Recycling of RFID-Tagged Corrugated Packaging

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By Way of Introduction

- Packaging Corporation Of America
  - Producers of corrugated packaging and related products
  - One of the larger in North America
  - 4 Mills producing 2.3 million tons of containerboard/year
  - 70 corrugated plants
  - EPCglobal end-user subscriber, active member

- Fibre Box Association
  - Industry association representing nearly all Major North American corrugated producers

Fibre Box Association

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Why I’m Speaking to the Subject

- Corrugated packaging: the preferred and overwhelming choice for transport packaging.
- One of the highest recapture and recycling rates

  - of any packaging material.
- The Industry relies on recycled fiber (OCC)

  - an important feed-stock to supplement farmed-fiber
- RFID tagged boxes pose potential challenges to Corrugated Recycling

  - continuing effectiveness and economic efficiency

A Sense of Scale…

- Corrugated production
  - North America 42.5 billion M^2
  - Europe 42.8 billion M^2
  - Asia 58.8 billion M^2
  - World/Total 156.8 billion M^2
- Recapture rates
  - North America 76.6%
- Recycled content (effective)
  - North America 43%

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Corrugated…and What's at Stake

- An environmentally sustainable material and package
  - Natural.
  - Renewable.
  - Recyclable.
  - Source-Reduced Packaging
  - Efficient.
  - Sustainable.
  - A consumer of greenhouse gases

Industry Objectives

- Continued recapture and recycling of our product
- Maintain and enhance environmental advantages
- Recognize the many advantages of RFID/EPC (enablement of transport packaging)
- Investigate impacts of receiving tagged-corrugated back (in potentially large quantities)
  - recapture rate
  - process/production
  - product performance, acceptability
  - environmental and compliance concerns
  - sustainability

When We Speak of Recycling…

- No means or incentive for recapture or recycling of passive tags currently (re-use not possible).
- Recapture and recycling of used corrugated is just the opposite.
  - Infrastructure exists, economically effective
  - Demand, process and business require
  - High recycling rates enabled by near 100% recapture at retail

Recycling Tagged Corrugated

- Recycling Process Considerations
  - Sourcing
  - Process/productivity impact
  - Output vectors:

    Product (containerboard with recycled content)
    - Physical
    - Food contact
    - Ancillary

    Process
    - Unutilized fiber
    - Efficiency and effluent
    - Solid waste
    - Impact on disposal options, economics?

Work Undertaken: 2004-2005

Fibre Box Association
American Forest and Paper Association

A jointly funded study:

to examine the process, product and environmental implications of recycling tagged corrugated containers.

Study Scope and Parameters

- Initial, and preliminary in scope
- Multi-part:
  - Desk research, first
  - Preliminary study (fully laminated tags)
  - Pilot manufacturing study (printed antenna inlays)
- Tag/inlay types
  - Copper-foil/PET tags (Alien/ Printronix type)
  - Silver-printed/P.S. label-stock inlays (Precisia/Alien I2 format)

Study Findings

- Copper-foil/(PET laminated) tags tended to separate, be removed intact – early in the process.
- Copper foil tags (at least when polymer-laminated) posed limited risk of exceedances
- Printed silver tags (non-laminated label stock substrate) did not screen-out readily. Most of the silver mobilized in the process.

Directionality Modeled

Distribution of Incoming Silver across Process Vectors

Output Vector	Percent (observed)	Percent (adjusted)
Screening/cleaning rejects	63 % ± 10 %	4.1 % ± 0.6 %
Whitewater settled solids	3.4 % ± 1.1 %	8.9 % ± 1.4 %
Whitewater effluent	1.3 % ± 0.4 %	3.4 % ± 0.7 %
Product	32 % ± 8.8 %	84 % ± 1.9 %

Distribution-adjusted results observed in pilot-plant study to reflect a 25th percentile (low-water use, “Tough-Case”) aggressive, full-scale, Mill recycling environment.

Silver Concentrations Modeled and Compared to Limits

Output Vector	Percent of Silver to Vector	Modeled Silver Concentration in Vector, ppm	Limit Value, ppm	Model Percent of Limit	Limit Type
Screening/cleaning rejects	4.1	0.0237[1]	5	0.47	TCLP[2]
Whitewater settled solids	8.9	0.0067[1]	5	0.13	TCLP[2]
Whitewater effluent	3.4	0.1751	0.0032	55[3]	WQC[4]
Product	84	9.65	0.3[5]	See Note 6	ADI_{CSR}

1) Modeled concentration, assumed 1% extraction efficiency based on conservative interpretation of preliminary TCLP study of wet ink.
2) Maximum Concentration of Contaminants for the Toxicity Characteristic, 55 FR 11862, March 1990.
3) Percent value incorporates lower 25th percentile for in-stream dilution.
4) National Recommended Water Quality Ambient Criteria: 2002. EPA-822-R-02-047, November 2002.
5) The chemical-specific acceptability daily intake based on the silver RfD, the ADICSR, is 0.30 mg/person/day
(USEPA 2005). FDA does not establish numerical limits for silver.
6) Extraction testing results indicate virtually no movement of silver from product sample into extraction
solvents. Extraction results are shown in Appendix E.

Results/Notes/Interpretation

- Effluent projections were arrived at with difficulty, for a number of reasons. Model is preliminary, and likely very conservative. Model assumes low-water-use Mills, (near worst-case Ag concentrations) no additional effort to manage metals in transfer to treatment processes.
- Attempts to extract silver via boiling water, from the recycled board were essentially unsuccessful. This follows expectations given the chemistries involved.

In Perspective:

- A preliminary study and report
- Goal being an understanding of the direction antenna metals take in the recycling process
- Bench and pilot-plant work
- Difficulty in analytical determination of elemental-silver concentrations
- Accuracy/precision inferred:

  - no greater than order-of-magnitude
- Results: general understanding of directionality, not definitive determination of impacts or compliance

Takeaways

- If we assume:
  - Preliminary study results are reflective of production-scale mass balances and…
  - A printed-silver world for near term, then…
    - Much of the silver appears to be recycled into the finished product. Transfer/food-contact is not expected to be problematic.
    - While effluent projections are conservative, reflecting near-worst-case Mill-configuration…
    - Levels initially modeled indicate caution required.
    - Considerable work remains to gain confidence in estimations of outfalls, compliance issues

Takeaways, II

- If we assume:
  - A polymer laminated solid-metal antenna, then:

    The tag/inlay is likely to be removed early from the process
  - A non-laminated solid-metal antenna, then:
    - The stamped or etched foil, from experience, will separate from the fiber and degrade into smaller pieces – some of which may be too small to be screened-out, subsequently ending-up in the “product”.
    - Regulatory impact undetermined.
    - False-positive metal detection of food packaging to increase.

Conclusions

- Initial investigation - reason for caution , and some optimism?
- By no means definitive
- Indicates opportunity and need for further/scaled work
- While there are currently no U.S. FDA numerical limits on silver content of food contact packaging – we believe attempts should be made to separate tags/inlays as early in the recycling process as possible
- New technologies and investment at Mill-level likely required, with logical economic implications
- Process costs should be expected to increase
- Technical and tag/inlay development opportunities exist

Thank You

- If you would like to discuss further, please contact me:

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