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LSC Plastic Vial Study

How might switching from Glass to HDPE vials impact data quality?

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- Thank you

Acknowledgements:

The comparison study for efficiency and quality parameters was performed primarily by Rose Preston, Brenda Maes, and Bob Reese from the Radiation Protection Sample Diagnostics (RPSD) group at Sandia National Laboratories. More data is being collected on leaching and migration and will be included in their final report. All results as of now are preliminary.

Input from the drop study performed by Mark Allen and his son as part of a science project for the SY Jackson Elementary School Science Fair.

A bit of history….

While asking questions at a previous HPIC meeting, the subject of Glass vial usage vs Plastic vial usage was discussed.

A benchmark “poll” of other labs in the complex yielded the following:

- SNL was one of the few labs still using glass vials (ANL does also)
- Most labs use the Perkin Elmer or a TriAthler Liquid Scintillation Counting Instruments
- Window settings are similar
- Most use 20 ml vials with cocktail/cocktail water mix
- Most use Whatman filters
- All respondents cited Ultima Gold as the cocktail of choice
- None of the respondents knew whether data had been collected (or if it was retrievable) to verify the difference in efficiency or other quality parameters
    - The results from the benchmark were presented to EFCOG last year

The results from the benchmark were discussed with RPSD and they made a group Project goal out of it!

Test methods:

- Standard running of various sample matrices side by side with known activity
- Comparison of quench calibration
- Evaluation of TSIE
- MDA evaluation
- Tritium Leach test-parking vials with activity in “storage”
  - A subset was parked in storage with some thermal stressing (shed outside)
- Drop test

And the RESULTS!

Efficiencies were similar (error bars not included)

Unit 18 is an ultra low background unit (cooled and has extra shielding)

H3 SINGNUC LSC18

Ordered Pairs

2013		2016 (CURRENT)		HDPE-2018	
TSIE	EFF	TSIE	EFF	TSIE	EFF
51.7	2.85	45.57	2.62	60	3.39
95.49	7.73	56.35	3.76	113.25	9.41
113.55	9.95	61.8	4.42	133.27	11.77
139.08	12.71	91.54	8.09	166.6	14.88
172.14	16.36	139.83	14.23	205.39	18.51
212.44	20.67	195.17	20.33	260.56	23.86
249.11	23.51	221.53	23.02	301.84	26.66
297.49	27.46	268.61	26.64	349.13	30.19
316.42	29.01	276.22	27.49	377.84	31.56
358.1	30.92	309.41	30.46	411.84	33.34

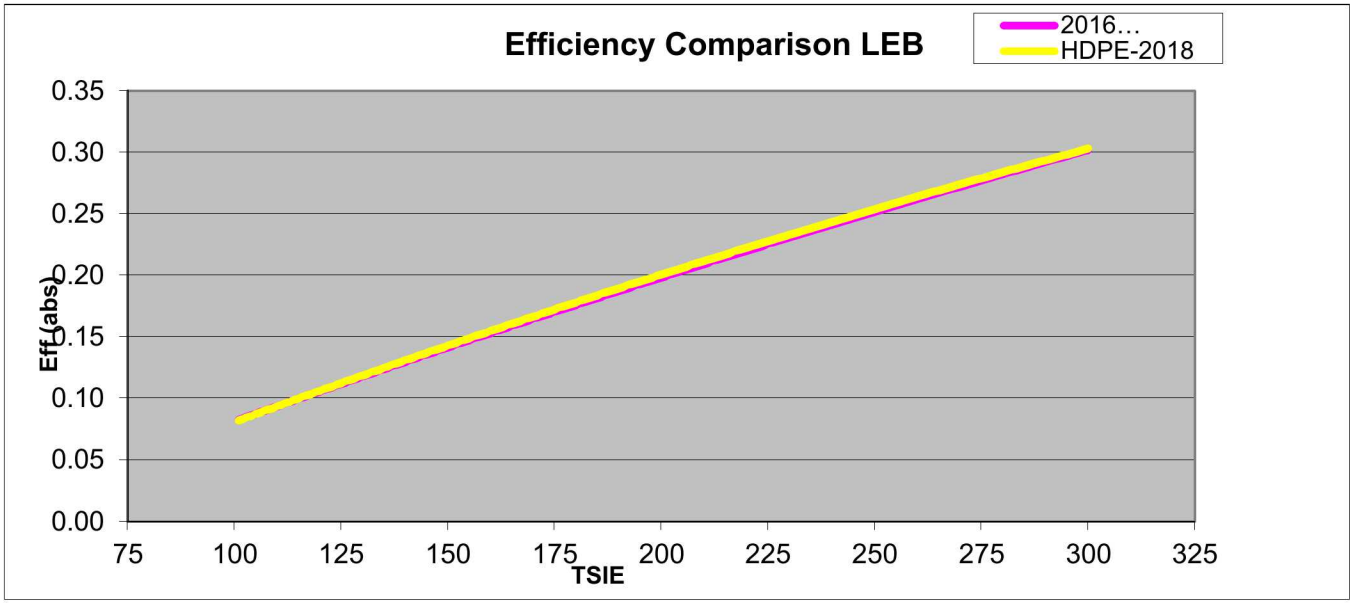
NI63 SINGNUC LSC18

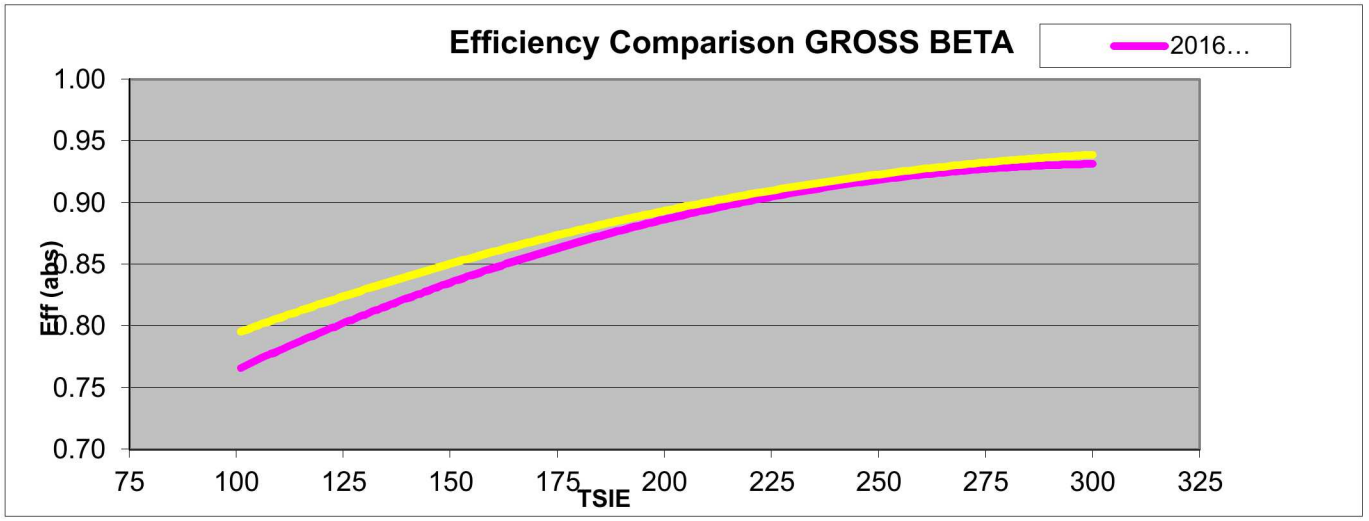
Ordered Pairs

2013		2016 (CURRENT)		HDPE-2018	
TSIE	EFF	TSIE	EFF	TSIE	EFF
49.1	21.52	48.53	23.39	57.87	25.39
92.41	39.25	61.61	28.69	113.33	43.96
109.56	43.8	67.37	31.33	130.54	48.21
129.4	48.54	99.6	42.42	159.9	53.13
161.46	53.81	151.98	53.42	204.63	58.71
203.12	59.2	213.95	59.59	259.58	63.72
241.68	62.64	236.39	62.88	303.32	65.95
280.68	64.95	283.49	66.4	366.18	69.67
297.6	66.65	296.35	65.54	396.6	71.7
333.31	68.14	305.37	67.32	428.69	73.23

Note: this data is still preliminary

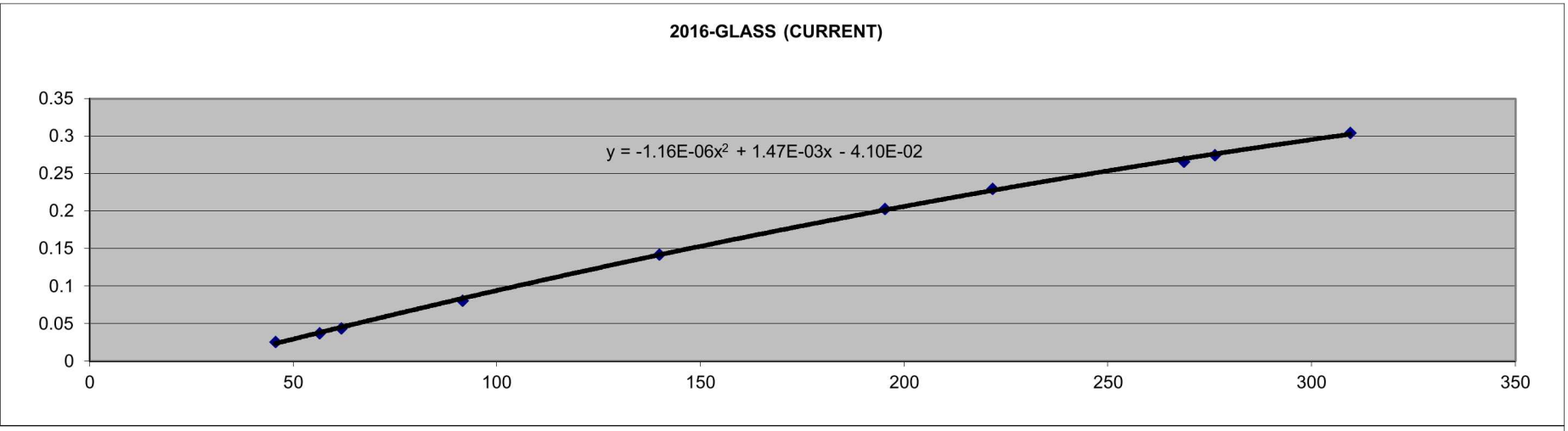
EFFICIENCY COMPARISON: GLASS vs. PLASTIC VIALS								
		INTRUMENT: LSC18				INTRUMENT: LSC20		
		DEVIATIONS						
TEST		MAXIMUM	MINIMUM	AVERAGE		MAXIMUM	MINIMUM	AVERAGE
H3 DPM MODE		15.6%	10.4%	12.1%		2.7%	0.6%	1.5%
NI63 DPM MODE		4.8%	0.0%	3.2%		1.2%	0.5%	0.8%
CL36 DPM MODE		2.4%	0.4%	0.9%		0.3%	0.2%	0.3%
CM244 DPM MODE		1.4%	0.7%	0.8%		0.5%	0.0%	0.3%
LOW-ENERGY BETA		14.7%	0.1%	9.3%		1.2%	0.0%	0.8%
GROSS ALPHA		2.4%	0.5%	1.8%		2.7%	0.0%	1.9%
GROSS BETA		6.8%	0.0%	1.7%		3.8%	0.5%	1.3%

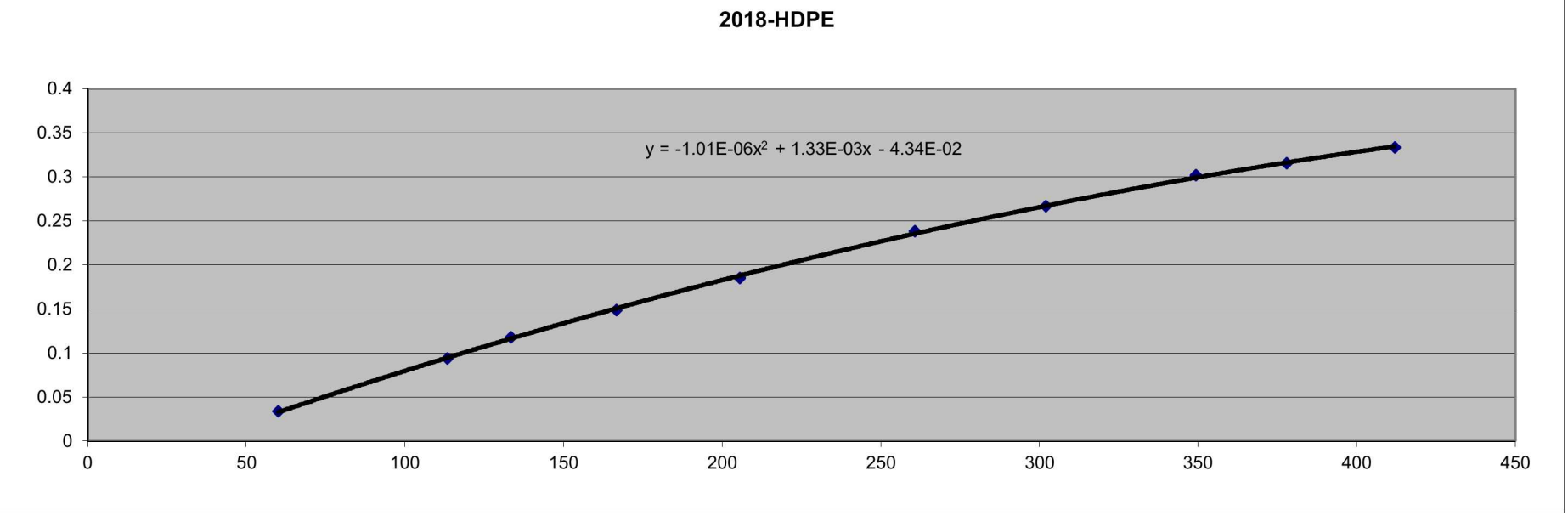

Efficiency Comparison LEB
2016…
HDPE-2018
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Eff (abs)
75
100
125
150
175
200
225
250
275
300
325
TSIE


Efficiency Comparison GROSS BETA
2016…
1.00
0.95
0.90
0.85
0.80
0.75
0.70
Eff (abs)
75
100
125
150
175
200
225
250
275
300
325
TSIE


Efficiency Comparison GROSS ALPHA
2016…
Eff (abs)
1.05
1.00
0.95
0.90
0.85
0.80
0.75
75
100
125
150
175
200
225
250
275
300
325
Efficiency Comparison H3 (SINGNUC)
2016…
Eff (abs)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
75
100
125
150
175
200
225
250
275
300
325
TSIE

Curve fitting





The FUN part…

Dropping glass vials has been an issue *occasionally* at SNL. Many industry events, including major contamination of laboratories (think NIST), result from broken vials. We were naturally curious on how well the HDPE vials performed under normally "somewhat clumsy" to "extremely unfortunate blunders".

Vials were also subject to some thermal stress prior to the drop test events to simulate environmental conditions such as techs having them in their truck for long periods of time in the hot sun or on very cold days.

The following graphic shows information from drops of approximately 3 feet, ~10 feet and ~20 feet.

Plastic or Glass: Which vial is more durable?

Hypothesis

We think that the plastic vial is more resistant to breaking when it is dropped. We think that hot temperatures will make the plastic vial more prone to breaking.

Materials

- 9 plastic vials
- 9 glass vials
- Red food coloring
- Ladder
- Freezer, refrigerator, microwave
- Kitchen temperature probe




Procedure

1. Fill vials with water and put in a drop of red food coloring.
2. Cool down 6 vials in refrigerator until they reach 45°F.
3. Place 6 vials in freezer until liquid is frozen.
4. Heat up 6 vials in microwave until liquid reaches 180°F.
5. Drop hot, cold, frozen and room temperature vials from three different heights.
6. Record which vials break.

Purpose

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The Radiation Protection and Analytical Services groups at Sandia National Laboratories use 20mL glass vials for sample collection and analysis of radioactive contamination. Plastic vials are more expensive, but could be safer to use since they might not break as easily when accidently dropped. These vials are subject to a range of environmental temperatures during their lifetime which may affect their durability.





Results

The Fate of the Vials When Dropped From Different Heights

Plastic	Hot	Cold	Frozen	Room Temperature
Waist Height	Not broken	Not broken	Not broken	Not broken
Top of Ladder	Not broken	Not broken	Not broken	Not broken
Top of Roof	Cap broken	Cap broken	Not broken	Cap broken

Glass	Hot	Cold	Frozen	Room Temperature
Waist Height	broken	broken	Not broken (cracked)	broken
Top of Ladder	broken	broken	Not broken (cracked)	broken
Top of Roof	broken	broken	broken	broken

Discussion

- The plastic vials were more resistant to breaking compared to the glass vials.
- When the glass vials were frozen, they were more resistant to breaking. This is opposite of what we thought in our hypothesis.
- Even when dropped from waist height, the glass vials broke (unless they were frozen).
- The plastic vials did not break even when dropped from the roof, although their caps sometimes shattered. This showed that the caps are the weakest point on the plastic vials.
- Even when the outer part of the cap shattered on the plastic vial, the inner seal of the cap remained intact and kept the liquid from leaking out.

Cracked Cap Still Doesn't Leak!


Conclusions

We learned that the plastic vials are stronger than the glass vials and much less prone to breaking when dropped. Sandia National Laboratories should consider switching to plastic vials instead of glass.

ACKNOWLEGEMENT

My dad helped me drop the vials from the top of the house in the experiment. He also helped to write purpose, hypothesis and discussion sections and make a table of the results. My mom helped by taking pictures. The vials were provided courtesy of Sandia National Laboratories.

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BIBLIOGRAPHY

1. https://www.thermofisher.com/order/catalog/product/5057?SID=srch-srp-505

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Conclusions:

Preliminary data suggests that switching from glass vials to plastic vials will have no effect on the quality of the data generated.

Inadvertent drops should not have catastrophic consequences (unless the lid is not on tight…)

Estimated savings on vial costs is approximately $10K per year!

Any questions?