7.6 Quantification of Micro Stickies

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SUMMARY

The objective of this project was to compare the different methods for the quantification of micro stickies. The hydrophobic materials investigated in this project for the collection of micro stickies were Microfoam® (polypropylene packing material), low density polyethylene film (LDPE), high density polyethylene (HDPE; a flat piece from a square plastic bottle), paper machine wire (polyester), and Tyvek® (Federal Express envelope). A stainless steel frame, built to hold the collecting material, was used to insert each material into the pulp under controlled conditions. Collected micro stickies were measured gravimetrically.

In general, the most consistent results using the stickies pulp were obtained from the HDPE and microfoam collection materials. The control pulp with the HDPE collection material had consistent and low results, indicating that the control was clean and that this material was probably the best micro stickies collection material available.

This study demonstrated that fibers are associated with both macro and micro stickies and the fibers are a part of the weight gain on the collection material used for the quantification of micro stickies. Findings also indicate the possibility that a cellulase enzyme could alter the surface of the sticky and change its affinity for the hydrophobic surface of the collecting material.

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INTRODUCTION

Measurement of the concentration is based on the collection of micro stickies on a hydrophobic medium such as LDPE film (1), HDPE (2), polypropylene packing material (Microfoam®) (3), or a paper machine wire (4). Our objective was to determine which one of these methods for the quantification of micro stickies is reproducible and reliable. The goal is to identify a method (or methods) that is reproducible and reliable.

EXPERIMENTAL

The source of pulp used was blotter paper (Pulp Testing Paper, No. 417-01-50) and the source of micro stickies was fluorescent computer labels (4065 Avery Computer Labels, Lot #591052). The control pulp contained only blotter paper, and the stickies pulp contained blotter pulp to which fluorescent labels had been attached. Pulping was conducted at 14% consistency, pH of 8, and at temperature of 45-50° C for 20 min using a Voith laboratory pulper fitted with a high consistency rotor.

The stickies pulp was screened through a Valley flat screen with 6-cut slots to separate the macro stickies from the micro stickies. A layer of control pulp was used to line the collecting box to prevent the smallest micro stickies from passing through the collecting box screen. A third pulp, identified as US Postage Stamp Pulp, was supplied by USDA Forest Products Laboratory

A stainless steel frame was fabricated to attach to a 12-L stainless steel bucket while clamping the edges of the material being tested. The area of the material exposed to the pulp was 12.7 cm (5 in) long by 2.54 cm (1 in) wide. The frame was set at a 45° angle to the radius, and the middle of the frame was set 7.6 cm (3 in) away from the top edge of the bucket. The clamping assembly is shown in Fig. 1, and the bucket with the assembly is displayed in Fig. 2.

Table 1. Comparison of Different Materials for the Quantification of Micro Stickies.

Material Tested	Readings (mg)				Ave.	Std Dev.	%Var.
Stickies Pulp							
microfoam (double layer)		7.7	4.8	50.7	6.3	2.1	33.3
machine wire (polyester)		6.52	6.23	2.70	5.15	1.74	33.7
Plastic film (LDPE)		0.66	1.29	1.45	1.13	0.34	30.1
Tyvek	1.21	0.68	0.94	0.73	0.89	0.21	23.5
HDPE	2.07	1.97	2.04	1.69	1.94	0.15	7.7
microfoam (mono-layer)	2.48	2.41	2.45	2.64	2.50	0.09	3.5
microfoam (mono-layer + enzyme)		-0.18	-0.06		-0.12	0.08	66.7
Control Pulp							
machine wire (polyester)		5.12	0.48		2.80	2.32	82.9
Plastic film (LDPE)		0.95	-0.24		0.36	0.60	167.6
Tyvek		-0.04	-0.18		-0.11	0.07	-63.6
HDPE		-0.21	-0.21	-0.17	-0.20	0.02	-9.6
microfoam (mono-layer)		0.99	1.54	0.32	0.95	0.50	52.5
U.S. Postage Stamp Pulp							
HDPE	-0.19	-0.29	0.38	-0.12	-0.06	0.26	-469.7
microfoam (mono-layer)	0.92	0.66	0.99	0.39	0.74	0.24	32.0

The material tested was cut to size to fit the frame, washed, rinsed with deionized water, and dried to constant weight at 105° C. The dry material was weighed and inserted into the frame. Trials were run for both the control pulp and the stickies pulp with each material.

In each trial, a 144 g o. d. basis sample of pulp was diluted to 1.8% consistency with deionized water in the stainless steel bucket. The bucket was placed on a hot plate and a Williams stirrer was used to agitate the slurry. The stirrer rod was set at 7.6 cm from the top edge of the bucket and the frame holding the material was then positioned on the bucket. Each trial was conducted at 65° C for 30 min. After 30 min, the frame was removed from the bucket and the material was removed from the frame. The material was dipped three times in deionized water at 20° C, dried to constant weight at 105° C, and weighed.

Figure 1: **Frame used to hold hydrophobic collector material.**

Additional trials were run with a cellulase enzyme. A 0.05% sample of Celluclast 1.5 (Nova Nordisk) was added to the 1.8% consistency stickies pulp at 45° C for 20 min. The slurry was then heated to 65° C, the metal frame holding the collecting material was inserted, and the trial proceeded as above.

RESULTS AND DISCUSSION

The results of each trial are recorded in Table 1. In general, the most consistent results using the stickies pulp were obtained from the HDPE and microfoam collection materials (as indicated by the low standard deviation and variance). However, the higher and less consistent results of the control pulp with the microfoam collection material indicate that fibers without any stickies association seemed to be collecting on the microfoam. The control pulp with the HDPE collection material had consistent and low results which indicate that the control was clean and that the HDPE collection material is probably the best collection material to use for micro stickies.

Using the stickies pulp, the paper machine wire and the double layer microfoam had a considerable amount of visible fibers entrapped, thereby giving inconsistent results. Therefore, these materials were not considered good collection materials. The

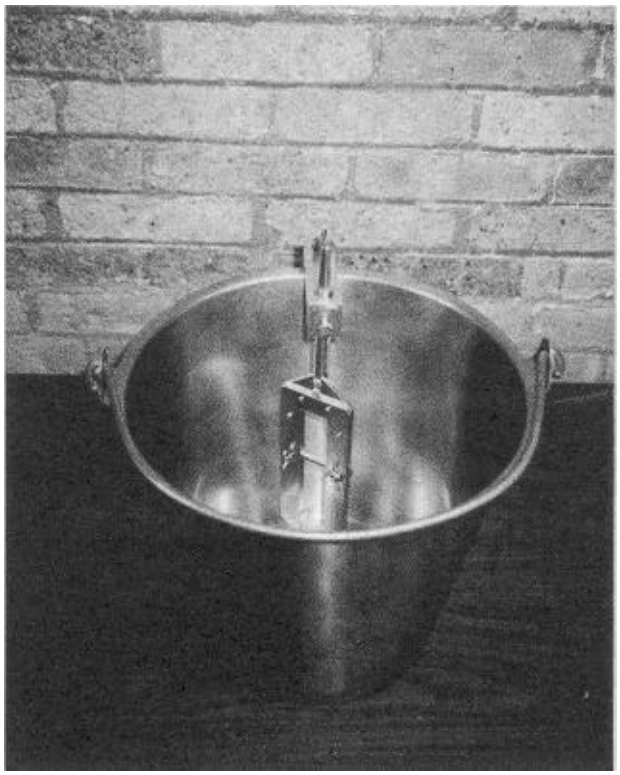

Figure 2: **Sample bucket and frame assembly.**

Tyvek and LDPE plastic film also had variable results and were not considered good collection media.

The deposited stickies were analyzed under a microscope and found to have fibers associated with each sticky. The attachment of fibers thus creates a "hairy sticky." Because of this observation, a cellulase enzyme was added to the slurry under the proper enzymatic conditions to help clean off the fibers before attempting to collect the micro stickies on the hydrophobic material.

Carré et al. (5), compared micro stickies quantification methods using paper machine wire and microfoam. They also observed that the amount of material collected on paper machine wire is far greater than that collected on microfoam. However, it is not clear how much of the deposited material was fiber. In their experimental setup, Carré et al. (5), attached paper machine wire onto a frame and used counter-rotating paddles to stir the pulp slurry.

The results obtained from the cellulase enzyme-treated slurry showed no micro stickies present. This is an interesting result and needs further investigation. One explanation is that the surface characteristics of the stickies were altered by the enzyme and, therefore, had no affinity for the hydrophobic surface of the collecting media.

The USDA Forest Products Laboratory conducted recyclability testing on stock containing pressure sensitive adhesives that can potentially be used on postage stamps (6). The stock was pulped and processed through screening (6-cut slot), forward and through-flow cleaning, washing, flotation, and dispersion. The final accept pulp from the process was tested for micro stickies. Results in Table 1 indicate that the concentration of micro stickies in the pulp is negligible.

CONCLUSION

In general, the most consistent results using the sticky pulp were obtained from the HDPE and the microfoam collection materials. The control pulp with the HDPE collection material had consistent and low results, indicating that the control was sticky-free and that the HDPE is probably the beat material to use for micro stickies collection.

This study shows that stickies are associated with fibers (through microscopic observation), and that the fibers are a part of the weight gain on the collection material.

This study also indicates the possibility that a cellulase enzyme could alter the surface of the sticky and change its affinity for the hydrophobic surface of the collecting material.

A sample of PSA-contaminated stock from the USDA Forest Products Laboratory did not have a measurable amount of micro stickies after it had been processed through their stock preparation system.

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