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Plastic Squeeze Tubes Recovery Facility Flow Test

REPORT

RECYCLEBC

MORE RECYCLING

OVERVIEW

More Recycling (MORE) is working with stakeholders to research and address barriers to plastic squeeze tube recycling. Plastic tubes are typically defined as having a semi-flexible body, pinched off at one end and covered on the other by a rigid head or cap. They are used for household personal care products, food and other non-food applications. In order to test the ability of recycling equipment to sort tubes of a variety of sizes and shapes, Recycle BC, the organization responsible for residential packaging and paper recycling in British Columbia, facilitated a flow test at Recycle BC's Container Recovery Facility (CRF) in British Columbia in July 2018.[1]

METHODOLOGY

The project team tested 19 sets of tubes provided by project funders in this flow study. Each tube set sample was 100 tubes, except two.[2] All tubes contained product and were squeezed empty to mimic how a consumer would typically recycle a tube.[3] Each tube submitted for testing was tagged with a Radio Frequency Identification (RFID) tag that was unique to the tube type. The RFID tags contained an identifying code for the type of tube, as well as a unique code for each individual tube. RFID readers were installed by Stark RFID and were strategically placed throughout the CRF to ensure that tubes were tracked throughout the entire sorting process and all avenues to which the tubes could be sorted were covered. RFID scanners were placed at the beginning of the sort line, and at each subsequent commodity stream. The commodity streams covered by RFID scanners included glass, aluminum, mixed plastic and each of the segregated plastic resins sorted at that facility (including HDPE, PET, and other plastic types). For the purpose of this report all RFID information will be addressed at the tube type level.

Pre-mixed samples of all 19 tube types were added to the start of the sort line starting at 9:05 am local time. The tubes were added to the line at a pace of roughly 100 tubes per minute. By 9:25 am all tubes had been added to the line and the RFID scanning equipment read the tags as the tubes circulated throughout the CRF. By 10:45 am the Stark team confirmed that the RFID scanners had finished picking up new readings, signaling that all of the tubes were finished moving through the CRF and had reached their destination streams.

1 This Container Recovery Facility (CRF) is similar to a Material Recovery Facility (MRF), but different in that fiber has already been removed from the material the CRF receives and the CRF sorts plastic material into more categories than a typical MRF along with aluminum, tin, and cartons.
2 Tube sample sets 15 and 18 were tested as sample sets of 90 and 60 tubes, respectively, because MORE was unable to procure 100 of the same tubes for these specific tubes, but the size of the tubes made them important data points.
3 Fifteen tube sets were received full and were squeezed empty by MORE staff. For the remaining 4 sets of tubes, 2 sets were partially filled by the brand providing them and squeezed empty; and the last 2 were received unfilled, partially filled with product by More Recycling, and then squeezed empty.

SUMMARY OF RESULTS

This flow study was focused on two areas: 1) the number of tubes that were sorted to the plastic container line (PCL) and 2) the number of tubes that were ultimately diverted to the appropriate commodity stream. The first data point tells us whether or not the tube successfully made it past the equipment intended to divert glass, where smaller tubes may have difficulty passing. The second point tells us whether or not the tube was recognized by an optical sorter or was otherwise appropriately diverted to the intended commodity stream. Because the tubes in this study are primarily composed of PE plastic, the HDPE (bottle) stream was considered the correct stream for tubes.

In this study, all tubes that were less than 1 ounce[4] were sorted primarily to the glass line, meaning they were so small that they fell through the mechanism designed to screen out broken glass. Tubes between 1 and 1.99 ounce had varying degrees of success in reaching the PCL. For example, two differently shaped 1-ounce tubes (Tubes 3 and 5) had very different sorting results. Tube 3, a slightly smaller tube in width and length, was sorted to the plastic container line at a rate of only 27% while Tube 5, larger in both width and length, was sorted to the plastic container line at a rate of 93%[5]. All other tubes sized 1.7 ounces and larger were sorted to the plastic container line (PCL) at rates of ≥90% with the exception of tube 7 (a narrow 1.7 oz tube), which was sorted to the PCL at a rate of 87.63%. The results suggest that tube shape can impact the ability of smaller tubes (1-2 ounces) to make it to the PCL.

Table 1. Results from Flow Testing[6]- Sortability to the Plastic Container Line

	Sorted to Plastic Container Line (PCL)	Not Sorted to Plastic Container Line (PCL)
Tube 1 - 0.5 oz	26.26%	73.74%
Tube 2 - 0.85 oz	33.33%	66.67%
Tube 3 - 1.0 oz	27.00%	73.00%
Tube 4 - 1.0 oz	-	-
Tube 5 - 1.0 oz	93.00%	7.00%
Tube 6 - 1.7 oz	93.94%	6.06%
Tube 7 - 1.7 oz	87.63%	12.37%
Tube 8 - 2.0 oz	100.00%	0.00%
Tube 9 - 2.5 oz	100.00%	0.00%
Tube 10 - 2.7 oz	-	-
Tube 11 - 3.0 oz	99.00%	1.00%
Tube 12 - 3.5 oz	97.67%	2.33%
Tube 13 - 4.2 oz	99.00%	1.00%
Tube 14 - 4.2 oz - no cap	100.00%	0.00%
Tube 15 - 5.0 oz	100.00%	0.00%
Tube 16 - 5.0 oz	96.84%	3.16%
Tube 17 - 5.1 oz	96.94%	3.06%
Tube 18 - 5.1 oz - no cap	90.00%	10.00%
Tube 19 - 8.0 oz	100.00%	0.00%

4 Ounces were used as a marker for tube size for this study and refers to volume held in the tube and not the weight.
5 Tube 3 dimensions: Length: 10.5 cm, Cap Width: 2.5 cm, End Width: 4.5 cm. Tube 5 dimensions: Length: 11.0 cm, Cap Width: 2.8 cm, End Width: 4.7 cm
6 Tubes 4 and 10 were not picked by the RFID readers, possibly because of unseen metallic layers.

Of the 14 samples where the majority made it to the PCL, 12 tube samples sets had >60% pass rate to the HDPE stream with three of those 12 passing at a rate >80% and three at a rate >90%. Tubes with black/dark gray pigment on a significant portion of the tube had a lower percentage sort to the HDPE stream and a higher percentage in the mixed plastic stream. Tubes 8, 17 and 18 all had large sections of black/dark pigment and/or caps and they were sorted to the mixed plastics stream at a rate of 83%, 24.5%, and 17.5%, respectively.

Table 2. Results from Flow Testing – Sortability to Commodity Streams

	Sorted to HDPE Stream	Sorted to Mixed Plastic Stream	Sorted to PET Stream	Sorted to Other Plastic Streams	Unknown Destination after PCL
Tube 1 - 0.5 oz	10.10%	10.10%	4.04%	0.00%	2.02%
Tube 2 - 0.85 oz	22.22%	8.33%	0.00%	0.00%	2.78%
Tube 3 - 1.0 oz	21.00%	4.00%	1.00%	0.00%	1.00%
Tube 4 - 1.0 oz	-	-	-	-	-
Tube 5 - 1.0 oz	**71.00%**	17.00%	4.00%	0.00%	1.00%
Tube 6 - 1.7 oz	**69.70%**	16.16%	6.06%	2.02%	0.00%
Tube 7 - 1.7 oz	**48.45%**	24.74%	6.19%	1.03%	7.22%
Tube 8 - 2.0 oz	11.00%	83.00%	5.00%	0.00%	1.00%
Tube 9 - 2.5 oz	**91.00%**	7.00%	2.00%	0.00%	0.00%
Tube 10 - 2.7 oz	-	-	-	-	-
Tube 11 - 3.0 oz	**77.00%**	19.00%	3.00%	0.00%	0.00%
Tube 12 - 3.5 oz	**88.37%**	3.49%	2.33%	0.00%	3.49%
Tube 13 - 4.2 oz	**83.00%**	8.00%	8.00%	0.00%	0.00%
Tube 14 - 4.2 oz - no cap	**93.00%**	5.00%	2.00%	0.00%	0.00%
Tube 15 - 5.0 oz	**94.51%**	3.30%	2.20%	0.00%	0.00%
Tube 16 - 5.0 oz	**74.74%**	18.95%	1.05%	0.00%	2.11%
Tube 17 - 5.1 oz	**63.27%**	24.49%	2.04%	0.00%	7.14%
Tube 18 - 5.1 oz - no cap	**70.00%**	17.50%	2.50%	0.00%	0.00%
Tube 19 - 8.0 oz	**85.00%**	13.00%	1.00%	0.00%	1.00%

The breakout above is the percentage of the total samples for each set sorted to the noted commodity stream with the remainder not sorted to the plastic container line as reflected in Table 1. The Mixed Plastic stream was a passive sort, meaning anything that entered the Plastic Container Line (PCL), but was not positively sorted to a commodity stream by an optical sorter passed to the Mixed Plastic stream. There are a few other plastic streams optically sorted besides HDPE and PET at this facility. All tubes that were “Unknown Destination after PCL” were last sensed by the RFID scanners after entering the PCL, but not sensed by the scanners at any of the commodity streams.

Additional Comments:

- Tubes 14 and 18 were tested without caps as complements to Tubes 13 and 17, respectively. In both cases the tubes without the caps sorted more successfully to the HDPE stream, likely due to the increased PE surface without the PP cap.
- Tube 7 had a significant percentage of missed scans after start and for the final destination. 12% were last scanned at the start and 7% were last scanned at the PCL. Tube 18 also had 7% of tubes last read at the start.

CONCLUSION

Size and shape impact the ability of tubes to flow to the plastic container line, but HDPE plastic squeeze tubes of sufficient size and shape do optically sort to the HPDE commodity stream. Wider pinched ends and longer lengths may aid in sortability in smaller tubes. Additionally, tubes with larger PP caps and more dark pigment were less likely to sort to the HDPE line as comparable tubes with smaller PP caps or no caps at all, or without as much dark pigment.

ADDITIONAL INFORMATION

This Recovery Facility Flow test was funded by the following companies: Berry Global, Colgate-Palmolive, Estee Lauder, Johnson & Johnson, Procter & Gamble, and Unilever.