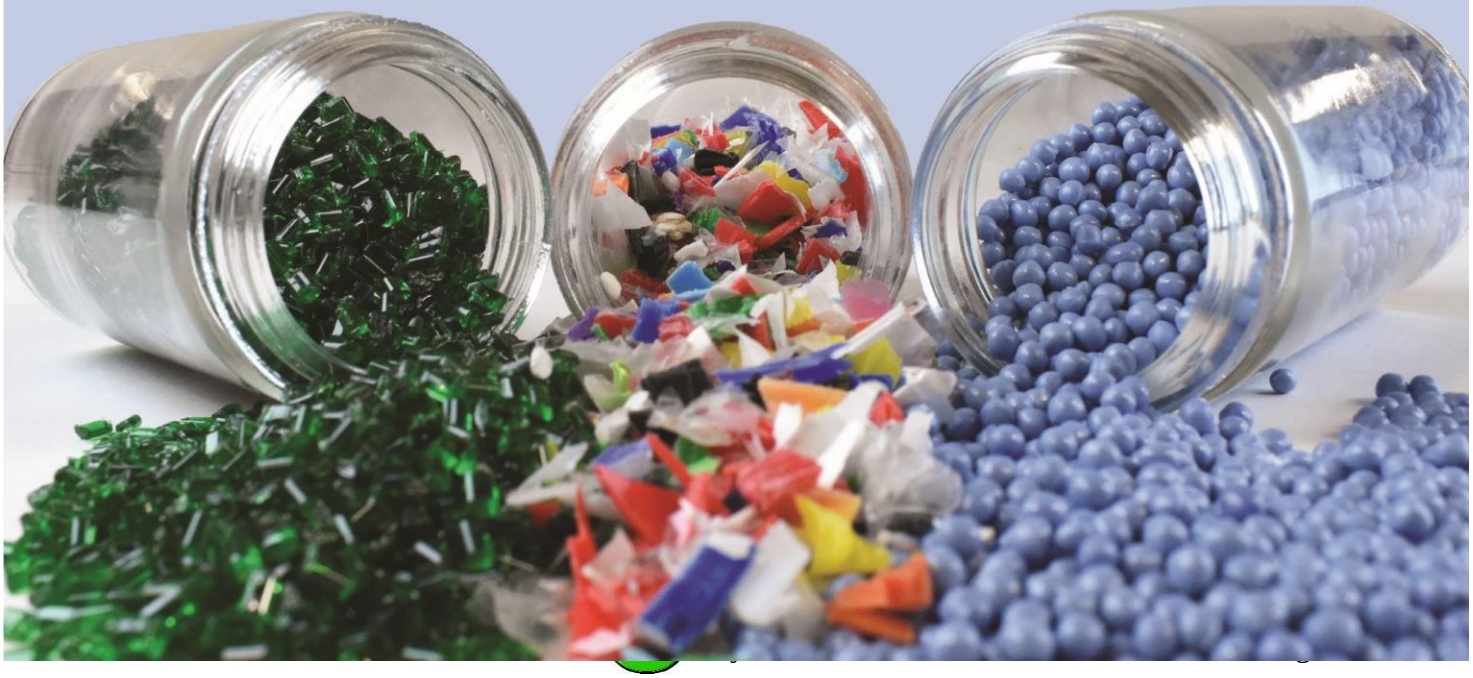
Plastics Forming Enterprises LLC

Case Study Report #C100

Metalized Label Case Study



PFE Metalized Label Case Study Report

Overview

Plastics Forming Enterprises (PFE) have conducted a metalized label case study continuing the efforts from the previous Avery Dennison Metal label evaluation. The evaluation was to better understand different technologies, the impacts of different sizes/plies specific to how they are detected and sorted. The materials are evaluated per the Association of Plastics Recyclers (APR) sortation protocol SORT-B-03 "Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized, or Metallic Printed Components". The evaluation to further survey and study these technologies created an opportunity to propose a change to this protocol.

The industry has seen some challenges regarding metal components and labels for both the Material Recovering Facilities (MRF) and processing Reclaimers. This challenge is traditionally focused on the yield loss they have experienced at their facilities, separate from reprocessing issues at the grinding and extrusion steps. The testing protocol in its current form could be developed further and separate these challenges by the materials as a component's vs a label at a MRF, PET reclaimer, HDPE reclaimer or film reclaimer. Some metalized label technologies may not always be an issue for reprocessing but are being sorted and removed as a yield loss.

PFE worked with a reclaimer as well as reviewed a belt detection system that is commonly used as an infeed to extrusion processes and other steps along the recycling process. These evaluations are to compare samples of the following technologies Metalized Transfer Product, Filmic Metalized Label and Metallic Ink.

PFE received bottles from the reclaimer that were sorted as a yield forward then typically ground and processed vs. bottles that are being landfilled due to detection and diversion. The statistics of the one reclaimer has opportunity to develop with additional reclaimer data but has not become available at this. With a key focus only on label technologies, but this gives a good starting point.

Conclusion

Based on the Avery Dennison study, the conveyer detection analysis, and the reclaimer sample review; the APR label working group (WG) suggests the preferred sphere range in the Association of Plastics Recyclers (APR) sortation protocol SORT-B-03 "Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized, or Metallic Printed Components" be changed from the current guidance (Table A) to the suggested guidance (Table B). Additionally, a square inch range of these technologies is suggested by the WG to not require testing (Table C).

With the data generated from this study, we can conclude that a change to the testing protocol is imperative to meet the industry standards for the reclaimers. These changes will help minimize yield loss of bottles ending in landfill while providing the label industry with guidance to design and develop for better recyclability practice. It is strongly encouraging that additional data be produced and provided to support or adjust these suggestions. This is an opportunity to set the standard in a direction that supports growth for more innovation but not lose valuable materials, harm equipment, or decrease the quality of the end products.

Table A - APR Sort-B-03, Version 2, Dated April 26, 2022, on Page 8

SPHERICAL EQUIVALENT (B)								
PET ARTICLE		HDPE ARTICLE		FILM/FLEXIBLE ARTICLE			Applicable APR Recyclability Category for "NIR Sorting Potential" (see category definitions In APR Design Guide for Plastics Recyclability Home Page)	Check Applicable Box
Rigid metal	Metallic label	Rigid metal	Metallic label	Metalization	Foil laminate	Rigid Attachment		
0-2mm		0-2mm		0-12mm		0-2mm	APR Design Guide Preferred	
>2 - <16mm		>2 - <12mm				>2 - <12mm	Detrimental to Recycling	
>=16mm		>=12mm		>=12mm	all	>=12mm	Renders Package non-Recyclable per APR Definition	

Table B (Red Text - Draft for Change)

SPHERICAL EQUIVALENT					
PET Rigid Article					
Rigid metal or Attachment	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink	
0-2mm		0-8mm	0-8mm	0-8mm	Preferred
>2 - <16mm		8.1-15.9mm	8.1-15.9mm	8.1-15.9mm	Detrimental
>=16mm	All	>=16mm	>=16mm	>=16mm	Non-Recyclable

SPHERICAL EQUIVALENT					
HDPE and PP Rigid Article					
Rigid metal or Attachment	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink	
0-2mm		0-12mm	0-12mm	0-12mm	Preferred
>2 - <12mm					Detrimental
>=12mm	All	>=12mm	>=12mm	>=12mm	Non-Recyclable

SPHERICAL EQUIVALENT					
Film/Flexible Article					
Rigid metal or Attachment	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink	
0-2mm		0-12mm	0-12mm	0-12mm	Preferred
>2 - <16mm					Detrimental
>=12mm	All	>=12mm	>=12mm	>=12mm	Non-Recyclable

Table C (Supporting Design Guidance Suggestion)

PET Rigid Article				
	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink
Preferred Surface Area	N/A	122cm2 (48in2)	76cm2 (30in2)	122cm2 (48in2)
HDPE and PP Rigid Article				
	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink
Preferred Surface Area	N/A	122cm2 (48in2)	76cm2 (30in2)	122cm2 (48in2)
Film/Flexible Article				
	Solid Foils	Metalized Transfer Product	Filmic Metalized Label	Metallic Ink
Preferred Surface Area	N/A	122cm2 (48in2)	76cm2 (30in2)	122cm2 (48in2)

Appendix

Avery Dennison Phase 1-5, Reclaimer Phase 6 Overview and Step Conclusions

Phase 1:

Description

- Examine the effects of different printing styles and varnishes on metal sortation. A total three varnishes (Gloss, Satin, and None) were tested and four printing styles (Flexo, Screen, Gravure, and Cold Foil). Samples were not applied to bottles and were sent through detector in cut panels at $12in^2$.

Conclusion

- Varnish type played no noticeable role in metal detection.
- 48(in2) tested area for Flexo/Screen/Gravure correlates to a sphere size of approximately 0.7mm
- Area for Cold Foil correlates to a sphere size of approximately 1.5mm

Phase 2:

Description

- Examine the effects of label surface area on metal sortation using Metallized BOPP (which showed the highest impact of all the received samples. Both single ply and double ply were evaluated to examine the difference in product design/coverage.

Conclusion

- Main contributor to the metal detection was the overall surface area of the label.
- Single vs Double Sided had a minor effect on detection.
- Bottle type had an effect on metal detection. (This is likely due to how the bottle compresses)

Phase 3:

Description

- Examine the effects of label surface area on metal sortation using Flexo/Screen/Cold Foil. Each printing style was applied to bottles at four different surface areas (15, 24, 30, and 48 square inches). Only the No Varnish variables were tested. Only single ply was tested as it was proven to be a non-factor in Phase

Conclusion

- Both the Screen and Flexo printing were not detected on the metal detector at any surface area.
- Cold Foil was observed to have an increase in average sphere size as the surface area went up.

Phase 4:

Description

- Calculate the expected standard deviation within testing for bottles with metallized labels. Selected samples were run a total of 10 times in each direction. Standard deviation was calculated to establish a sphere size uncertainty within a run.

Conclusion

- Each bottle was run a total of 20 times (10 times in the horizontal orientation and 10 times in the vertical orientation).
- The average standard deviation of all samples was roughly 3%.
    - It was confirmed that the spheres also move day to day. In the future the calibration curve will be adjusted daily to combat this and keep the standard deviation steady in the 3% range.
- The larger standard deviation is believed to be caused by slight changes in compression from being moved between boxes.

Phase 5:

Description

- Using a Commercial Scale Lab Environment Metals Belt technology at supplier recommended sensitivity, sort selected bottles and compare data with Eriez lab technology. Bottle sensor readings were recorded in addition to if the belt was tripped or not. Data was analyzed and compared to APR Protocol and Eriez Sphere Correlations.

Conclusion

- Sensor only tripped the belt if the product caused the bars to extend past **both** the circled lines (Total of 8 bars in either direction before lines are crossed) Scan shifts right and then left as the bottle went through the detector.

Phase 6:

Description

- Using PET commercial Reclaimer facility technology at recommended sensitivity, materials were sorted and reprocessed. Yield loss was recorded during the reprocessing stages and the data was analyzed and compared to APR Protocol and Eriez Sphere Correlations.
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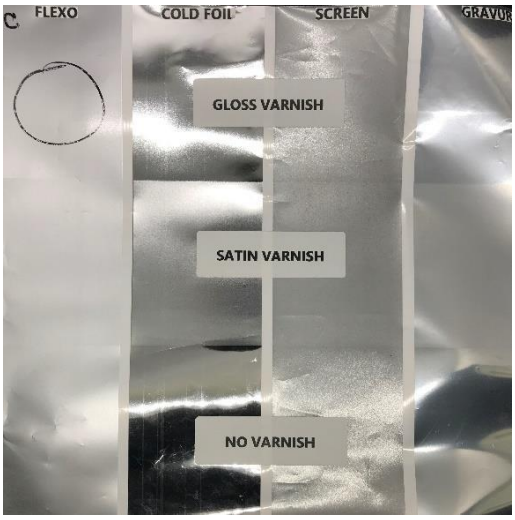
Conclusion

- There were consistent rejections when the area of the metalized labels was 22 in^2 and above with a spherical equivalency of 5 and above. It is un known the technologies for the variables used in this random sample evaluation.
- The outlier rejections could be from metal on the caps, or the size of the sample could have triggered a bad reading.

APENDIX

Phase 1

Incoming Roll Sample



Sample Roll Results and Conclusions (24in^2)

Technologies	Varnish Type	Length Reading	Width Reading	Area (LxW)
Flexo (Metallic Inks)	Gloss	108.3	5.0	541.5
	Satin	108.3	5.6	606.5
	None	108.3	5.4	584.8
Screen (Metallic Inks)	Gloss	108.3	5.0	541.5
	Satin	108.3	5.6	606.5
	None	108.3	5.4	584.8
Gravure (Metallic Inks)	Gloss	108.3	5.2	563.2
	Satin	108.3	5.0	541.5
	None	108.3	5.0	541.5
Cold Foil (Metalized Transfer Product)	Gloss	483.9	25.7	12436.2
	Satin	510.2	30.1	15357.0
	None	525.3	33.8	17755.1

Phase 3 - data same results with label applied to bottles

Phase 2 Metal BOPP on Bottle Evaluation Pictures

Bottle B6 and B10

Bottle	Label Length (in)	Label Width (in)	Plies	Label Area (in^2)	Horizontal Spherical Equivalent (area)	Vertical Spherical Equivalent (area)	Average Spherical Equivalent
B-5	4.000	5.000	1	20	3.6 (485258)	6 (3712972)	4.8
B-6	5.000	6.000	1	30	11 (44537870)	5.6 (2801618)	8.3
B-10	3.000	5.000	2	30	13.8 (110589378)	4.4 (1095487)	9.1
B-11	5.00	6.000	2	60	11.7 (57885056)	9.0 (19457620)	10.4
V-1	5.000	6.000	1	30	8.6 (16487856)	4.8 (1520784)	6.7
V-2	3.000	5.000	2	30	5.6 (2804652)	5.0 (1737491)	5.3

Phase 4 – additional evaluation was performed to confirm confidence in standard deviations

Phase 5 Commercial Scale Lab Environment Metals Belt Technology

Bottle	Label Area (in^2)	Horizontal Sensitivity Rating (Did it trip Y/N)	Vertical Sensitivity Rating (Did it trip Y/N)	Horizontal Spherical Equivalent	Vertical Spherical Equivalent	Average Spherical Equivalent
S48	48	2 (N)	2 (N)	0.7	0.7	0.7
F48	48	2 (N)	2 (N)	0.7	0.7	0.7
CF48	48	3 (N)	3 (N)	2.4	1.7	2.1
B1	1	2 (N)	2 (N)	0.8	0.9	0.9
B2	2	2 (N)	2 (N)	0.7	1.1	0.9
B3	6	2 (N)	2 (N)	1.0	2.5	1.8
B4	15	8 (N)	11 (N)	2.6	4.0	3.3
B5	20	8 (Y)	12 (Y)	3.2	5.2	4.2
B6	30	12 (Y)	12 (Y)	13.6	3.1	8.4
B12	60	12 (Y)	12 (Y)	11.7	9.0	10.4
1.0mm	N/A	2 (N)	2 (N)	N/A	N/A	N/A
2.0mm	N/A	2 (N)	2 (N)	N/A	N/A	N/A
4.0mm	N/A	5 (N)	2 (N)	N/A	N/A	N/A
5.0mm	N/A	8 (Y)	8 (Y)	N/A	N/A	N/A
8.0mm	N/A	10 (Y)	10 (Y)	N/A	N/A	N/A
10.0mm	N/A	12 (Y)	12 (Y)	N/A	N/A	N/A
12.0mm	N/A	14 (Y)	14 (Y)	N/A	N/A	N/A
14.0mm	N/A	14 (Y)	14 (Y)	N/A	N/A	N/A
15.0mm	N/A	14 (Y)	14 (Y)	N/A	N/A	N/A

** S is Screen, F is Flexo, CF is Cold Foil, B is Metallized BOPP*
(Y) states belt stopped, and metal detected

Phase 6 PET Commercial Reclaimer Rejections

Sample	Code	Horizontal	Vertical	Largest	Length	Width	Area	Area in Inches	Label Size
Oral-B	3.12	1.3	1.1	1.3	5	7	35	5	Single Ply
Gold	3.14	29.2	24	29.2	5	11	55	9	Single Ply
Mundet #7	1.1	6.6	5.7	6.6	6	8	96	15	Two Ply
Gummy	3.11	33.7	20.2	33.7	6	8	96	15	Two Ply
BIH	1.8	1.9	2.7	2.7	4.5	11	99	15	Two Ply
Mundet #5	1.2	1.1	1	1.1	11	5	110	17	Two Ply
Excesso	3.13	30.1	31	31	5	12	120	19	Two Ply
Mundet #2	1.4	8.5	7.1	8.5	7	10	140	22	Two Ply
Orange	1.9	10.4	9.4	10.4	7	10	140	22	Two Ply
Crest	1.10	1	1	1	14	5	140	22	Two Ply
Optims	1.12	1.4	1.3	1.4	7	10	140	22	Two Ply
Mundet #4	3.1	6	5.4	6	7	10	140	22	Two Ply
Mundet	3.2	7.6	5	7.6	7	10	140	22	Two Ply
Mundet #3	3.3	4.9	4.8	4.9	7	10	140	22	Two Ply
Mundet #5	3.5	1.2	1.3	1.3	7	10	140	22	Two Ply
Purple	1.11	1.1	1	1.1	9	8	144	22	Two Ply
Mundet #6	1.6	5.9	5.7	5.9	12.5	7	175	27	Two Ply
Mundet	1.3	5.9	5	5.9	8	13	208	32	Two Ply
Mundet #2	3.4	5	3.1	5	7	15	210	33	Two Ply
BIO	3.10	3.6	6.4	6.4	15	7	210	33	Two Ply
Gourmet	1.15	34.3	20.7	34.3	7	16	224	35	Two Ply
Fab #2	3.9	6.9	8.2	8.2	11	12	264	41	Two Ply
Mundet #3	1.7	8.4	5.8	8.4	8	18.5	296	46	Two Ply
Ritos	3.6	9.2	9	9.2	12	15	360	56	Two Ply
Mundet #4	1.5	8.8	9.2	9.2	13.5	14.5	392	61	Two Ply
Fab	3.8	15.9	12.2	15.9	14	15	420	65	Two Ply
Fab	1.14	9	9.5	9.5	15	15	450	70	Two Ply
Sun	1.13	11.7	10.2	11.7	13.5	18	486	75	Two Ply
Sun	3.7	12.6	16	16	13.5	18	486	75	Two Ply

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