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Recyclability of New Postage Stamp Material

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Abstract

As the need for recycling of paper increases in the next several years, the quality and type of paper that is being recycled will significantly change. To increase the overall level of paper recycling further, less homogeneous and lower quality waste paper sources will need to be utilized. One such source is Mixed Paper which contains a variety of paper types. However, due to consumer sorting, which tends to remove corrugated, newsprint, and office paper, certain other paper types are concentrated in the remaining mixed paper. One such type of paper includes postal materials such as envelopes and stamps which recyclers will need to depend on more in the future. These papers have not been well studied as to their effects on the recycling processor the quality of the final pulp and paper products. This work is an initial study into the efficacy of current technology to remove those contaminants that are present in postage stamp materials.

In this work, pilot scale separation sequences were used to assessing the recyclability of postage stamp material. This has involved paper stock preparation, removing the contaminants, and measuring the contamination level throughout the process. Stock preparation included shredding and high consistency pulping. Following this, the pulp was diluted, screened, forward cleaned, flow-through cleaned, flotation deinked, and washed through a sidehill screen. Additional studies were done using a laboratory slot screen. Removal efficiency was measured by preparing dyed handsheets which were subsequently evaluated for dirt count using an Optimax Speckcheck. Several different levels of postage stamp material were investigated.

The results indicated that the stamped material can be pulped to free the pulp fiber from the adhesive and ink. The release coating in the material does not cause any problems and could not be detected. Much of the ink was removed in the forward cleaner, which is typical of inks having a density of greater than water. Conventional screening and cleaning processes were satisfactory for reducing the adhesive levels in the material. However, at high levels of contamination, additional sequence steps were necessary. Future work will include investigations into new technologies such as the use of enzymes and high-shear field separations.

Objective

Provide Technology and assessment of recyclability of new postage stamp materials

Summary

Pilot scale separation sequences have been established for assessing the recyclability of postage stamp material. This has involved paper stock preparation, processing the paper stock, and measuring the contamination level as the paper stock was processed.

Conclusions

- 1) The stamped material can be pulped to free the pulp fiber from adhesive and ink. The release coating was not detected and probably is released along with the ink or released separately. In either case the release coating does not appear to cause any problem and could not be detected.
- 2) Much of the ink was removed in the forward cleaner. This is typical for inks having densities greater than water.
- 3) Adhesive levels were satisfactorily reduced by conventional screening, cleaning, and flotation processes. Flotation was especially effective for removing adhesive particles in the mid size range.
- 4) Conventionally available equipment removed ink and adhesive material from the wood pulp slurry. At high levels of contamination, additional sequences are required for contaminant removal, but this is typical for any contaminated waste paper pulp.
- 5) The stamped material is recyclable.

Recommendations

Further development of recyclable stamped material could involve developing a stamped material which would be an example for all manufacturers of synthetic adhesives which are used for paper and paperboard applications. We offer the following observations and suggestions: the FPL, as well as many other laboratories, is currently developing technology for using enzymes for deinking waste paper. This new technology will undoubtedly become increasingly adapted as it is being demonstrated as more effective, less costly, and more environmentally friendly than the conventional chemical deinking processes.

Incorporating a small amount of water insoluble enzyme labile material in the adhesive portion of the stamped material could possibly make the stamped material much simpler to recycle. That is, the enzymes used to enhance the deinking of waste papers could also reduce the adhesive material to such small size that it would either not be a problem, or be easily washed out and be removed in the process water treatment step.

This development, if successful, could point the way for reducing a major technical barrier facing paper manufacturers who recycle waste paper. The problem of removing synthetic adhesives, called stickies, from pulp slurries derived from waste paper is a problem that is common to all waste paper grades and is a problem to the papermaker who recycles waste paper no matter what paper or paperboard product is manufactured.

Discussion of Results

Trial #1 Control, 100% Paper

In the 1.5-5-mm² speck range only three specks were observed in the six sample locations (see Figure 1 and Table 8). Above 5-mm², 16 specks were reported. For each of the six sample points the speck count stayed about the same, in the 7-16 particle range. Most of the particles detected were in the 0.02-0.1-mm range, and below. This represents the background dirt which must be subtracted from the other samples with stamped material which contain ink, adhesive, and release coating. It can probably be assumed that there are no stickies in this sample. Also, probably all the particles detected are dirt or ink specks. The speck check printout for this sample gives 45.7-ppm for the range of between 0.02-mm² and 5.0-mm². A recent report (Heller, P., and Griffin, A., Successful Start-up of a New Deinking Plant to Recycle Office Waste into Market Pulp, In TAPPI 1994 Recycling Symposium Proceedings, Boston, May 15-18, TAPPI Press, Atlanta, 1994) listed the specifications for dirt to be less than 20-ppm in the same size range and stickies to be less than 150-mm²/kg for commercial deinked market pulp.

However, the methods for measuring dirt and stickies has not been standardized yet. So we must measure what we consider to be satisfactory and compare our measurements to the published specifications in order to compare our measurements to target specifications. Assuming each stickie to be about one mg, then the stickie specification is less than 150-ppm. Assuming that our bond paper control sample is satisfactory in dirt count, then our 45.7-ppm should translate to at least as good as the less than 20-ppm specification recently published.

Trial #2, No Adhesive, 20% Stamps

This sample was similar to the control except 20% stamped material was substituted for the bond paper. The contaminant added in this trial was ink and release coating. After screening and cleaning (collection point #3) the speck count was as clean or cleaner than the control at the final sample point. The screen was effective in removing small particles of materials which were possibly ink attached to the release coating. The cleaner further removed small particles which were possibly ink. At any rate, the speck levels were reduced to below that of the Control after screening and cleaning. Ink specks were expected to be removed by the cleaners due to their high density. Apparently the release coating was either attached to the ink and removed with the ink, or else the release coating particles became so small they were not detectable. In either case the release coating does not appear to be a problem.

Trial #3, Envelopes with Stamps

This Trial consisted of 30% envelopes with one stamp per envelope. The resulting concentration was 0.35% stamped material on a dry solids basis. One wouldn't expect to see much difference between this Trial and the control. However, we did see a reduction of small particles after the flotation process to below that of the control. It appeared that the adhesive in the stamped material acted as a scavenger for the small particles, and that these small particles were removed by flotation. The result was that the dirt count in

the final sample point for this sample was less than that for the control at the final sample point.

Trial #4, 10% Stamps, 90% Paper

This Trial contained 10% by weight postage stamp material. As would be expected, the initial speck level was much greater than the control. Two separation processes were effective in reducing the number of specks. The cleaner removed significant specks, especially in the below 0.02-mm² range and in the 0.2-0.1-mm² range. The flotation cell removed particles in the 0.02-5-mm² ranges. Particles larger and smaller than that were not removed. The final number of specks for this sample was much greater than the control and was unacceptable from both ink and adhesive level.

Trial #5, 20% Stamps, 80% Paper

Additional processing was included for this Trial. Flow through cleaning, flotation, and sidehill screening were added. As would be expected, the initial sample after pulping was very high in particle count. Again as in Trial #4, the cleaner and flotation steps were very effective in reducing particle counts. After the first six steps this trial resulted in particle counts similar to that of the previous trial even though the stamp level was double for this trial. The additional removal steps resulted in particle counts somewhat similar to the control in the smaller ranges, but higher in the higher particle size ranges. The final dirt count was 190.6-ppm compared to 47.5-ppm for the control. The dirt count at sample point six, before the additional cleaning was added was 743.4-ppm. The reduction due to additional processing suggests that even further similar separation processing would further reduce the particle counts. Additional separation processing is usual for mills producing printing and writing grades of paper from recycled waste paper.

Trial #6, 10% Stamps, 90% Paper

Reducing the level of stamped material from 20% to 10% on a dry basis, did not change the results of the particle counts between the two trials. At the sixth sample point the dirt count was 599-ppm and at the final sample point, 226-ppm. Again, further separation processing is indicated.

Trial #7, 5% Stamps, 95% paper

Reducing the stamped material to 5% from 10% on a dry basis resulted in particle counts similar to the control. Both ink and adhesive levels were reduced to that of the control. This trial resulted in satisfactory contamination removal, and the additional processing steps were needed.

Experimental

Seven trials were performed. Each trial consisted of a series of processing steps: pulping, screening through 0.012" slots to remove large particles, 3" forward centricleaning to remove high density particles, flowthrough centricleaning to remove low density particles, flotation deinking to remove residual ink and other responsive debris, and, lastly, washing using a 70-mesh sidehill screen to remove ash and very small particulates.

Table 1 is an equipment list.

Step one: Stamp and paper preparation

Eight rolls of stamps were received: seven with adhesive and one without. All rolls were shredded upon receipt into 1/4"-wide strips using a heavy-duty paper shredder. Random lengths, about 12-15", were cut from the supplied rolls and fed to the shredder. Shredded stamps from each roll were kept segregated from the each other.

A "post-consumer" trial used commercial business envelopes having one stamp each. The entire envelope was shredded as above, resulting in the stamp also being shredded.

Table 2 gives the feedstock for each trial.

The various concentrations of stamps in the pulper were accomplished by diluting the shredded stamp (or envelope) stock with commercial copy paper, also shredded into 1/4" strips. This paper was selected since it contains fillers, presumed to be at the same concentration as the fillers in the envelopes. Since flotation is affected by filler content the "preconsumer" trials would have the same approximate filler level as the "post-consumer" trial.

For each trial, samples from the various rolls were included to allow the feedstocks between trials to be fairly uniform. See Table 3.

Step two: Pulping

Pulping involved repulping either twelve or nine batches of feedstock per trial in order to provide sufficient slurry for the subsequent steps. Initially, twelve batches were made when a pulping time of 10 minutes proved acceptable. When feedstocks included adhesive were tried a 20 minute pulping time was required and the total trial time dictated that only nine batches could be made. This reduced amount of pulp was still adequate for conducting the trial. In each trial the pulped batches were thoroughly blended into a single batch before beginning the screening.

Table 3 details the pulping conditions for each batch for each trial.

All batches contained 5 kilograms feedstock in 50 L total volume (10% consistency). Feedstock weight was on an air-dry (as-received) basis. Target pulping conditions were 49 degrees C (120 degrees F) at pH 10.

Each trial was conducted on the same day as the repulping to minimize any degradation due to the soaking at high pH.

(Upon completion of all trials all remaining shredded stamps were destroyed by pulping. During this step the following was learned: 100% stampstock could be completely pulped in about 20 minutes; cold water worked fine; a high pH was unnecessary. No attempt was made to further process this pulp.)

Screening

Blended slurry from the pulping was diluted to about 4% consistency for pumping purposes. Temperature when diluting was maintained at about the 49 degree target level. After thoroughly mixing the stock a 4-liter sample was saved. The slurry was then pumped to the flatscreen where it was further diluted using about 49 degree water. Accepts passing through the 0.012" slots were pumped to a stock tank and diluted to about 0.70-0.75% consistency at about 49 degrees C. Rejects from the screening were bagged and returned to the cooperoperator. A 4-L sample of the accepts was saved.

Centricleaning

The 0.70-0.75% target consistency stock was pumped through the forward cleaner (feed pressure 40 psi, back pressure 14 psi). Three cleaners were run in parallel. Rejects (1/8" dia. tip opening) were collected and drained in a screencart. Accepts passed to a 150-gallon surge tank and then pumped through the flow-through cleaner (feed pressure 30 psi, back pressure 12 psi). Rejects (core diameter was 5/8") were collected and drained in a screencart. Accepts were pumped to a stock tank where the entire batch was thoroughly blended. A 4-liter sample was then saved.

Since the surge tank between the two cleaners could not hold the entire batch the 4-liter sample was collected from the flowing stream of accepts after the cleaner was running for about 5-10 minutes and it was at thermal equilibrium. It is assumed that this sample collected as the accepts sample for the forward cleaner for the forward cleaner is representative of the entire batch.

After Trial four (20% stamps) it appeared that the flowthrough cleaner was overloaded with adhesive. It was decided that a second pass through the flowthrough cleaner would considerably reduce the residual adhesive in the accepts. Trials five, six, and seven had two passes through the flowthrough cleaner. A 4-liter sample was collected after each pass.

Flotation and washing

When the accepts from the flow-through cleaner were completely mixed a 70-liter sample of the stock was pumped to the laboratory flotation unit. A flotation aid was added (Hercules DI-600: 1.05 gram = 0.2% of fiber weight) and thoroughly mixed. Aeration commenced and sustained for 10 minutes. Foam was removed at first by simple overflow and then manually using a scraper blade. Air was shut off after 10 minutes and while mixing the cleaned slurry a

4-liter sample was removed from the bottom of the unit. The remaining stock was allowed to flow by gravity from the same bottom drain to a 70-mesh laboratory sidehill screen where free drainage removed water and small particulates. Sidehill accepts were saved. A 10-liter sample of the washwater reject stream was also saved.

As indicated above Trials 5-7 had two passes through the flowthrough cleaner. The flotation and washing steps were carried out both on the accepts after the first pass and on the accepts after the second pass.

Laboratory slot screening

Before centricleaning three 20-liter carboys of slurry were saved. For trial one this sample was collected from the feed tank preceding screening. Because of the large quantity of screening rejects in that trial it was decided that more reliable data could be gotten using screening accepts rather than screening feeds for this phase of the study. Therefore, for Trials two through seven the three carboys were filled from the screening accepts tank before commencing centricleaning.

From one of the carboys a sample was removed and 4000 grams 4000 ± 1 grams weighed out, then slot-screened through a small laboratory unit. Rejects were carefully removed and dried on a filter pad and weighed. Accepts drained in a 100-mesh screenbox. A sample of the accepts was saved for analysis. The unit was thoroughly cleaned and the process was repeated using a sample from the second carboy; likewise from the third carboy. The slot size was then changed and three samples were screened as before. Two additional slot sizes were similarly used: a total of four slot sizes were evaluated.

This procedure was followed for each of the seven trials.

Table four contains the data for this phase of the study.

Speckcheck Analysis

Handsheets were made according to Tappi T205. Sheets were conditioned to TAPPI conditions. The sheets were then dyed with a solution of hexane and Morplas Blue 1003 (0.67 grams of Morphas Blue 1003 in 1000ml of hexane). the sheets were then evaluated for dirt count using an Optimax Speckcheck instrument (this uses a Hewlett Packard ScanJet IIc flatbed 400 dpi scanner which is connected to a Dell 486 Dimension computer). The range of particles reported was from 0.02 mm^2 to 5.0 mm^2 . (Same range as used on Tappi Dirt estimation Chart T437 om-90).

Table one: Equipment List

Pulper: Voith, high consistency, laboratory, model HD-0.05

Flatscreen: Impco, atmospheric, 6-plate bronze vat

Forward cleaner: Bauer, 3", model 600-N, with 1/8" tip opening.

Flowthrough cleaner: Black-Clawson, 3" X-Clone

Flotation unit: Denver, 90-liter, laboratory, model no. 8

Sidehill screen: FPL-made, 70-mesh

Table two: Feedstock for Trials

Trial one	:	030794	:			100%	copy paper
Trial two	:	030894	:	20%	no-adhesive stamps	+	80% copy paper
Trial three	:	030994	:	30%	stamped envelopes	+	70% copy paper
Trial four	:	031094	:	10%	stamps	+	90% copy paper
Trial five	:	031494	:	20%	stamps	+	80% copy paper
Trial six	:	031594	:	10%	stamps	+	90% copy paper
Trial seven	:	031694	:	5%	stamps	+	95% copy paper

Table three: Pulping Conditions

Trial - Batch No. No.	Temp. deg.C	Alkalinity pH	NaOH added ml.	Pulping Time min.	Stamp Roll I.D.
030794 - 1	39.1	10.00	70	10	n/a
- 2	47.2	10.08	70		
- 3	48.5	10.04	80		(copy paper)
- 4	47.6	10.00	75		
- 5	44.5	9.99	75		
- 6	47.0	9.99	70		
- 7	49.0	10.05	68		
- 8	48.4	10.02	68		
- 9	47.8	10.03	69		
- 10	48.2	10.02	69		
- 11	48.0	10.02	71		
- 12	48.5	10.04	--		
030894 - 1	48.6	10.07	90	10	(stamps with no adhesive)
- 2	46.6	10.10	70		
- 3	45.1	9.98	70		
- 4	48.8	10.07	65		
- 5	46.8	9.99	65		
- 6	46.9	9.99	68		
- 7	48.5	10.07	60		
- 8	47.3	10.06	65		
- 9	47.5	10.02	60		
- 10	47.4	10.03	60		
- 11	48.2	10.01	60		
- 12	47.2	10.02	50+		
030994 - 1	49.1	10.04	50		(envelopes)
- 2	48.4	10.06	50		
- 3	48.0	9.99	51		
- 4	49.0	10.01	51		
- 5	48.2	10.00	45		
- 6	49.2	9.99	45		
- 7	48.8	9.99	50		
- 8	47.6	10.06	<50		
- 9	49.0	10.07	<40		
- 10	47.9	10.01	<20		
- 11	48.7	10.07	30		
- 12	48.2	10.01	30		

Table three con't: Pulping Conditions

Trial - Batch No.	Temp. deg.C	Alkalinity pH	NaOH added ml.	Pulping Time min.	Stamp Roll I.D.
031094 - 1	48.5	10.02	40	20	1A2Y
- 2	49.4	9.95	50		1A1X
- 3	47.5	10.00	55		1A1X
- 4	49.2	10.00	50		1A2Y
- 5	48.2	10.00	50		1A2X
- 6	47.5	10.00	50		1A2X
- 7	47.9	10.00	40		1A1Y
- 8	47.6	10.00	40		1A2X
- 9	48.9	10.03	<40		1B1Y
031494 - 1	47.3	10.03	50	20	1A2X
- 2	49.0	10.00	<20		1A2Y
- 3	47.0	10.02	<20		1A2Y
- 4	48.0	10.06	15		1B2X
- 5	49.0	10.05	50		1B1Y
- 6	48.5	10.03	50		1A2Y
- 7	47.6	10.00	50		1A2X
- 8	48.6	10.00	50		1A1X
- 9	49.6	10.06	40		1B1X
031594 - 1	47.9	10.00	50	20	1B2X
- 2	48.7	10.03	50		1A1Y
- 3	49.4	10.03	50		1A1Y
- 4	47.7	10.00	<50		1A2X
- 5	49.1	10.06	50		1B2X
- 6	47.2	10.04	50		1B2X
- 8	48.3	10.04	45		1A2Y
- 9	47.3	10.06	--		1B1Y
- 10	49.3	10.06	--		1A1X
(BATCH 7 NOT USED: LARGE STRINGY AGGLOMERATION PRESENT -roll 1B1Y)					
031694 - 1	47.5	10.00	55	20	1A1Y
- 2	48.6	10.06	50		1B2X
- 3	48.7	10.06	50		1A2Y
- 4	48.6	10.02	50		1B2X
- 5	47.0	10.02	50		1A2X
- 6	49.6	10.05	50		1A1Y
- 7	48.1	10.06	45		1A2Y
- 8	48.3	10.03	50		1B1X
- 9	47.0	10.01	55		1A2Y

Table four: Laboratory Slot Screen Analysis

TRIAL #	FEED STOCK	REJECTS (% of O.D. Feed)				
		SLOT SIZE (inch)				
		0.012	0.010	0.008	0.006	0.004
1	COPY PAPER	0.008	0.038	0.038	0.023	
2	STAMPS, no adh.		0.035	0.069	0.139	0.104
3	ENVELOPES		0.060	0.060	0.030	0.090
4	10% STAMPS		0.1316	0.1494	0.1185	0.1617
5	20% STAMPS		0.1737	0.2218	0.2097	0.2358
6	10% STAMPS		0.1309	0.1242	0.1341	0.1411
7	5% STAMPS		0.0761	0.0607	0.0693	0.0700

Table 5: Sidehill Screen Rejects Analysis

Sample I.D.	BOD	Total Suspended Solids (a)	Total Dissolved Solids (b)	Total Solids (a+b)
	mg/l	g/l	g/l	g/l
030794-1-7	286	0.697	0.659	1.356
030894-2-7	355	0.804	0.624	1.428
030994-3-7	289	0.937	0.588	1.525
031094-4-7	283	0.662	0.469	1.131
031494-5-7	295	0.631	0.624	1.255
031494-5-11	247	0.694	0.567	1.261
031594-6-7	313	0.803	0.423	1.226
031594-6-11	307	0.901	0.378	1.279
031694-7-7	211	1.012	0.549	1.569
031694-7-11	205	0.775	0.637	1.412

Table 6: Speckcheck Dirt Count Data

Trial No.	Trial Description	Dirt Count									
		no. particles per 10 sheets/ area (pct x E-03)									
		sample collection point									
		1	2	3	4	5	6	8	9	10	
1	control	96	92	103	123	74	104				
	100% paper	5.5	5.0	5.6	7.7	4.2	6.2				
2	no adhesive	257	51	28	70	89	58				
	20% stamps	26.2	4.0	1.2	4.7	6.7	2.6				
3	envelopes	120	102	83	95	52	35				
	w/stamps	30.1	12.6	12.4	5.7	2.5	5.8				
4	10% stamps	1406	1420	876	523	160	224				
	90% paper	818.9	409.6	501.7	174.9	74.1	77.1				
5	20% stamps	2456	1508	1147	881	206	196	497	112	109	
	80% paper	1800	531.2	690.6	319.3	91.3	115.8	107.3	24.0	20.6	
6	10% stamps	887	742	656	763	175	160	256	288	227	
	90% paper	690.7	291.0	474.5	555.2	66.0	76.9	73.8	25.6	31.6	
7	5% stamps	420	482	335	220	111	109	207	178	89	
	95% paper	435.0	196.0	133.2	69.5	48.3	66.9	49.2	29.4	15.1	

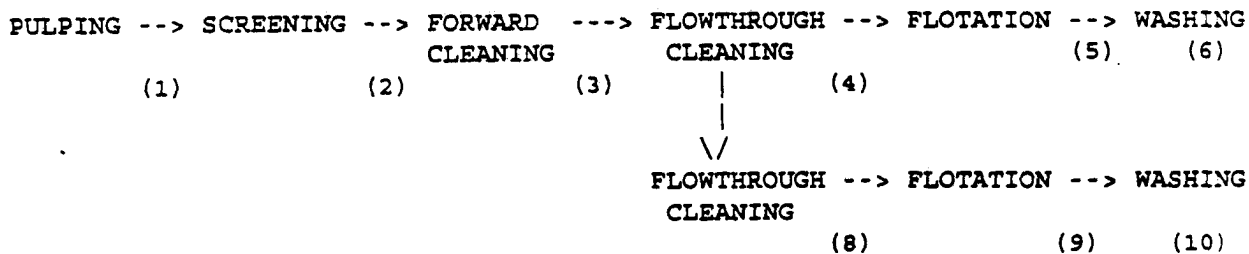
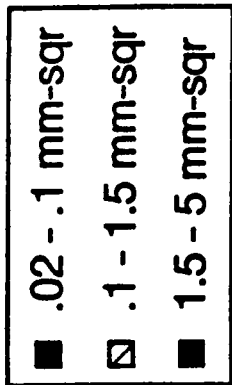


Table Seven: Screening Substudy Analysis

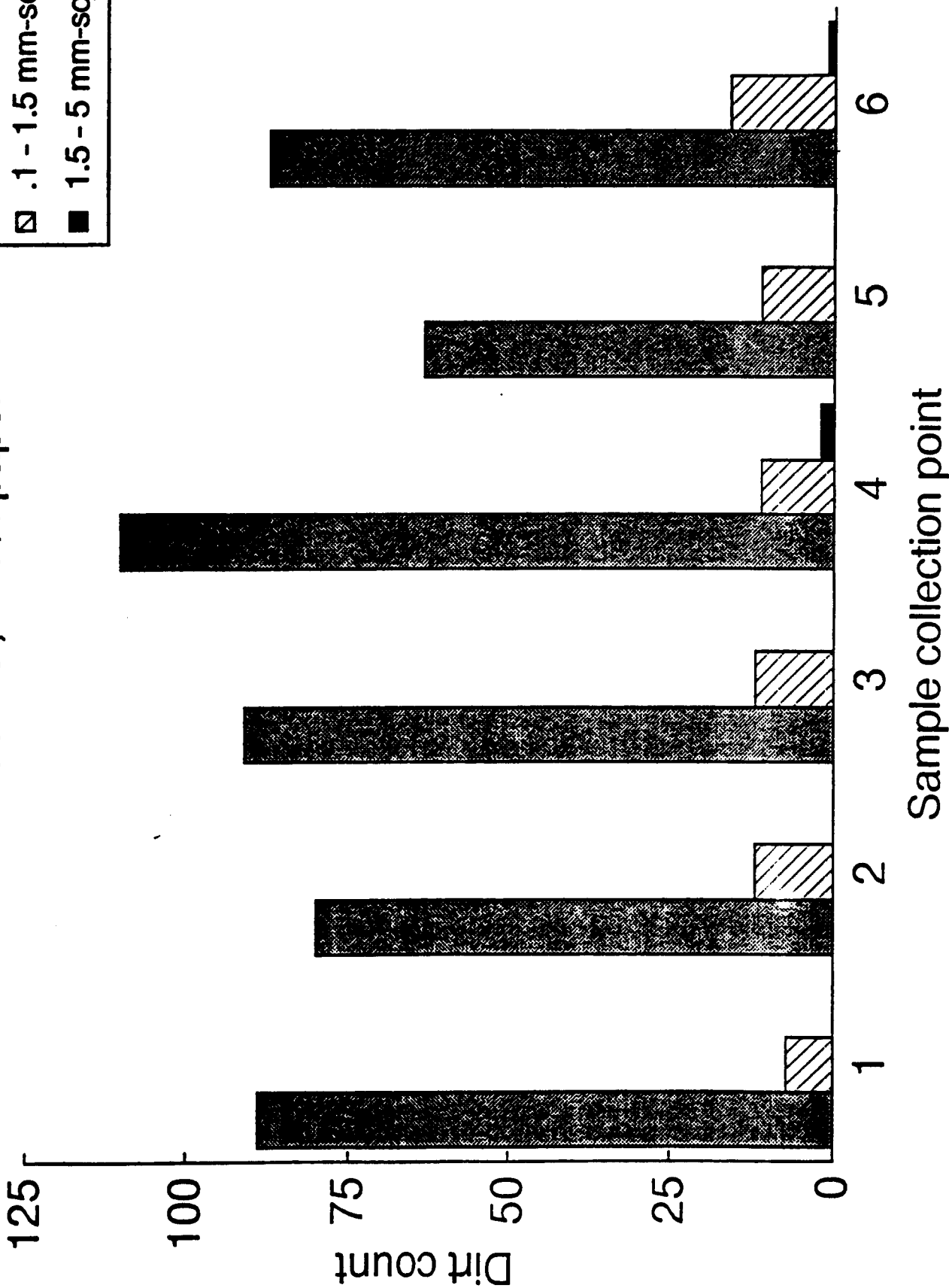
Trial No.	Sample Description	Dirt Count				
		<u># of particles: area of particles (µ x µ-3)</u>				
		Screen Slot Size (inch)				
		0.004	0.006	0.008	0.010	0.012
1	control		89: 4.7	76: 3.6	134: 5.8	132: 6.9
	100% paper		90: 5.6	72: 3.0	132: 7.9	113: 5.8
			36: 1.7	63: 3.0	104: 6.6	69: 3.4
						92: 5.0
2	no adhesive	254: 15.9	278: 20.3	269: 16.6	242: 15.0	
	20% stamps	280: 19.4	202: 13.1	249: 15.3	215: 14.1	51: 4.
		167: 14.6	256: 15.8	242: 14.8	258: 14.7	
3	envelopes	151: 6.4	210: 17.1	77: 4.6	108: 7.5	
		276: 16.5	123: 11.6	192: 10.9	163: 10.2	102: 12.
		94: 5.6	96: 6.1	165: 7.4	152: 10.8	
4	10% stamps	981: 65.7	1480:169.6	1044: 88.2	1247:111.9	
	90% paper	926: 58.9	1247:155.8	1011: 72.4	1288:102.3	1420:410.
		871: 53.0	1136:113.8	926: 69.6	996: 92.7	
5	20% stamps	1442: 90.9	1643:220.1	1271:103.5	1497:187.9	
	80% paper	1245: 82.4	1257:174.2	1677:147.9	1518:160.4	1508:531.
		1366: 82.4	1678:220.0	1591:120.9	1331:164.9	
6	10% stamps	551: 43.1	792:110.9	549: 62.8	694: 73.9	
	90% paper	535: 34.4	697: 93.6	874: 83.8	639: 77.0	742:291.
		636: 44.7	775: 97.1	867: 71.4	702: 75.8	
7	5% stamps	450: 32.4	471: 67.8	544: 38.3	503: 38.9	
	95% paper	521: 33.2	629: 63.6	400: 35.5	433: 40.5	482:196.
		267: 23.1	503: 73.4	601: 45.8	725: 64.6	

Table 8 Speck Counts

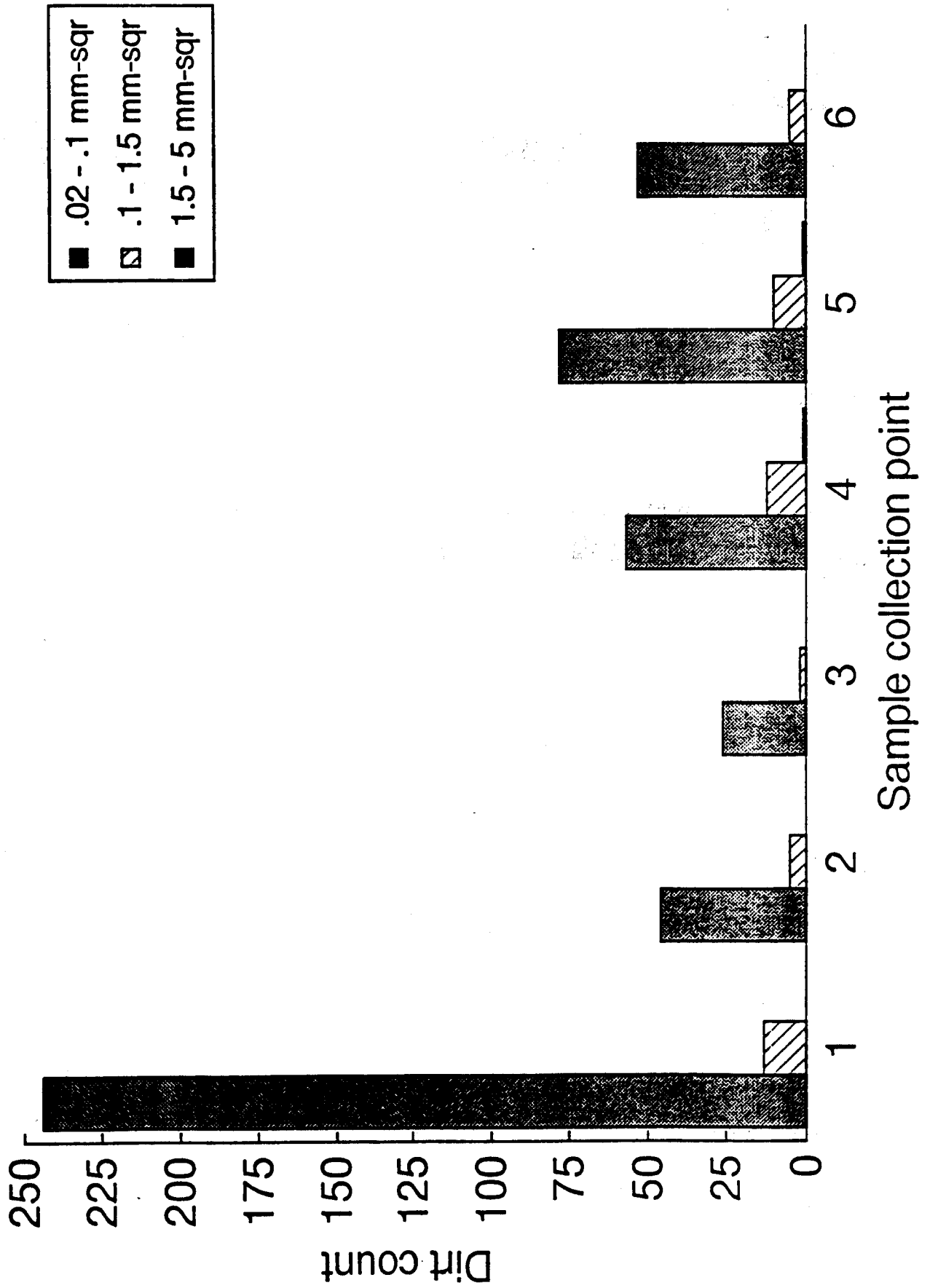
Trial	Sample Location	Number of Specks				
		< 0.02 mm	0.02-0.1 mm	0.1-1.5 mm	1.5-5.0 mm	> 5.0 mm
1	1	240	89	7	0	4
	2	203	80	12	0	5
	3	249	91	12	0	1
	4	305	110	11	2	0
	5	181	63	11	0	2
	6	317	87	16	1	4
2	1	5252	244	13	0	2
	2	637	46	5	0	0
	3	86	26	2	0	3
	4	286	57	12	1	1
	5	299	78	10	1	4
	6	193	53	5	0	0
3	1	299	88	26	6	3
	2	274	71	27	4	1
	3	179	58	21	4	2
	4	357	68	27	0	3
	5	56	34	18	0	0
	6	63	32	3	0	2
4	1	4724	897	383	126	64
	2	6957	1026	317	77	31
	3	506	347	413	116	30
	4	380	242	234	47	7
	5	307	99	41	20	5
	6	405	143	55	26	3
5	1	10612	1661	601	194	152
	2	6705	969	441	98	32
	3	707	398	602	147	45
	4	819	357	439	85	13
	5	444	118	61	27	10
	6	386	109	52	35	14
	7	923	286	183	28	7
	8	381	89	16	7	4
	9	303	80	25	4	3
6	1	5063	546	259	82	75
	5	2949	414	258	70	18
	2	424	242	311	103	33
	3	507	273	361	129	36
	4	363	131	30	14	10
	5	301	99	37	24	7
	6	302	133	99	24	3
	7	679	220	65	3	5
8	394	170	49	8	6	
7	1	1505	242	122	56	49
	2	2656	358	107	17	10
	3	466	187	118	30	8
	4	292	101	99	20	2
	5	267	74	16	21	7
	6	196	54	28	27	6
	7	336	117	78	12	3
	8	799	151	21	6	4
	9	375	76	11	2	7



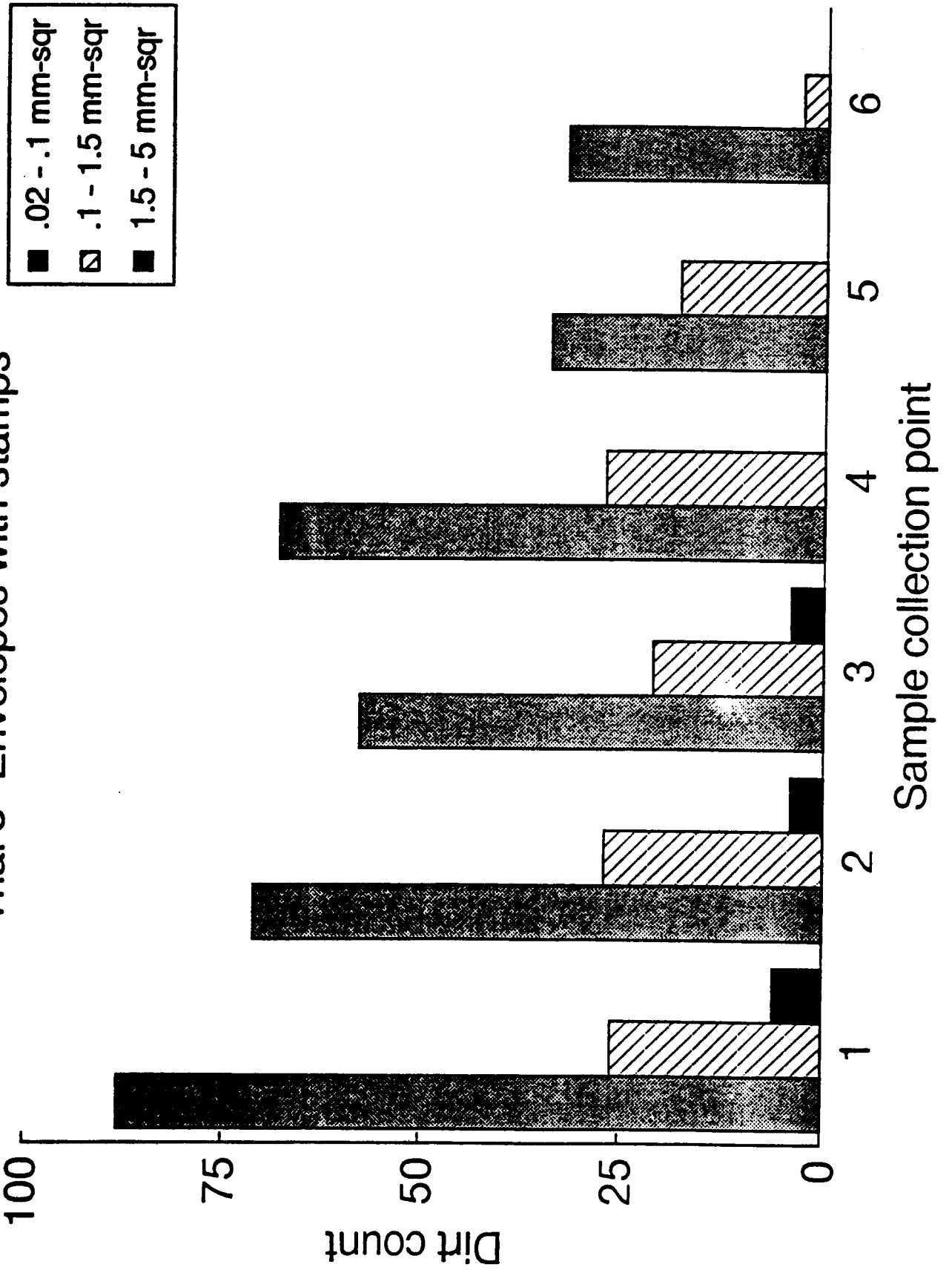
Trial 1—Control, 100% paper



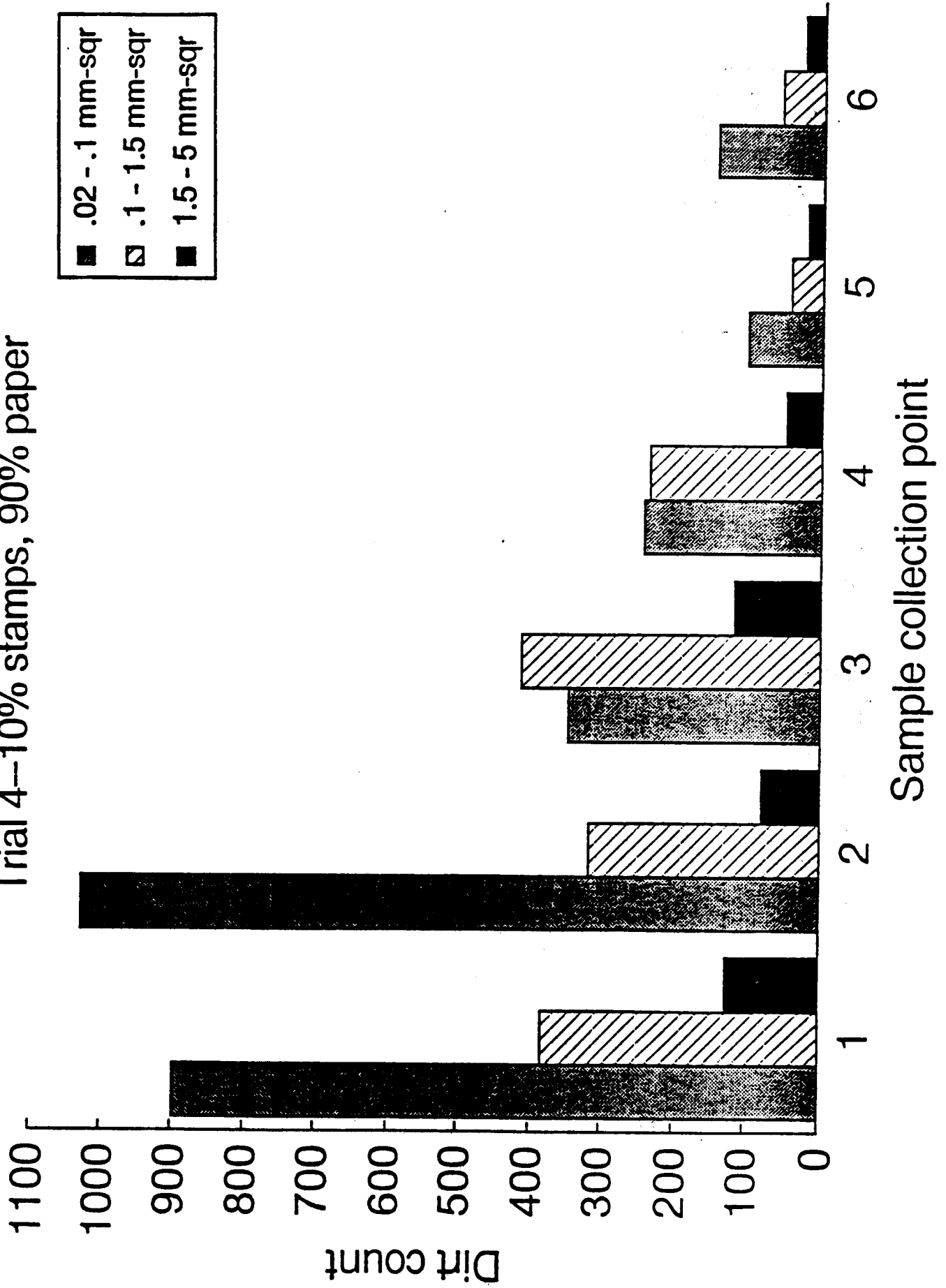
Trial 2—No adhesive, 20% stamps



Trial 3--Envelopes with stamps



Trial 4--10% stamps, 90% paper



Trial 5--20% stamps, 80% paper

