Recycling Paper Food Packaging with Corrugated Cardboard:

A Proposal for a New Recyclability and Repulpability Protocol and Preliminary Test Results for Fiber-Based Hot Cups

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Introduction

Working with corporate partners, Global Green USA seeks to develop paper fast food packaging that can be collected and recycled with corrugated cardboard, closing the loop on the paper packaging, reducing greenhouse gases, and assisting municipalities in reaching their solid waste diversion goals. To ensure that paper packaging that enters the OCC stream is of high value, a protocol would need to be developed to ensure the value of paperboard packaging in the OCC recycling stream.

Recognizing the financial and logistical burden caused by non-recyclable corrugated treated with a moisture barrier, the Fibre Box Association and American Forest and Paper Association, developed a protocol that voluntarily certifies treated corrugated as recyclable and repulpable utilizing process technology either in effect or readily achievable in mills currently involved in recycling.

Utilizing the corrugated protocol as a template, Global Green USA and Western Michigan University feel that with minor modifications, a new protocol can be develop that certifies paper food packaging as recyclable and repulpable with the OCC stream. Similar to FBA's protocol for treated corrugated, the proposed protocol would establish a screening method to determine the repulpability and recyclability of treated paperboard products within the container board stream. The test method would consist of two parts:

- Repulpability determined by fiber yield when only the treated paperboard is processed in accordance with this standard.

- Recyclability evaluated by its effect on mill operations and finished products when it is added to untreated corrugated in the amounts specified.

The following paper outlines the modifications that need to be made to the existing protocol, includes, a draft protocol, and preliminary results from initial testing of two brands of fiver-based hot cups.

Western Michigan University's Coating and Recycling Pilot plant performed initial bench top research on two brands of hot cups mimicking the Fibre Box Association's protocol for treated corrugated. One brand passed repulpability standards while the other failed. Through WMU's experience, it appears that there is a very large amount of usable fiber from cup stock heading unnecessarily to landfills and cups could be designed for repulpability that could be integrated within OCC or mixed waste paper streams.

Both initial tests conducted by WMU and proposed adaptations to the FBA protocol are designed to initiate a dialog and further study regarding opportunities to design paper packaging for recovery and to close the loop on our resources.

Who We Are

Global Green USA's Coalition for Resource Recovery

Global Green USA's Coalition for Resource Recovery is an industry working group that helps businesses increase profits by transforming waste into assets. The Coalition identifies and promotes effective waste diversion technologies and programs through conducting pilots in New York City. Members of the Coalition for Resource Recovery include: Action Carting, Chemol, International Paper, Interstate Container, Plasma Waste Recycling, Pratt Industries, Spectra-Kote, Starbucks Coffee Company, and Tomra. For more information, please visit: www.thecorr.org.

The Coalition for Resource Recovery is a project of Global Green USA (Global Green). Started in 1994, Global Green is the US arm of Green Cross International, which was founded by President Mikhail S. Gorbachev to foster a global value shift toward a sustainable and secure future by reconnecting humanity with the environment.

Western Michigan University Coating and Recycling Pilot Plant

WMU has a long history in paper science. The paper engineering program was started in 1948. Starting in the late 1950's pilot facilities were built at WMU's campus. In the late 1970's a recycling pilot plant was built and has been updated and added to till this day. This is 1 of only 3 pilot labs certified to perform the FBA wax replacement protocol. In the last few years we have taken this protocol and modified it as needed to do repulping and recycling testing on many other fiber based products is pet food packagine, packaging materials, frozen food packaging….

WMU has performed proprietary research specific to individual customers till this point. WMU believes we are in a position to help all cup stock makers, French fry package makers, and any other fiber based food packaging organization achieve a tested and statically based certification to help educate the public on the need for recycling drink and food packaging. For more information, please visit: www.wmu.pilotplants.com.

Prologue to Draft Protocol

The following is a draft version of the protocol to voluntarily certify paperboard food packaging as recyclable and repulpable within the corrugated stream. In preparing this draft, the following items areas were identified where dialogue and additional research is needed to develop an operational draft of the protocol.

Percentage of Paperboard Food Packaging Expected to Enter the OCC recycling stream

The Fibre Box Association's protocol for treated corrugated compares the results between a sample containing a mix of treated and untreated corrugated and a sample containing solely untreated corrugated. The proportions of the mixed sample are 20% treated and 80% untreated. The 20% treated corrugated is designed to reflect a percentage four times that which can be expected in the OCC stream. In developing a new protocol, an appropriate percentage of treat paperboard that would enter the OCC stream would need to be developed.

Appearance Tests

FBA's test for treated corrugated compares the appearance between treated and untreated corrugated handsheets as part of the recyclability tests. More information is needed on the impact of bleach and dyes on the value of the fibre to corrugated mills and on appropriate appearance tests given this difference.

Recyclability Logo

The FBA has developed a modified Corrugated Recycles logo that can be used by all treated corrugated designs that pass the protocol and submit paper work to the FBA. A logo or other form of visual designation would need to be developed to identify paperboard food packaging that passes the new protocol.

Governing Body

Manufacturers that pass the standard for treated corrugated submit certifications to the FBA. FBA then monitors and ensures proper use of the Corrugated Recycles symbol. A third party entity would have to be designated to play a similar role for a new voluntary standard.

Draft Protocol

Purpose

1. This standard establishes a repeatable method for simulating a commonly used subset of repulping and recycling processes. It is intended to evaluate the impact of repulping and recycling treated paperboard on containerboard mill operations and final products.

2. This standard establishes a method for identifying treated paperboard that can be repulped and recycled in this selected subset of processes. It establishes minimum levels of performance for the handsheets made from treated paperboard, repulped and recycled in accordance with a detailed test protocol given in Appendices A & B. This standard is not intended to preclude the development or use of any technological advances in mill or treatment processes. It is intended to encourage the development, use and repulping and recycling of treated paperboard products for use in high-moisture environments or exposed to grease.

Scope

1. This standard applies repulping and recycling process technology either in effect or readily achievable in mills currently involved in recycling.

2. This standard establishes a **screening method** to determine the repulpability and recyclability of treated paperboard with corrugated.

3. The test method in this standard has two parts:

Part 1 determines the **repulpability** of treated paperboard by determining fiber-on-fiber yield when only the treated paperboard is processed in accordance with this standard (Appendix A).

Part 2 determines the **recyclability** of the treated paperboard by evaluating its effect on mill operations and finished products when it is added to untreated corrugated in the amounts specified (Appendix B).

4. This voluntary standard does not relieve the user from compliance with all applicable local, state and federal laws and regulations, and contractual agreements.

5. This standard is not intended to address the functionality or marketability of the treated paperboard or of mill products that use the treated corrugated as a fiber source.

6. This standard does not address all of the factors that should be considered in the development of a repulpable and recyclable treatment. The companies that develop treatments and treated paperboard and test them under this standard are responsible for making sure that, in addition to being repulpable and recyclable, the products will be safe and suitable for their intended applications— e.g., packaging in contact with food— and will not create other non-desirable environmental effects at the point of use or disposal.

7. Treated paperboard containers recovered for recycling should not be contaminated by their contents, such as hazardous or perishable materials.

Definitions of Key Terms

Fiber yield is the amount of fiber that remains after the processing action, expressed as a percentage of the fiber present in the material (based on initial mass of treated sample) to be tested.

Handsheets are sheets made from a suspension of fibers in water in an operation, whereby each sheet is formed separately by draining the pulp suspension on a stationary sheet mold.

OCC (Old Corrugated Containers) is a grade of waste paper comprised of untreated corrugated boxes that have been used for the purpose for which they were originally purchased and have subsequently been source separated from other waste.

Recyclable means used paper, including in-plant and post-consumer waste paper and paperboard, which is capable of being processed into new paper or paperboard using the process defined in this standard.

Recyclability test sample consists of a minimum of percentage by weight (tbd) of the treated paperboard to be tested and the remainder of the untreated corrugated.

Repulpable means the test material that can undergo the operation of re-wetting and fiberizing for subsequent sheet formation, using the process defined in this standard.

Treated paperboard is the paperboard that has been subjected to a specific treatment for the purpose of improving its performance in the presence of water, water vapor, or grease. The level of treatment used in the test must be equal to or greater than the level of treatment to be used in the field.

Untreated corrugated/control is corrugated that has not been subjected to any treatment to improve performance in the presence of water, water vapor, or grease.

Test Method

Preliminary Analysis: Before beginning the test protocol, determine the moisture content of the treated paperboard sample.

PART 1: Repulpability

A 100% charge of treated paperboard is repulped in a Modified Waring Blender and a British Disintegrator in water at a pH of 7 (±0.5 pH) that is maintained at 125°F (±10°) following the procedure outlined in Appendix A. The pulped material is separated in a screen with 0.010-inch or smaller slots to determine fiber recovery as a percentage of the amount of fiber charged.

Detailed procedures for repulpability are given in Appendix A.

PART 2: Recyclability

Mix a minimum percentage (tbd) treated paperboard and the remainder of the untreated corrugated in a pilot laboratory-scale pulper at pH 7 (±0.5 pH) and 125°F (±10°). This is the recyclability test sample. As a control, a charge of 100% of the untreated corrugated is also pulped using identical conditions. Each pulped material is passed through (in succession) a pressure screen equipped with a basket with 0.062

inch holes, the same screen or a similar screen equipped with a basket with 0.010 inch slots and a reverse centrifugal separator under conditions specified in the procedure

Handsheets (3.0 gram) are made from the final stage (cleaner) accepts. For each batch tested, the handsheets are pressed and dried with heat and tested for product performance properties. Properties include slide angle, short span compressive strength (STFI), bursting strength and water drop penetration, using the established TAPPI official test methods. Appearance tests shall be done according to the procedure outlined in Appendix B. The final sheets shall have no more than 15 spot counts, or not exceeding 30% greater counts than the control, with an area of ≥ 0.4 mm2 area, averaged over 3 sheets. The properties and appearance of the handsheets from the recyclability test sample and untreated corrugated tests will be compared. Detailed procedures for recyclability are given in Appendix B.

PART 3: Performance Levels

Treated paperboard satisfying all of the requirements of the voluntary standard will be regarded as repulpable and recyclable. There are three general performance requirements: fiber yield, operational impact and product requirements.

Fiber yield from the repulpability test must be at least 80% based on the total weight of the initial mass of the treated sample.

Operational impact is acceptable if:

1. The entire procedure can be completed without using an acid wash to clean the flat screen in the Repulpability Test or dismantling the pressure screens to clean them before finishing the Recyclability Test, and

2. There is no visible deposition on any part of the disintegrator during the Repulpability Test or in the pulper during the Recyclability Test.

Product requirements are satisfied if:

1. The appearance of the handsheets made from the recyclability test sample shows no substantial difference from that of the handsheets made from the control and the spot count is ≤ 15 counts, or not exceeding 30% greater counts than the control, with an area ≥ 0.4 mm2, averaged over 3 sheets.

2. The decrease in the slide angle of the handsheets (the average of five first slides) made using the recyclability test sample from the slide angle of the handsheets made from the control must be no greater than 15%.

3. STFI and burst strength of the handsheets made using the recyclability test sample, normalized to the sheet basis weight, must show no more than a 10% decrease from the respective values for the control. All test results are to be reported in English units.

4. The water drop penetration of handsheets made from the recyclability test sample must not exceed the water drop penetration of the control handsheets by more than 200 seconds.

Certification and Marking (Self-Certification)

1. Tests for Parts 1 and 2 are repeated twice. For each set of tests the results for the first treated sample must be compared to the results for the first untreated sample tested. Similarly, the results of the second treated sample must be compared to the results of the second untreated sample. If the recyclability test sample passes all tests on both trials, it satisfies the standard. If it passes all tests on one trial, but fails some on the other, it may be retested in a third trial. The recyclability test sample must pass all tests in the third trial to satisfy the standard.

2. Manufacturers of treated paperboard or paperboard treatments may self-certify their own product by using any capable laboratory, working in accordance with the detailed protocol provided in this standard. The laboratory may be internal to the company or a third party laboratory. All laboratories (internal and third party) shall certify that their facilities and equipment are suitable for testing the tendered product within the instructions and tolerances of this standard. Treated paperboard must be recertified if there is any significant change in treatment product, substrate chemistry or any increase in the ratio of treatment to fiber.

   The substrate chemistry will be considered to have been changed, requiring recertification, if wet strength chemicals, a high level of sizing chemicals or other chemicals significantly affecting the repulpability of the substrate (which were not used in the original certification test) are used in conjunction with the previously approved treatment product.

   Once a treatment material has been approved at one location, it does not have to be recertified to be used at another location, if it is applied at the previously approved, or lower, treatment-to-fiber ratio and is applied on the same grade of paperboard.

   Minor modifications to a treatment material, which do not affect the water resistance or recyclability of the treated paperboard, will not require recertification, as long as the treatment material is sold under the same trade name. If the treatment material chemistry is modified sufficiently to require a change in product name, it has to be recertified. Likewise, if the chemistry of the treatment material is changed such that the water resistance is increased or the recyclability of treated paperboard could reasonably be expected to be more difficult, the treatment material has to be recertified. Any treatment material that is sold as a proprietary product for one specific box manufacturer, or for a group of box manufacturers, must be tested to be certified.

   The completed test report from Appendix C must be submitted to FBA. Reports will be de-identified for review on an as-needed basis.

3. Marking

   If the repulpable/recyclable certification marking (to be developed) is used, it must clearly appear on the box with the box manufacturer's name and location. See Appendix D for guidelines on use of this symbol.

Appendix A: Repulpability Test Procedure

Purpose

To determine the repulpability of paperboard in containerboard mills. (Note that the Repulpability Test must be run at least twice on the treated paperboard. The sample must pass two out of three tests.)

APPARATUS

- Specimen Cutting Device
- Balance (accurate to 0.01 gram)
- Waring Blender (with special blade, see Figure 1)
- Hot Water 125° F ± 10° F (52° C ± 5° C)
- British Disintegrator (Standard Apparatus for Pulp Evaluation No. 270)
- Open Flat Screen 10 Cut (0.010”), such as the Valley or Somerville screens
- Aluminum Weighing Pans
- Laboratory Oven at 221°F (105°C)

SPECIMEN TESTING (sample refers to paperboard or corrugated, depending on test being run)

1. Cut sample into 1 1/4 in. (31.8 mm) by 4 in. (102 mm) strips.
2. Weigh out .055 lb. (25 gm.) of sample.
3. Place sample in 1500 ml. of water at 125° F ± 10° F (52° C ± 50 C).
4. Preheat blender and British disintegrator to 1250 F ± 100 F.
5. Blend in a one-gallon Waring blender (equipped with special blades) on low speed (15,000 rpm) for four minutes.
6. Rinse all fibers from the blender with 500 ml. of hot water.
7. Deflake for five minutes in the British disintegrator (2000 ml. total volume) at 3000 rpm.
8. Run on .010” (.254 mm) slotted open flat screen, maintaining 1” water head, – for 20 minutes; save the accepts and rejects in aluminum weighing pans.
9. Dry in a laboratory oven for 12 hours (± 4 hours) at 221°F (105°C).
10. Weigh the pans and record the net weight of accepts, rejects, and the sum of the accepts and rejects.

CALCULATION

$$\% \text{ of Rejects} = \frac{\text{Net Rejects} \times 100}{\text{Net Accepts} + \text{Net Rejects}}$$

REPORT

Percentage of rejects to the nearest 0.1%.

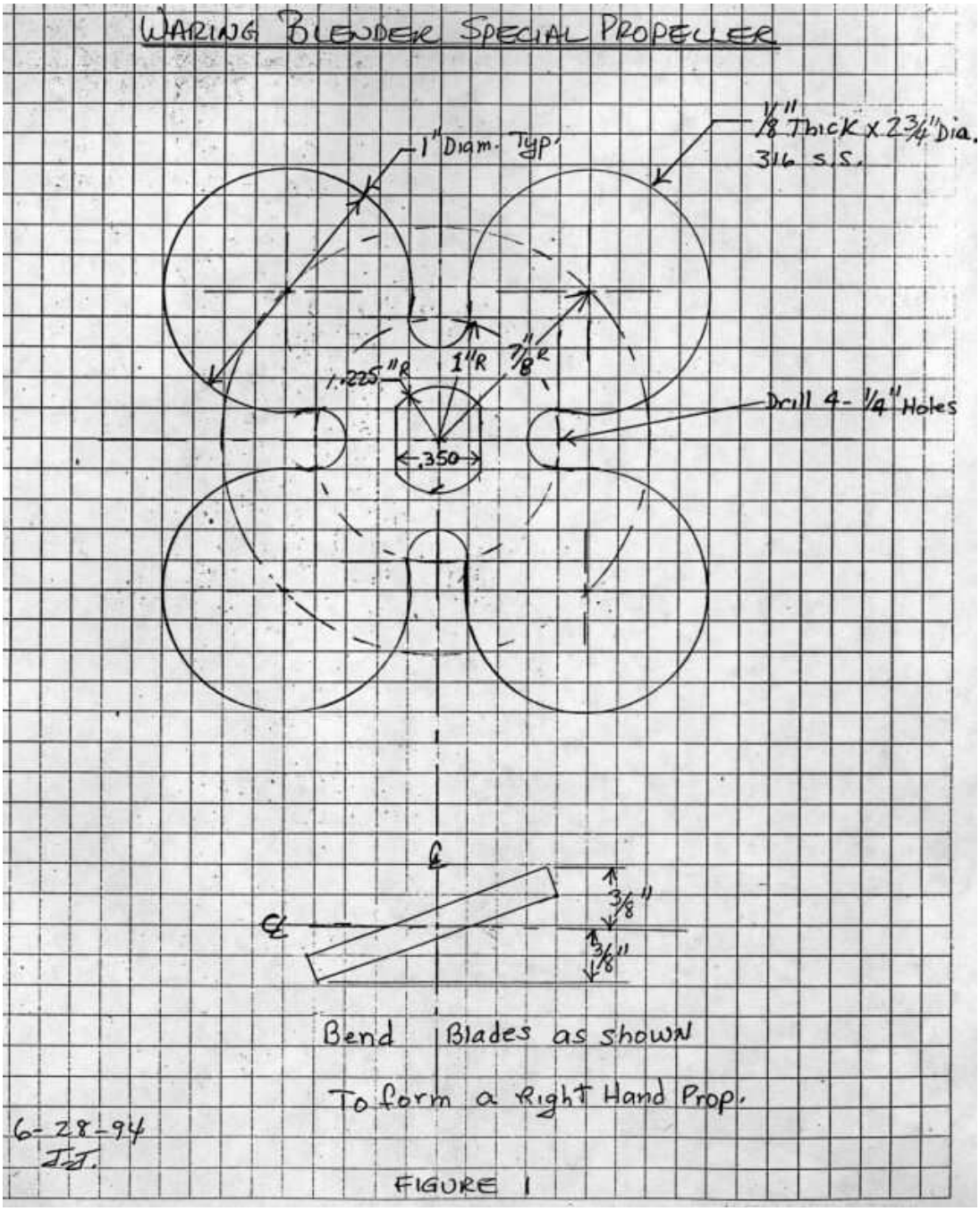


FIGURE 1

Appendix B: Recyclability Test Procedure

Note: Both the Control sample and the sample of Treated and Untreated test material must be tested at least twice and must pass two out of three tests.

1. Obtain a sample of the treated paperboard to be evaluated. From this sample, select a sufficient amount of material for the test. The selection should be as representative as possible of the material as a whole. Also obtain a sufficient amount of untreated corrugated to run the protocol. Selection of the charge size will depend upon the capacity of the pilot plant pulper to be used. Pulping is to be carried out at 3% consistency, or, at the consistency recommended by the pulping equipment manufacturer.

2. Determine the moisture content [TAPPI T 412]. Perform steps 3 through 9 twice—once with the untreated "control" sample, once with the "recyclability test sample."

3. Use selected sample materials of any convenient size, but no smaller than 1 x 1 inch square. Bring the equipment to 125°F (±10°). Adjust the pH of the charge so that after pulping the pH will be equal to 7 (± 0.5 pH). Raise the temperature of the pulper to 1250F (±100). Charge the pulper and pulp for 15 minutes while maintaining 125°F (±10°).

4. Repeat step 3 until sufficient material has been obtained for the following steps. Maintain the temperature of the pulp at 125°F (±10°) until it is used in step 5.

5. Combine the pulp from several batches, as necessary, and dilute to the manufacturer's recommended consistency with water heated to 125°F (±10°). Adjust the pH to 7 (± 0.5 pH). Preheat a screen with 0.0625 inch holes to 125°F (±10°) and maintain the temperature throughout this screening step. Pass the pulp sample through the preheated screen at a volumetric reject rate of 10% of the feed rate or at appropriate volumetric reject rate based on manufacturer's specifications or recommendations.

6. With the accepts from step 5, repeat the procedure in step 5, using a screen basket with 0.010 inch slots, again maintaining the temperature, consistency and a 10% reject rate or at a rate based on manufacturer's specifications.

7. Pass the accepts from step 6 through a lightweights reverse centrifugal-type cleaner, maintaining the temperature at 125°F (±10°), consistency, and the pressure differential specified for the cleaners being used. Determine the volumetric reject rate and report.

8. From the accepts from step 7, form handsheets according to TAPPI T 205 with the following conditions:

    - The slurry should be vigorously agitated (without causing a change in fiber distribution in the slurry) and maintained at 125°F (±10°) and pH 7 (±0.5 pH).

    - Dry the sheets under restraint to 7% moisture content on a surface dryer maintained at 250 – 275°F.

- Recondition to TAPPI standard conditions prior to testing.

Test the handsheets for:

- Basis Weight [TAPPI T220]
- Slide Angle [TAPPI T 815]
- Short Span Compression (STFI) [TAPPI T 826]
- Bursting Strength [TAPPI T 810]
- Water Drop Penetration [TAPPI T 831]

Note 1. The Slide Angle test on the handsheets is to be tested blotter side to blotter side.

Note 2. The Water Drop Penetration test is to be conducted with five (5) drops each on the wire side and the blotter side of the handsheets.

Note 3. Basis Weight, STFI, Bursting Strength and the Indexed Value are to be reported in English units.

9. If the test must be halted to clean any post pulping apparatus in any aspect of the procedure, note your observations on the test report.
10. Report the results using the form provided (Appendix C).

HANDSHEET PREPARATION FOR STICKIES/SPOT COUNT TEST

1. Plug in Carver press and pre-heat top and bottom platens to 350° F.

- Caution: use gloves and wear safety glasses when using Carver press – the plates get very hot and can burn you.

2. Dilute test stock to approximately 1% consistency.
3. Form and dry a 500 ml check sheet.

- Couch off the excess water with two blotters, the round metal plate, and the roller.
- Dry on top of a new blotter in the speed dryer.

4. Weigh the handsheet and mark its identification and dry weight on the topside of the handsheet (not the wire side).
5. Calculate the amount of slurry to use for test sheets using the following formula:

   - 2.00 grams ÷ dry sheet weight x 500 = mls of slurry to use for test sheets.

6. Form 3 handsheets for testing by using the calculated amount of slurry.

7. Place sheets on blotters and dry on the speed dryer, then mark their identification on the topside of each sheet.

8. Remove test sheets from the speed dryer (drying period is 3-5 minutes).

9. Place each test sheet between filter paper and blotters in the following configuration (bottom to top):

Blotter
Filter
Stickie Sheet
Filter
Blotter

10. Set the stacks of test sheets on top of each other and press them in the pre-heated Carver press for five minutes at 350° F and 500 psi. Watch to see that the pressure gauge maintains 500 psi.

11. Remove the test sheets from the Carver press and weigh each sheet.

    - Record dry weight on each sheet.

12. Count the spots in the handsheets that are ≥ 0.4 mm2 in area using any appropriate analysis tools, such as the dirt count estimator in TAPPI T-537 or the image analysis system mentioned in TAPPI T-277 and TAPPI T-563.

Initial Hot Cup Research Using Modified FBA Protocol

Conducted and summarized by Joel Kendrick, Western Michigan University Pilot Coating Plant

Western Michigan University's Coating Pilot plant performed initial bench top research on hot cups with 3 sizes of 1 brand, referred to further as cups A1, A2, A3, and 1 size of another brand referred to further as cup B.

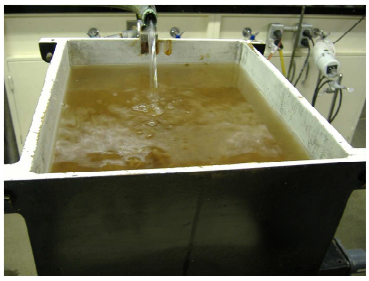
OCC Clippings for Control Group

Part 1, the repulpability component, of the FBA protocol was mimicked. Part 2, the recyclability component of the FBA protocol, requires full scale pilot plant equipment. Since there were not enough cups for a pilot scale evaluation, methods were modified to bench top scale. This should be noted as it is not possible to simulate full scale pilot equipment with bench top. You can get false positives or false negatives.

Procedure:

Part 1: Repulpability

The 4 different cups were pulped using a modified Waring blender and British Disintegrator. Each batch was weighed before pulping. Slurried pulp samples were run over a 0.010" slotted vibrating screen to determine accepts vs. rejects. According to the FBA standard, rejects exceeding 15% of initial weight are considered not suitable for repulping. All 3 cups labeled A passed. Cup B had rejects of 22.7%. It failed repulping and will not be tested for recyclability in Part 2.



Screening Out Contaminants

Part 2: Recyclability

This procedure was modified from the FBA standard part 2. Using a Morden Slush maker we pulped 4 lbs. of 100% OCC with 130 ºF water. Slurried pulp was screened as described in part 1. Next, the accepts fiber was collected and handsheets were made for paper properties testing. Then we repeated the process with a blend of 80% OCC and 20% of equal portions of A1, A2 and A3. All the cups included hot sleeves and were flattened out to simulate bailed cups.

Part 3: Performance Levels

4 of 5 tests the FBA standard calls for were performed on the 100% OCC sheets and the 80/20 blended. The 5th test, STFI, was not tested do to the testing equipment issue.

Burst Strength (Index) T-403

Rep	Control 100% OCC	Rep	80/20 Blended
1	17.67	1	17.24
2	16.61	2	15.99
3	17.53	3	15.08
4	16.83	4	14.16
Avg	17.16	Avg	15.62

Is the indexed burst of the treated recyclability test sample no more than 10% lower than the untreated control test sample? Yes

Slide Angle T-815

Rep	Control 100% OCC	Rep	80/20 Blended
1	36	1	30
2	34	2	32
3	34	3	35
4	32	4	36
5	35	5	35
Avg_C	34.2	Avg_R	33.6

85% $Average_C$ = 29.75

Is 32.3333°>/= 29.75°? Yes

Stickies Count

	Control		
Rep	100% OCC	Rep	80/20 Blended
1	9	1	6
2	11	2	10
3		3	
Avg_C	10	Avg_R	8

Is the spot count ≤ 15, or, no more than 30% greater than the control? Yes

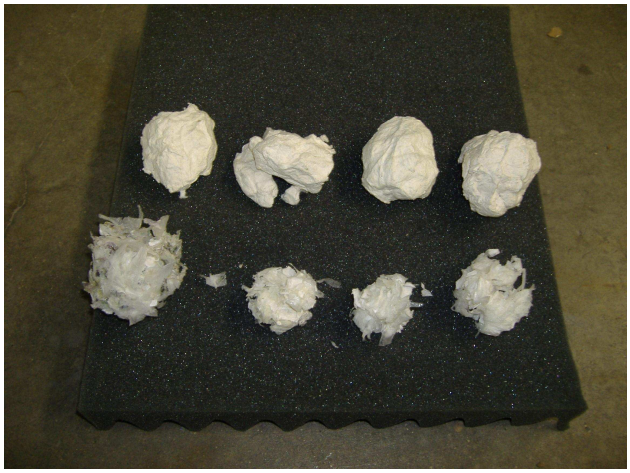
Water-Drop Penetration T-831

Both 100% OCC and Blended sheets were less than 3 seconds. This is a pass.

As you can see from the results the 20% loading into an OCC stream appears not to be an issue. All 4 tests passed the protocol's requirements.

Additional Experiments Performed:

As a side experiment, sheets were made from 100% repulped cups also. Optical properties were tested.



From L to R: Cup B, A1, A2, A3. Top is accepts and bottom is rejects from part 1 repulpability test.

Brightness	T-452		Opacity	T-425	
	Cup A	Cup B		Cup A	Cup B
1	75.8	74.3	1	80.1	80.3
2	74.5	73.5	2	79.9	80.9
3	75.2	74.4	3	80.3	80.8
4	76.0	74.6	4	79.8	81.1
5	76.6	74.7	5	79.6	80.6
6	76.0	74.2	6	80.2	80.5
7	76.4	74.8	7	79.5	80.5
8	75.9	74.7	8	79.9	80.2
9	76.1	74.4	9	80.1	80.5
10	76.3	74.4	10	80.3	80.8
Avg	75.9	74.4		80.0	80.6

Conclusions:

Cups A1-3 certainly appear not to be an issue for a recycle mill using OCC. These cups appear to have a PE lining inside. Cup B also appears to have a PE lining but it failed part 1. It is worth noting again the difference between bench top and pilot scale research, and that this experiment targeted an OCC stream only.

It appears, through WMU's experience, that there is a very large amount of usable fiber from cup stock heading unnecessarily to land fills. This data also shows that fiber based hot cups are not equal and may not be suited for recycling. From this experiment and our expertise in recycling trials I believe there could be a recyclable standard for hot cups.