Evaluation of Various Adhesive Contaminant (Stickies) Analysis Methods for Use in Old Corrugated Container Recycling Plants

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ABSTRACT

The objective of this research is to evaluate several different macro-stickies test methods for pulps made from old corrugated containers. The stickies test methods evaluated included a deposition test, two handsheet methods and two methods that utilized laboratory screening. These tests were performed on a series of blends of recycled OCC and quaternary screen rejects as a model for highly contaminated pulps. The tests were also performed on a series of blends of virgin kraft pulp and recycled OCC as a model for pulps with low levels of contamination. The detection of stickies in handsheets using bleaching and/or dyeing techniques was found to be effective on these samples for both low and high concentrations of stickies in the pulp. Stickies detection methods with screening involved were sensitive to stickies contamination in pulps with low levels of stickies but not with pulps with high levels of stickies. It is expected that this limitation could be remedied by using smaller sample sizes of the highly contaminated pulps. The detection of stickies via deposition on a papermachine wire was found to be effective for pulps with high concentrations of contaminants but not with low concentrations. In general, the methods using a screening step were less demanding with regard to labor and time than were the methods utilizing handsheets.

KEYWORDS

Adhesive contaminants, Deposition, Detection, Dyeing, Macro-stickies, OCC, Old corrugated containers, Screening, Stickies, T277, Test methods.

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INTRODUCTION

Adhesive contaminants and any other contaminants with a propensity to deposit (stickies) are a serious production and product quality problem for old corrugated container (OCC) recycling mills. The ultimate goal for OCC mills is to completely remove these stickies through proper equipment/process operation. To make progress toward that goal, a recycling mill must have a measurement method for stickies that is accurate and precise. Accuracy, the ability to detect a quantity's true value, in stickies detection is important. Knowing at which points in the process stickies exist and at what concentration is valuable information that can assist in developing a stickies control strategy. Precision (the range of expected scatter in a measurement) in stickies detection is also important. The variability of a measurement coupled with the natural variability of the process and the finite amount of sampling and testing that can be performed all combine to determine a confidence range of a measurement. It is the differences in the change in stickies contents greater than these confidence ranges that can be used to evaluate a unit operation or a change in process conditions.

Many stickies detection methods have been proposed and evaluated. However, there are no extensive quantitative comparisons of these methods on the same furnish that would allow a proper evaluation of the utility of each method. Further, many of these methods are for bleached pulp or wood containing pulps that are relatively bright, not dark pulps like OCC. It is the objective of this research to evaluate several different stickies quantification methods for application in OCC recycling.

BACKGROUND

The most recent review on stickies quantification methods was presented by Doshi and Dyer at the

2000 TAPPI Recycling Symposium, "Review of Quantification Methods for PSA and Other Stickies"[1]. Over 40 references were presented discussing different methods of stickies quantification. Other comprehensive reviews are available [2,3,4]. Overviews of the methods utilized at NCSU have also been published [5,6]. The large number of test methods reflect the (a) differing test needs for different types of pulp (e.g., OCC vs printing and writing grades) or different types of sticky contaminants (e.g., micro and macro stickies), (b) a general desire for an improved, convenient test method and (c) the great importance of stickies detection.

There is in general a lack of information describing the relative performance of the various test methods. In one study Venditti and coworkers have correlated the results from deposition tests performed at NCSU with dyeing/image analysis results performed at the Forest Products Laboratory on the same pulps [7]. A correlation was found between deposition and image analysis with stickies concentrations from 1 to 10^4 PPM, as measured by image analysis.

The use of a deposition test with a papermachine wire versus with a microfoam packing material was compared by Carre, Fabry and Brun [8]. Both methods detected a maximum of depositable stickies at the point at which the charges in the system were neutralized. It was concluded that the papermachine wire was more sensitive than the microfoam method but this conclusion was not justified.

The accuracy of stickies determinations has been reported in some cases. Gravimetric methods used in a Forced Adsorption Contact deposition test with known spiked quantities of stickies revealed that the amount of deposits recovered and detected on the deposition surface varied for various adhesives from 0 to 100% [9]. By optimizing the deposition conditions for a given pressure sensitive adhesive, the recovery rate could be higher than 80%. However, the optimal conditions for recovery were different for different adhesives. In a deposition study utilizing counter-rotating papermachine wires spiked with a single type of PSA contaminant, it was found that the recovery of adhesive as deposits on the wire depended greatly on the pulp furnish components in the system [10,11]. The recovery and detection of PSA was less than 25% of the known PSA in the system when cationic starch, talc, or alum (each separately) at the levels studied were present. In contrast, the recovery and detection of PSA in a pulp consisting of copy paper was above 75%.

Despite the magnitude of research in the area there is not a solid set of data from which to compare test methods. With respect to OCC, the information on stickies detection methods is very scarce. This indicates that a well-controlled set of experiments in which different test methods are used on the same OCC pulp samples would provide useful information upon which further stickies research could be based.

EXPERIMENTAL

Materials

Fully recycled OCC pulp ready for board production (termed recycled OCC), rejects from the quaternary screen of the OCC recycle process (termed screen rejects), and virgin kraft pulp (termed virgin pulp) were supplied by Longview Fibre, Longview WA. The samples were shipped at 10% consistency from Longview WA to Raleigh NC in approximately two days. A recycled OCC pulp sample and a screen rejects sample were blended in ratios of 0, 25, 50, 75 and 100% screen rejects to provide a well-controlled set of samples spanning the contaminant level range expected in a recycled OCC mill.

Blends were also produced from a virgin pulp sample and a recycled OCC sample, in ratios of 0, 25, 50, 75 and 100% recycled OCC. The blends of the virgin pulp and recycled OCC provided a well-controlled set of samples that had contaminant levels lower than the recycled OCC and screen rejects blends. The recycled OCC samples used for the two types of blends were taken on two separate occasions, and therefore, due to normal variability in operations and OCC, were expected to be similar, but not identical in composition.

Methods

The stickies test methods evaluated are described below. All of the methods below are sensitive to macro-stickies. (Macro-stickies are typically defined as those stickies particles retained by a slotted lab screening device, 0.006 inch width slots [1].) Some of the methods additionally are sensitive to micro-stickies, such as bleaching and dyeing, PT Method 1 and deposition.

Bleaching and Dyeing

Bleaching was performed in a 4000-ml glass beaker equipped with a motorized stirrer in a hot water bath kept at 70°C (in a laboratory hood). 1920-mls of water were placed into the beaker along with 80 OD g of pulp sample. 12 g of sodium acetate and 24-mls of glacial acetic acid were added to the pulp slurry. These two chemicals act as a buffer for the bleaching step. After the pulp mixture reached 70°C, 12 g of sodium chlorite was added. This amount of sodium chlorite was also added at 30 minutes and 60 minutes. 15 g of sodium thiosulfate was added to the mixture 30 minutes after the last dose of sodium chlorite to stop the bleaching reaction. After the reaction was stopped, approximately one min after adding the sodium thiosulfate, the beaker was removed from the hot water bath. The pulp was washed with deionized water on a Buchner funnel with vacuum using a Whatman 541 filter paper. During washing the pulp changed from a cream to a slight gray color. When the color change had stopped, the pulp was removed and placed in a plastic bag for storage. Standard TAPPI method T205 was followed to produce 1.2 gram handsheets.

In a laboratory hood, a dye solution was made in a 1000-ml volumetric flask by adding 95% Heptane to 0.67 g of Morplas Blue #1003 (Sunbelt Corp., Rock Hill SC) powder. The solution was stirred with a magnetic stirrer overnight. The dye solution was filtered in a Buchner funnel using Whatman 541 filter paper to remove undissolved material. 250-mls of the filtered dye solution was placed into a crystallizing dish. Each handsheet was swirled in the solution for 10 seconds. The handsheets were placed on a line to dry overnight in the hood. Approximately 25 handsheets could be dyed with a 250 ml sample of the dyeing solution.

The Apogee Specscan Image analysis program was used to determine the dark specks in both the bleached and the bleached/dyed handsheets. Dark specks in the bleached handsheets are considered to be non-sticky dirt. Dark specks in the bleached and dyed handsheets are considered to be both non-sticky dirt and stickies. Subtraction of the results of the bleached handsheets from the bleached/dyed handsheets produced only a measure of the dyed particles, assumed here to be stickies. (It is assumed in this test that only sticky material is changed from light to dark in the dyeing procedure.) The settings on the Specscan program were as follows:

- Normal Sample
- 6" round sheets
- 256 grayscale
- 600 dpi resolution
- Threshold setting, 80 % of average grayscale value
- Minimum particle size detected 0.02 mm^2
- Set of 5 HS scanned, both top and bottom

Deposition

80 OD grams of the pulp sample was placed into a modified PIRA deposition chamber and diluted to a 1 % consistency, approximately eight liters. The sample was maintained at 55°C in a stainless steel beaker in a water bath in the modified PIRA deposition chamber. Four 7.5-cm X 14.5-cm rectangles of polyester paper machine wire obtained from Weavexx Corporation were oven dried (105°C for 30 min) and weighed and placed in the holding paddle. The paddles were counter rotated at 0.75 Hz for 30 minutes in the pulp stock. The paper machine wires were then removed from the paddle and gently rinsed with deionized water and then dried and weighed. Inspection of the wires after rinsing revealed no fibers attached to the papermachine wires. The wires were dyed in the same manner as described above for the bleaching and dyeing of handsheets. Image analysis settings with the Apogee equipment was as follows:

- Normal Sample
- 7 X 14 cm rectangles
- 256 grayscale
- 600 dpi resolution,
- 103 Absolute Threshold
- Minimum particle size detected 0.02 mm^2
- Set of 4 to be scanned, front and back

Deposition results are reported for the weight gain after drying (Deposition Gravimetric) and for the PPM after dyeing and image analysis (Deposition IA).

TAPPI Provisional Test Method T277

A sample of 20 g OD was disintegrated with a TAPPI Disintegrator for 5 minutes and then screened using the Pulmac Masterscreen with 0.006 inch slots. The rejects were captured on black filter paper, approximately 2.7 g and 20.5 cm in diameter (from Fisher Scientific). The filter pad was placed face up with a special coated paper obtained from Voith (Appleton, WI) and pressed using a Carver press at 90°C and 11.6 psi for 10 minutes. The filter pad was then rinsed with a shower of deionized water at 15 psi for 25 seconds. The filter pad was pressed again with the same parameters as before but now against a silicone coated release liner. The filter paper was then weighed to obtain a reject weight. The white coating specks on the black filter paper were then detected using image analysis. (The procedure calls for using a black felt pen to hide all of the brown fiber existing on the filter paper. However, we found that by choosing the threshold listed below, brown fiber was simply assigned to the background by the image analysis system. We therefore did not need to use the black pen to darken the fibers.) The settings on the Specscan program were as follows:

- Reverse Threshold • 20 cm round sheets
- 256 grayscale • 400 dpi resolution
- Manual threshold setting of 66
- Minimum particle size detected 0.02 mm^2

Port Townsend Paper Corp. Method 1: Dyeing of Handsheets (PT Method 1)

20 g OD of sample was disintegrated in a TAPPI disintegrator for 5 min to break fiber bundles. The sample was diluted to 0.5% consistency and 250 ml of the material was used to make a consistency determination. Five 1.2 gram standard TAPPI handsheets (T 205) were then made. Drying of the handsheets was performed by placing the handsheet between a Teflon and metal plate and heating with an Emerson Speed Dryer Model 135 at 300°F for 5 minutes. The sheets were conditioned in a TAPPI conditioning room overnight. Handsheets were placed on the surface of a pool of Parker Quink Ink (Reliable Office Supplies, Jacksonville FL) until the ink absorbed through the entire handsheet, about 10 seconds. The handsheets were then placed on blotter paper and allowed to dry overnight. Areas covered with stickies remained light whereas the fibers were dyed black. Image analysis using the Apogee Specscan program was as follows:

- Reverse Threshold • 6" round sheets
- 256 grayscale • 400 dpi resolution
- Threshold setting, 23 manual
- Minimum particle size detected 0.02 mm^2
- Set of 5 handsheets, top and bottom

Port Townsend Paper Corp. Method 2: Screening Method (PT Method 2)

80g OD of a pulp sample was diluted to a 1.2% consistency and disintegrated for 5 minutes in a TAPPI disintegrator to remove fiber bundles. A 1000-ml sample of the slurry was used to make a handsheet (speed dried) to determine consistency. Three samples (17 oven dry grams each) were then screened using a Pulmac Masterscreen with 0.006 inch slots and the rejects were captured on 20.5-cm white filter paper. The filter paper, between a metal plate on the bottom and a Teflon plate on the top, was dried using the Emerson Speed Dryer at 300°F for 5 minutes. The filter paper was allowed to condition in the TAPPI conditioning room overnight to obtain an accurate reject weight. The filter papers were then dyed with Parker Quink Ink, dried and analyzed in a similar manner as the PT Method 1. A 20 cm diameter circle was analyzed for each of the three filter papers. Again, the stickies appeared light brown whereas the fibers were black. Image analysis using the Apogee Specscan program was as follows:

- Reverse Threshold • 20 cm round sheets
- 256 grayscale • 400 dpi resolution
- Threshold setting, 23 manual
- Minimum particle size detected 0.02 mm^2
- Set of 3 filter pads

RESULTS AND DISCUSSION

Pulps with High Stickies Concentrations: Blends of Recycled OCC and Screen Rejects

The results of the tests as described above were performed on the blends of recycled OCC and screen rejects in the ratios of 0, 25, 50, 75 and 100% screen rejects. These pulp sample blends have a range of stickies concentrations that include typical levels of stickies in accepts streams in a recycle mill and also typical levels of stickies that exist around secondary, tertiary and quaternary cleaning/screening devices. The correlation coefficient (R^2), slope and y-intercept, as determined using a linear regression analysis, for each test result are shown in **Table 1**. Plots of selected test results are shown in **Figure 1.** It is observed that the R^2 value for the two test methods that utilized handsheets for analysis, i.e., bleaching and dyeing and PT Method 1,

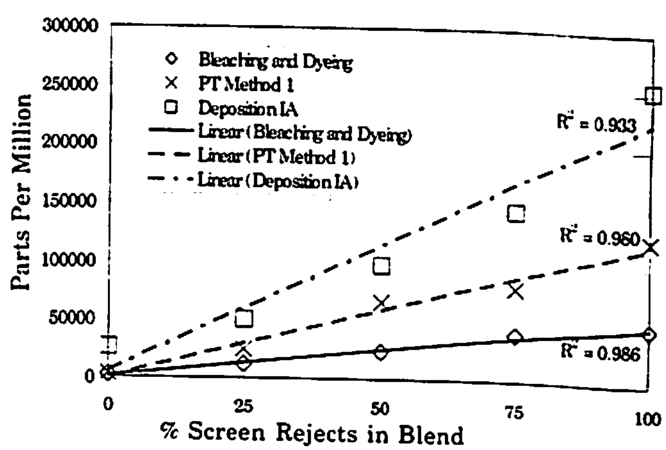

Figure 1. **PPM of stickies detected versus the % screen rejects in a blend of recycled OCC/ screen rejects for various test methods. The original deposition results have been multiplied by a constant factor of 2000 for presentation purposes.**

Table 1. **Results of linear regression analysis of detected stickies and simple contaminant levels versus the % screen rejects in a blend of recycled OCC/screen rejects for various test methods.**

Stickies Test Methods							
		Test Result			Individual Measurements		
	Meas. per Test	R^2	Slope	y-Intercept	R^2	Slope	y-Intercept
Bleaching and Dyeing	5	.986	486	875	.967	486	875
PT Method 1	5	.980	1190	54.4	.826	1190	54.4
PT Method 2	3	.027	343	106000	.022	343	106000
Deposition IA	4	.933	1.10	2.44	.545	1.10	2.44
Deposition Gravimetric	4	.854	.0001	.0011	.561	.0001	.0011
Contaminant Test Measurements							
		Test Result			Individual Measurements		
	Meas. per Test	R^2	Slope	y-Intercept	R^2	Slope	y-Intercept
PT Method 2 Screen Rejects Weight	3	.970	.035	.347	.930	.035	.347
T277 Screen Rejects Weight	1	.906	.0728	1.57	.906	.0728	1.57
Bleaching and Dyeing IA Visible Contaminant PPM in Undyed Handsheets	5	.991	215	3170	.901	214	3170

were extremely high, around 0.98. These methods are sensitive and linearly related to the blend ratio at the given high contamination levels. The deposition method, either with image analysis or gravimetric analysis to detect the deposits, also was able to detect the stickies. However, the R^2 values were less than that with the handsheet methods.

PT Method 2 had a very poor correlation with the % screen rejects, R^2=0.027. This method concentrates the stickies and other contaminants on a filter pad for subsequent dyeing and image analysis. For all of the blends with screen rejects greater than 25%, the filter pad was completely covered with stickies and other contaminants, which prevented image analysis of the dyed pad from detecting any differences between these samples. The T277 testing method also has screening the pulp as one of its steps to concentrate the stickies. Again, it was found that the rejects filter pad was completely covered with material for all of the blend ratios investigated, rendering the results not useful. It may be possible to modify these tests for heavily contaminated pulps by screening smaller quantities of pulp for analysis. This was deemed outside of the scope of this study.

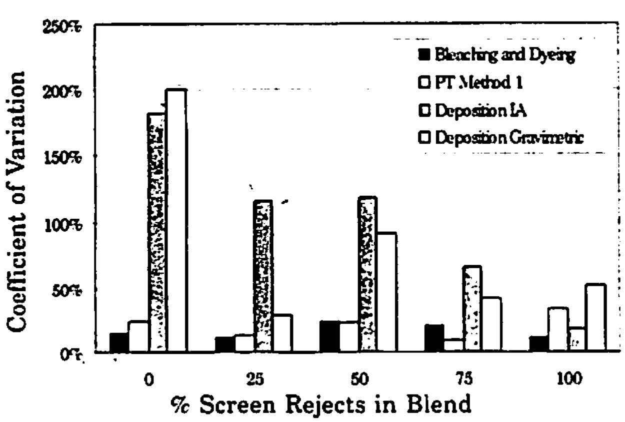

Figure 2. **Coefficient of variation of individual measurements versus % screen rejects in a blend of recycled OCC/screen rejects for various test methods.**

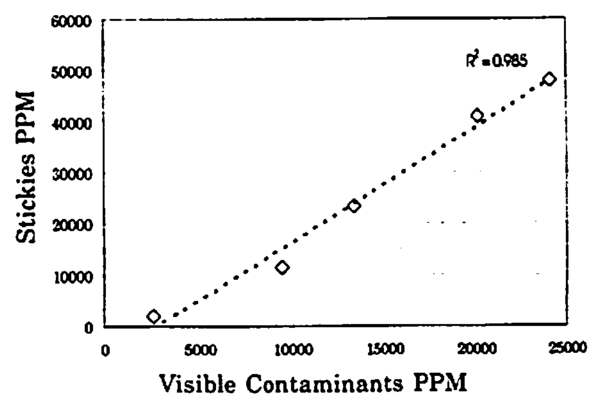

Figure 3. **Stickies PPM detected (dyed material in bleached and dyed handsheets) versus visible contaminants PPM detected (all dark contaminants in bleached but not dyed handsheets). Data were obtained on blends of recycled OCC/screen rejects.**

All of the test results except T277 were the test averages calculated from multiple individual measurements (either a handsheet or a filter pad). The number of individual test measurements used for each test is listed in **Table 1**. It was of interest to determine if the use of individual measurements would lead to a similar strength of linear correlation as the test results. If so, the testing procedures with multiple individual measurements might be modified. The R^2 values for all of the individual measurements versus blend ratio are significantly lower than that for the test results, **Table 1**. As expected, the quantity of material analyzed has a significant impact on the results.

Of the tests deemed adequate for these high levels of contamination, the deposition test showed a significantly higher coefficient of variation (100% * standard deviation / average) than did the stickies handsheet methods, bleaching and dyeing and PT Method 1, for individual measurements, **Figure 2**. This is attributed to the complicated and random nature of the stickies attachment to the papermachine wire in the deposition test that is not present in the handsheet methods.

It was of interest to investigate if simple measures of the concentration of contaminants in the samples correlated with the stickies content. If this was so, recycling operators might be able to use a measure of contaminant concentration as an indirect method of estimating the stickies content of a pulp. The image analysis results of the bleached but not dyed handsheets provided a measure of visible contaminants in the pulp. There is a linear correlation between the visible contaminants detected in the undyed handsheets and the stickies content in the pulp as detected with the full bleaching and dyeing procedure, as shown in **Figure 3**.

Also, the screen rejects weight for the PT Method 2 and T277 testing method are simple measures of the contaminant concentration in the pulp. **Table 1** shows that the correlation coefficients between the contaminant concentration as measured simply by screen rejects weights (from test results or individual measurements) and the blend ratios is high, about 0.90 or greater. Thus, in the blends studied, there was also a linear relationship between simple measurements of contaminant concentrations from screen rejects weights and stickies concentrations.

In practice, this correlation may be evident at certain times, however, when large quantities of wet-strength materials (or other unpulpable contaminants) are present in the furnish, the overall contaminant concentration may be very high while the stickies concentration may be normal.

Pulp with Low Stickies Concentrations: Blends of Recycled OCC and Virgin Pulp

It was also of interest to evaluate these test methods on pulps with lower stickies concentrations. To do this, the stickies tests as described in the experimental section were performed on blends of recycled OCC and virgin pulp in the ratios of 0, 25, 50, 75 and 100% recycled OCC.

The deposition test on the recycled OCC – virgin pulp blends was found to be insensitive to the % of recycled OCC. It was already known that the deposition test on the 100% recycled OCC resulted in extremely low results; the detected PPM and weight gain due to deposited stickies was 12 PPM and 0.5 milligrams, respectively. These detected quantities were near the minimum practical detection limit for both image analysis and gravimetric measurements. It was thus expected that deposition measurements with blends of recycled OCC and virgin pulps would not be useful. In fact, deposition tests with 50% recycled pulp and 50% virgin pulp resulted in 0 PPM and 0.0 milligrams. Also, for the 100% virgin pulp 0 PPM and 0.0 milligrams were recorded. Due to these findings, the other blend ratios were not tested using deposition. It was concluded that the deposition test is not useful for the low stickies concentration pulps tested and the experimental procedures followed herein.

The deposition method is different from the other test methods in that it identifies stickies contami-

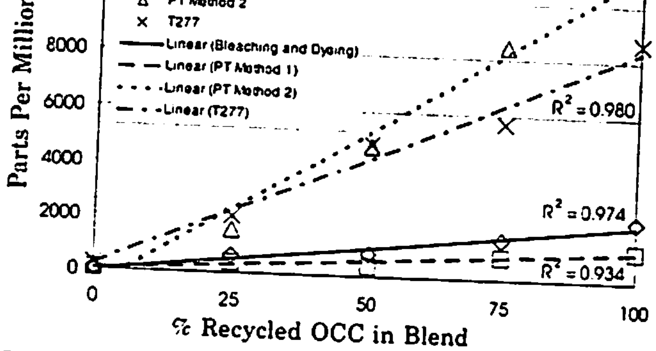

Figure 4. **Average PPM of stickies detected versus the % recycled OCC in a blend of virgin kraft/recycled OCC for various test methods.**

nants that deposit on materials such as papermachine fabrics under certain operating conditions. For instance, this could be an issue if the deposition test is performed at 50°C but the stickies present are depositable only at higher temperatures. Also, this can be a disadvantage in measuring total stickies content if detackifying materials in the pulp prevent the deposition of otherwise depositable stickies [10,11]. However, the deposition test method can be very useful in the evaluation of anti-deposition programs or alternate fabric materials.

For the other stickies detection methods, the tests were performed in triplicate rounds on all of the blends and the results for one round of testing are shown in **Figure 4**. The two handsheet methods, i.e., bleaching and dyeing and PT Method 1, were consistent, resulting in similar (but not equal) stickies PPM levels versus blend ratio (**Figure 4**). The average sticky size for the handsheet methods were both about 0.1 mm^2 for all of the blend ratios (data not shown). This indicates that the two handsheet methods are, in general, detecting the same types and quantities of contaminants in the tests.

Also, the two screening methods, i.e., PT Method 2 and T277, were consistent, resulting in similar (but not equal) stickies PPM levels versus blend ratio (**Figure 4**). The average sticky size for both of the screening methods was clustered about 0.4 mm^2 (data not shown). The larger average sticky size detected for the screening methods relative to the handsheet methods is understandable, as the screening operation eliminates the small particles from subsequent detection.

The correlation coefficient (R^2), for each test and each round are shown in **Table 2**. The average R^2 values of the three rounds for each test is also shown in **Table 2**. The average R^2 values for the two test methods that utilized handsheets for analysis, bleaching and dyeing and PT Method 1, were high, greater than 0.9. The two screening methods, PT Method 2 and T277 also had very high average R^2 values, greater than 0.94. Thus, all four of these methods are sensitive and linearly related to the blend ratio and accordingly, the stickies content.

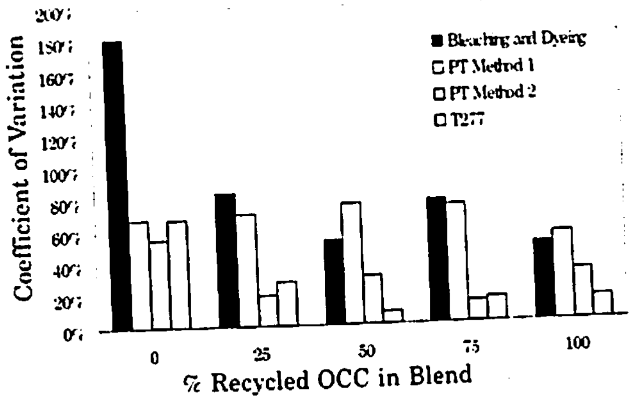

Figure 5. **Coefficient of variation of individual measurements versus % recycled OCC in a blend of virgin kraft/recycled OCC for various test methods.**

Also shown in **Table 2** are the R^2 values when the individual measurements (either handsheets or filter pads) were plotted versus % recycled OCC. For the handsheet methods, the R^2 values for the individual measurements were significantly lower than for the test results. Thus, a significant sensitivity loss would be realized for these methods if one was to attempt to use an individual handsheet measurement rather than the prescribed number of handsheets for the testing procedure. Interestingly, an R^2 value of 0.9 was determined for the individual measurements for the PT Method 2, indicating a lower, but adequate, strength of correlation relative to the prescribed testing procedure. No comparison was made for T277 because the prescribed test method includes only one individual measurement.

Table 2. **Results of linear regression analysis of detected stickies versus the % recycled OCC in a blend of virgin kraft/recycled OCC for various test methods.**

		R^2 For Best Fit Line				R^2 For Best Fit Line of Individual Measurements			
Testing Method	Meas. per Test	Round 1	Round 2	Round 3	Avg.	Round 1	Round 2	Round 3	Avg.
Bleach/Dyeing	5	.974	.852	.995	.940	.483	.359	.757	.533
PT Method 1	5	.934	.875	.940	.916	.557	.711	.389	.552
PT Method 2	3	.983	.915	.952	.950	.978	.838	.909	.908
T277	1	.980	.982	.976	.979	.980	.982	.976	.979

The coefficient of variation of the individual measurements for each blend ratio and test method are shown in **Figure 5**. The results show that in general, the coefficient of variation for the screening methods (T277 and PT Method 2) is less than that for the handsheet methods (bleaching and dyeing and PT Method 1). This is in agreement with the R^2 values being higher for individual measurements for the screening methods than the handsheet methods, as shown in **Table 2**. The individual samples for both bleaching/dyeing and PT Method 1 had 1.2 OD grams of material per handsheet. T277 utilized 20 OD grams of initial material per individual sample. PT Method 2 utilized 17 OD grams of initial material per individual sample. It is expected that there will be less variability in the individual measurements of the screening methods relative to the handsheet methods in part because the quantity of pulp analyzed for the individual measurements is larger.

Estimated Time and Labor Required for the Various Test Methods

From a practical standpoint the actual time and labor that is required to perform these stickies test methods is of importance. The results herein have been shown to be sensitive to the quantity of sampling, even for a static, single mother sample of pulp. Clearly, sampling issues are of extreme importance when trying to characterize quantities of pulp flowing in the 100 tons per day range with tests that analyze less than 100 grams of pulp. Thus, given a limited amount of testing resources, convenient and rapid testing methods will allow for increased sampling and testing and more precise measurements. Estimates of the total time and labor required for each testing method are shown in **Table 3**. These values are estimates intended to demonstrate the relative efforts needed among the different testing methods. It is very plausible that the total time and the labor needed could be decreased by modifications to the described procedure. For example, overnight drying as done in this work (estimated as 12 hours) could be replaced with a more rapid technique, such as drying in a heated convection oven.

The labor required was about three hours for the handsheet methods (bleaching and dyeing and PT Method 1) and only about one hour for the screening methods PT Method 2 and T277). Thus, the screening methods show a real advantage in decreased required labor relative to the handsheets. As stated before, it is expected that the screening methods can be used for both low contaminant levels and high contaminant levels, if the sample quantity is adjusted adequately depending on the contaminant level.

The deposition method does not require more labor than the other techniques. However, it does require the fabrication of non-commercially available equipment. The results herein show that deposition loses utility at low concentrations of stickies. Further, the deposition of stickies is sensitive to the test conditions, including such variables as the temperature and the presence of detackifying agents. For these reasons it is not recommended

Table 3. **Estimates of the time and labor required in hours for the various stickies test methods.**

Testing Method	Bleaching & Dyeing		Deposition IA		Deposition Gravimetric		PT Method 1		PT Method 2		T277	
	Total Time	Labor	Total Time	Labor	Total Time	Labor	Total Time	Labor	Total Time	Labor	Total Time	Labor
Test Preparation	1	.3	1	.5	1	.5	1	1	.5	.5	.5	.5
Test Run Time	2	.5	1	*	1	*	*	*	1.5	.5	.5	.2
Handsheet Preparation	.3	.3	*	*	*	*	.3	.3	*	*	*	*
Drying	12	*	1	*	1	*	.8	*	.5	*	.2	*
Rinsing	*	*	*	*	*	*	*	*	*	*	.1	.1
Weighing	.2	.2	.2	.2	.2	.2	.2	.2	.1	.1	*	*
Dyeing	.5	.5	.3	.3			.5	.5	.2	.2	*	*
Drying	12	*	12	*			12	*	12	*	.2	*
Weighing	*	*	*	*			*	*	*	*	.1	.1
Rinsing	.5	.5	.3	.3			*	*	*	*	*	*
Drying	12	*	12	*			*	*	*	*	*	*
Image Analysis	1	1	.8	.8			1	1	.3	.3	.1	.1
Total	41.5 HR	3.3 HR	28.6 HR	2.1 HR	3.2 HR	.7 HR	15.8 HR	3 HR	15.1 HR	1.6 HR	1.7 HR	1 HR

that deposition be used as a routine stickies concentration measurement method. Rather, its value is more related to its ability to understand the effect that processing conditions have on the deposition of stickies and to evaluate strategies for stickies deposition control.

CONCLUSIONS

The detection of stickies concentrations in handsheets using bleaching and/or dyeing techniques was found to be effective for both low and high levels of stickies in a series of well-controlled pulp blends. Stickies detection methods utilizing a screening step were also effective in determining the stickies concentrations in pulps with low levels of stickies. These screening methods are expected to be useful in analyzing pulps with high levels of stickies if the quantity of the sample analyzed is decreased. The detection of stickies via deposition on a papermachine wire was found to be effective for pulps with high concentrations of stickies but not with low concentrations. In general, the methods using a screening step were less demanding with regard to labor and time than were the methods utilizing handsheets.

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LITERATURE CITED

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