



Purpose: Evaluate 2 papaya box samples “Kirkland” and “New World Farms” for basis weight of components, Edge crush test (ECT) and estimation of % recycle fiber content.

Background:

A fundamental strength property of shipping boxes is the edge crush test which is usually related linearly to the basis weight of the components comprising the corrugated board. More strength per unit basis weight is achieved when using virgin rather than recycled pulp. The fraction of recycled pulp in this project is estimated on the basis of comparative microscopic images and counting the individual fibers according to various classifications. The standard comparison is made to a microscopic image of a known 100% virgin linerboard. Recycled fibers are those that are not expected to be found in a furnish and fibers that appear to be fragmented or fibrillated from mechanical defibering action in the repulping process.

About IPST Paper Analysis Laboratory:

Paper Testing at IPST has over 2800 square feet of lab space dedicated to address any paper, board, and specialty product testing needs in areas of strength, optical, surface, and structural properties. In addition to conventional TAPPI method testing capabilities, the Paper Testing group can provide special services in the areas of environmental simulations and accelerated aging. Environmental chambers cover high and low temperature and humidity conditions. Unique capabilities include precision paper grinding or sheet splitting to produce specific thickness sections, score cracking of linerboards, needle abrasion testing to predict relative slitter and knife blade wear caused by abrasive components in both base sheet and coating materials, nondestructive in-plane and out-of-plane (Z-directional) ultrasonic testing, optical 3D Moiré surface topography for the measurement of curl or cockle. Our labs also offer the latest automated capabilities for real time hygroexpansive response measurements, and horizontal plane static and kinetic coefficient of friction determinations. Humidity and temperature

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conditions are monitored and tracked continually to ensure proper standard TAPPI conditions of 23°C and 50 % RH.

Data from the IPST Paper Analysis Laboratory have been validated through IPST participation in the Collaborative Testing Services Inc., and PAPRICAN Paper and Pulp Monitor programs. Internal checks by comparison of selected samples with their historic data and regular instrument calibrations using standards are standard procedures. This ensures that the equipment, methods and results are consistent with correct industry practice.

Methods:

Standard Tappi methods are used in most tests unless otherwise specified. Measurements consist of 6 or more repeats per sample.

Basis weight of components - 9 x 12 inch samples were weighed to 3 decimal places, soaked in water, the layers peeled apart then equilibrated at 20% RH to dry and followed by conditioning at 50% RH then weighed. C flue was assumed with a take up factor of 1.43 for the medium actual length in the calculation of grams per unit area.

Edge Crush Test – samples were cut using a Billerud cutter for the horizontal edges 2 x 2” and tested using method T 839 with an L&W compression tester, 10 readings per sample were made.

% Recycle estimation - Graff C stain is applied to microscopy slides prepared from disintegrated pulp. 122 milligrams of each sample component was disintegrated into 100 ml of water using a Waring Blender at medium speed for 40 seconds. 4 0.11 drops are placed of each such pulp slurry on a microscopy slide and stained with Graff C stain. Unbleached kraft shows up as yellow bleached kraft shows as gray. The assumption is made that virgin corrugated board consists of unbleached softwood kraft fibers that would appear several millimeters long without fibrillation or fragments indicating mechanical repulping action. Magnification of 40X is used for general observation and fiber counting, 100X and 400 X is used for species identification when required. Comparison of test slides with slides prepared from 100% virgin bleached

softwood kraft show indicate that an average count of 153 long fibers can be expected in a standard slide scanning count. Therefore, the % recycle is based on one of 2 formulas:

- 1) If long fiber counts > 153, % Recycle = $\{1 - (\text{bleached kraft count}) / \text{total fiber count}\} \times 100$
- 2) If long fiber counts < 153, meaning some of the long fibers have been fractured:
% Recycle = $\{1 - \text{long fiber count} / 153 + \text{kraft count} / 153\} \times 100$

Data:

Most measurements consist of at least 6 repeats or more whenever possible.

A comparison of significant differences between samples can be gleaned through comparison of the results with error bars representing the 95% confidence intervals of the results from repeated measurements for each sample. Values with overlapping error bars cannot to be considered to be statistically significant.

Table 1. Summary of the testing results. The “c.i.” are 95% confidence intervals for each corresponding average value.

Sample ID	Basis weight of components (g/m ²)				ECT (lb/in)	
	single face	medium	double face	total		c.i.
Kirkland	255.9	166.9	342.1	836.7	56.8	1.4
New World Farms	278.8	181.1	271.1	805.9	55.9	1.0

Table 2. Summary of fiber microscopy observation counts and estimates of recycle content.

	long yellow	bleached kraft count	% recycle	observations
Kirkland single f.	195	60	0	no fibrillation no debris white pine softwood unbleached and birch bleached kraft
Kirkland Medium	166	27	100	all short fibers unbleached hardwood and softwood and some kraft
Kirkland double f.	116	31	44	
New World Farms SF	87	16	47	pine softwood, birch kraft
New World Farms med.	35	38	77	also counted 101 unbleached kraft count as recycle
New World Farms DF	75	8	56	



Figure 1. Stained microscopy shot 40X of virgin unbleached kraft pulp showing pine softwood fibers. This is the slide used for comparison purposes to estimate the % recycle content in other samples.

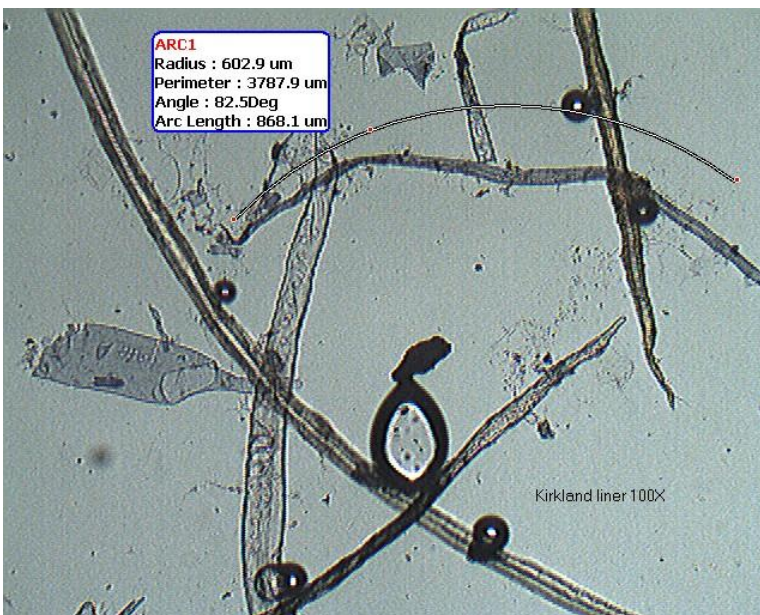


Figure 2. Kirlkland single face white top liner microscopy shot 100X showing long pine softwood fibers (White or Scots pine from the pitting pattern) and a hardwood (yellow poplar) bleached kraft vessel. White tops are usually made from bleached hardwood kraft for superior coating and graphics printability.



Figure 2. Kirkland medium, much debris and short fibers 40X .

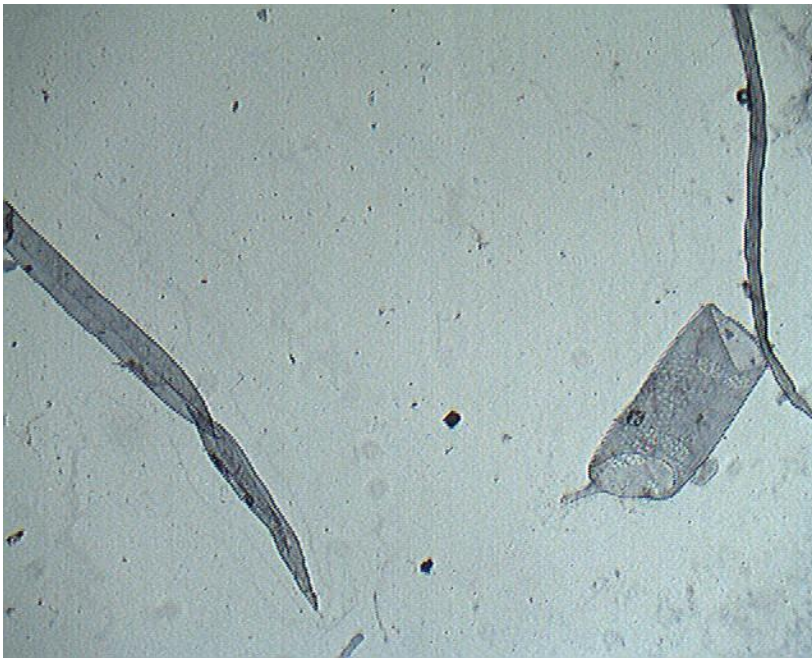


Figure 3. Kirkland medium detail 100X, bleached hardwood birch (left) and yellow poplar (right) vessels.



Figure 4. New World Farms box single face 40X showing the shorter gray unbleached hardwood kraft fibers among the wider longer flat softwood pine fibers. Presence of small debris fragments indicates repulping mechanical action.



Figure 5. New World Farms medium at 100x showing bleached (gray) hardwood vessels and fibers among long flat pine unbleached softwood fibers.



Figure 6. Birch hardwood vessel detail 400 X found in the Kirkland double face sample. Bleached kraft appears as gray when stained with Graff C and is considered as a recycling contaminant in corrugated board components which ideally consist of virgin unbleached softwood fibers. In this case, this vessel appears relatively intact and is considered here as virgin for the white-top.

Prepared by:

*Roman Popil
Senior Research Scientist
Georgia Tech/Institute of Paper Science and Technology
Paper/Board/Box Physical Analysis Laboratory
500 10th ST NW,
Atlanta, GA 30332.*

*Ph: 404 894 9722
e-mail: Roman@gatech.edu*

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