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NSC Nonwoven

Introduces IsoProDyn® and IsoProfile®, a major innovation to provide even physical properties to crosslaid nonwovens and cost reductions

If we were to look back over the past 20 years we would see that there have been many leaps of technological development bringing higher production rates and better weight uniformities in the needled fabrics, all contributing to reduced incremental manufacturing costs and better overall fabric performance relating to the enhanced weight uniformities in the finished fabric.

In fact, the overall focus in crosslapped nonwoven manufacturing has been more focused on cross width weight uniformity than speed, due in large part to an overall stabilization of doffing speeds within a window of 90-120 m/min. This general range of doffing speed is related to the capabilities of the crosslapper and the extended speed range required in crosslapping when using the advanced batt shaping technologies which require the crosslapper to have lay-down speeds which are dramatically higher than the doffer speed.

The state of the art in dynamic batt forming with technologies such as ProDyn®, WebMax and CV1 have brought the CD weight uniformity to CV values between 1-4%, depending on the technology employed, the finished weight, draft and needled parameters within the manufacturing line. As was the development of profiling technology, first introduced in 1991, the introduction of ProDyn® dynamic batt shaping in 1999 was a technological leap relative to using profile technology.

One of the additional developments in crosslapping has been in the control of the web as it enters the top carriage with Ouat!Sys®. This ability to control the web at higher input speeds has eliminated web control problems associated with the top carriage as it moves toward the card, thus enabling higher doffer/feed-in speeds.

The focus in technology has actually focused in other areas where increases in operating efficiency or reduction in maintenance cycles has been where many advances have taken place; all which help to reduce the manufacturing cost and hopefully enable the nonwoven manufacturer maintain a competitive advantage of the competition.
Thus, with these dynamic batt shaping technologies the overall focus has been in cost reduction, via fiber savings generated through better CD weight uniformities and optimization of operating efficiencies through better fiber management systems in web forming and overall fiber processing.

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The question is therefore what is next, what advancement can we expect which will create differentiation between nonwoven roll good manufacturers. How can a manufacturer create separation versus the competition when similar technologies and economies of scale are employed?

As presented above in looking over the general trends in technology over the past 20 years all the advancements eventually lead to making it faster, making it more uniform in weight (CD and MD) and making it at higher operational efficiencies which are all cost related and not performance related efficiencies.

The question is therefore why there isn't more focus in manufacturing a needlepunched nonwoven which combines the advancements in speed, weight uniformities and efficiencies while generating fabrics which also exhibit more uniform physical/tensile properties in the finished nonwoven felt?

The dynamic batt shaping technologies all work with methods to adjust the web weight prior to entry into the top carriage of the crosslapper and therefore we can assume that the batt will reflect the overall averaging of web alignment within the folds of the batt.

It would seem logical to believe that if one were able to generate uniform cross directional weight uniformity that we would also generate uniform physical performance values, but this is an incorrect assumption.

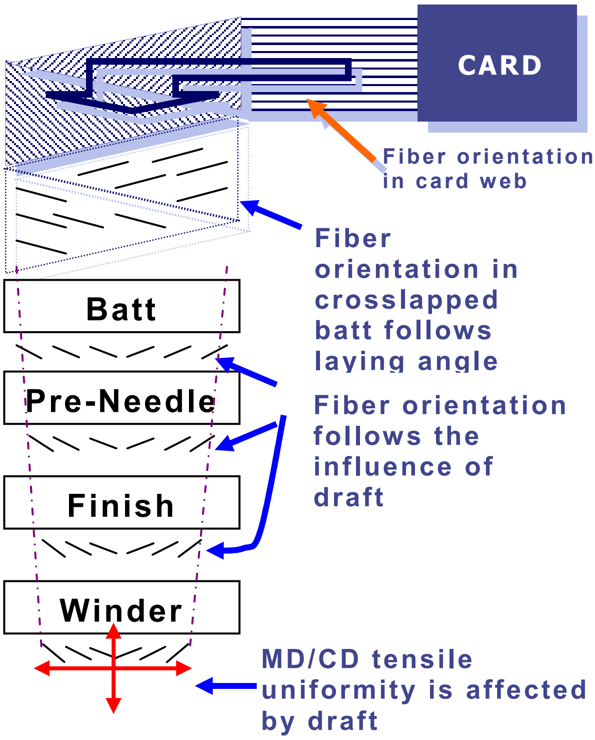
This assumption that weight uniformity equates to physical performance uniformity (tensile) is indeed incorrect as dynamic batt shaping is focused on generating web weights which pulse between a min/max weight range to effect the development of a batt weight profile to offset the effects draft has on fiber migration and the reduction in felt width generated from batt forming through bonding to the winder.

The modulation of web weight to meet the desired batt weight profile does not significantly change fiber orientation in the web to have any impact on the tensile uniformity of the needled felt.

The orientation of fibers in the web is largely controlled by the card although systems such as WebMax & CV1 draft the carded web (typically with one web condensed) to help create the required batt shape to counter the effects of draft whereas ProDyn® adjusts the web weight on the doffer (parallel and/or condensed), thus maintaining the fiber orientation of the doffed web

It would be reasonable to assume that in applications where higher MD performance is required to equate a balance in MD/CD, or is required to achieve higher tensile strengths that more draft would be applied in the consolidation and bonding process to pull the fibers toward the MD orientation. This of course will impact the batt width due to the tension differential between the fibers at the center of the batt and those who are closer to the edge of the batt.
The balance in fiber tension decreases with distance from the center and proximity to the edge of the batt, thus impacting not only the weight distribution of the batt due to this imbalance in fiber tension and fiber migration but also the consistency in fiber orientation in the batt. This variance in fiber

tension and migration as the width shrinks due to draft translates into inconsistency of physical properties as measured across the width of the finished needlepunch felt.



The graphic shown here demonstrates the fiber alignment and eventual migration as the batt is needlepunched and moves through the needlelooms to the winder. The fiber orientation changes are not uniform, with fiber alignment remaining relatively stable in the center and having considerable re-alignment at the sides by the time the felt arrives at the winder.

It should be realized that the dynamic technologies employed in batt shaping is all designed to negate the effects draft has on cross width weight uniformity. In essence, the crosslapped batt would have a weight distribution which is a mirror image of the finished felt without employing batt shaping technology, thus the batt would display a heavy center versus a lighter weight basis toward the sides of the batt.

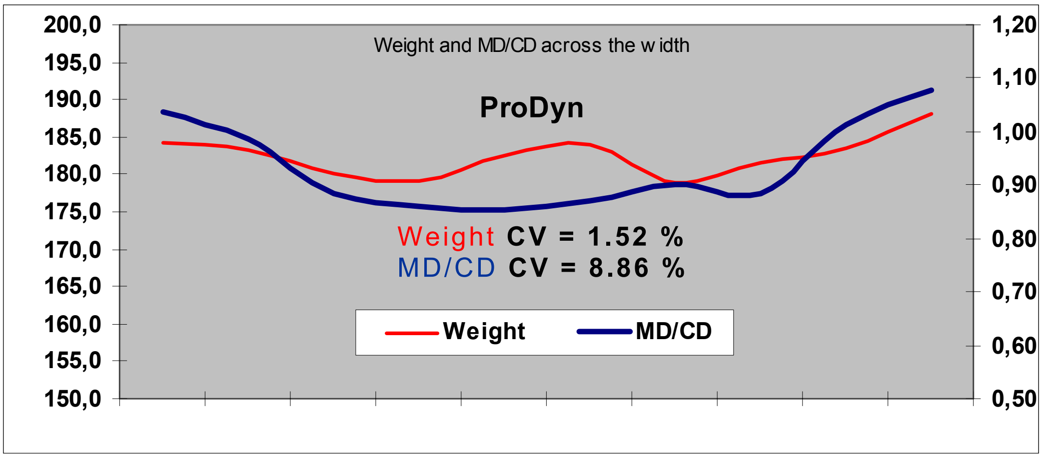
The ability to overcome the weight distribution deformities caused by draft has been a focus of technology development for many years and the dynamic web/batt shaping technologies available today has proven efficient in balancing the effects of draft with cross direction weight uniformities having low CV% values.

The question is: does this capability to generate cross width weight uniformity also translate to cross width uniformity in physical characteristics? No.

To illustrate this point the chart below shows the CV% values and curves of cross direction weight uniformity and CV% of the physical characteristics uniformity (tensile) as measured in MD/CD ratio.

As the curves show, the cross width characteristics in weight has been addressed but the physical profile has not benefited from the improvement in weight uniformity.

The logic therefore of weight uniformity equating to performance uniformity is not realized as the ability to generate a batt profile in crosslapping answers only to weight distribution but not fiber alignment; demonstrated in the analysis of cross width characteristics demonstrated for geotextile application in the table below in which the CD weight profile has a CV% of 1.52% whereas the CV% of the physical performance is 8.86%.



Thus it is clear that the ability to correct weight uniformity does not translate to the same capabilities in the tensile uniformity in the fabric.

It is interesting to note that in other nonwoven technologies and the markets they serve that weight uniformity and physical performance uniformity are equally important criteria to meet the expectations of the end customer.

The chart below is indicative of a spunlace fabric which must meet criteria for physical uniformity in the cross direction which is logical due to the nature of the fabric as it is generated by multiple cards (typically) in-line, thus the CD weight uniformity and physical characteristics are relevant indicators to the behavior of the fabric in its application in the field.

55 gsm US supplier	Lane A	Lane B	Lane C	Lane D	Lane E	AVG
Weight	57,3	54,7	56	54,7	56	**55,74**
MD Tensile	109,41	109,79	107,35	104,93	100,16	**106,33**
MD elongation %	43,8	45,3	45	43,5	42,3	**43,98**
CD Tensile	19,38	21,86	21,61	23,17	19,34	**21,07**
CD elongation %	137,2	134,9	141	145,6	145,8	**140,90**
Thickness	0,73	0,7	0,73	0,68	0,69	**0,71**
Bonding ratio	2,25	2,41	2,30	2,34	2,13	**2,29**
MD/CD tensile ratio	5,65	5,02	4,97	4,53	5,18	**5,07**
MD/CD elongation ratio	3,13	2,98	3,13	3,45	3,45	**3,23**

In heavier weight spunlace applications where crosslapping is employed, the same dynamics as seen in needlepunching occurs, with draft impacting cross directional tensile uniformity.

The difference between light weight spunlace manufacturing and heavier weight spunlace manufacturing is light basis weight spunlace lines are machine direction lines with the cards feeding the bonding process, thus MD becomes the dominant strength. In lines with crosslapping, the dominant strength in the web (MD) is placed in the cross direction, thus creating a batt which is based on the weaker and therefore less stable as the batt proceeds to the following bonding processes.

In heavier weight spunlace lines it is common to have batt drafting machines to try to increase line speeds as well as to re-orientate fibers into the machine direction and generate a balance between MD and CD in the finished felt. Thus the need to batt shape and tensile shape uniformity into the crosslapped batt is needed in any application where crosslapping is used due to the imbalance in the physical values in the carded web between the MD and CD orientation.

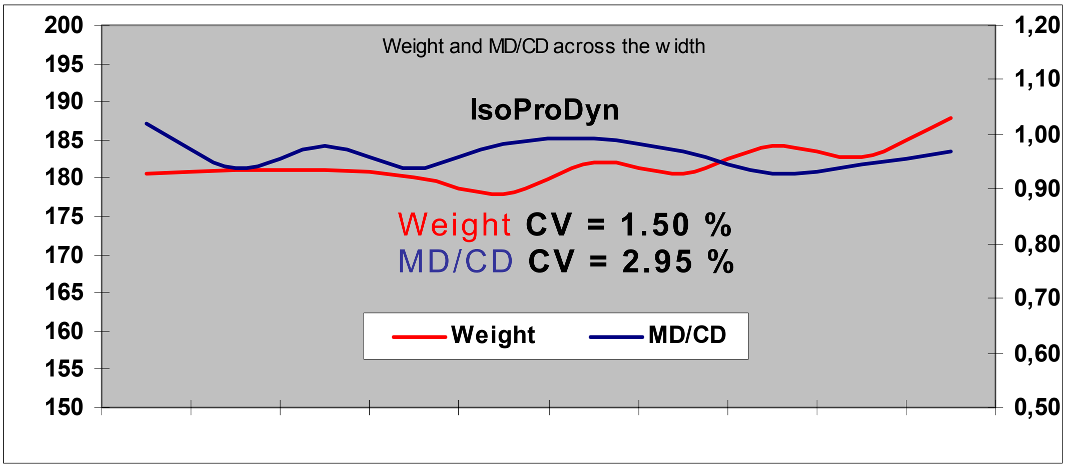
The singular focus on weight uniformity without addressing tensile uniformity is interesting when considering the nonwoven felt should meet a performance criteria relative to it’s end application. Today the qualifying parameter of tensile performance is based on the average tensile and/or minimum tensile value in the felt.

It seems illogical to average the physical values (tensile/elongation) of the needlepunch fabric when there can be such a disparity of performance values across the width of the needlepunched felt.

This averaging of cross width physical properties can be the result of the lack of technology which could otherwise generate a better uniformity of physical properties which up to today has not been available.

In essence, what most manufacturers do is manufacture heavier felts to ensure the average values required are met, thus increasing their manufacturing cost. It is interesting to note that before batt shaping technology was introduced, the same phenomena of over producing felt weights to ensure meeting the minimum weight standards today applies to meeting tensile performance standards. Therefore many felts are made heavier to ensure the minimum tensile performance values are met.

The development of IsoProDyn® technology addresses this problem of physical performance uniformity. IsoProDyn® addresses the issue of cross width tensile uniformity which offers two advantages to the roll goods supplier; felts which have optimized weight uniformity and tensile uniformity.



As demonstrated in the chart above using IsoProDyn® technology we can see the dramatic improvement in cross width tensile uniformity where the MD/CD tensile CV% is 2.95% versus 8.86% when only employing ProDyn® technology. The addition of Isodynamics to ProDyn® does not impact the ability to optimize batt shaping as demonstrated in the comparison of weight CV% between the ProDyn® and IsoProDyn® charts, with essentially equal CV% values of 1.52% and 1.50%.

It is this enhancement of tensile performance uniformity which offers advantages to the roll goods manufacturer as performance quality is dramatically improved. The ability to produce felts with dramatically more uniform tensile values not only creates separation from other roll goods competitors in the marketplace, but it also provides an opportunity to lower basis weights in manufacturing while still meeting the required physical specifications in tensile performance and basis weight.

In this way, just as with the advantages Profile and the advancements with dynamic batt shaping brought in reducing manufacturing costs through fiber savings made through the lowering of the target basis weight while still ensuring customer minimum weight specifications, IsoProDyn® brings similar cost savings to the roll goods manufacturer with enhanced CD weight profile and lower basis weight felts which meet the required minimum performance specifications.

The development of IsoProDyn® has been installed onto an industrial needlepunch line in Europe at BONAR T.F. commissioned 8 months ago manufacturing Geotextile nonwoven felts and another installation in North America has just been commissioned with this same technology at THRACE LINQ, thus offering further data upon which to analyze technology and the advantages brought through their implementation into the demanding performance driven Geotextile industry.

The Geotextile felt in the table below was manufactured with a draft coefficient of 300+% and a shrinkage in width of 20%, thus the ability to both improve CD weight uniformity at a low basis weight with high draft becomes a challenge due to both the high draft values but also the length of the Geotextile manufacturing line which includes multiple needle looms, batt drafters, Tenter frames with thermal fixation and the winder. The length of the line enables greater time for the fibers within the felt to migrate under tension created by draft.

120 gsm Geotextile felt 4.18 meter finished width									
MD/CD Samples technology	**Right 1**	**R-C 2**	**Center 3**	**C-L 4**	**Left 5**	**Average**	**MD/CD CV%**	**range**	**gsm CV%**
Traditional	1.24	0.90	0.79	0.87	1.14	0.99	**19.08**	0.44	**4.36%**
IsoProDyn ®	0.86	0.87	0.97	0.91	0.87	0.90	**4.97**	0.11	**1.79%**

An example of meeting minimum specifications is seen in the above table which displays the changes to the finished Geotextile in the cross directional improvements in physical performance and weight uniformity with the MD/CD CV% improving by a factor of 4 with a drastic improvement in the CD weight CV values.

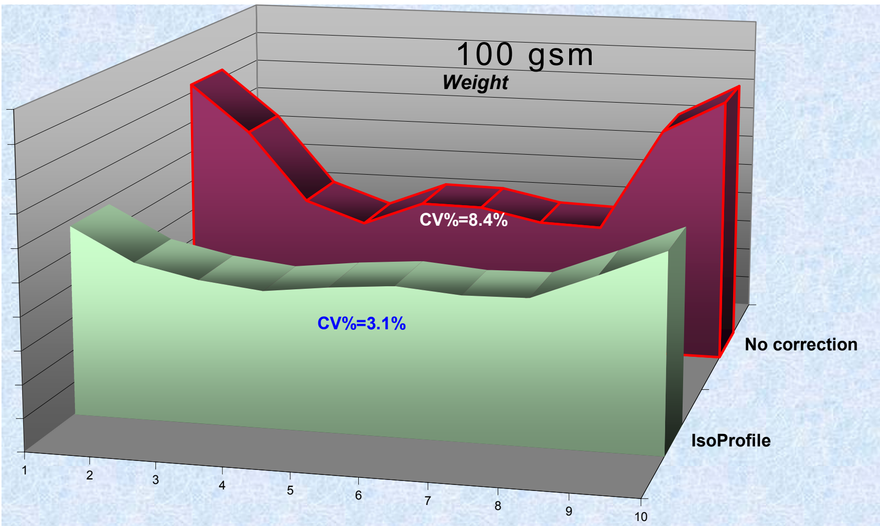
The use of Isodynamics is not limited to use with ProDyn® technology where its main function is to address fiber orientation and CV% tensile uniformity in the finished felt whereas ProDyn® technology addresses cross directional weight uniformities. The use of Profile technology can also benefit from Isodynamics where this technology optimizes the batt shaping capabilities with enhanced cross direction weight uniformities as compared when only profiling technology is used.

This marriage of profile technology with Isodynamics essentially combines the Isodynamic technology to first generation batt shaping profile technology to improve the cross directional weight uniformity.

The following analysis of applying Isodynamics technology with Profile technology establishes that Isodynamics brings similar improvements relative to weight and performance uniformity as seen with IsoProDyn®, plus significative enhancements to the weight evenness profiling capabilities in CD thus enabling older lines without ProDyn® capability to also improve their needlepunch uniformities through the use of IsoProfile® technology.

The trials followed a similar concept of high draft with light basis weight relative to what would be found on Geotextile line which causes high shrinkage in width and fiber migration, thus the example below of a 100 gsm finished weight having a 2.7 meter batt width and a finished trimmed width of 2.0 meters.

100 gsm needled felt
2700 mm batt width
2000 mm finished width



The dramatic reduction in CV% when using IsoProfile® from 8.4% to 3.1% demonstrates the compatibility of adding Isodynamics to standard Profile crosslappers as the technologies are compatible, thus the application of one technology does not interfere with the other but rather, they have a positive knock-on effect when used together.

Another example of Isodynamics when combined with existing batt shaping technologies of Profile and ProDyn® will enable a comparison of applying different technologies together and seeing what advantages and influences they have on the manufacturing process.

The example below of a 175 gsm needled felt was made with a high draft multiplier to amplify the influence of draft on fiber migration using the needlepunch line in three operating modes:

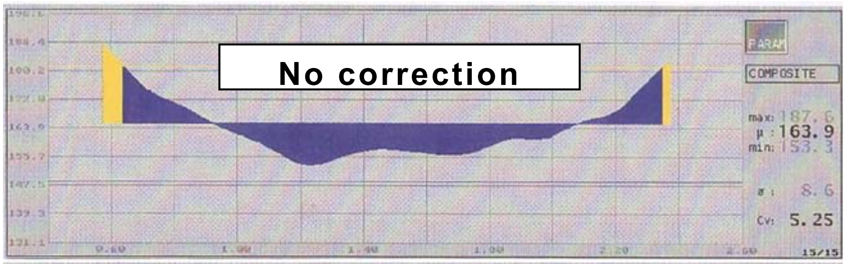
a) using crosslapping without any Profiling technology,
b) using IsoProfile® technology
c) using IsoProDyn® technology.

In order to maintain consistency in these examples, the same draft values were used in this trial as per the previous example. The draft values were rather excessive but also reflect conditions similar to industrial line conditions for markets such as Geotextiles where a high draft multiplier is used to improve the MD physical properties and improve the balance between MD & CD performance values. Another benefit is through high draft the production levels are optimized as measured in winding speeds (and kg/hr capacity).

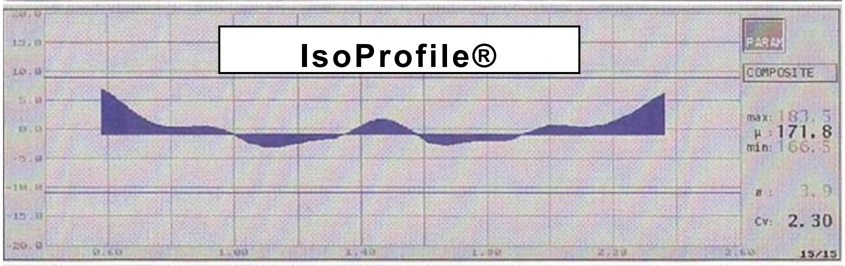
This draft will therefore impact not just the distribution of cross direction weight but also the orientation of fiber and therefore the uniformity of physical properties.

The examples shown below provide sufficient evidence for the need to use technology to improve the quality of the needled felt as seen in the top example, where neither Profiling batt shaping nor Iso technology was employed, thus showing a wide min-max range of weight variation in the classic “smile” weight profile.

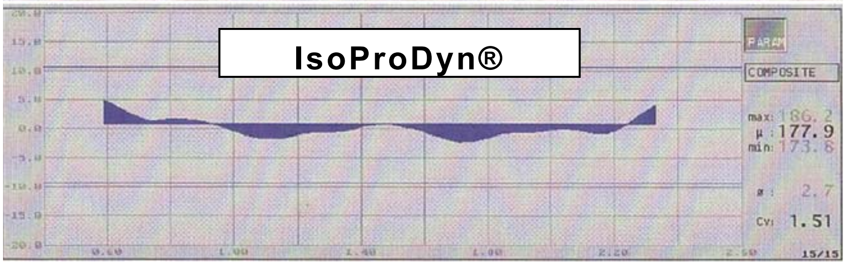
175 gsm needled felt
2700 mm batt width
2000 mm finished width



No correction
Range: 34.0 gsm
CV%: 5.25



IsoProfile®
Range: 17.0 gsm
CV%: 2.30



IsoProDyn®
Range: 12.0 gsm
CV%: 1.51

The analysis of the CD weight distribution curve when using IsoProfile® technology shows a large improvement in weight uniformity with a 50% reduction in weigh range (min/max) as well as improving the CV% to 2.30% from 5.25%.

The last analysis with IsoProDyn® technology further improves the min/max range in measured weight and further flattens the weight distribution curve, especially at the sides of the needled felt with the improvement in CV% to 1.51% from 2.3% when just using IsoProfile® technology alone.

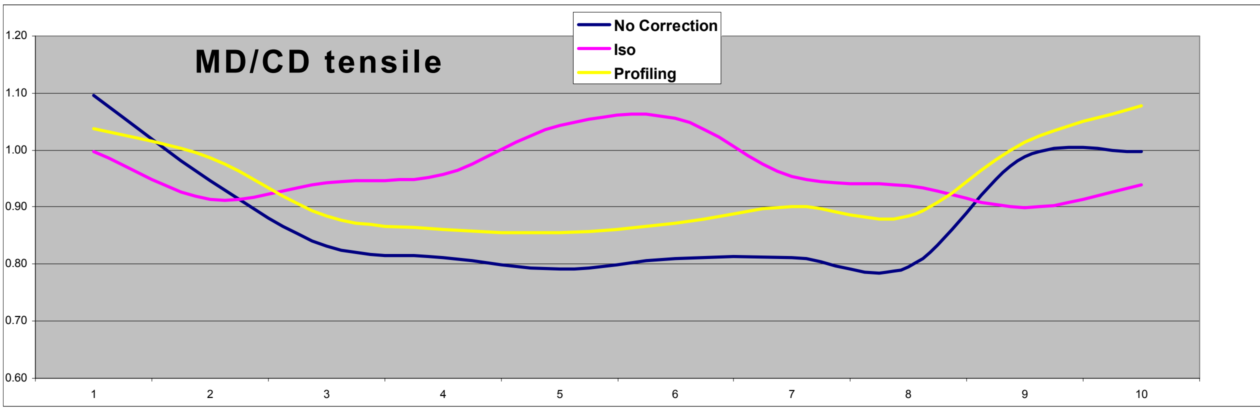
The findings shown in the analysis of weight uniformity is logical as we would expect when using applying different levels of technology to obtain higher levels of weight uniformity.

The following analysis on tensile uniformity on the same felts offers an opportunity to see what impact the use of these technologies have on the physical uniformity of the felt. The analysis of both weight uniformity and tensile uniformity offers a broader perspective of the impact these technologies have on the qualities within the finished nonwoven fabric.

The chart below is an analysis of the MD/CD tensile values as measured in the cross direction, with the CV% values for both MD/CD tensile and weight uniformity displayed in the table below the chart.

As seen visually in the colored graphics, the MD/CD tensile curves of the felts without correction and IsoProfile® share similar general tendencies with the sides displaying the disparity in fiber migration due to draft with higher values on the sides as compared with the measured values in the center of the felt. The difference between no correction and IsoProfile® was a flattening of the tensile uniformity curve improving the MD/CD CV% from 12.3% to 8.9%.

The use of IsoProfile® addressed both the need to further improve CD weight uniformity and improved MD/CD performance uniformity as confirmed in the analysis in weight uniformity in the charts above and the improvement in MD/CD tensile uniformity as per the chart and associated table below.



Technology employed	Weight CV%	MD/CD CV%
No correction	**5.25%**	**12.3%**
IsoProfile®	**2.3%**	**8.9%**
IsoProDyn®	**1.51%**	**5.4%**

The examples presented herein with either the marriage of Isodynamics to Profile technology or ProDyn® technology illustrate the advantages these combinations of technology offers the roll goods supplier to improve not only the weight uniformity of the needlepunch fabric but also the physical uniformity of the fabrics manufactured with these technologies.

The question we may ask is in which markets or applications within any given market will the employment of IsoProfile® and IsoProDyn® technologies offer

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advantages to the roll goods supplier versus fabrics generated using existing technologies?

As one might expect, Geotextile applications would benefit from the use of these technologies as evidenced in the many examples presented within this paper as well as the fact that the first two industrial installations using IsoProDyn® have been with Geotextile manufacturers.

Another application may be seen in the Automotive industry where enhanced MD/CD uniformities would translate to better performance in applications such as molded felts where uniformity in physical properties translate to consistency in draw as the nonwoven is deformed into the required shape in the molding process.

The use of Isodynamics on both Profile technology and with ProDyn® technology extends the range and capability of the crosslapper and the dynamics of batt shaping with the added value of being able to correct MD/CD tensile uniformity across the width of the finished felt. The ability of Isodynamics to influence the felt quality is in large part dependent upon the crosslapper technology (Profile or ProDyn®) as well as the parameters within the product specifications which in turn dictate most of the operating conditions within the nonwoven process, such as draft, the distribution of draft within the process, needle density, needle type, fibers and finished weight. Thus the examples presented here reflect neither the minimum nor maximum impact of employing IsoProfile® or IsoProDyn®.

It may be presumptuous to know every market or application where the value of generating a needlepunch felt with a dramatically more balanced physical performance profile as measured in MD/CD tensile balance along with improved weight uniformity may provide a competitive advantage versus your competitors, but we would imagine that in today's economy that these advantages may be the key to survival in these turbulent times.

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