD) monofilaments. Both fabrics were soaked in water for 24 hours, so full saturation could take place.

**The moisture uptake of Duralon is similar to Polyester at around 0.3 % which ensures dimensional changes in a wet environment are almost zero. This compares to the Polyamide 6 which takes up around 9.5 %.**

This fact ensures that the dimensional changes of Duralon in a wet environment are almost zero.

The Polyester/Polyamide profile (Fig.5) is showing the effect of the higher moisture uptake of the Polyamide, highlighted by a significant plane (or height) difference of 38.7 µm between the Polyamide and Polyester.

This plane difference and the CoF differences explains the phenomena that in some applications a fabric starts-up with high power consumption which then reduces as the fabric "beds-in" and becomes worn. Fig.6 shows that the Duralon

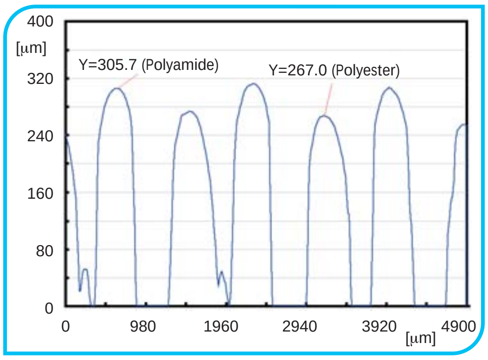



Fig.5 Polyester / Polyamide CMD profile: Significant plane variation

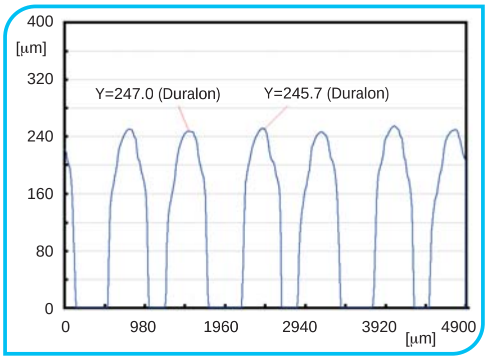



Fig.6 Duralon CMD profile:Co-planar

sample is almost co-planar with a measured variance of only 1.3 µm.

Figures 7 and 8 are 3D images of the machineside weft taken from the Nanofocus analysis and demonstrate the above characteristics. In Fig 7 it is readily apparent that every second monofilament is out of plane – highlighted by the grey colour of every second monofilament. The consequence of this plane difference is a variance in the contact

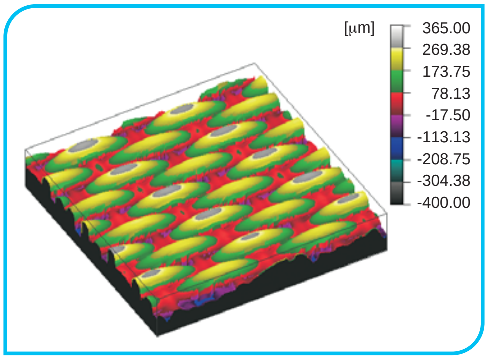



Fig.7 Polyester / Polyamide fabric: Every 2nd monofilament is non-planar (grey colour)

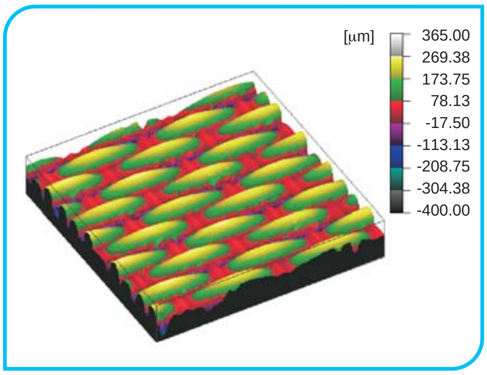



Fig.8 Duralon fabric:
All monofilaments are co-planar

area of the machineside. Fig 8 shows no variance and demonstrates the co-planar machineside of the Duralon containing fabric which translates into an increase in contact area.

Measured at a distance of 100 µm from the machine or roll side surface, the Duralon fabric exhibits a 13.79 % increase in contact area when compared to the Polyester/Polyamide fabric.

**Case Study 1**

The papermachine with a twin-fourdrinier former (Fig.9) produces Fluting and Testliner at speeds of 600-1100 m/min with a grammage range of 90-180 gsm. The standard designs on the bottom position were 16 shaft SSB with alternating Polyester/Polyamide wefts on the machineside.
The design supplied by Heimbach was a 24 shaft PRIMOBOND.HD SSB containing exclusively Duralon wefts on the machineside.

The power consumption of this PM has always been on the high side, and with high grammages and speed the PM was "on the edge".
The fabric guiding has also been a significant problem – which is due to the plane difference / contact area of alternating Polyester/Polyamide on the machineside.

The Duralon containing design was presented to the customer as the solution to both of these key issues, along with a systematic approach to service by Heimbach. Figure 10 shows the average drive load (mill figures) of each fabric on the bottom position over a two year period. (The final two data points are from after a rebuild to increase machine speed – hence higher numbers. These two data points have not been taken into account for the comparative calculations.)

The Duralon containing fabrics are showing a significant reduction in drive load in comparison to both competitors (Fig.10). If the drive loads are averaged by supplier we can note a reduction from a high of 69.80 % with competitor A to 53.80 % with the Duralon containing fabrics from Heimbach (Fig.11).

The maximum power capacity for the bottom position drives, namely the couch and the forward drive roll are around 640 kW each and an additional 162 kW for the auxiliary drive giving a total drive capacity of around 1442 kW.

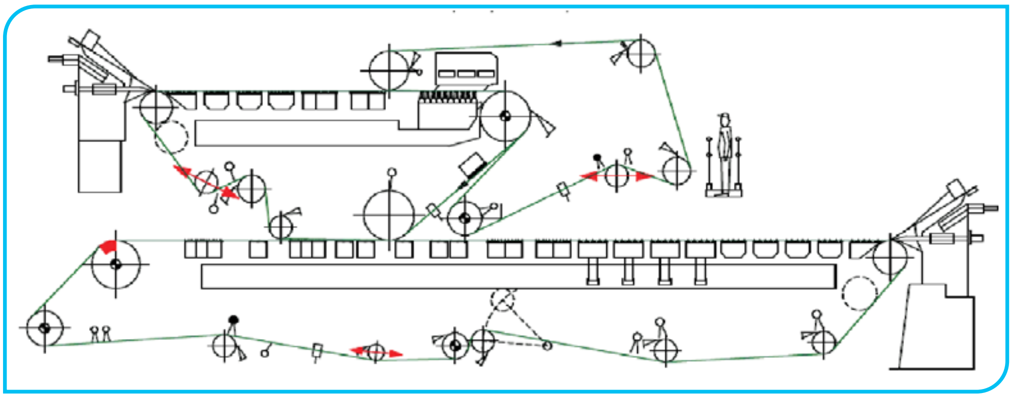


Fig.9 Twin-Fourdrinier: 600-1100 m/min, Fluting / Testliner (90-180 g/m$^2$)

# Reducing Power Consumption / Increasing Lifetime due to a New Material in Forming Fabrics

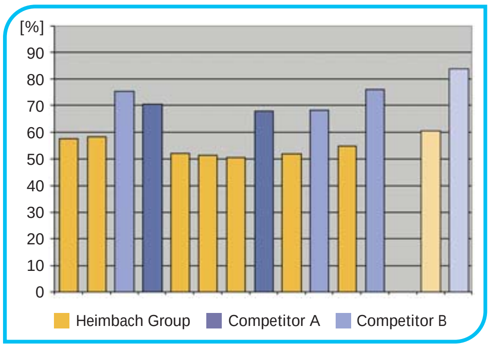



Fig.10 Average Drive Load for each forming fabric on the bottom position over a 2 year period. The last two data points are after a rebuild of the PM.

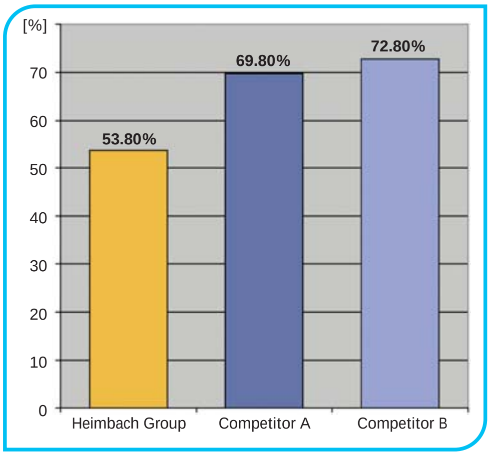



Fig.11 Average Drive Load by supplier over the same 2 year period

Comparative Calculation

*(based upon the data points in Fig.11)*

**Cost to drive the forming section with Polyester/Polyamide fabrics** (Competitor A):

• 1442 kW (max.capacity) x 69.80 % (drive load) = 1006.52 kW (drive load)

• 1006.52 kW x 24 hours x 350 days x 0.07 EUR/kWh = **591,830 EUR/year**

**Cost to drive the forming section with Duralon fabrics** (Heimbach):

• 1442 kW (max.capacity) x 53.80 % (drive load) = 775.80 kW (drive load)

• 775.80 kW x 24 hours x 350 days x 0.07 EUR/kWh = **456,170 EUR/year**

Based on the above calculations it is possible to save more than EURO 135,000 with Duralon fabrics solely by reducing the power consumption to drive the bottom fabric. Additionally, within the above mentioned two year period the fabric lifetimes have been noted.

Compared to the Polyester/Polyamide fabrics the lifetimes of the Duralon fabrics increased significantly (Fig.12 and 13), achieved mainly due to the better frictional properties of Duralon (Fig.4).

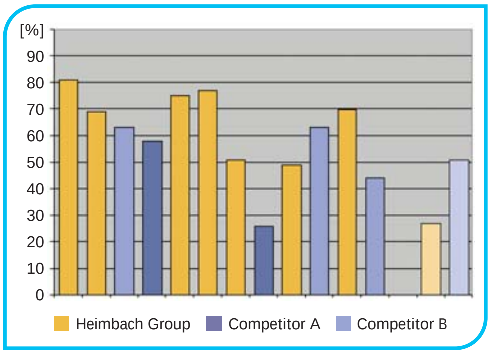



Fig.12 Fabric Lifetimes on the bottom position over the 2 year period

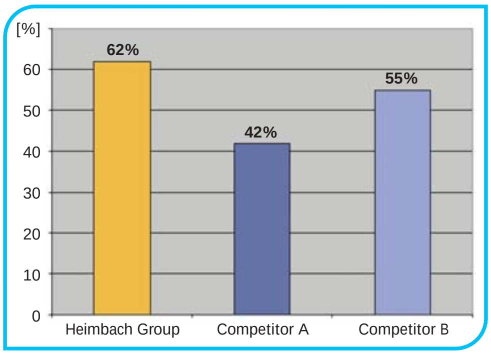



Fig.13 Average Lifetimes by supplier over the same 2 year period

Comparative Calculation

**Annual fabric consumption with Polyester/Polyamide fabrics** (Competitor A):

• 9 fabrics, each EUR 25,900 = **EUR 233,100**

**Annual fabric consumption with Duralon fabrics** (Heimbach):

• 6 fabrics, each EUR 25,900 = **EUR 155,400**

Based on the above calculations it is clearly demonstrated that with Duralon containing fabrics significant annual cost savings are possible: by reducing the power consumption of more than EUR 135,000 as well as by reducing the

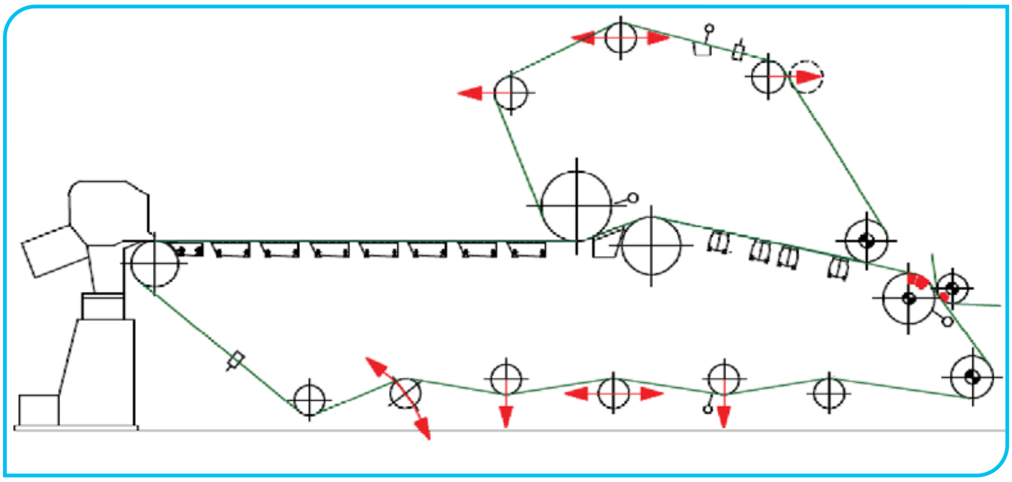


Fig.14 Hybrid Former: approx. 1000 m/min, Copier (68-100 g/m$^2$)

fabric consumption of more than EUR 77,000 – a total more than EUR 210,000. This does not take into consideration the increased production due to the reduction of PM stops to replace the bottom fabrics.

**Case Study 2**

The papermachine measured here has a hybrid former (Fig.14) and produces Copier at around 1000 m/min with a grammage range of 68-100 gsm. The standard competitive designs on the bottom position were 20 shaft SSB with alternating Polyester/Polyamide wefts on the machineside.

The design supplied by Heimbach was a 24 shaft PRIMOBOND.F SSB containing exclusively Duralon wefts on the machineside. The main objective of the customer was to improve dry content after the couch. The power consumption had not been an objective – until Heimbach presented the results of the Duralon trial.

The key objective to increase dryness was achieved with an average increase of 2-3 %. Clearly this is not due to the Duralon material but an effect of good application of the right forming fabric design. Figure 15 clearly demonstrates the

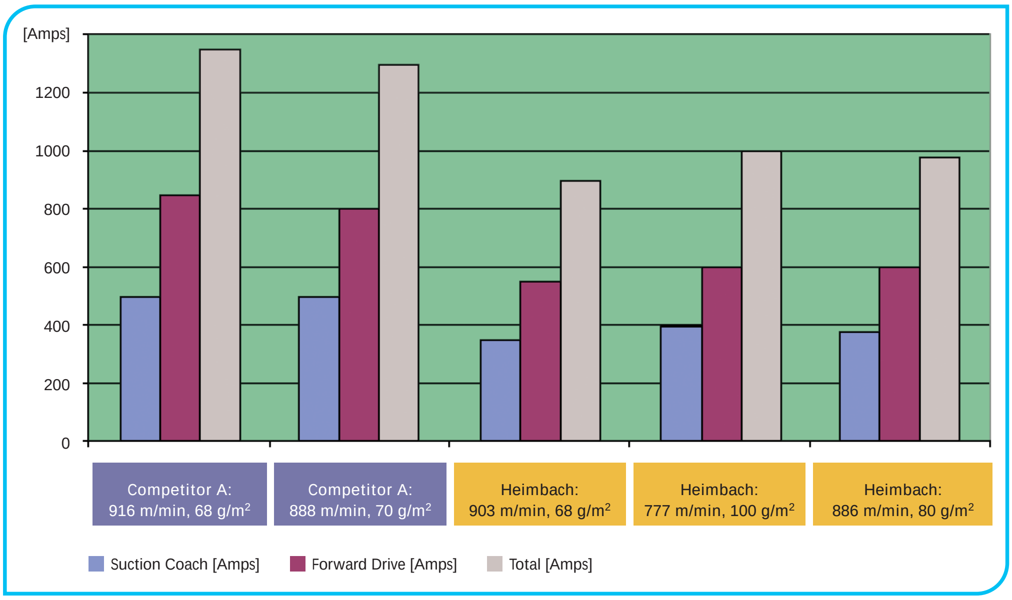



Fig.15 Comparison: Drive Amps of the bottom position

reduced drive amps needed by the bottom position running with Heimbach fabrics containing Duralon.

Comparative Calculation

**Cost to drive with Polyester/Polyamide fabrics** (Competition)

• 621 kW (drive load) x 24 hours x 340 days x 0.07 EUR/kWh = **354,715 EUR/year**

**Cost to drive with Duralon fabrics** (Heimbach)

• 414 kW (drive load) x 24 hours x 340 days x 0.07 EUR/kWh = **236,477 EUR/year**

The above calculations clearly demonstrates that by using PRIMOBOND.SF SSB fabrics containing Duralon it is possible to save more than EUR 118,000 by the significant reduction in power consumption.

**Summary**

The experimental material analysis has described the theory behind the successful practical experiences of Duralon, and has gone some way to explaining the mechanisms of high initial and overall power consumption in the forming section.
The two case studies are a reflection of numerous fabric installations rather than isolated instances and clearly demonstrates that it is possible to achieve substantial and quantifiable reductions in power consumption and associated costs through the utilization of this innovative material.

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