PREDICTING LINT PROPENSITY OF PAPER
AT THE MILL: A TEST THAT WORKS

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ABSTRACT
Linting results from the removal of particles and fibers from the surface of the paper during printing. The phenomenon occurs mostly in offset lithography but not exclusively. A new test has been developed to characterize the linting propensity of paper. Among other things, it allows measurements at the mill to assess the linting propensity in real time. The validation process is described: correlation with existing tests, the effect of ambient conditions, repeatability and reproducibility, and variability. The method makes it possible to conduct tests at the mill and enable actions to be taken during fabrication to correct the linting tendency of the paper. The test can also be conducted in a pressroom.

INTRODUCTION
The measurement of the linting tendency of a paper that was responsible for a lint episode in a pressroom is necessary when one is trying to identify the cause, but in most cases all it does, is confirm what the printer already knew. The exercise is tedious, time consuming and usually very costly in order to be reliable. Monitoring lint before shipping to the printer is an equally hard task and mills use various methods to estimate the linting propensity of their paper: MB lint tester, Prüfbau pick resistance, IGT pick, Fibro 1000, black cloth and Apollo press are among the tests most used.

A new lint propensity test has been designed to allow papermakers to test the linting potential of their paper at the mill, on samples taken off the reels or the paper rolls. The test is simple, quick and therefore offers the capability of monitoring linting propensity almost in real time. One obvious benefit is that the paper manufacturer will not have to wait until he gets a report from the printer to learn about lint issues which, in some cases, may amount to months following shipping from the mill. Not only is the test simple but it is portable, therefore offering the possibility to take it to a site where lint problems are underway or anticipated, and to test paper rolls on the spot. One could anticipate being able to identify problem rolls and remove them from the production line in a pressroom.

The simplicity and the frequency of sampling also provide a means to test various scenarios to reduce linting during fabrication of the paper: chemical additives, process changes, furnish selection and fiber supply to name a few, such that results are obtained as the trial is taking place and no long delays are needed to perform the sample analyses at a remote location.

Knowing the linting propensity of the paper will allow the papermaker to manage the issue by selecting production batches that should be kept from going to lint sensitive accounts or to simply point to corrective action during fabrication once a data base is established and the process modifications confirmed.

LintView has been introduced to the pulp and paper industry over a year ago and has undergone severe testing in several newsprint mills and some added-value grade mills as well. Correlations with the better known lint propensity tests have been established, repeatability has been confirmed on numerous occasions, and some users are using the LintView lint propensity index to support process changes with regards to customers’ needs.

In this study, we review the highlights of the various development phases of LintView and discuss the potential for the printed communications industry.

BACKGROUND - EXISTING TEST METHODS
To review the work that has been done with regards to linting of paper in pressrooms and particularly with the offset lithography process falls outside the scope of this report. The published literature is relatively abundant on the subject and there are a few comprehensive reviews that have exhaustive lists of references: reviews by Mangin [1] and Aspler [2] published respectively in 1991 and 2003, and a special ifra report on materials by Hoc in 2000 [3].

Instead, we propose a short review of the methods used in the industry to measure and if possible, predict the linting propensity of paper. But before, we take one more look at what lint is often made of once collected with clear tape off a contaminated blanket in an offset press. Figures 1 and 2 show two such “tape pulls”: the first represents contamination during printing of a directory paper whereby ray cells constituted almost exclusively the contaminant. The second shows what the authors like to refer to as a more classic lint episode where different types of debris have collected on the blanket during printing of a supercalendered grade: fiber fragments, ray cells, vessel elements, chopped compression wood fibers and likely inorganic material. Such debris are often found in both linting and piling occurrences.
There have been several tests proposed to monitor the linting propensity of paper directly at the paper mill. They range from the straightforward evaluation of the amount of white dust collected on the surface of the paper by various means, to laboratory-size presses that require trim rolls, dedicated spaces and operators, and controlled consumables. Among them, the simple ones are too often unreliable, while the more complex ones are not user-friendly and end up being rather costly.

The various tests that are most often found in paper mills are listed below with a brief description and comments:

The Emerson Dusting/Surface Contamination gauge has had some degree of success but the fact remains that it is operator dependent during sampling; its greatest advantage is its simplicity.

The IGT pick test is a test that gives interesting correlations but is time consuming and relies on an operator preparing the samples and grading the results. Because of the aggressive nature of the picking phase of the test, it is recognized by many in the industry as being more useful for predicting sheet delaminating properties rather than linting. IGT is also marketing a Fluff test reported to measure "loose and weakly bound paper particles", but the authors are unaware if it is used in paper mills.

The MB Lint Tester does one side and always at the same position although some operations have modified it to test the two sides of the sheet. The method has not been adopted universally because it still does not always predict lint but some manufacturers that have been using it for several years have certainly found a correlation that justifies its continued use.

The Fibro instrument (FRT 1000) is reported to "enable evaluation of a paper's surface properties in minutes, without printing. It measures fiber rising, fiber roughness, number of lifted fibers and fiber length involved in linting, gloss reduction (roughening) or tissue softness". It was designed more for testing the phenomenon of fiber rising and the technique, although it has reported some success, may not quite simulate the stresses incurred by the paper in a printing press. Some papermakers believe that a stiff mechanical TMP fiber will react very differently to the test than a conformable chemical fiber.

The Prüfbau pick resistance test is akin to the IGT pick test whereby a laboratory press is used to simulate commercial offset printing. The operating conditions are set to collect particles from the surface of the printed substrate; the test gives interesting correlations but is time consuming and relies on an operator preparing the samples, running the press and grading the results.

The Apollo press is a laboratory press and requires that rolls of paper be trimmed on the paper machine for that specific use. It is designed to simulate the offset printing operation and therefore the equipment requires due maintenance and the inks must meet designed specifications. With regards to lint, the press is run for a predetermined number of copies after which, the material collected on the blanket is removed with clear tape. The lint collected by the tape pulls is then analyzed visually. Obviously this technique is laborious and not well suited in a production environment.

Twinturbo has reported great success at removing surface particles on paper during printing and claimed that runs of million of copies for newspapers have been obtained without blanket wash-ups. However, this equipment can only clean and correct for papers once the paper rolls are on the printing presses but is of little use to the papermaker who is trying to control the linting propensity of his paper at the mill, during the manufacturing process.

Dennison wax pick test is reported as follows: "Waxes are heated and applied to the surface of the sheet. Once cooled, they are pulled from the surface and the wax is checked to see if it has pulled fiber or coating from the
surface. The highest value wax, which does not rupture the surface, is reported as the pick strength of the sheet." The authors have not seen this test applied by papermakers on a regular basis.

One very good test is the Domtar lint test but because it measures “printed lint”, it is not well suited to predict lint. However, it is useful to quantify debris accumulation on blankets in the pressroom or confirm lint which several other laboratory tests do.

Descriptions and/or information regarding the different tests presented above can be found on the Internet through various search engines.

One of the more interesting observations about the performance of several lint tests was stated in a paper by Lindem and Moller [4] where it is acknowledged that none of the lint methods evaluated correlated well with blanket lint deposit quantities. In this study, the methods used were: NSI Lint Measurement, GFL Lint Number, Elphic Lint Number, Kujava Lint Number, IGT Pick Test, Prüßbau Wet Pick, Fiber Rising, Fiber Roughness and the VTT Lint Number. A short description is given in the paper for each method with its origin and/or reference.

Numerous other methods are more elaborate and rigorous, and deliver better results but are more appropriate for research studies because they are time consuming and require sophisticated equipment and/or manipulation. In most cases they rarely meet the requirements of a manufacturing plant looking for a simple, fast, user friendly test that can be reproduced without great effort or sophisticated conditioning of the paper samples as well as performed in an environment that does not require extreme control over the ambient testing conditions.

TEST METHOD

The test requires a vision system hooked to a computer loaded with the appropriate image analysis software. The test samples are prepared from sheets of paper, low-tack tape, a metal roller of prescribed dimensions and weight, and a specifically designed carpet. As little as four samples for each side of a sheet of paper are required to measure the linting propensity of the paper. A useful method has been elaborated and comes with the test. The method describes all the steps needed to complete the test in a matter of minutes for four samples at a time.

Of particular interest is the technique developed to collect the lint samples. A Technical Note has been prepared concurrently with this report that describes the methodology for sample preparation. It is akin to methods used to delaminate paper except that the low-tack tape removes exclusively material that is poorly bonded to the surface of the paper. The orientation of the pull relative to paper was chosen to be that which is parallel to the direction of travel of the paper on the machine: the machine-direction (MD), while the direction of the pull is against the paper-making direction and has been termed the anti-MD direction; therefore, it is important to clearly identify this direction when collecting and testing samples.

The surface onto which the test is performed has been standardized and throughout the development work, repeatability of the results was a major concern. Now the carpet has a composite layer-structure where the top layer is made from a piece of offset blanket for which tolerances have been evaluated and guarantees obtained from the supplier with regards to the stability and reproducibility of the physical properties of the material.

TEST VALIDATION

A test originally designed by one of the authors was in use at the University of Quebec in Trois-Rivières (UQTR) which was reporting some degree of success at quantifying linting tendency of paper on samples submitted by various sources.

A more elaborate version of this test was later developed and made portable. The test was first recognized to correlate with “printed lint” from a study of an SC sheet that had been tested for linting on the Institute of Graphic Communications’ pilot offset press where the “printed lint” had been measured with the Domtar Lint Collector test. Samples of virgin paper collected on the original rolls were subjected to the lint propensity test and after adjusting various parameters, the correlation that was obtained is shown in Figure 3.

Here, the data for the top side of the paper yielded a coefficient of determination (R²) of about 0.71, a number deemed high enough to pursue the work with other grades of paper. The coefficient of determination for the bottom side was around 0.72.
A series of 25 newsprint samples from the same paper machine were submitted for analysis. These papers were produced in February, April and May 2004; the paper produced in May came from a trial with chemical additives to curb linting. The additives were starch and wax but there was no specific information regarding the anti-linting products. The samples of paper were tested for linting propensity with a Prüfbau laboratory press and a MB on-line lint tester at the mill; the former was carried on both sides of the paper while the later was done on the top side of the sheet only. To avoid introducing unfavorable conditions during the testing with the new method, the same person tested all samples in one location under known atmospheric conditions.

The results for the LintView and the Prüfbau tests are shown in Figure 4. The correlation is quite impressive between the two methods except for the last few points representing high level of linting propensity. This is due to the Prüfbau test, which only recognizes discrete levels of linting from 1 to 4; beyond this level the paper is considered to have a very high propensity for linting and does not require further gradation. The listed values in between those levels (e.g. 1.5 to 3.5) indicate the uncertainty for the operator to distinguish between levels and therefore a compromise is to record a value midway between two levels. On the other hand, the LintView results show a gradation within the full range of the Prüfbau test. The capability of the LintView test to extend beyond level 4 of the Prüfbau test may provide more information about the papermaking process to allow the mill to identify the causes for high linting propensity of the paper.

The coefficient of determination was $R^2 = 0.74$; when the last three points were omitted, it increased to $R^2 = 0.85$. For this correlation, both the top side and bottom side values of the paper were utilized, however, the linting propensity was lower for the top side of all samples tested.

Although the LintView data show more sensitivity to the variations between samples, the coefficient of determination was $R^2 = 0.84$. The LintView data points represent an average of four measurements taken on random sheets from the samples supplied. The variation within each set of measurements was monitored to ascertain that no value lay outside a statistically acceptable range. A formal study on the variability of the test is reported in the following section.

More recently, we had the opportunity to compare LintView with the IGT pick test in use in a paper mill. The comparison was done using the data for both sides of a newsprint sheet and the correlation is shown in Figure 6. The coefficient of determination was $R^2 = 0.80$, a number quite similar to what had been obtained with other tests during the development of LintView. We were aware that values around IGT 3.5 were missing, but our experience with many grades of paper as well as different sources of the same grade, had taught us that the interpolation here was legitimate and that the correlation between LintView and IGT pick was valid.

The correlation between LintView and MB lint test is shown in Figure 5. For this analysis, only the LintView data for the top side of the sheet were retained to match the data for the MB lint test collected on-line on the paper machine top side.

![Figure 4. Correlation between LintView and Prüfbau lint propensity test.](image1)

![Figure 5. Correlation between LintView and MB lint test.](image2)

![Figure 6. Correlation between LintView and IGT pick test.](image3)
detecting the finest particles, even those that the eye cannot see, will probably show higher variability than IGT pick, which is based on a subjective visual evaluation of the onset of sheet delamination. Images of the debris collected with either method are compared in a subsequent section.

**VARIABILITY ANALYSIS**

**Frequency of sampling – number of measurements**

One important feature for a test to gain acceptance in a production environment, is that it should be quick and not require long manipulation or excessive replications to validate minimum statistical requirements. With LintView, once the samples are available, it only takes 2-4 minutes to obtain a lint propensity number; however, it was important to determine the number of individual pulls to characterize a sample. It had been observed that the coefficient of variation (cv) was consistently around 12% after several hundred tests, although a few papers seemed so uniform that a variation as low as 4% was confirmed on a number of occasions.

A specific study was carried to determine the number of replications required to yield adequate results. Samples from four papers were selected at unique cross-direction positions and not consecutive in the machine-direction (several plies within a reel). Four pulls were taken on 5 different samples of each paper, the lint indices were measured and the averages of the four measurements were recorded for each set. The index varied quite significantly between papers and the results are summarized in Table I for three North American papers and one European paper.

<table>
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<th>Papers</th>
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<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
<th>Total</th>
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<td>%</td>
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<td>5.84</td>
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<td>13</td>
</tr>
<tr>
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<td>3</td>
<td>1.29</td>
<td>15</td>
</tr>
<tr>
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<td>7</td>
<td>11.10</td>
<td>6</td>
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<td>11</td>
</tr>
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<td>EU 1</td>
<td>0.67</td>
<td>6</td>
<td>0.67</td>
<td>4</td>
<td>0.66</td>
<td>8</td>
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</table>

Table I. Variability analysis of four newsprints.

The results indicate some level of variation within samples but after 20 tests, the coefficient of variation is at 12% or below, in line with the observations mentioned earlier. We will develop a better understanding of the significance of such variations as users build their own database, but it must be remembered that this test is used to measure a propensity to linting and that no exact index number has yet been determined that will draw the line between a paper that will lint and one that will not. This number will likely vary for each paper machine and may in fact vary for different pressrooms.

In analyzing these results, one will notice that a high value for the coefficient of variation may suggest that extra tests be performed, but in the case of sample #4 for the paper NA 3, it would be futile to do extra tests because at a lint index of “9” it is clear that this paper will lint; concomitantly, a paper with a very low index (EU 1) need not be tested unduly because it will not lint on printing presses. It is the border line grades that could require more extensive testing. In all however, we feel that 4-6 tape pulls will be sufficient in a majority of cases to determine the linting propensity of a sheet of paper and that can be performed in one scan only. This is a major contributor to the quickness of the test.

On the technical side, such variations between papers are perhaps indicative that lint varies according to some other paper property. It would be interesting to verify if such variations are detectable in some of the intrinsic properties of paper (e.g. formation, basis weight, caliper, roughness), or other physical properties. Because these tests were taken at different positions in the MD direction, it is conceivable that if such correlations existed, then the test could be useful to investigate temporal variations or instabilities in the papermaking process.

**Repeatability – Reproducibility**

In order for a test to be adopted by industry, it is imperative that repeatability be confirmed over many tests and Table I is a small demonstration of the hundreds of tests that were conducted during the development of LintView. Reproducibility on the other hand, is significantly more difficult to monitor on a regular basis when a new product is introduced. However, it has been verified on a number of occasions and we report a recent demonstration of reproducibility for a newsprint and a supercalendered paper whereby both users wanted confirmation of their readings.

Figure 7 shows seven series of measurements taken at the mill and in the laboratory at LintView. The measurements for the SC paper were those of different batches and the user wanted to confirm the improvement from an index of close to 4 down to less than 1: the improvement was legitimate. The newsprint indices were obtained from measurements of different positions along the CD profile and measurements were made on both the top (T) and bottom (B) sides of the sheet. The reproducibility was judged excellent with the widest spread between laboratory and mill measurements being a little over 7% and no particular care given to the samples during transit apart from being kept in opaque plastic containers.
AMBIENT CONDITIONS

It was necessary to verify the sensitivity of the test to the ambient atmospheric conditions especially since one of the objectives was to develop a test that would be reliable in a mill or pressroom environment outside the optimal conditions of a control laboratory. Of course such an environment will always be preferred because it offers better guarantees for repeatability and certainly for reproducibility.

Unlike lint tests where inks or resin/oil mixtures are used in conjunction with a print machine to remove fiber debris from the paper surface whereby the fluids are sensitive to temperature through the viscosity-temperature relation [5], it was soon established that temperature had no discernable effect on the repeatability of the results. The results are shown in Figure 8 for a paper with a low LintView index. Although the range tested was somewhat narrow, it was still considered representative of a mill environment. The relative humidity was kept constant throughout the test.

The bigger challenge was to quantify the effect of relative humidity on the test, given that it affects the physical testing of paper [6,7,8]. A series of twelve different newsprint samples from European and North American mills were measured for their linting propensity at two significantly different levels of relative humidity. The results are shown in Table II.

The higher humidity level made the paper shed more debris in significant proportion. The value of the ratio 54/46 is given in the last two columns of Table II where differences of up to 61 and 75% can be calculated for the top and bottom sides respectively. Obviously, this is a cause for concern especially since the difference between good and questionable performance may lie in a range encompassed by the spread recorded here. At present, these results mean that the test will have to be confined to a controlled environment laboratory.

A more thorough study was then carried for one of the North American papers whereby several levels of relative humidity were tested. The results are plotted on the graph shown in Figure 9.

Table II. LintView readings at relative humidity of 46 and 54% for top (T) and bottom (B) sides of newsprint samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>RH = 46%</th>
<th>RH = 54%</th>
<th>Ratio 54/46</th>
</tr>
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<tr>
<td></td>
<td>T</td>
<td>B</td>
<td>T</td>
</tr>
<tr>
<td>Eu 1</td>
<td>0.76</td>
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</tr>
<tr>
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</tr>
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<tr>
<td>NA 4</td>
<td>2.40</td>
<td>4.86</td>
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</table>

Figure 8. Effect of ambient temperature on LintView index.

Figure 9. Effect of relative humidity on LintView index for a North American newsprint.
CROSS-DIRECTION LINT PROPENSITY PROFILES

We know that paper is not made equal over the full width of a paper machine; the question then rises whether the linting propensity also varies along the CD position on the machine. Because of the simplicity and quickness of the test, it now appeared possible to verify what some print experts had experienced: that is, the lint propensity varied with the position of the paper on a jumbo roll. This meant that the position relative to the paper machine would have an effect on the linting tendency of paper. This in itself was not surprising because the differences in paper properties for paper fabricated at different CD-positions on the paper machine is well known; the middle of the machine yielding better and more uniform properties. The runnability record in pressroom correlates well with this phenomenon.

The lint propensity profiles of a few sheets have been measured and the results are shown in Figure 10 for a newsprint sheet from a machine trimming above 5 meters (200 inches). Full width strips of newsprint from three different reels were analyzed with LintView. Two measurements at 40 equidistant positions were made on both the top and bottom side of the paper for each strip of paper. One of the strips was measured twice to confirm the repeatability of the test. The combined results of the four sets of data are plotted on the graph for the two sides of the paper. The curves are a result of a smoothed average and each are skewed showing a higher lint index towards the middle of the paper machine. The important point here is that the relationships are not horizontal lines but that the edges of the sheet yielded a lower linting propensity for both sides of the sheet. Profiles from other machines have been obtained and they all showed some degree of skew; some showed a reasonably flat profile except that there was always at least one end, back or front that showed a lower propensity for linting.

The roughness data (Figure 11) show a relatively small degree of two-sidedness favoring the top side as the smoother side; the average values between series of measurements are relatively close (top: 3.39µm versus bottom: 3.63µm), and the small difference is far from the large one measured for the lint propensity data of the two sides. The roughness profiles show little signs of skewness when compared to that exhibited by the lint profiles; however the question arises whether the lower roughness can be indicative of a surface relief that is more flat through stronger bonding of the surface fibers that would yield a lower tendency to linting, given that the lower lint indices match the lower numbers of the smoother top side and conversely for the bottom side.

In an attempt to find correlations with usual paper properties, we measured two surface properties on either side for one of the strips at positions next to where the tape pulls had been sampled. Parker Print Surf roughness (PPS S10) and Hunter gloss (75°) were selected and their CD profiles are compared with those for the lint in Figures 11 and 12 respectively.

Figure 10. LintView data for top and bottom CD positions.

Figure 11. LintView index and roughness (PPS-S10) data for top and bottom CD positions.

Figure 12. Lint index and gloss (Hunter 75°) data for top and bottom CD positions.
IMAGE ANALYSIS

When we compared the debris collected by LintView and IGT pick test (Figure 6), it became clear that the latter was significantly more aggressive than the former, removing relatively large areas of fibers at the paper surface (Figure 13), while LintView still removed discrete particles that were poorly bonded to the surface (Figure 14).

We know that IGT numbers are related to the onset of delamination of the paper surface, a condition that cannot always be associated with the phenomenon of linting on offset presses because with delamination, the pressroom would be experiencing catastrophic failure of the sheet. Debonding of layers of fibers is not what pressroom linting is about: linting is the contamination resulting from the small particles collected at the paper surface by the blanket. Many if not all investigations of lint episode have revealed the presence of such material on the classic tape pulls used to characterize what the printers must deal with when linting occurs. Several experts share our view that IGT pick is a paper surface strength or delamination test and is not used by laboratories to quantify the linting propensity of paper.

That we see a correlation between IGT numbers and LintView does not invalidate the situations discussed above: that is, we can easily associate the delamination of paper on a laboratory press as seen with the IGT test, with the contamination of offset blankets from the removal of fiber fragments and loose particles from the paper surface. The reverse however, is not necessarily true because when a sheet is adequate by IGT standards, it can still lint during printing because of the small particles accumulating on the blankets that are identified with LintView but not with IGT.

We recognize that there is a large number of long fibers in the image of a LintView tape pull (Figure 14) and that such long fibers are usually not part of the debris collected on press blankets except in very severe cases of linting. We believe that not all fibers released by the paper web stay on the blanket during printing and that some are “washed” away as if some particles had surface areas more suited for sticking to the blanket like ray cells while the longer fibers eventually get entrained by the running web. Some printers have claimed that some papers will clean their blankets.

DISCUSSION AND FUTURE WORK

As mentioned earlier but not well documented, some print specialists have been aware of the variation of lint tendency relative to the position of the paper on the paper machine. Here, the CD profiles investigations have confirmed that indeed the propensity to linting varies according to the CD position but in a somewhat unsuspected manner: it is the center of the web that shows the higher propensity and we have seen some of the lowest numbers for papers close to the edge of the paper machine. We can only speculate on the causes for such behavior but one thing has become certain: a tool is now available to collect lint numbers easily and in great numbers to allow experimentation with the process. All the CD profiles measured so far show that the same pulp produces different lint indices on the paper machine. This is crucial for managing lint issues for paper because the findings above clearly indicate that linting is not exclusively a phenomenon
induced during the pulping stage: too low a refining energy or poor screening and cleaning although they remain factors to be optimized, are not the only causes that can lead to linting, the paper machine itself can also be a factor.

The more entrepreneurial papermakers will seek to determine what papermaking conditions exist near the edges that bond the surface of the sheet better than in the middle; a system like LintView now provides almost real time data to experiment with the process without causing long interruptions and/or disturbances to the operation of the machine.

Effects of winding, calendering, dryer temperatures, press loading profiles, roll crowning and changes, tuning of the approach system, adjustment of the headbox, jet/wire ratio studies, adjustments of dewatering elements, retention numbers, wet end chemistry dosages, anti-adhesive chemicals on press rolls, clothing changes, breaking-in periods and aging of felts and wires, and draws can now be studied with LintView without upsetting the process apart from setting the loading profiles, roll crowning and changes, tuning of the machine.

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Effects of winding, calendering, dryer temperatures, press loading profiles, roll crowning and changes, tuning of the approach system, adjustment of the headbox, jet/wire ratio studies, adjustments of dewatering elements, retention numbers, wet end chemistry dosages, anti-adhesive chemicals on press rolls, clothing changes, breaking-in periods and aging of felts and wires, and draws can now be studied with LintView without upsetting the process apart from setting the operating parameters under investigation. A test in the mill has to be the preferred scenario for monitoring paper properties rather than sending samples to be analyzed under conditions.

As it addresses two major components: first it allows to study lint in-house and build a unique data base that was never very practical before, and second, it is the only quality tool that allows monitoring lint propensity through a quick and simple procedure test, and practically in real time. At present, two regular users have tracked the reduction in their LintView numbers by a factor of 2-3 and have received positive feedback from their customers; they were able to identify the process responsible for the improvement.

The authors believe that guaranteeing lint-free paper to customers is closer than ever: LintView is a test that can support frequent monitoring of the linting propensity of paper as it addresses two major components: first it allows to study lint in-house and build a unique data base that was never very practical before, and second, it is the only quality tool that allows monitoring lint propensity through a quick and simple procedure test, and practically in real time. At present, two regular users have tracked the reduction in their LintView numbers by a factor of 2-3 and have received positive feedback from their customers; they were able to identify the process responsible for the improvement.

We are also progressing with the exploration of the capabilities of the LintView lint propensity test to better serve the paper and the printing industry: we are engaged in the investigation of the effect of aging of paper, the effect of calendering, the development of calibration standards, the stability of the CD profiles, a microscopy study to compare debris collected on a blanket with those removed with LintView on the virgin paper, the relevance for coated and woodfree grades and automation of the test is under development.

**CONCLUSIONS**

A new test for measuring linting propensity of paper has been developed. The test is simple, quick, user-friendly, requires no specific expertise, and most importantly, it is done at the mill. For all these reasons, the test can be carried routinely on every parent reel produced and represents real time measurements. The method has been duly put to test over a period of several months in paper mills during which time correlations have been established with other well known tests as well as with pilot press studies. Although no exhaustive study has been completed in a commercial pressroom, more and more users are claiming excellent correlations with the performance of their paper in pressrooms.

The test has shown excellent repeatability from the beginning and it has been possible to demonstrate that reproducibility between mill environments and laboratory was very good. Variability within samples was also addressed thoroughly and the uniformity of results confirmed that 4-6 samples were sufficient to conduct the test successfully, which was a major factor for gaining acceptance in a production environment.

The test is also sought to provide a prediction of lint propensity to eliminate tests such as the Apollo test which is cumbersome; it will take a great number of tests before the statistics allow such replacement but we feel confident that the accuracy and repeatability will dictate the switch.

Ambient temperature was shown to have no effect on the results but like many other physical properties of paper, the test is sensitive to relative humidity. However, more tests are under way to better understand this sensitivity.

The simplicity and quickness of the test provides a means for measuring linting profiles in the cross-machine direction: all the machines tested have shown skewed profiles with the lowest numbers for linting propensity near the edges of the machine. Because papermaking conditions are not equal across the width of the machine, the results clearly show that linting is not exclusively a pulp quality issue but that some of the processes taking place on the machine can contribute as well. So far, it has been observed that the linting propensity is higher for the bottom side of the paper on a majority of machines.

Because the test provides a quantitative measure of linting propensity at the mill, it removes the subjectivity in the assessment of linting tendency of paper. It offers the capability to monitor paper in the mill and define some strategy to improve and/or modify the papermaking processes. It can help the papermaker manage questionable paper and prepare orders for specific customers with low lint record or short runs rather than to cull several tons of saleable paper. It also provides benchmarking capabilities in targeted pressrooms.

Although the test was developed primarily for newsprint and directory grades, it is proving successful with other mechanical grades and woodfree grades as some tests have clearly showed the collection of debris coming from the paper samples.

To exercise better control over lint in pressrooms has become a must in order to satisfy an ever demanding printing industry. We believe LintView provides a step closer towards achieving that control.
REFERENCES


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