Recycling of Foil Stamped Board/Stock

The Foil Awareness Committee for the Foil Stamping & Embossing Association (FSEA) has recently taken on the responsibility and initiative to begin a campaign to educate many sectors of the graphic arts and design communities on sustainability and other environmental issues in regards to foil stamping and embossing.

Certain groups and companies have been making false allegations about foil stamping and its ability to be recycled once it has been stamped, as well as claiming other environmental concerns with the process. With the surge of green initiatives surfacing from all different directions, we have made the decision to become extremely proactive on this front.

Our first step is to conduct a research and development study from a 3rd party company to certify and confirm that foil stamped products are completely recyclable.

We have contacted an organization in the UK that completed a similar study several years ago (PIRA). They have provided us with a proposal for the completion and update of this study. If you would like a full copy of the proposal, simply send me an e-mail and I will be glad to forward it to you.

From our evaluation of the proposal, we are recommending that we conduct tests on approximately 5 to 6 samples that would be foil stamped with different levels of coverage all the way up to 100% coverage. We also are suggesting that the study include 5 or 6 samples that are applied with a cold foil process to show that foil applied in either process is completely removable through the de-inking recycling process.

To begin raising the appropriate funds for this initial study and for future environmental initiatives, the FSEA Board of Directors has approved an amount of $2,000 to start this "Special Project Fund" from FSEA reserves. We are now asking our FSEA members to become involved and contribute funds toward this first study and help support continued efforts for the future.

We believe that this is the first step in our proactive attempt to combat any untruths about foil stamping and its use. We have attached a form that has been developed for contributing to the fund, with a suggested contribution based on your company's industry sales. Any contribution is accepted and appreciated.

All funds that are donated to this special fund will be used for initiatives directly related to environmental issues affecting our association and industry. They will not be used for any other purpose.

If you have further questions or comments, please contact me. I will be glad to discuss this initiative with you. We appreciate in advance your help with this very important project. We believe that the FSEA can utilize the information from this study and future initiatives as an opportunity to put foil stamping on the top of the list as an "environmentally friendly" process. Your support and financial help will make this happen. We look forward to hearing from you.

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Pira Report

Testing Group

Repulpability of foil – decorated paper

Pira reference: S.008909

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1. Introduction

Pira International was approached by the Foil Stamping and Embossing Association (FSEA) to carry out repulpability testing on paper samples decorated with foil by hot and cold stamping. The test method was adapted from published methods from INGEDE (International Association of the Deinking Industry) and FINAT (International Federation for Self Adhesive Labels). These standard methods were developed for assessing issues arising from recycling adhesive-coated products but have been found effective in addressing repulping issues with other materials.

Two sets of samples were tested:

- Hot-stamped foil laminates (600 sheets 1020 x 720 mm) on 540micron folding boxboard base with 3 die images using gold foil (API MV4001+) from Foil Ribbon, UK
- Cold-stamped foil laminate (via Scienta, Cardiff UK)

2. Test methods

2.1 Test method selection

The methods were adapted from 'INGEDE Method 12' and 'FINAT FTM-19'. Both methods are summarised below. Each method is aimed at replicating industrial conditions, for deinking and for 'standard' recycling. Both methods involve repulping the material to be evaluated along with clean paper pulp, then screening the pulp through a slotted screen.

The INGEDE method applies typical deinking processes to re-pulping and chemical conditions, and evaluates the material caught by the screen. It does not consider the impact of material passed through the screen on downstream processes. The FINAT method applies typical paperboard recycling conditions, and evaluates the contaminants in the pulp both before and after screening. The method does not require evaluation of the rejects caught by the screen but evaluates the material which has passed through the screen. It is a more laborious and costly method due to the need to collect and test all the material screened and not just rejects.

The reason for the amalgamation of both methods is to combine the quantification of basic repulpability of the INGEDE approach with the measurement of contaminants prior to screening inherent in the FINAT method, which method also provides an assessment of potential problems in contamination of paper machine drying cylinders or felts by stickies. Test handsheets were made from pre-screened stock as described in the FINAT method in order to evaluate the load on the screens.

The material caught by the screen was measured as described in the INGEDE method to evaluate the effectiveness of the screening process.

The following levels of foil coverage on the sheet were tested:

- Hot Foil: 25% foil, 50% foil, 75% foil and approximately 100% foil
- Cold Foil: 100% foil

In addition, unstamped samples of the hot-foil base stock were tested as experimental control in order to show whether any of the particles trapped by the screen originated in the base sheet.

2.2 Test protocol

2.2.1 Sample requirements and preparation

- Sample required: 3.5g product
- Augment to 70g with bleached hardwood pulp (from FINAT FTM-19 Recycling Compatibility of Self-adhesive Labels – recycled fibre is 5% of total furnish)

2.2.2 Pulping

- Recycling conditions: 5% disintegration; adjusted to pH 10-11 with sodium hydroxide caustic soda at 45^{0}C;

2.2.3 Sheet-forming from unscreened disintegrated stock –

- pH7, 2g sheets
- 5 sheets pressed at 90^{0}C between filter papers

2.2.4 Screening - as-described in INGEDE 12

- 100 um slotted screen (Sommerville)
- Collect screened residue

2.2.5 Reject assessment

Weigh rejects as for INGEDE 12, hot-press rejects as for FINAT FTM-19

- Collect rejects on pre-weighed filter papers
- Dry and weigh
- Hot-press between filter papers

2.2.6 Size of metallic particles

As an additional exercise, the particle size range of the metallic particles was estimated by microscopic measurements of particles visible on the surface of the handsheets. The size was estimated using a calibrated graticule in the microscope eyepiece. The sampling was not statistically rigorous but was intended to provide a guide as to the particle size range.

2.3 Reporting results

- Total weight of particles passed through screen (ie weight added – weight collected)
- Whether sample sheets stick to upper or lower filter paper after hot-pressing
- Whether sample sheets are damaged after peeling from filter papers
- Whether sheets contain visible contaminants (visible impurities or transparent spots)
- Representative digital images
- Comparison of pre and post screening results
- Assessment of whether recycling problems could be anticipated.

3. Results

3.1 Hot stamped foils

3.1.1 Handsheet adhesion testing

Table 1 **Handsheet results – hot foil**

Handsheet Testing			
Foil %	Forming		Observations (see photos)
	Hot pressing	Peeling	
0	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, no evidence of visible contaminants
25	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, evidence of glittering particles
50	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, evidence of glittering particles
75	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, evidence of glittering particles
100	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, evidence of glittering particles

The adhesion results in Table 1 show no stickie adhesion between the handsheets for any of the foil coverage levels. There was no evidence of transparent spots or 'fisheyes', though glittering particles were present – see Images in sections 3.1.3 and 3.1.4 later.

3.2 Screening

Table 2 **Summary of screening results – hot foil**

Somerville Screening			
	Weight of particles (g/10g dry fibre)		
Foil %	Collected g/10g dry	Passed through g/10g dry	Observations (see photos)
0	0.05	9.95	All fibre particles from board
25	0.06	9.94	Mostly fibre particles from board, slight glittering particles. One large particle of laminated board.
50	0.06	9.94	Mostly fibre particles from board, some glittering particles. One large particle of laminated board.
75	0.07	9.93	Mostly fibre particles from board, some glittering particles
100	0.06	9.94	Mostly fibre particles from board, some glittering particles

The screening results in Table 2 show that there are fibre-like particles from the repulping of the original board substrate that are retained on the screen. Their origin is confirmed by the fact that the amount collected on the screen remained constant with increasing foil content. The small glittering particles originated from the foil laminate itself. Some were retained on the screen, but the majority passed through.

Table 3 **Particle count of collected material– hot foil**

Total particle count –left on screen		
	Average count (per 100cm^2)	
Film %	Fibrous material	'Glittering particles'
0	3967	0
25	4617	233
50	4667	350
75	5333	467
100	5367	1033

The particle count in Table 3 shows an increase, with increasing film coverage, in the count of both the fibre-like material and the glittering particles collected on the screen.

3.3 Cold stamped foils

3.3.1 Handsheet adhesion testing

As no undecorated control sample was provided, the contribution of the base stock to screenings and particles was assessed by reference to the original base sheet. Intermediate levels of foil coverage were not assessed as only 100% covered samples were supplied.

Table 4 **Handsheet results – cold foil**

Handsheet Testing			
Foil %	Forming		Observations (see pictures)
	Hot pressing	Peeling	
0	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, no evidence of visible contaminants
100	Samples did not stick to upper or lower filter paper	No damage when peeled from filter paper	No evidence of transparent spots, evidence of glittering particles

* Results for 0% taken from previous hot foil samples

From Table 4, the cold foil samples gave the same results for the handsheet tests as the hot foil samples and showed no evidence of stickies or 'fisheyes'.

3.3.2 Screening

Table 5 **Summary of screening results – cold foil**

Somerville Screening			
Foil %	Weight of particles (g/10g dry fibre)		Observations (see photos)
	Collected	Passed through	
0*	0.05	9.95	All fibre particles from board
100	0.06	9.94	Mostly fibre particles from board, some glittering particles

The screening results for the cold foil at 100% coverage were the same as for the hot foil with a small proportion of particles collected by the screen – Table 5

Table 6 **Particle count of collected material – cold foil**

Total particle count – left on screen		
	Average count (100cm²)	
Film %	Fibres	'Glittering particles'
0*	3967	0
100	183	83

The particle count in the screened material showed fewer fibre clumps and glittering particles than with the hot foil – Table 6.

3.4 Size of metallic particles

From random sampling of areas on the handsheets, the majority of the particles fell into the range of 200-400 microns in the largest dimension. There were minority populations of small and large particles of 50-200 microns and 200-500 microns respectively in their largest dimensions. This was largely true for both hot and cold foil samples. However, more detailed particle size analysis should be undertaken for an accurate particle-size distribution.

3.5 Density of metallic particles

During the Somerville screening exercise, it was observed that the metallic particles tended to separate from the bulk of the screened fibre and accumulate in the bottom of the receiving tank. This observation suggests that the density of the particles is sufficiently high to allow separation in the centrifugal cleaners of a mill stock preparation. This could be verified by further experiment. A small proportion of the larger particles were seen the float on the surface of a diluted hot foil sample in a beaker, but this was due to wetting and surface tension effects on the foil flakes when the sample was repulped under neutral pH, which would unlikely to prevail in a mill situation.

4. Discussion

There is no evidence that either the hot or cold foil gives rise to stickies, hickies or 'fisheyes'. The fibrous material present in the hot foil screened rejects originates in the board only, being equally present in the 0% and 100% coverage hot foil samples. The material is largely long kraft fibre from the coated outer layer of the board and would be removed or dispersed by deflakers in a recycling mill.

The cold foil sample showed much lower levels of fibrous material as screened rejects. This is believed to be a function of the relative strength and toughness of the different base stocks beneath the hot and cold foil samples. The base of the hot foil sample was harder to disintegrate than the cold foil base. This is an important observation since it confirms that the fibrous portion of the rejects originated in the base stock and not the foil.

The metallic foil specks largely passed through the screen. In a recycling mill, it is likely that they would be removed by centrifugal (cyclone) cleaning of the thin stock. This has been verified by centrifugation tests in the laboratory. A small proportion might end up distributed between the product and the paper machine back water system where they would probably tend to concentrate in backwater tanks or savealls. How much of a problem this would pose would depend on the efficiency of the cleaner system, the product grade and the proportion of the foil laminates to other recycled materials in the fibre furnish.

5. Conclusions

- The main conclusion is that both the hot and cold foil decorated samples tested in this work would cause no problems in repulping.
- On the basis of our findings, neither the hot nor the cold foil decorated samples would give rise to problems with stickies or with visible specks of undispersed polymer – 'hickies' or 'fisheyes' – in the paper.
- The undispersed fibrous particles captured in the screening process with the hot foil samples originated in the base stock and not the foil; there were no equivalent particles with the cold foil base.
- The higher density of the metallic particles from the foil indicates that they can be separated by thin stock centrifugal cleaners ('hydrocyclones').

6. Recommendations - re-use of repulped foil decorated material

- The repulped material tested in this work would be suitable as a minority component (<5%) of the fibre furnish for the following recycled grades: fluting medium, inner plies of solid boards, book binding boards and white-top liners, spirally-wound tube and core stock. The rationale is that the metallic particles would be unlikely to cause an aesthetic problem in these grades.

- If the metallic particles can be removed by centrifugal cleaners, then bleached foil decorated stock could be used in bleached grades depending on the fibre source – chemical or TMP - used in the original stock. Unbleached fibre could be used in linerboards, sack kraft and bag grades.