Designation: D7823 – 16

Standard Test Method for Determination of Low Level, Regulated Phthalates in Poly (Vinyl Chloride) Plastics by Thermal Desorption—Gas Chromatography/Mass Spectrometry[1]

This standard is issued under the fixed designation D7823; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method provides a procedure to identify and quantify six phthalates by thermal desorption (TD) gas chromatography (GC) mass spectrometry (MS). The phthalates are BBP, DBP, DEHP, DNOP, DINP and DIDP.

NOTE 1—The method can be extended to include other phthalates.

1.2 Within the context of this method, "low level" is defined as 1000 ppm.

1.3 The values in SI units are to be regarded as standard.

1.4 This test method includes references, notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in the tables and figures) shall not be considered as requirements of this method.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics
D1600 Terminology for Abbreviated Terms Relating to Plastics
D3465 Test Method for Purity of Monomeric Plasticizers by Gas Chromatography
D7083 Practice for Determination of Monomeric Plasticizers in Poly (Vinyl Chloride) (PVC) by Gas Chromatography
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E355 Practice for Gas Chromatography Terms and Relationships
E594 Practice for Testing Flame Ionization Detectors Used in Gas or Supercritical Fluid Chromatography
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
IEEE/ASTM SI-10 Practice for Use of the International System of Units (SI), the Modernized Metric System

2.2 *ASTM Adjuncts:*

Adjunct to D7823 Vinyl Plasticizer Library—Total Ion Chromatograms and Mass Spectra[3]

3. Terminology

3.1 *Definitions*—For definition of plastic terms used in this test method, see Terminologies D883 and D1600.

3.2 For units, symbols, and abbreviations used in this test method refer to Practices E594, E355, or SI10.

3.3 *Compounds and Instrumentation:*

3.3.1 *(DOA) Hexanedioic acid, 1,6-bis(2-ethylhexyl) ester* CAS #103-23-1

3.3.2 *(DINCH) 1,2-Cyclohexanedicarboxylic acid, dinonyl ester, branched and linear* CAS #474919-59-0

3.3.3 *(DBP) 1,2-Benzenedicarboxylicacid, 1,2-di-n-butyl ester* CAS #84-74-2

3.3.4 *(BBP) Benzyl butyl phthalate* CAS #85-68-7

3.3.5 *(DEHP) Bis(2-Ethyhexyl) Phthalate* CAS #117-81-7

3.3.6 *(DNOP) Di(n-octyl) phthalate* CAS #117-84-0

3.3.7 *(DINP) 1,2-Benzenedicarboxylicacid, di-C8-10-branched alkyl esters, C9-rich (Jayflex)* CAS #68515-48-0

3.3.8 *(DINP) 1,2-Benzenedicarboxylicacid, 1,2-diisononyl (Palatinol)* CAS #28553-12-0

3.3.9 *(DIDP) 1,2-Benzenedicarboxylicacid, di-C9-11-branched alkyl esters, C10-rich (Jayflex)* CAS #68515-49-1

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[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.70 on Analytical Methods.

Current edition approved May 1, 2016. Published May 2016. Originally approved in 2013. Last previous edition approved in 2014 as D7823 - 14. DOI: 10.1520/D7823-16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from ASTM International Headquarters. Order Adjunct No. ADJD7823S-EA. Original adjunct produced in 2016.

***A Summary of Changes section appears at the end of this standard**

3.3.10 *(DIDP) 1,2-Benzenedicarboxylicacid, 1,2-diisodecyl* CAS #26761-40-0

3.3.11 *TD Thermal Desorption*

3.3.12 *GC Gas Chromatography*

3.3.13 *GC/MS Gas Chromatography/Mass Spectrometry*

3.3.14 *PVC Poly (Vinyl Chloride)*

3.3.15 *THF GC grade or higher "Tetrahydrofuran"*

3.3.16 *DCM GC grade or higher "Methylene Chloride"*

3.3.17 *EGA-MS Evolved Gas Analysis-mass spectrometry*

3.3.18 *FTIR Fourier Transform Infrared Spectroscopy*

3.3.19 *TIC Total ion chromatogram*

3.3.20 *DQO Data quality objectives*

Note 3—DINP and DIDP, when used in various PVC formulations are technical mixtures. Take care, when preparing the phthalate calibration standard to use the technical grade. Here is specific information on DINP and DIDP. For more information, please refer to Appendix X3.

Jayflex DIDP: 1,2-Benzenedicarboxylicacid, di-C9-11-branched alkyl esters, C10-rich: CAS# 68515-49-1.

Jayflex DINP: 1,2-Benzenedicarboxylicacid, di-C8-10-branched alkyl esters, C9-rich: CAS# 68515- 48-0.

4. Summary of Test Method

4.1 200 mg of the PVC sample are dissolved in 10 mL of THF. 10 µL of the THF solution are analyzed using TD-GC/MS. Phthalates are identified by their retention times and their mass spectra. Quantification is based on the area of a designated quant ion (SIM or full scan)—see Table 1. Standard addition is the calibration method.

Note 4—Standard addition calibration will negate matrix interference. It also takes into account the overall performance of the instrumentation at the time the samples are analyzed.

5. Significance and Use

5.1 Identification and quantitation of phthalates: DBP, BBP, DEHP, DNOP, DINP, and DIDP are required for regulated articles. Regulations include: EU—Directive 2005/84/EC, US—Consumer Product Safety Improvement Act of 2008—section 108, Japan—Health, Labor and Welfare Ministry guideline No.336 (2010). This test method provides a procedure to identify and quantify regulated phthalates in PVC.

5.2 Other techniques successfully used to separate and identify phthalates in PVC include GC/MS, HPLC/UV, HPLC/MS, FTIR, and GC/FID (flame ionization detector).

6. Interferences

6.1 Retention times for GC are dependent on several variables and it is possible to have two or more components with identical retention times. The analyst shall take the necessary steps to insure that adequate separation of the plasticizer components is achieved and or the ions used to monitor for a target phthalate are free of interference. This includes, but is not limited to changing the selectivity of the chromatographic column. Calibration by standard addition offers the advantage of minimizing interferences.

TABLE 1 Ions and Ion Ratios Used to Identify Each Phthalate

	DBP	BBP	DEHP	DNOP	DINP	DIDP
Quant ion	223	206	279	279	293	307
Confirm ion 1	149	149	149	149	149	149
Area ratio (±10%) (Quant/ Confirm 1)	<0.04	<0.23	<0.08	<0.06	<0.20	<0.12
Confirm ion 2	167	167	167	167	167	167

6.2 When using a TD-GC/MS method, care must be taken to ensure that the sample cups are inert and clean. Any and all solvents used to prepare standards and sample solutions must be free of contamination.

6.3 The presence or absence of each phthalate is based upon three criteria: (*1*) the relative retention time of the peak (*2*) the presence or absence of the quant ion and the two confirming ions and (*3*) the ratio of the quant and the confirming ion one must satisfy the established guideline (see Table 1).

6.4 Calculating the phthalate concentrations using the areas of compound specific ions and standard addition significantly reduces interference from non-target compounds.

7. Apparatus

7.1 Gas chromatograph/mass spectrometer capable of operating in the 75 to 350°C range.

Note 5—Optional but recommended: Vent-free GC/MS Adapter. This facilitates the rapid conversion between detailed analysis and evolved gas analysis.

7.2 Thermal desorption unit capable of heating the sample from 100 to 350°C at 20°C/min.

7.3 Inert, reusable or disposable sample containers or cups.

7.4 GC capillary column: 5 % diphenyl-95 % poly (dimethylsiloxane) stainless steel, 30 m by 0.25 mm ID with a 0.25 µm film thickness, or equivalent.

7.5 Integrator or data handling system, capable of measuring peak areas and retention times to four significant figures.

7.6 Analytical balance, capable of weighing to ±0.000001 g (1 µg). If using a balance capable of weighing to ±0.00001 g (10 µg), weight used in the sample and standard preparation must be scaled accordingly in order to ensure that the data are accurate to three significant figures.

7.7 Pressure regulators, for all required gas cylinders.

7.8 Flow meter, or other means of measuring gas flow rates ±0.1 mL/min.

8. Reagents and Materials

8.1 Helium carrier gas, chromatographic grade.

8.2 Methylene chloride (DCM) or n-hexane for preparing the phthalate standard solution (Solution #1, 10.2), spectral quality or chromatographic grade.

8.3 Tetrahydrofuran (THF), or a solvent suitable for preparing the PVC sample (Solution #2, 10.3), spectral quality or chromatographic grade.

8.4 Standards of the appropriate phthalates for use when constructing an external calibration curve or preparing Solution #3 (10.4) used for standard addition. See Note 3.

9. Safety and Precautions

9.1 Use THF and methylene chloride in a well-ventilated space.

10. Preparation of the Analytical Samples (based upon using a 1 µg balance) Weights must be scaled up if using a 10-µg balance.

10.1 Three solutions must be prepared: (*1*) a stock solution of the target phthalate standards, (*2*) a solution of the sample and (*3*) the sample solution spiked with the standard stock solution.

10.2 *Solution #1*—Prepare a stock standard solution of the phthalates by dissolving 0.30 mg of each phthalate in 10 mL of methylene chloride (0.30 mg/10 mL). N-hexane has also been used with success. See Fig. 1 for a typical chromatogram.

10.3 *Solution #2*—Dissolve 200 mg of the sample in 10 mL THF (200 mg/10 mL). Shake (or sonicate) the solution for five minutes—see Note 6. The solution is likely to range from clear to slightly cloudy. Place 10 µL of the sample solution in a clean sample cup. Evaporate the solvent; the sample is ready to analyze. See Figs. 2 and 3 for example chromatograms.

NOTE 6—A critical step in the accurate determination of phthalates is sample homogeneity. This is discussed in more detail in Appendix X2.

NOTE 7—It is possible that the solution will contain inorganic material. Studies have shown that the presence of insoluble inorganic material will not affect either the accuracy or precision of the phthalate determination.

10.4 *Solution #3*—Place 10 µL of the sample solution (#2) into a clean sample cup. Add 10 µL of the phthalate standard solution (#1). Evaporate the solvent.

NOTE 8—To expedite the evaporation process, pass a steady stream of a high purity inert gas using clean, (plasticizer- and additive-free) tubing over the sample cup.

11. Procedure

11.1 Establish that the analytical system contains concentrations of phthalate contamination that are lower than the

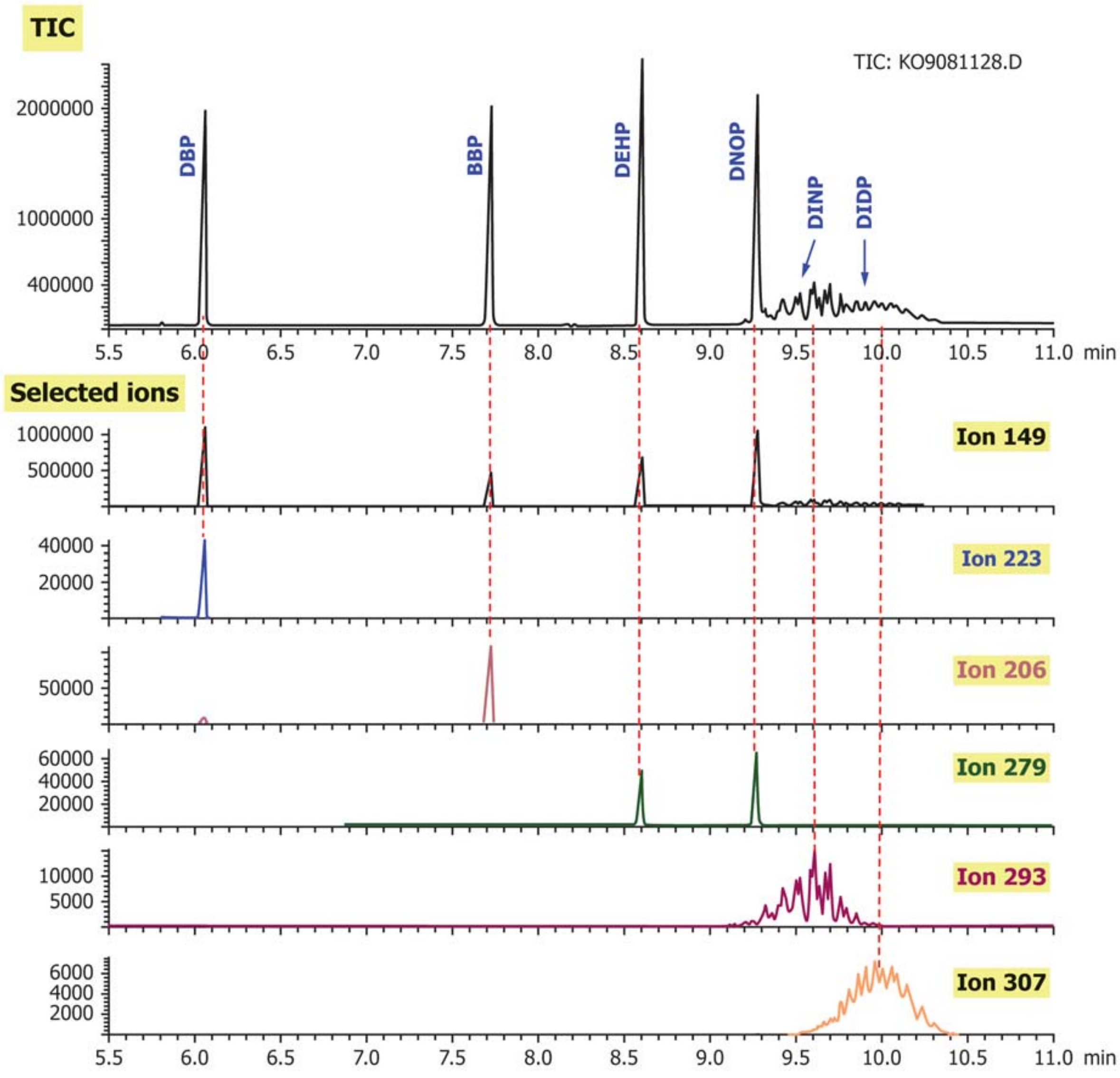


FIG. 1 Solution #1—Phthalates Standard Mixture (see 10.2)

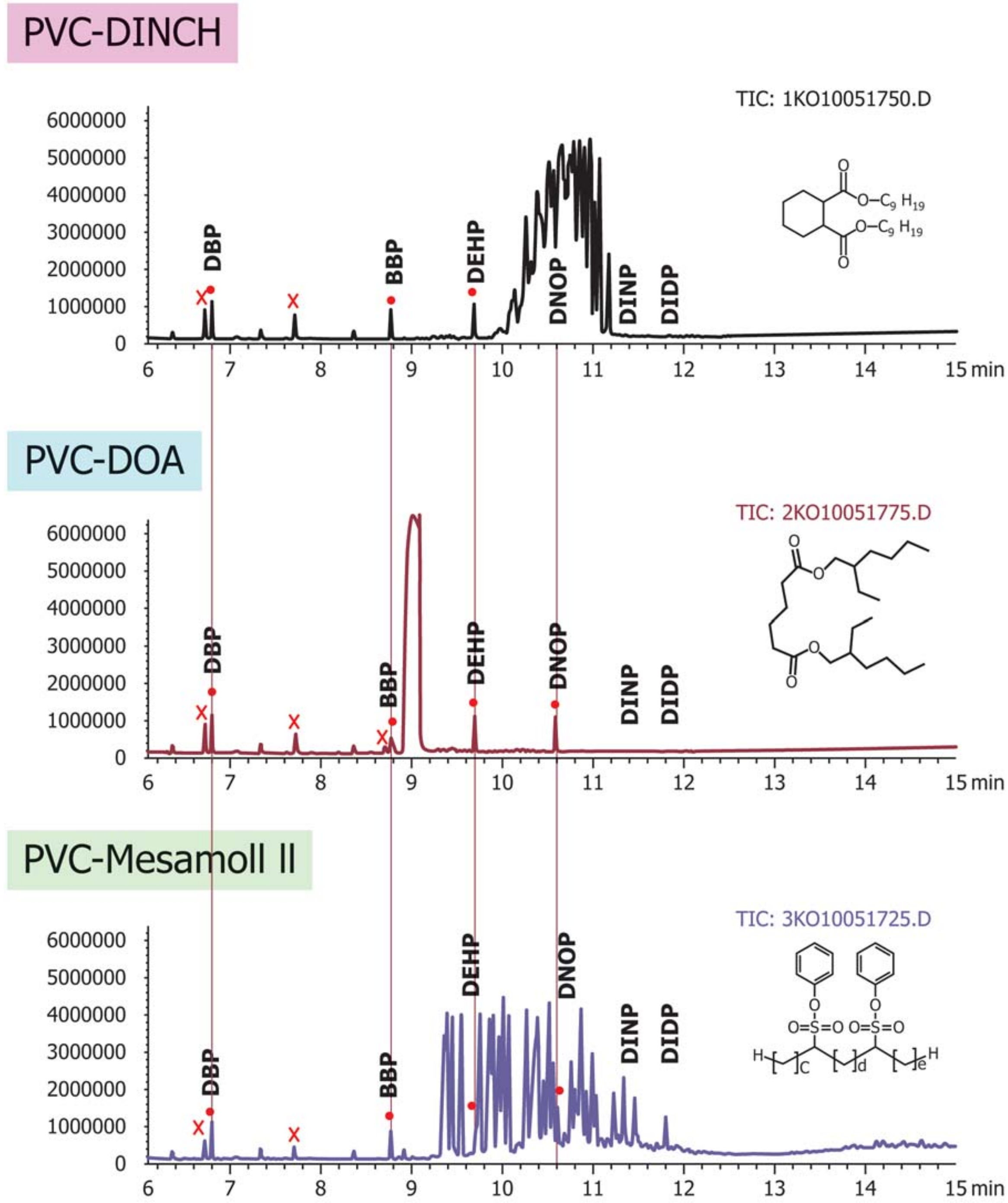
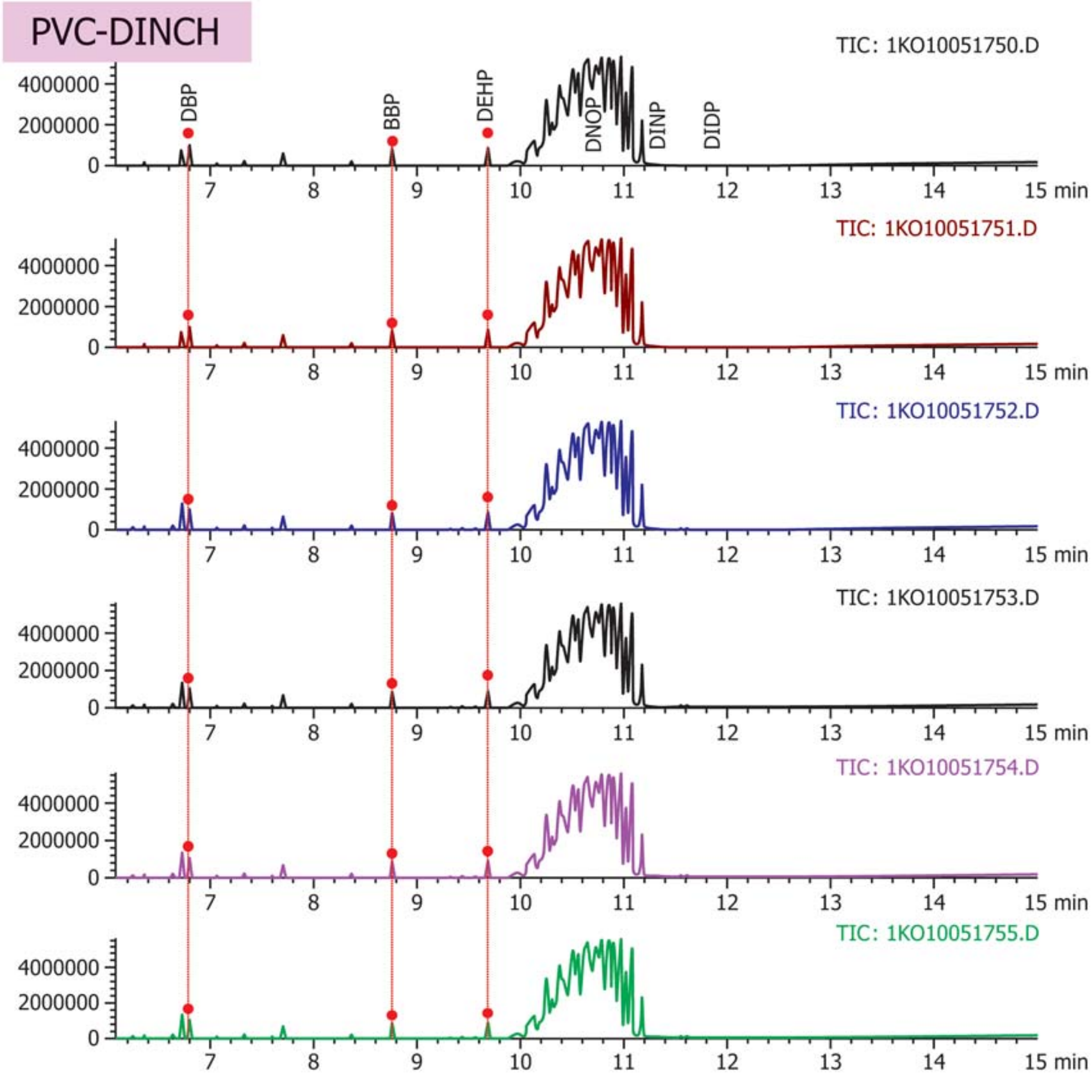


FIG. 2 Solution #2—Chromatograms (TIC) of PVC with Three Different Plasticizers, TD-GC/MS Analysis (see 10.3 and 11.3)

background contamination acceptable to the project specific Data Quality Objectives by analyzing 10 µL of THF.



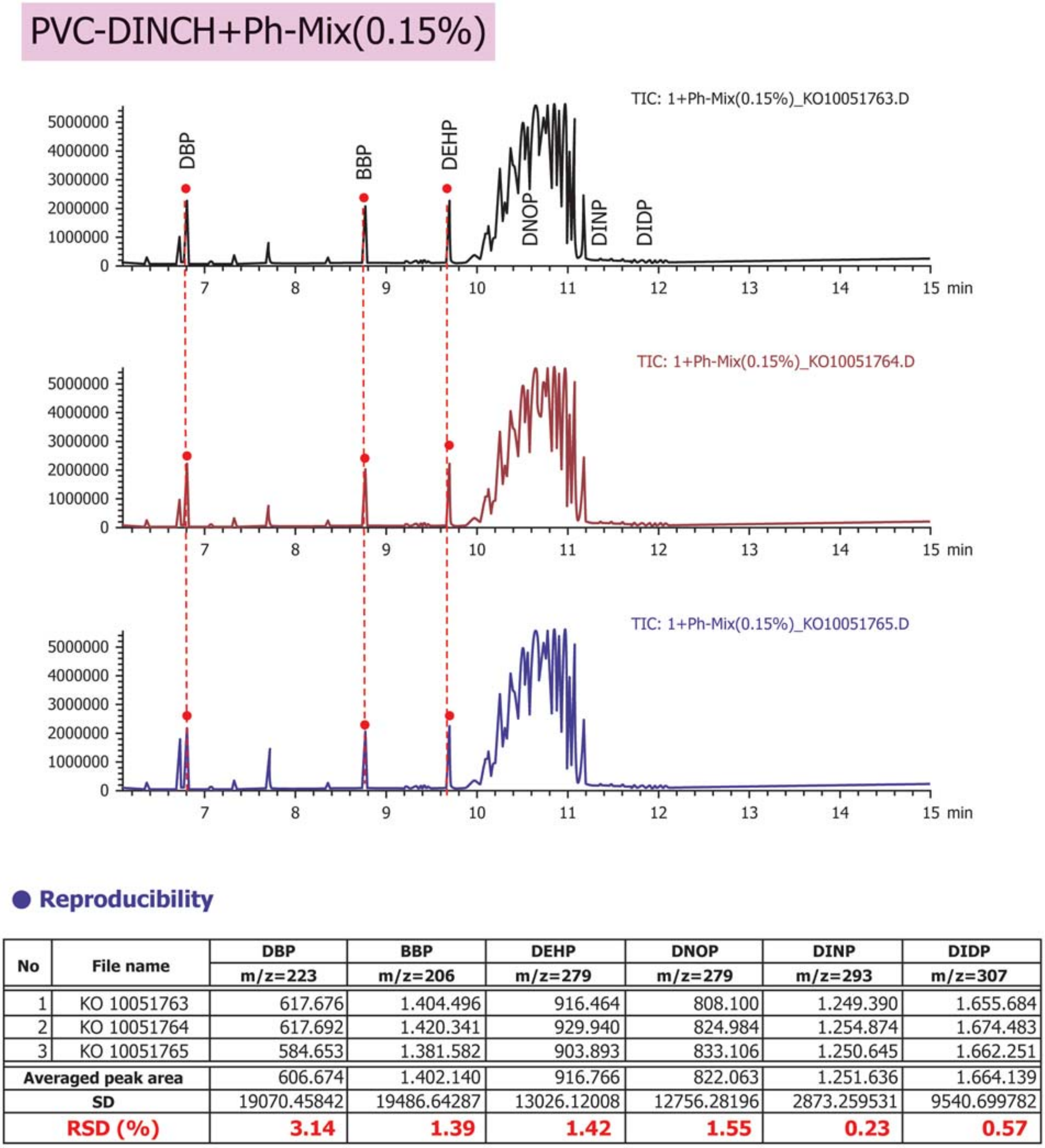
No	File name	DBP	BBP	DEHP	DNOP	DINP	DIDP
		m/z=223	m/z=206	m/z=279	m/z=279	m/z=293	m/z=307
1	KO 10051750	243.840	505.044	328.756	332.096	489.945	616.594
2	KO 10051751	242.452	517.461	340.418	321.613	497.762	633.184
3	KO 10051752	240.288	517.972	354.329	331.371	507.979	657.815
4	KO 10051753	246.959	528.137	349.345	327.968	505.853	646.300
5	KO 10051754	238.760	515.500	345.159	336.845	504.904	656.879
6	KO 10051755	246.510	521.102	343.431	333.874	503.383	653.434
Averaged peak area		243.135	517.536	343.573	330.628	501.638	644.034
SD		3293.118547	7556.303832	8729.726158	5296.045748	6684.847213	16242.41879
RSD (%)		**1.35**	**1.46**	**2.54**	**1.60**	**1.33**	**2.52**

FIG. 3 Solution #2—Reproducibility of PVC-DINCH (n=6) (see 10.3 and 11.3)

11.2 Establish the relative retention time and mass spectrum of each phthalate using Solution #1—10.2: The following conditions were used to obtain the example chromatograms shown in Figs. 1-4:

Thermal Desorption (TD)-GC/MS Analysis

TD temperature:	100 - 20°C/min - 320°C (5 min hold)
Py interface:	320°C (Auto mode),
GC injector :	300°C



No	File name	DBP	BBP	DEHP	DNOP	DINP	DIDP
		m/z=223	m/z=206	m/z=279	m/z=279	m/z=293	m/z=307
1	KO 10051763	617.676	1.404.496	916.464	808.100	1.249.390	1.655.684
2	KO 10051764	617.692	1.420.341	929.940	824.984	1.254.874	1.674.483
3	KO 10051765	584.653	1.381.582	903.893	833.106	1.250.645	1.662.251
Averaged peak area		606.674	1.402.140	916.766	822.063	1.251.636	1.664.139
SD		19070.45842	19486.64287	13026.12008	12756.28196	2873.259531	9540.699782
RSD (%)		**3.14**	**1.39**	**1.42**	**1.55**	**0.23**	**0.57**

FIG. 4 Solution #3—Standard Addition (see 11.7)

GC oven:	80 (1 min hold) to 200°C (at 50°C/min) to 320°C (15°C/min, 2 min hold)
Solvent delay:	6 min
Column:	UA-5 (5 % Diphenyl-95 % dimethyl polysiloxane) 30 m by 0.25 mm i.d, 0.25 µm film) or equivalent
Column He flow:	1.2 mL/min, Split ratio: 1/20
Mass range:	29-600 m/z,
Scan speed:	2.57 scans/sec,
Threshold:	50
MSD Transfer Line Temp.:	300°C
Ion Source (EI) temp.:	230°C

11.2.1 Confirm the TD zone using Evolved Gas Analysis (EGA)-MS. The total ion chromatogram of the sample (Solution #2, 10.3) needs to be similar to that presented in Appendix X1.

11.3 Analyze the sample (Solution #2, 10.3) using the conditions outlined in 11.2. Typical chromatograms are shown in Figs. 2 and 3. The precision of the TD method is shown in Fig. 3.

11.4 Peak identifications are based on relative retention data, full scan extracted ion chromatograms of both the quant and confirming ions and the ion area ratios as indicated in Table 1. Phthalate quantitation is based upon the peak areas of the quant ions listed in Table 1. The assumption being made is that the sole source of the quant ion at a predetermined retention time is the phthalate. Use the peak area of the quant ion can be used to accurately determine the amount of the phthalate.

11.5 If using selected ion monitoring (SIM), peak identification is based solely on the presence or absence of the quant ion and the two confirming ions at a predetermined retention time. Quantitation is based on the area of the quant ion.

11.6 When DINP and DIDP are both present in a sample or standard, use m/z 127 as a qualifying ion for DINP and m/z 289 for DIDP. This is because DINP and DIDP partially co-elute and both produce m/z 149 and 167. If 149 qualifier ion ratios are set when DINP and DIDP are at equal concentrations, then any samples with different ratios will produce substantially different 149/167 ratios, potentially leading to a false negative.

NOTE 9—A typical total ion chromatogram obtained using the conditions specified in 11.2 is shown in Fig. 1. Because the absolute retention times are dependent upon the entirety of the GC system; relative retention times can be used to identify each phthalate. The choice of the base phthalate is left to the laboratory.

11.7 Quantitation is done using standard addition. Analyze Solution #3. A typical total ion chromatogram is shown in Fig. 4. Analytical precision is presented in the table at the bottom of Fig. 4. Standard addition is very useful when it is difficult to eliminate interferences from the sample matrix. This is often the case when analyzing PVC where DINCH, Mesamoll or both are present.

11.8 Pay attention to the chromatographic peak shape of the DNOP as partial co-elution with di-octylterephthalate (which produces all the same ions in different ratios) has been observed. Careful integration of quantifying ion (m/z 279) response that is only due to DNOP and not DOTP needs to take into account principles of chromatographic peak shape and areas.[4]

NOTE 10—Use the coefficient of determination, R^2, to monitor the quality of the calibration. Typical the R^2 values for all target phthalates are 0.99 or better—see Fig. 5.

12. Example calculations

12.1 A typical set of standard addition curves are presented in Fig. 5. Included in Fig. 5 is an example of how to calculate the concentration of the target phthalate and the analytical precision (n=6) of the method.

13. Quality Control

13.1 Perform the quality checks outlined in Table 2.

TABLE 2 System Performance Verification

Sample Description	Frequency	Rationale
Method Blank 10 µL THF	Prior to sample analysis and after the analysis of 10 samples	Verifies that the phthalate background is below the maximum level of phthalate set by the project's DQO
Laboratory Control Sample 10 µL of Sample #1	Prior to sample analysis and after the analysis of 10 samples	Verifies the stability of the chromatographic system and the stock solution.

13.2 Ensure the system is free of phthalate contamination before analyzing samples. Prior to sample analysis the ability of the system to perform properly shall be verified.

13.3 The run-to-run precision for all phthalates shall be better than 5 % RSD. Report the precision.

14. Report

14.1 The amount of each target phthalate in ppm.

14.1.1 Analyze 10 % of the samples in triplicate, report the standard deviation for each target compound. If the sample batch is less than 10 samples, then analyze one sample in triplicate and report the standard deviation.

14.1.2 If a sample batch is analyzed over more than two days, the percent difference between the first and last Laboratory control sample must be less the 10.

14.2 Report the concentration (ppm) of each target phthalate in the method blank.

14.3 Report the chromatographic conditions and note any deviations from those specified in 11.2.

14.4 Report the Coefficient of Determination for the calibration line for each target phthalate.

15. Precision and Bias

15.1 The precision of this test method is based on an interlaboratory study of Test Method D7823, conducted in 2013. As many as four laboratories tested a single PVC material for low level phthalates. Every "test result" represents

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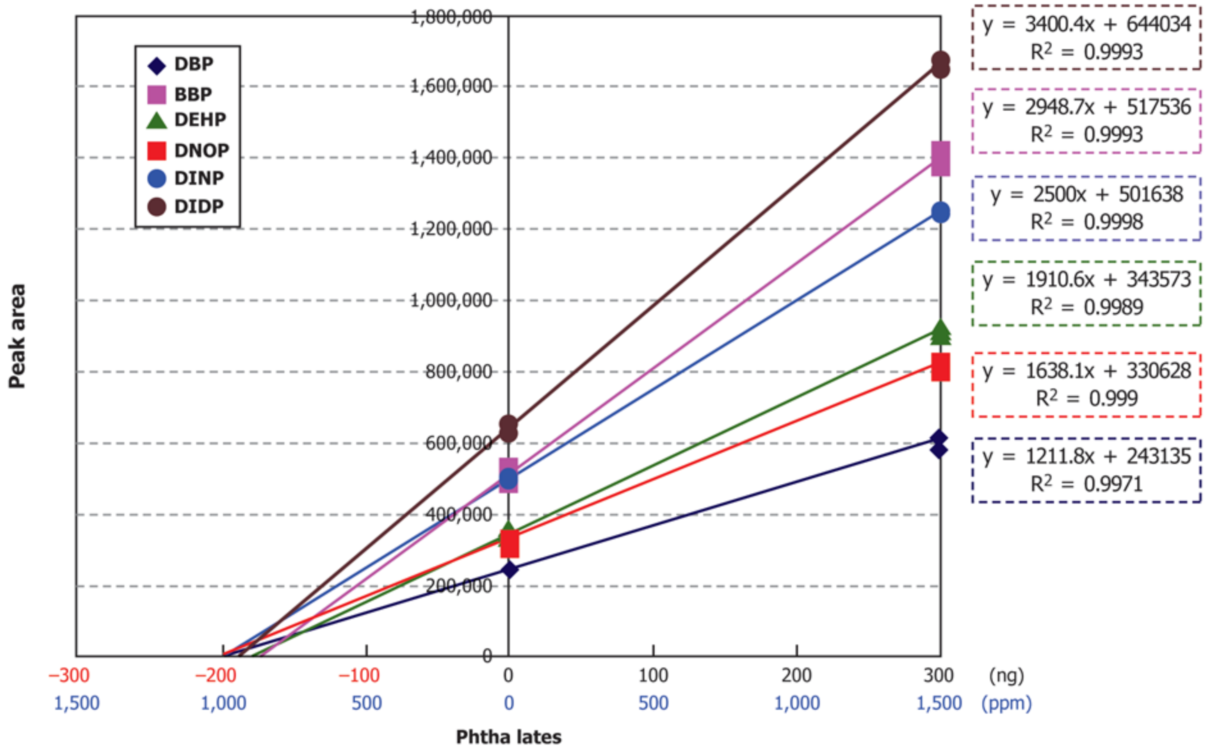
[4] A good overview of standard addition can be found on page 476, *LCGC North America*, Vikyne 27, number 6, June 2009



Example - DBP

A. Calibration curve is given by: y = 1211.8x + 243135 (R² =0.9971)

when y=0 then x = −243135/1211.8 = −200.6, ∴ 200.6 (ng)

B. Concentration in ppm is given by:

Value of DBP/Assumed content of PVC-DINCH = 200.6 (ng)/200 (µg) =1.003 (ng/µg)

= 1003 (ng/mg) =1003 (ppm)

● **Quantitative results**

PVC-DINCH		DBP m/z=223	BBP m/z=206	DEHP m/z=279	DNOP m/z=279	DINP m/z=293	DIDP m/z=307
Quantitative value	ng	200.6	175.5	179.8	201.8	200.7	189.4
	ppm	1,003.2	877.6	899.1	1,009.2	1,003.3	947.0
Reproducibility (n=6)	**RSD (%)**	1.35	1.46	2.54	1.60	1.33	2.52

FIG. 5 Quantitative Results Using Standard Addition (see 12.1)

an individual determination, and all participants were asked to report four replicate test results. Except for the inclusion of only one test material, Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. D20-1263.[5]

15.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

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[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1263. Contact ASTM Customer Service at service@astm.org.

15.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, that is accepted asplausible due to random causes under normal and correct operation of the test method.

15.1.1.2 Repeatability limits are listed in Table 3.

15.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

TABLE 3 Phthalates in PVC (ppb)

	Average^A	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
DIDP	961.695	21.078	62.601	59.018	175.284
DINP	1086.519	29.608	64.733	82.903	181.252
DnOP	1050.138	50.234	102.574	140.656	287.207
DOP	895.161	21.289	38.545	59.609	107.927
BBP	808.738	35.820	80.857	100.295	226.400
DBP	972.310	49.406	74.857	138.338	209.600

[A] The average of the laboratories' calculated averages.

15.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

15.1.2.2 Reproducibility limits are listed in Table 3.

15.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

15.1.4 Any judgment in accordance with statements 15.1.1 and 15.1.2 would have an approximate 95 % probability of being correct.

15.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

15.3 The precision statement was determined through statistical examination of 68 test results, reported by four laboratories, on one material.

15.4 To judge the equivalency of two test results, it is recommended to choose the material closest in characteristics to the test material.

APPENDIXES

(Nonmandatory Information)

X1. VERIFICATION OF THE EGA THERMAL DESORPTION ZONE (SEE NOTE 9)

X1.1 The thermal desorption zone for phthalates as cited in 11.1 appears to be independent of the plasticizer used in the PVC formulation. If it becomes necessary to confirm the thermal zone, EGA-MS is the method of choice. Thermo gravimetric (TGA) analysis is an alternative. The thermal desorption zone is easily determined using evolved gas analysis.

NOTE X1.1—For a discussion on EGA-MS, Yuzawa et al., Ana. Sci, 25, 1057(2009).

X1.1.1 A typical EGA thermogram of PVC is presented Fig. X1.1.

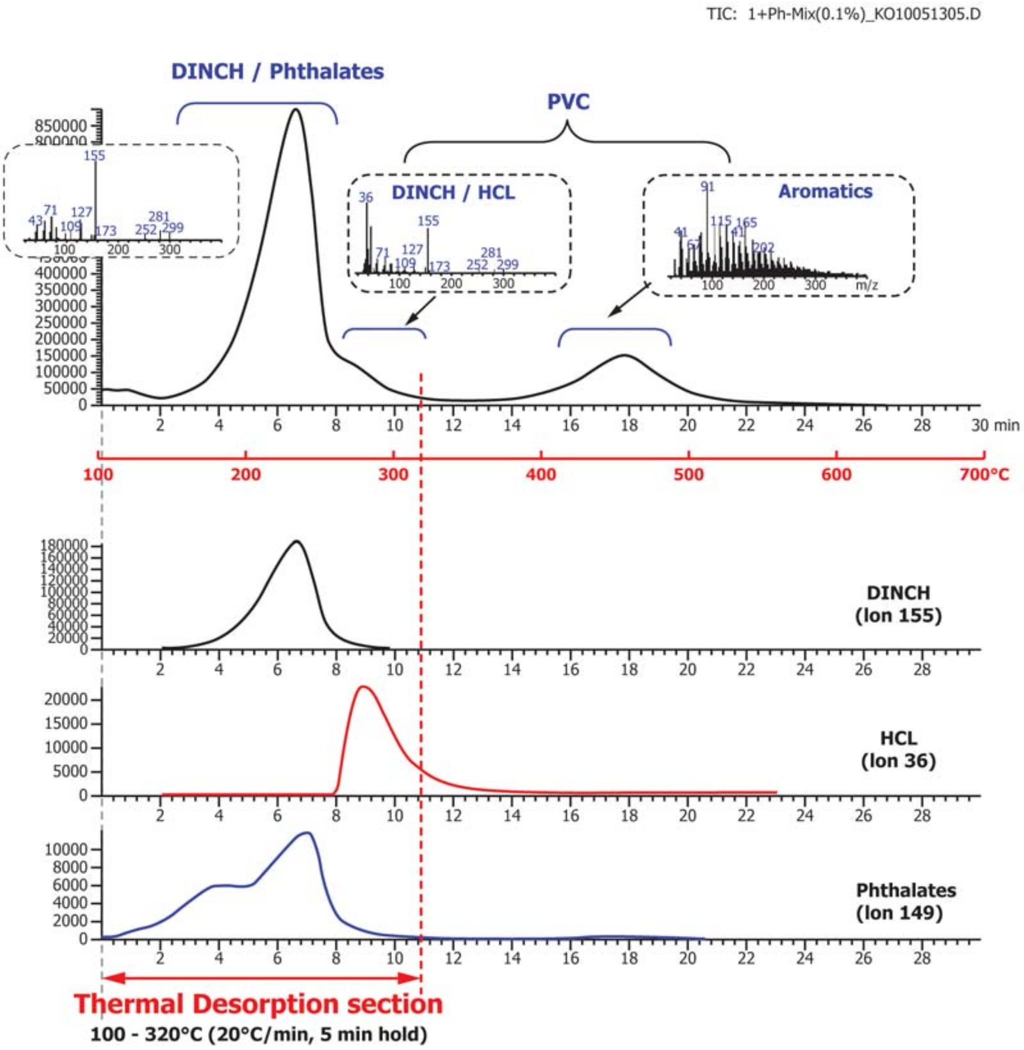

FIG. X1.1 Typical EGA Thermogram of PVC

X2. SAMPLE PREPARATION (SEE Note 6)

X2.1 The biggest challenge when working with multi-component samples is to ensure that a representative sample is inhand. Fig. X2.1 illustrates the need for sample homogeneity. One technique used for this is cryo milling (to <45 µm) although other techniques have proven to be just as effective. The resulting small particles are well mixed before an aliquot is removed for analysis.

X2.2 Solution #2 should be made using milligrams of sample. The more accurately the weight of the analytical sample is known, the more accurate is the phthalate determination.

X2.3 When working with a heterogeneous sample, sample aliquots should be randomly selected in order to ensure that a representative sample is being analyzed. In the sample shown in Fig. X2.2, 3 mm disks were punched out of the PVC sheet. The disks were combined in a glass vial, solvent was added and the resulting solution was analyzed.

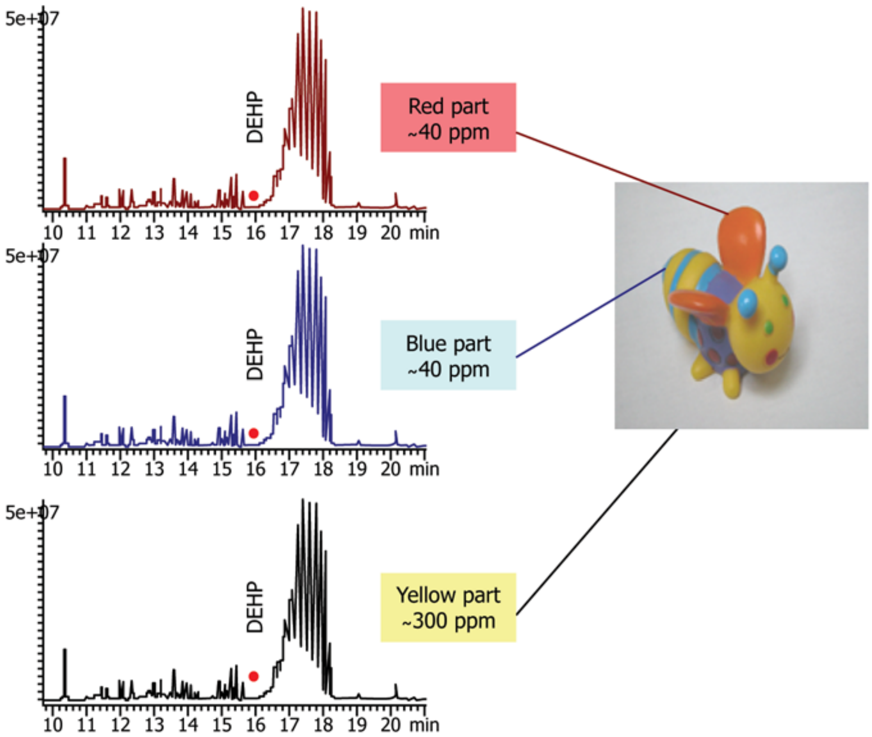

FIG. X2.1 Example of the Need for Sample Homogeneity

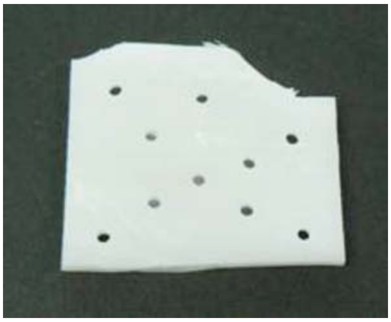

FIG. X2.2 Sample Aliquot

X3. COMMON PLASTICIZERS (SEE Note 3)

X3.1 Table X3.1 lists some of the current plasticizers that are commercially available. The CAS numbers and the chemical names are included for reference purposes and to assist in the preparation of calibration standards.

The Adjunct Method "Vinyl Plasticizer Library—Total Ion Chromatograms and Mass Spectra" lists the commercially available plasticizers and additives that may be co-extracted and co-elute in the testing range. CAS numbers, chemical names, and GC/MS Chromatograms of over 40 materials are included in the library that will comprise the Adjunct Method, enabling those who are using ASTM D7823 to have a useful reference library.[3]

TABLE X3.1 Common Plasticizers

Product	Commercial Name	Chemical Name	CAS#	Producer	Alcohol	Acid
DBTP		1,4-Benzene dicarboxylic acid, 1,4-dibutyl ester	1962-75-0	Eastman	linear	Terephthalic
BOP		1,2-Benzene dicarboxylic acid, 1-butyl 2-octyl ester	84-78-6		linear/branched	Phthalic

TABLE X3.1 *Continued*

Product	Commercial Name	Chemical Name	CAS#	Producer	Alcohol	Acid
DIBP	DIBP	1,2-Benzene dicarboxylic acid bis(2-methyl propyl) ester	84-69-5		branched	Phthalic
DBP	DBP	1,2-Benzene dicarboxylic acid, 1,2-di-n-butyl ester	84-74-2		linear	Phthalic
BBP	PLASTHALL BBP/ Santicizer 160	Benzyl butyl phthalate	85-68-7	Halstar/Ferro	linear/aromatic	Phthalic
DIHP	Jayflex 77	1,2-Benzene dicarboxylic acid,esters, diisoheptyl	41451-28-9	ExxonMobil	branched	Phthalic
DOP (DEHP)	Palatinol DOP	Bis(2-Ethyhexyl) Phthalate	117-81-7	BASF	branched	Phthalic
DNOP		n-Dioctyl phthalate	117-84-0			
DINP	DINP Jayflex	1,2-Benzene dicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich	68515-48-0	ExxonMobil	branched	Phthalic
DINP	Palatinol N	1,2-Benzene dicarboxylic acid, 1,2-diisononyl	28553-12-0	BASF	branched	Phthalic
DIDP	Jayflex DIDP	1,2-Benzene dicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich	68515-49-1	ExxonMobil	branched	Phthalic
DIDP		1,2-Benzene dicarboxylic acid, 1,2-diisodecyl	26761-40-0			
DPHP	Palatinol DPHP	1,2-Benzene dicarboxylic acid, 1,2-bis(2-propylheptyl) ester	53306-54-0	BASF	branched	Phthalic
L711P	Jayflex L711P	1,2-Benzene dicarboxylic acid, di-C6-12-branched and linear alkyl esters	392662-40-7	ExxonMobil	linear	Phthalic
L9P	Jayflex L9P	Dinonyl Phthalate	68515-45-7	ExxonMobil	linear	Phthalic
L911P	Jayflex L911P	(C9-C11) Dialkyl phthalate	68515-43-5	ExxonMobil	linear	Phthalic
911P	Palatinol 911P	(C9-C11) Dialkyl phthalate	68515-43-5	BASF	linear	Phthalic
L11P	Jayflex L11P	1,2-Benzene dicarboxylicacid, 1,2-diundecyl	3648-20-2	ExxonMobil	linear	Phthalic
L11P	Palatinol 111P- I	1,2-Benzene dicarboxylic acid, 1,2-diundecyl	3648-20-2	BASF	linear	Phthalic
610P	Palatinol 610P	benzene-1,2-dicarboxylic acid; decan-1-ol; hexan-1-ol; octan- 1-ol	68648-93-1	BASF	linear	Phthalic
DOTP	Eastman 168	1,4-Benzene dicarboxylic acid, 1,4-bis(2-ethylhexyl) ester/Dioctyl Teraphthalate	6422-86-2	Eastman	branched	Terephthalic

TABLE X3.1 *Continued*

Product	Commercial Name	Chemical Name	CAS#	Producer	Alcohol	Acid
DINCH	Hexamoll DINCH	1,2-Cyclohexane dicarboxylic acid, dinonyl ester, branched and linear	474919-59-0 (U.S.) 166412-78-8 (outside U.S.)	BASF	branched	
ATBC		Acetyl tri-n-butyl citrate	77-90-7	Morflex		citric
DOA	Plastomoll DOA	Hexanedioic acid,1,6-bis (2-ethylhexyl) ester	103-23-1	BASF	branched	adipic
DINA	Jayflex DINA	Hexanedioic acid,1,6-diisononyl ester	33703-08-1	Exxonmobil	branched	adipic
DIDA	Jayflex DIDA	Hexanedioic acid,1,6-diisodecyl ester	27178-16-1	Exxonmobil	branched	adipic
Plastomoll DNA	Plastomoll DNA	Hexanedioic acid,1,6-diisononyl ester	33703-08-1	BASF	branched	adipic
DOS		Hexanedioic acid,1,6-bis(2-methylpropyl) ester	141-04-8		branched	sebacic
DOZ	Edenol 9058 DOZ	Nonanedioic acid, 1,9-diethylhexyl ester	103-24-2	cognis	branched	azelaic
Benzoflex 9-88	Benzoflex 9- 88	Dipropylene glycol dibenzoate	27138-31-4	Eastman		
Benzoflex 2-45	Benzoflex 2- 45	2-[2-(benzoyloxy) ethoxy]ethyl benzoate/ Diethylene glycol dibenzoate	120-55-8	Eastman		
Benzoflex 50	Benzoflex 50	Diethylene glycol dibenzoate/ Dipropylene glycol dibenzoate	120-55-8; 27138-31-4	Eastman		
Santicizer 2148	Santicizer 2148	Phosphoric acid, mixed C12-16-alkyl and Ph triesters	159002-22-9	Ferro		phosphoric
Santicizer 278	Santicizer 278	1,2-Benzene dicarboxylic acid, 1-[2,2-dimethyl-1-(1- methylethyl)-3-(2-methyl-1-oxopropoxy) propyl]2-(phenylmethyl) ester	16883-83-3	Ferro		phosphoric
Santicizer 148	Santicizer 148	Phosphoric acid,esters,iso decyl diphenyl ester,mixt. with triphenyl phosphate	96300-95-7	Ferro	branched/aromatic	phosphoric
Santicizer 261	Santicizer 261	1,2-Benzene dicarboxylic acid, benzyl C7-9-branched and linear alkylesters	68515-40-2	Ferro	linear/aromatic	phthalic
Mesamoll	Mesamoll II	Sulfonic acids, C10-21-alkane, Ph esters	91082-17-6	Lanxess/Era		sulfuric

TABLE X3.1 *Continued*

Product	Commercial Name	Chemical Name	CAS#	Producer	Alcohol	Acid
Mixed Adipate	Plastomoll GA	Adipic Ester of Mixed C7,8,9,10,11 alcohols	215734-10-4	BASF		adipic

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue, D7823 - 14, that may impact the use of this standard. (May 1, 2016)

(1) Added new adjunct to Section 2.

(2) Added paragraph about new adjunct to X3.1.

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