Evaluation of a New Technique in Semi-Automated, Miniaturized Solid Phase Extraction

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Objectives of Sample Preparation

Sample Preparation has three objectives:

- Get the analytes of interest into solution
- Get rid of interferences found in the sample matrix
- Get the analytes to a concentration that the analytical instrument can detect

- Liquid-Liquid Extraction
- Solid Phase Extraction
- Solid Phase Micro Extraction (SPME)

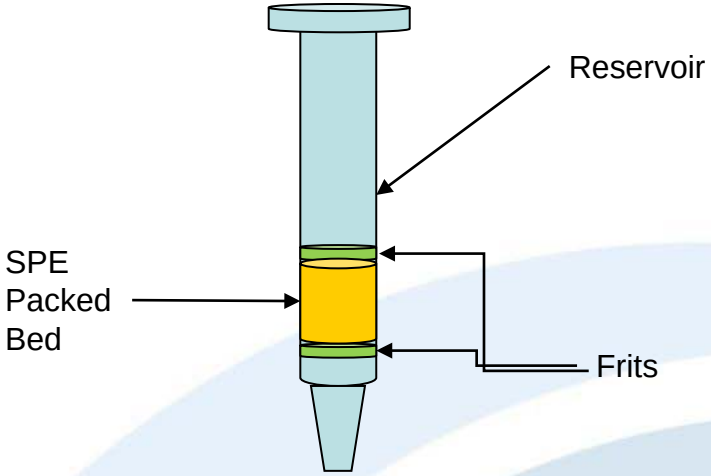
Micro Extraction by Packed Sorbent

What is MEPS?

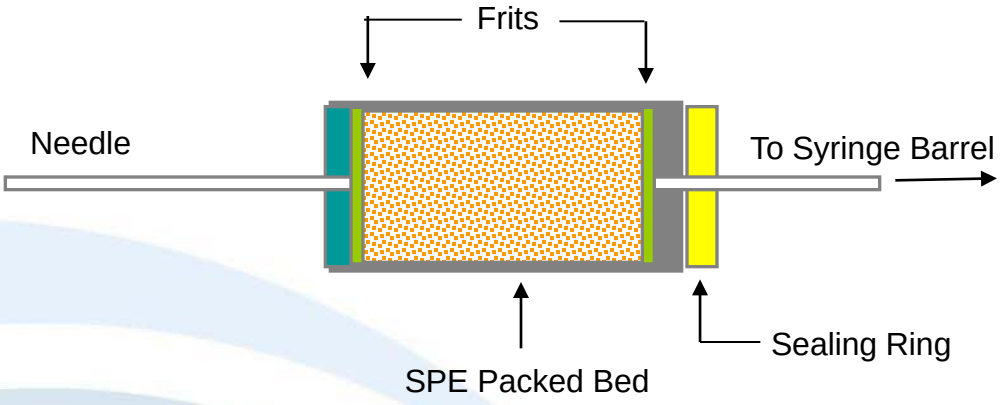
- MEPS is the miniaturization of packed bed solid phase extractions
- Manipulated by integrating the sorbent into a syringe needle
  - modified removable needle syringe
- Syringe configuration is readily integrated into automated sampling systems
- Extracted volumes are compatible with on-line use in both GC and LC systems

How Similar are SPE and MEPS?

- MEPS and conventional SPE function in the same manner
- They use the same phases
- Physically very similar
- Current SPE methods simply require scaling down of the volumes of sample, wash, and solvent used with MEPS
- Mean particle size is 45µm with a 60Å pore



SPE TUBE

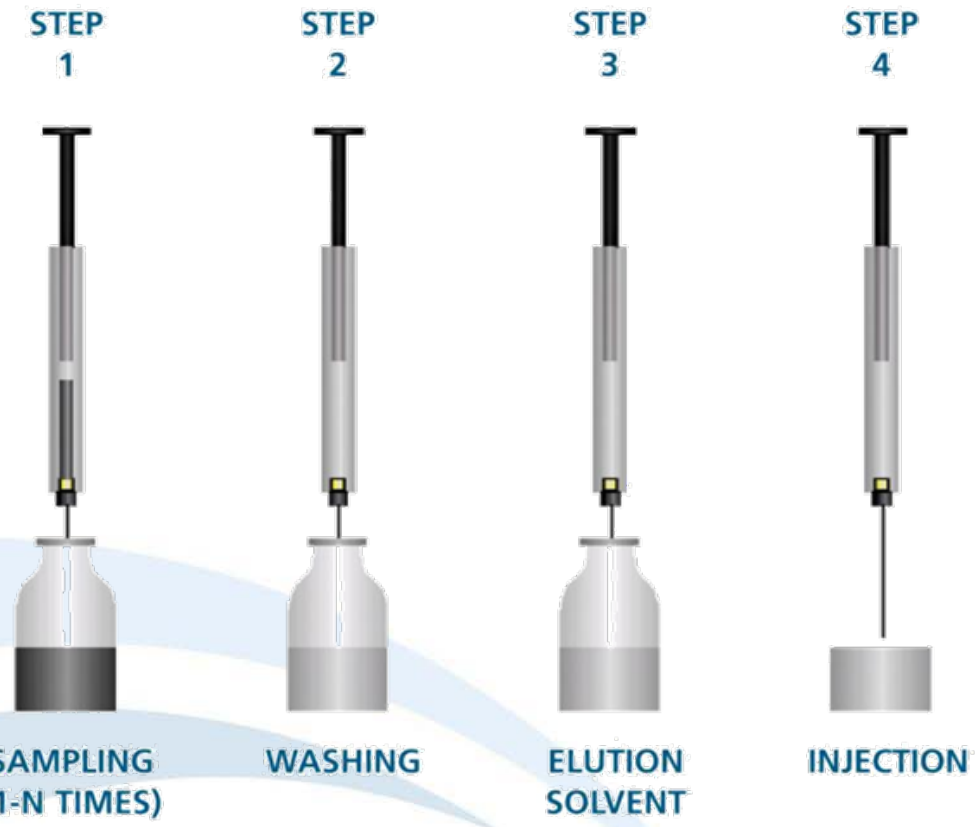


MEPS Barrel In Needle

MEPS Operation

How to use MEPS

- **Step 1:** Pump the sample through the MEPS cartridge (one or more volumes may be taken)
- **Step 2:** Wash the MEPS cartridge once by pumping 20µL to 50µL of wash solution through the cartridge to remove interferences
- **Step 3:** Elute the analyte by drawing solvent through the cartridge into the syringe barrel
- **Step 4:** Inject the analyte directly into the injector
- Pump 50µL solvent followed by 50µL wash solution to prepare cartridge for the next sample



Sorbent Capacity

The amount of sorbent determines the maximum amount of analyte that can be retained.

The capacity of non-ionic, silica based sorbents can be estimated as 3% to 5% of the sorbent bed mass.

MEPS has a sorbent bed mass of 4mg so the capacity is:

4mg X 3% **= 120µg**

4mg X 5% = **200µg**

Sorbent Bed Volume

The sum of the spaces between sorbent particles and the pore volume of the sorbent is called the **Bed Volume**

Conventional silica-based SPE products have a bed volume that can be estimated as 1.5µL per mg of sorbent. MEPS uses 4mg of packing so:

1.5µL X 4mg = **6µL bed volume**

Bed volume is used to estimate the solvent volumes required in SPE. Solvent volumes of 4 to 8 times bed volume are recommended to ensure proper conditioning, washing and elution:

4 X 6µL = **25µL**
8 X 6µL = **48µL**

Background

- Polycyclic Aromatic Hydrocarbons (PAH) are common environmental contaminants.

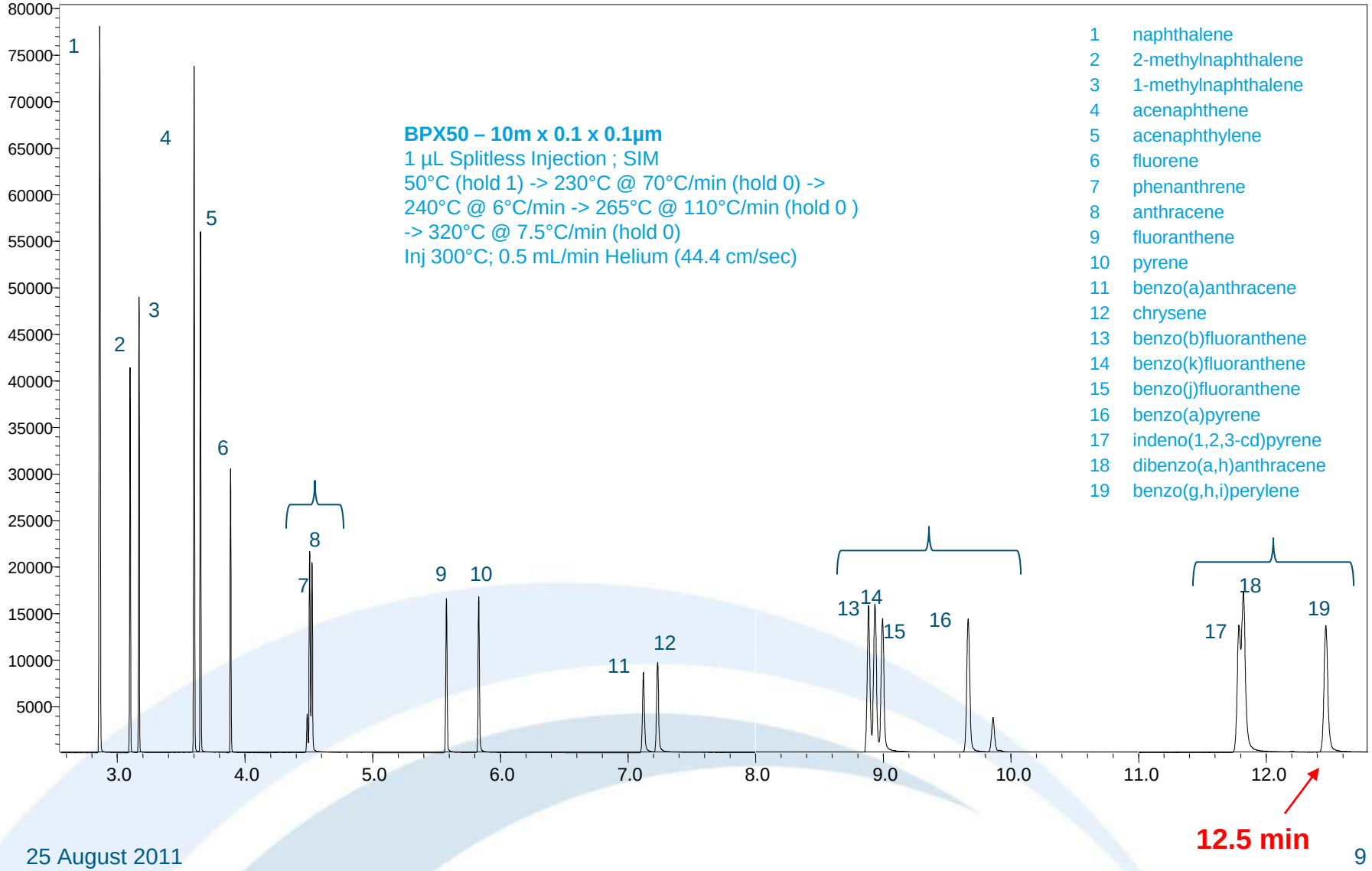
- PAHs are comprised of fused benzene rings with Naphthalene being the smallest of the PAHs with two fused benzene rings

- EPA lists several test methods for the analysis of the following 16 priority pollutants
    - Trace level analyses, GC/MS is often utilized in SIM mode.

Acenaphthene	Benzo(a)pyrene	Chrysene	Indeno(1,2,3-cd)pyrene
Acenaphthylene	Benzo(b)fluoranthene	Dibenzo(a,h)anthracene	Naphthalene
Anthracene	Benzo(ghi)perylene	Fluoranthene	Phenanthrene
Benzo(a)anthracene	Benzo(k)fluoranthene	Fluorene	Pyrene

Polycyclic Aromatic Hydrocarbons

12.5 min Analysis



MEPS Method Development

Stationary Phases

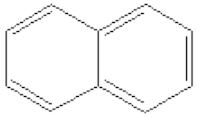
250µL Removable needle MEPS syringe: C8 and C18

Elution Phases

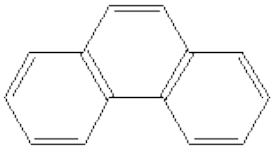
Methylene Chloride
Methanol
Acetonitrile
Acetone
Toluene
Isopropanol
1:1 Methylene Chloride / Acetonitrile
1:1 Methylene Chloride / Methanol
Methylene Chloride + X% Acetonitrile

Properties

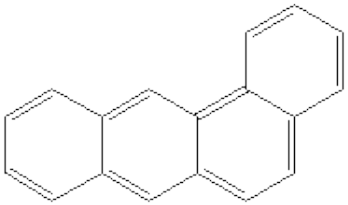
Compound	M.W.	Aq. Sol.
Naphthalene	128	30 mg/L
1-methylnapthalene	142	25.8
2-methylnapthalene	142	24.6
Acenaphthylene	152	3.9
Acenaphthene	154	3.9
Fluorene	166	2
Phenanthrene	178	1.2
Anthracene	178	0.07
Fluoranthene	202	0.26
Pyrene	202	0.13
Benzo(a)anthracene	228	0.01
Chrysene	228	0.002
Benzo(b)fluoranthene	252	0.014
Benzo(k)fluoranthene	252	0.008
Benzo(j)fluoranthene	252	0.007
Benzo(a)pyrene	252	0.004
Benzo(ghi)perylene	276	0.003
Indeno(1,2,3-cd)pyrene	276	0.0005
Dibenzo(a,h)anthracene	278	0.00026



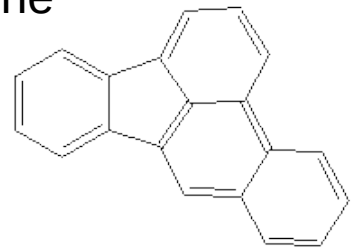
naphthalene



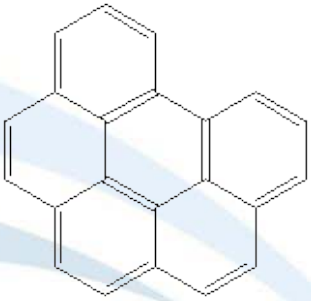
phenanthrene



benzo(a)anthracene



benzo(b)fluoranthene



benzo(ghi)perylene

MEPS Method

Hardware
250µL Removable needle MEPS syringe (cat 006292)
MEPS BIN for 250µL syringes; C18 (cat 2900301)

Sample Preparation
“Sample” prepared in MilliQ with 10% Isopropanol

Condition
100µL Methylene Chloride x 2 at 15µL/sec
100µL Methanol at 15µL/sec
100µL MilliQ with 10% Isopropanol at 15µL/sec

Load
1mL of sample (4 x 250µL) at 15µL/sec

Dry
Air push through sorbent bed 200µL @ 25µL/sec
Also used Helium purge through syringe barrel

Elute
40µL Methylene Chloride into 200µL vial insert
2µL analyzed via GC/MS SIM

GC/MS Method

Injection

Pulsed Splitless (35psi 1min)
2µL injection + 1µL DCM Flush (w/ 2.5ng IS)
Injection Port 300°C

Column and Oven Conditions

BPX50 – 20m x 0.18 x 0.18
Helium 1.1mL/min Constant Flow
60°C (hold 1 min)
35°C/min to 230°C (hold 0)
6°C/min to 240°C (hold 0)
50°C/min to 265°C (hold 0)
4°C/min to 320°C (hold 1)

Mass Spec

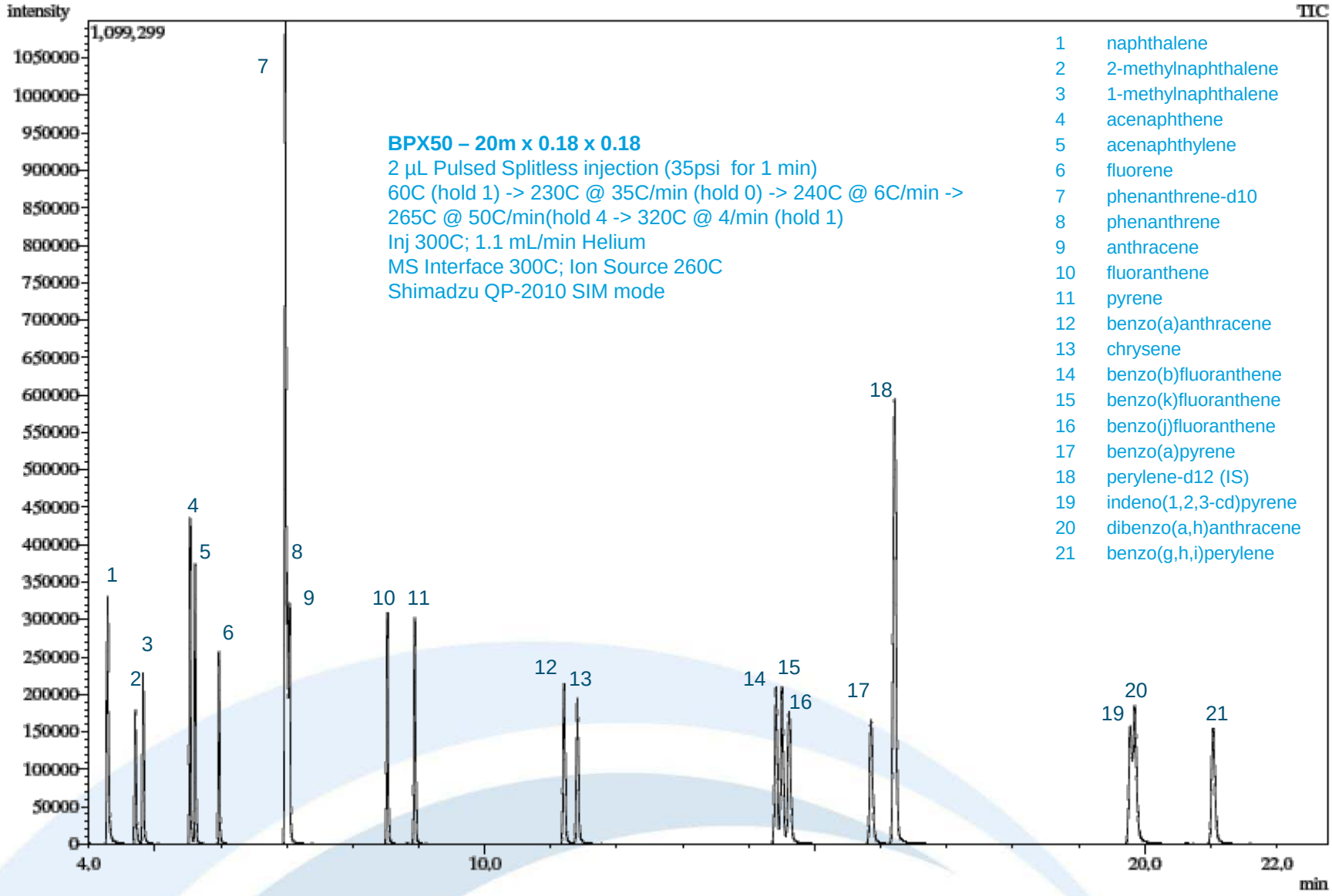
Autotune; 219 m/z
Mode – SIM
Interface 300°C
Ion Source 260°C

Shimadzu QP-2010

SIM Group	Time	Ion(s)	Event Time
1	4.00	128	0.20
2	4.60	142	0.20
3	5.25	152 / 153	0.20
4	5.75	166	0.20
5	6.25	188 / 178	0.20
6	7.50	202	0.20
7	10.00	228	0.20
8	12.00	252 / 264	0.20
9	18.00	276 / 278	0.20

0.005ng -10ng Quadratic Regression		
1ng Check Standard	Conc	% Rec
naphthalene	0.910	91.0%
2-methylnaphthalene	0.878	87.8%
1-methylnaphthalene	0.895	89.5%
acenaphthylene	0.926	92.6%
acenaphthene	0.913	91.3%
fluorene	0.943	94.3%
phenanthrene	0.858	85.8%
anthracene	0.948	94.8%
fluoranthene	0.904	90.4%
pyrene	0.885	88.5%
benzo(a)anthracene	0.933	93.3%
chrysene	0.911	91.1%
benzo(b)fluoranthene	0.876	87.6%
benzo(k)fluoranthene	0.868	86.8%
benzo(j)fluoranthene	0.869	86.9%
benzo(a)pyrene	0.871	87.1%
indeno(1,2,3-cd)pyrene	0.894	89.4%
dibenz(a,h)anthracene	0.830	83.0%
benzo(g,h,i)perylene	0.859	85.9%

BPX50 –1ng PAH Mix



ERA Low-Level PAH QAPET

ERA

A Waters Company

Certificate of Analysis

Lot No. P159-715
Expiration Date:[1] 01/2011

PriorityPollutnT™ Low-Level PAHs

Catalog No. 715
Issue Date: April 07, 2009
Revision: Original

Certification

Parameter	Certified Value [2]	Uncertainty [3]	QC Performance Acceptance Limits [4]	PT Performance Acceptance Limits [5]
	µg/L	%	µg/L	µg/L
Acenaphthene	7.71	3.3	4.00 - 9.02	4.10 - 9.00
Acenaphthylene	6.26	0.65	3.18 - 7.01	3.08 - 7.44
Anthracene	1.39	1.4	0.688 - 1.68	0.403 - 1.90
Benzo(a)anthracene	0.787	3.2	0.513 - 0.937	0.448 - 0.948
Benzo(b)fluoranthene	0.824	0.60	0.510 - 0.989	0.372 - 1.06
Benzo(k)fluoranthene	1.62	0.49	0.967 - 1.96	0.913 - 1.95
Benzo(g,h,i)perylene	0.322	4.6	0.167 - 0.386	0.133 - 0.450
Benzo(a)pyrene	0.830	4.6	0.472 - 1.00	0.314 - 1.15
Chrysene	0.685	2.4	0.456 - 0.877	0.383 - 0.897
Dibenz(a,h)anthracene	0.965	3.2	0.474 - 1.24	0.273 - 1.38
Fluoranthene	1.37	2.6	0.793 - 1.71	0.802 - 1.65
Fluorene	5.26	1.8	2.73 - 6.00	2.25 - 6.23
Indeno(1,2,3-cd)pyrene	1.37	3.4	0.817 - 1.64	0.630 - 1.70
Naphthalene	8.26	2.4	3.38 - 9.25	3.25 - 9.09
Phenanthrene	1.82	3.1	1.05 - 2.15	0.930 - 2.14
Pyrene	1.95	3.3	1.17 - 2.46	1.18 - 2.28

ERA Low-Level PAH QAPET

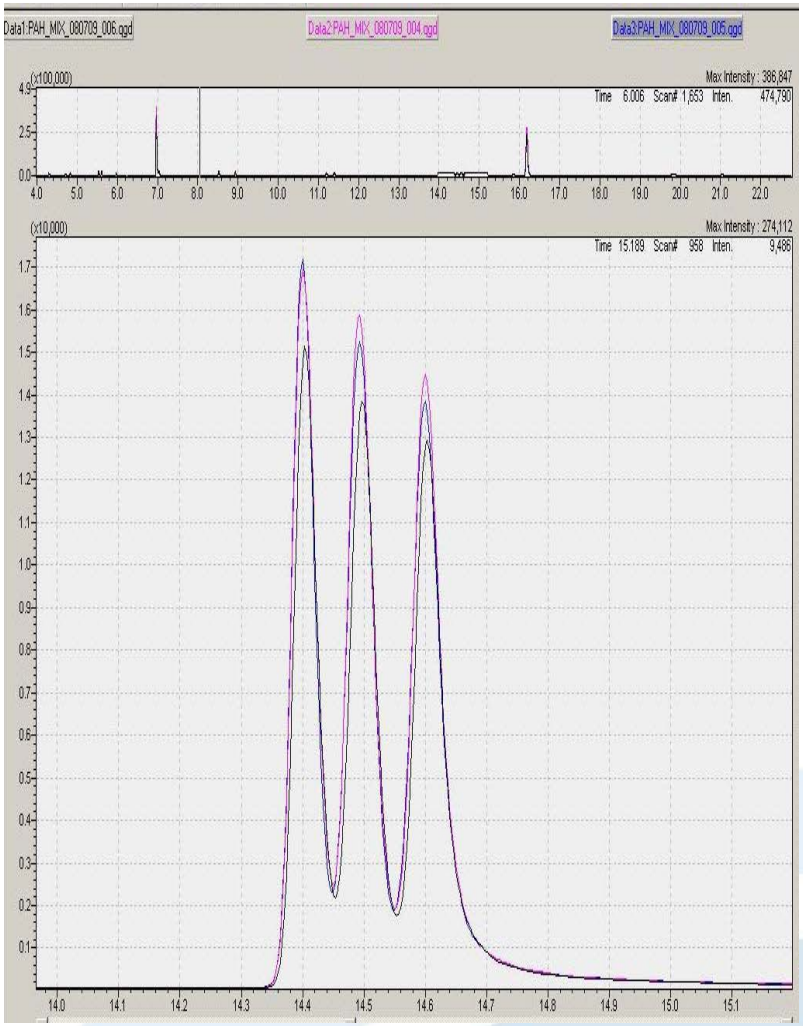
ERA Standard - EXT	Conc	Certified	% Rec	Pass/Fail
naphthalene	6.147	8.26	74.4%	PASS
acenaphthylene	4.849	6.26	77.5%	PASS
acenaphthene	6.299	7.71	81.7%	PASS
fluorene	4.646	5.26	88.3%	PASS
phenanthrene	1.524	1.82	83.7%	PASS
anthracene	1.233	1.39	88.7%	PASS
fluoranthene	1.161	1.37	84.7%	PASS
pyrene	1.625	1.95	83.3%	PASS
benzo(a)anthracene	0.553	0.787	70.3%	PASS
chrysene	0.577	0.685	84.2%	PASS
benzo(b)fluoranthene	0.526	0.824	63.8%	PASS
benzo(k)fluoranthene	1.006	1.62	62.1%	PASS
benzo(a)pyrene	0.576	0.83	69.4%	PASS
indeno(1,2,3-cd)pyrene	1.123	1.37	82.0%	PASS
dibenz(a,h)anthracene	0.647	0.965	67.0%	PASS
benzo(g,h,i)perylene	0.270	0.322	83.9%	PASS

Avg EXT Rec = 77.8%

AVG Stock = 95.4%

ERA Standard - STOCK	Conc	Certified	% Rec
naphthalene	8.977	8.26	108.7%
acenaphthylene	6.502	6.26	103.9%
acenaphthene	8.115	7.71	105.3%
fluorene	5.660	5.26	107.6%
phenanthrene	1.693	1.82	93.0%
anthracene	1.217	1.39	87.6%
fluoranthene	1.233	1.37	90.0%
pyrene	1.771	1.95	90.8%
benzo(a)anthracene	0.678	0.787	86.1%
chrysene	0.576	0.685	84.1%
benzo(b)fluoranthene	0.683	0.824	82.9%
benzo(k)fluoranthene	1.384	1.62	85.4%
benzo(a)pyrene	0.672	0.83	81.0%
indeno(1,2,3-cd)pyrene	1.330	1.37	97.1%
dibenz(a,h)anthracene	0.863	0.965	89.4%
benzo(g,h,i)perylene	0.273	0.322	84.8%

Reproducibility



WWEFF Spike 2.5ng/mL	Ext 1	Ext 2	Ext 3	StDev
naphthalene	1.601	1.682	1.964	19%
2-methylnaphthalene	1.697	1.899	2.049	18%
1-methylnaphthalene	1.935	2.160	2.337	20%
acenaphthylene	1.685	1.920	2.132	22%
acenaphthene	1.807	2.034	2.221	21%
fluorene	2.031	2.278	2.458	21%
phenanthrene	2.030	2.376	2.466	23%
anthracene	2.384	2.534	2.734	18%
fluoranthene	2.040	2.238	2.374	17%
pyrene	2.010	2.234	2.479	23%
benzo(a)anthracene	1.866	2.046	2.023	10%
chrysene	2.023	2.216	2.208	11%
benzo(b)fluoranthene	1.786	1.854	1.852	4%
benzo(k)fluoranthene	1.793	1.874	1.839	4%
benzo(j)fluoranthene	2.204	2.263	2.303	5%
benzo(a)pyrene	1.844	1.896	1.865	3%
indeno(1,2,3-cd)pyrene	1.691	1.710	1.546	9%
dibenz(a,h)anthracene	1.326	1.336	1.173	9%
benzo(g,h,i)perylene	1.574	1.546	1.454	6%

Extraction Comparisons

Liq-Liq Extraction		Liq-Solid Extraction		MEPS Extraction	
5	ng/mL	5	ng/mL	5	ng/mL
1000	mL extraction	20	mL extraction	1	mL extraction
150	mL DCM	3	mL DCM	0.04	mL DCM
33.33	ng/mL	33.33	ng/mL	125.00	ng/mL final conc
1	conc vol (mL)	0.2	conc vol (mL)	**NO CONCENTRATION**	
5000	ng/mL final conc	500	ng/mL final conc		
1	µL inj	2	µL inj	2	µL inj
5	ng per µL	0.5	ng per µL	0.125	ng per µL
5	ng on column	1	ng on column	0.25	ng on column
Extraction to injection ~2-3 hours		**Extraction to injection** ~40-60 min		**Extraction to injection** ~5-10 min	
Waste Generated ~1+ Liter		**Waste Generated** ~50 mL		**Waste Generated** <2mL	

MEPS with eVol®

eVol® is the coupling of two precision devices: A digitally controlled electronic drive and an XCHANGE® enabled analytical syringe.

The result is a digitally controlled positive displacement system that can be programmed to perform a wide variety of liquid handling procedures.

Special XCHANGE® syringes (50µL, 100µl, and 500µL) have been developed to work with MEPS needles.

As SPE is flow rate dependent technique, the programmability and precision of eVol® allows for smoother workflow and better consistency.

GC/MS Method

500pg EXT HDVB Analyte	Result	% Rec
naphthalene	346.8	69.4%
2-methylenaphtahlene	462.1	92.4%
1-methylnaphthalene	392.8	78.6%
acenaphthylene	419.2	83.8%
acenaphthene	405.3	81.1%
fluorene	461.4	92.3%
phenanthrene	468.6	93.7%
anthracene	443.6	88.7%
fluoranthene	476.4	95.3%
pyrene	436.2	87.2%
benzo(a)anthracene	412.9	82.6%
chrysene	395.6	79.1%
benzo(b)fluoranthene	333.8	66.8%
benzo(k)fluoranthene	328.6	65.7%
benzo(j)fluoranthene	331.3	66.3%
benzo(a)pyrene	337.3	67.5%
3-methylcholanthrene	305.5	61.1%
dibenzo(a,h)acridine	295.0	59.0%
dibenzo(a,i)acridine	295.4	59.1%
indeno(1,2,3-cd)pyrene	335.3	67.1%
dibenzo(a,h)anthracene	300.4	60.1%
benzo(g,h,i)perylene	291.2	58.2%
7H-dibenzo(c,g)carbazole	305.9	61.2%
dibenzo(a,e)pyrene	221.0	44.2%
dibenzo(a,i)pyrene	171.4	34.3%
dibenzo(a,h)pyrene	208.7	41.7%

Injection

PTV – LVI Injection
50µL injection (w/ 0.5ng IS)
40°C (hold 0.5min)
400°C.min to 300°C (hold 45 min)

Column and Oven Conditions

BPX50 – 20m x 0.18 x 0.18
Helium 1.4mL/min Constant Flow
40°C (hold 3 min)
35°C/min to 120°C (hold 0.5 min)
8°C/min to 200°C (hold 10 min)
11°C/min to 270°C (hold 0)
2°C/min to 300°C (hold 1 min)
40°C/min to 340°C (hold 7 min)

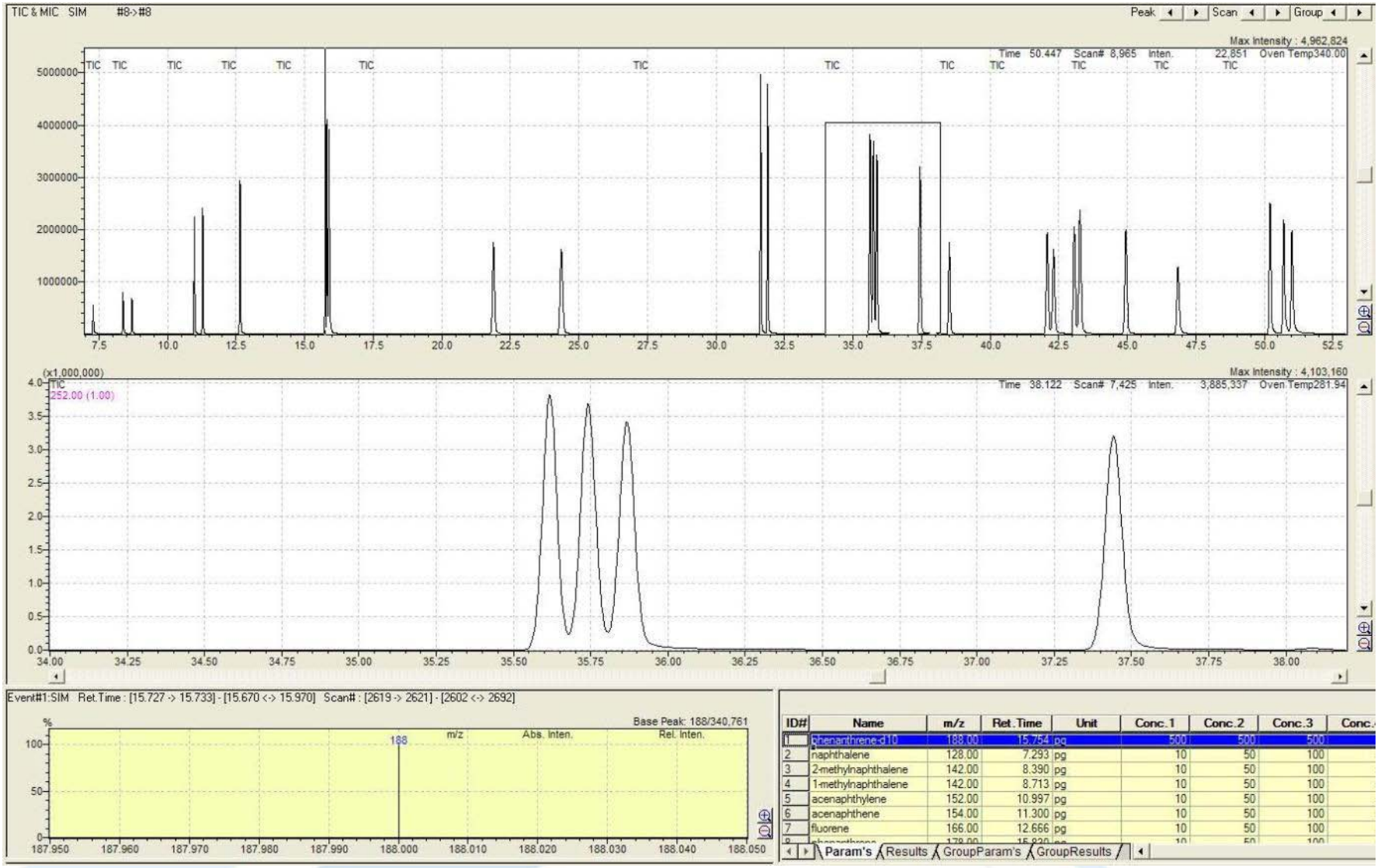
Mass Spec

Autotune; SEI Source
Mode – SIM
Interface 300°C
Ion Source 260°C

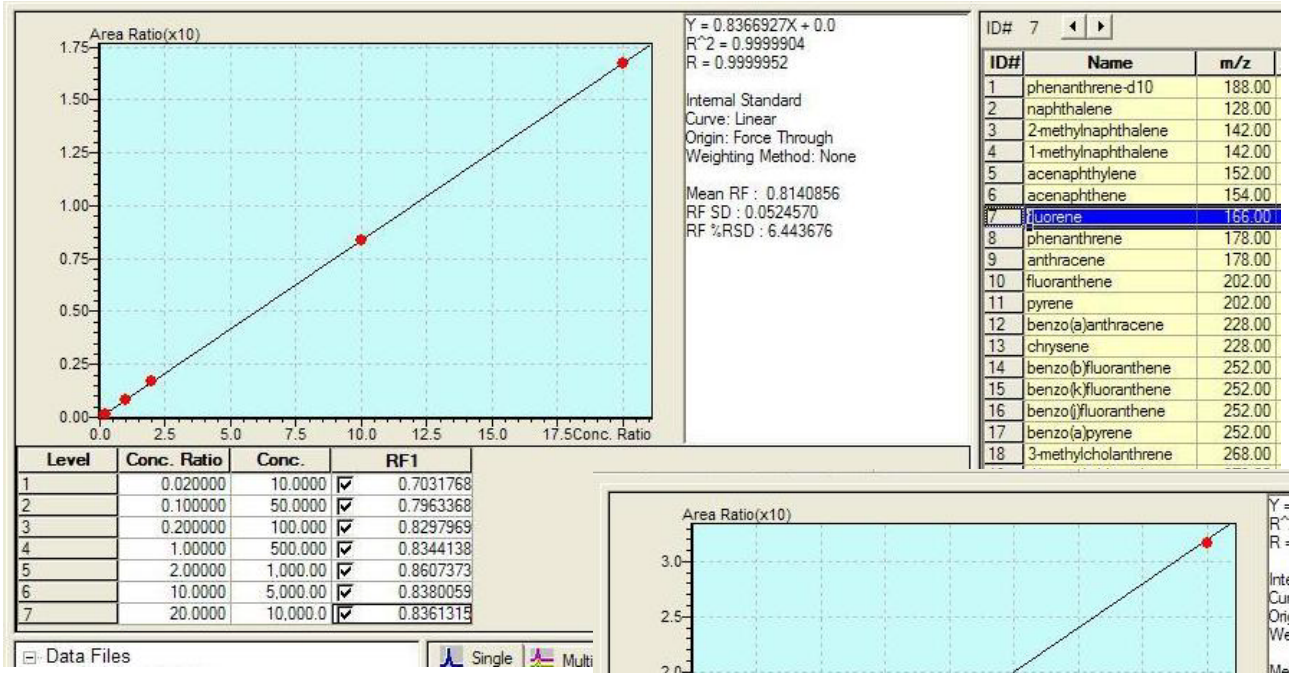
Shimadzu QP-2010

SIM Group	Time	Ion(s)	Event Time
1	7.00	128	0.20
2	8.00	142	0.20
3	10.00	152 / 154	0.20
4	12.00	166	0.20
5	14.00	188 / 178	0.20
6	17.00	202	0.40
7	27.00	228	0.20
8	34.00	252	0.30
9	38.20	268	0.40
10	40.00	279	0.50
11	43.00	276/278	0.50
12	46.00	267	0.50
13	48.50	302	0.50

GC/MS Method


TIC & MIC SIM #8->#8
Peak Scan Group
Max Intensity : 4,962,824
Time 50.447 Scan# 8,965 Inten. 22,851 Oven Temp340.00
TIC
(x1,000,000)
Max Intensity : 4,103,160
Time 38.122 Scan# 7,425 Inten. 3,885,337 Oven Temp281.94
252.00 (1.00)
Event#1:SIM Ret.Time : [15.727 -> 15.733] - [15.670 <-> 15.970] Scan# : [2619 -> 2621] - [2602 <-> 2692]
Base Peak: 188/340,761
m/z
Abs. Inten.
Rel. Inten.
188
ID# Name m/z Ret.Time Unit Conc.1 Conc.2 Conc.3 Conc.
1 chenanthrene-d10 188.00 15.754 pg 500 500 500
2 naphthalene 128.00 7.293 pg 10 50 100
3 2-methylnaphthalene 142.00 8.390 pg 10 50 100
4 1-methylnaphthalene 142.00 8.713 pg 10 50 100
5 acenaphthylene 152.00 10.997 pg 10 50 100
6 acenaphthene 154.00 11.300 pg 10 50 100
7 fluorene 166.00 12.666 pg 10 50 100
Param's Results GroupParam's GroupResults

Calibration with eVol



Y = 0.8366927X + 0.0
R^2 = 0.9999904
R = 0.9999952

Internal Standard
Curve: Linear
Origin: Force Through
Weighting Method: None

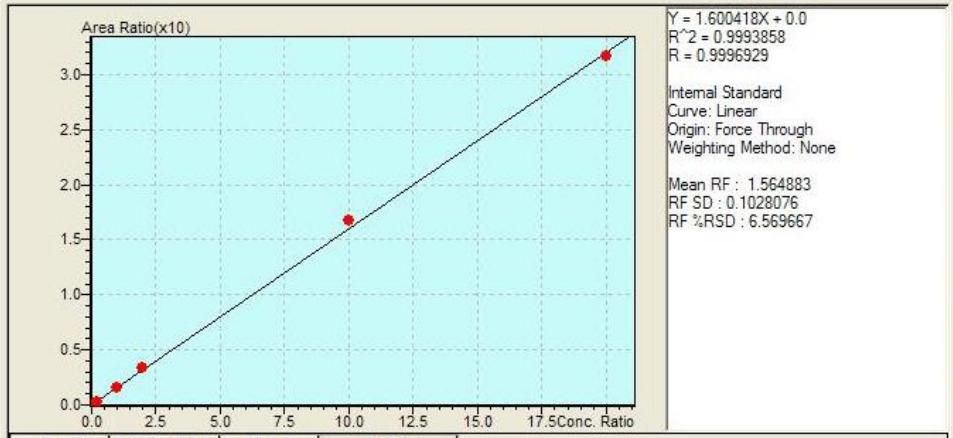
Mean RF : 0.8140856
RF SD : 0.0524570
RF %RSD : 6.443676

Level	Conc. Ratio	Conc.	RF1
1	0.020000	10.0000	0.7031768
2	0.100000	50.0000	0.7963368
3	0.200000	100.000	0.8297969
4	1.00000	500.000	0.8344138
5	2.00000	1,000.00	0.8607373
6	10.0000	5,000.00	0.8380059
7	20.0000	10,000.0	0.8361315

ID# 7

ID#	Name	m/z
1	phenanthrene-d10	188.00
2	naphthalene	128.00
3	2-methylnaphthalene	142.00
4	1-methylnaphthalene	142.00
5	acenaphthylene	152.00
6	acenaphthene	154.00
7	fluorene	166.00
8	phenanthrene	178.00
9	anthracene	178.00
10	fluoranthene	202.00
11	pyrene	202.00
12	benzo(a)anthracene	228.00
13	chrysene	228.00
14	benzo(b)fluoranthene	252.00
15	benzo(k)fluoranthene	252.00
16	benzo(j)fluoranthene	252.00
17	benzo(a)pyrene	252.00
18	3-methylcholanthrene	268.00

Data Files | Single | Multi



Y = 1.600418X + 0.0
R^2 = 0.9993858
R = 0.9996929

Internal Standard
Curve: Linear
Origin: Force Through
Weighting Method: None

Mean RF : 1.564883
RF SD : 0.1028076
RF %RSD : 6.569667

Level	Conc. Ratio	Conc.	RF1
1	0.020000	10.0000	1.593862
2	0.100000	50.0000	1.362048
3	0.200000	100.000	1.510507
4	1.00000	500.000	1.587762
5	2.00000	1,000.00	1.649716
6	10.0000	5,000.00	1.666948
7	20.0000	10,000.0	1.583339

ID# 16

ID#	Name	m/z
1	phenanthrene-d10	188.00
2	naphthalene	128.00
3	2-methylnaphthalene	142.00
4	1-methylnaphthalene	142.00
5	acenaphthylene	152.00
6	acenaphthene	154.00
7	fluorene	166.00
8	phenanthrene	178.00
9	anthracene	178.00
10	fluoranthene	202.00
11	pyrene	202.00
12	benzo(a)anthracene	228.00
13	chrysene	228.00
14	benzo(b)fluoranthene	252.00
15	benzo(k)fluoranthene	252.00
16	benzo(j)fluoranthene	252.00
17	benzo(a)pyrene	252.00
18	3-methylcholanthrene	268.00
19	dibenzo(a,h)acridine	279.00
20	dibenzo(a,j)acridine	279.00
21	indeno(1,2,3-cd)pyrene	276.00
22	dibenzo(a,h)anthracene	278.00
23	benzo(g,h,i)perylene	276.00
24	7H-dibenzo(c,g)carbazol	267.00
25	dibenzo(a,e)pyrene	302.00
26	dibenzo(a,i)pyrene	302.00
27	dibenzo(a,h)pyrene	302.00

Data Files | Single | Multi

Reproducibility

Sample	1	2	3	4	5	6	7	8	9	10
	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area
1,2-Hexanediol	1157509	1046091	1064208	1140998	1166602	1182808	1142381	1183535	1239176	1217651
4-Chlorophenol	2657476	2371204	2411114	2570969	2632854	2664875	2555697	2658165	2766991	2721435
Methyl Nonanoate	3283864	2918265	2988263	3190831	3280334	3321843	3172113	3310878	3446438	3407911
1-Decylamine	3133058	2881214	2877458	3140822	3170773	3227129	3091007	3211139	3385707	3314391
n-Tridecane	4617263	4124451	4189141	4508920	4595033	4669599	4482693	4650611	4849530	4781844
1-Undecanol	3684172	3231539	3276282	3526303	3605402	3702209	3575428	3705219	3806719	3758741
Acenaphthylene	4949958	4346589	4389130	4768592	4827957	4972287	4796788	4987041	5126852	5056115
n-Pentadecane	4350005	3801789	3813820	4183811	4210068	4354059	4212533	4357453	4498080	4420293

	Mean	SD	%RSD
1,2-Hexanediol	1154096	60728	5.26
4-Chlorophenol	2601078	127116	4.89
Methyl Nonanoate	3232074	169760	5.25
1-Decylamine	3143270	164190	5.22
n-Tridecane	4546909	233781	5.14
1-Undecanol	3587201	194798	5.43
Acenaphthylene	4822131	264755	5.49
n-Pentadecane	4220191	238644	5.65

eVol® MEPS Method

eVol Custom Method		
Prompt	**DCM**	**Speed**
Aspirate	250	1
Dispense	250	1
Prompt	**MeOH**	
Aspirate	250	1
Dispense	250	1
Prompt	**H2O**	
Aspirate	250	1
Dispense	250	1
Prompt	**SAMPLE**	
Aspirate	500	1
Dispense	500	1
Aspirate	500	1
Dispense	500	1
Prompt	**DRY**	
Aspirate	500	10
Dispense	500	10
Aspirate	500	10
Dispense	500	10
Aspirate	500	10
Dispense	500	10
Aspirate	500	10
Dispense	500	10
Aspirate	500	10
Dispense	500	10
Prompt	**ELUTE**	
Aspirate	120	1
Dispense	120	1
Prompt	**PUSH**	
Aspirate	500	5
Dispense	500	10
Aspirate	500	5
Dispense	500	10
Aspirate	500	5
Aspirate	500	10
Prompt	**CLEAN**	
Aspirate	500	1
Dispense	500	1

Hardware

500µL Removable needle eVol MEPS syringe (cat 2910026)
MEPS BIN HDVB (cat 2900705)

Sample Preparation

“Sample” prepared in MilliQ with 10% Isopropanol

Condition

250µL Methylene Chloride at 16.67 µL/sec
250µL Methanol at 16.67 µL/sec
250µL MilliQ with 10% Isopropanol at 16.67 µL/sec

Load

1mL of sample (2 x 500µL) at 16.67µL/sec

Dry

Air push through sorbent bed 2000µL @ 400µL/sec

Elute

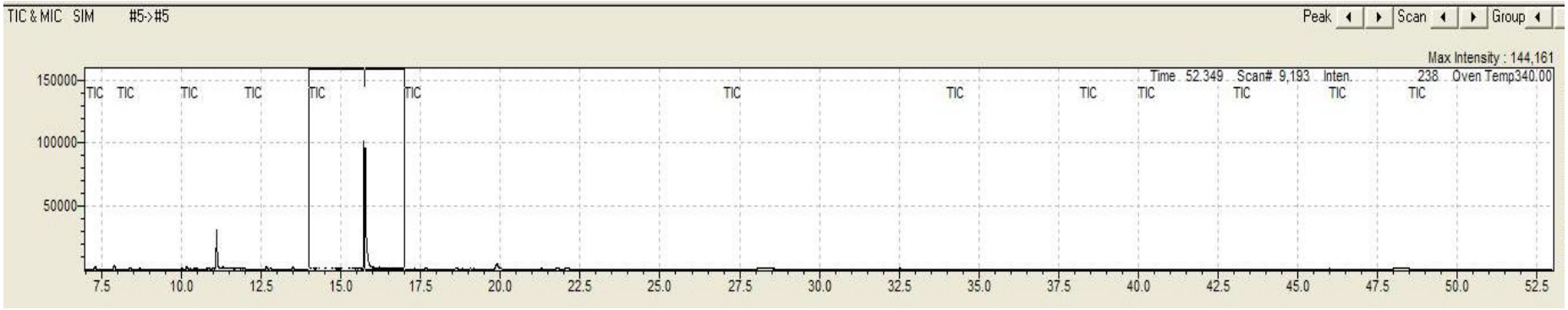
100µL Methylene Chloride into 200µL vial insert
1µL IS (phenanthrene-d10) added
50µL analyzed via GC/MS SIM

ERA Extraction - MEPS eVol

ERA STD (1uL)	certified	Conc (ng)	% Rec
acenaphthylene	6.26	5.95	95.1%
anthracene	1.39	1.37	98.8%
benzo(a)anthracene	0.787	0.87	110.1%
benzo(b)fluoranthene	0.824	0.83	100.4%
benzo(k)fluoranthene	1.62	1.75	107.7%
benzo(g,h,i)perylene	0.322	0.33	101.5%
benzo(a)pyrene	0.83	0.77	92.4%
chrysene	0.685	0.72	105.5%
dibenz(a,h)anthracene	0.965	1.15	119.6%
fluoranthene	1.37	1.42	103.5%
fluorene	5.26	5.26	99.9%
indeno(1,2,3-cd)pyrene	1.37	1.66	121.1%
naphthalene	8.26	6.15	74.4%
phenanthrene	1.82	1.81	99.4%
pyrene	1.95	2.00	102.4%

HDVB ERA EXT	certified	Conc (ng)	% Rec	
acenaphthene	7.71	5.54	71.8%	PASS
acenaphthylene	6.26	5.00	79.8%	PASS
anthracene	1.39	1.16	83.7%	PASS
benzo(a)anthracene	0.787	0.59	74.8%	PASS
benzo(b)fluoranthene	0.824	0.49	59.2%	PASS
benzo(k)fluoranthene	1.62	0.98	60.6%	PASS
benzo(g,h,i)perylene	0.322	0.16	48.7%	PASS
benzo(a)pyrene	0.83	0.43	52.2%	PASS
chrysene	0.685	0.47	68.3%	PASS
dibenz(a,h)anthracene	0.965	0.48	49.7%	PASS
fluoranthene	1.37	1.21	88.3%	PASS
fluorene	5.26	4.57	86.9%	PASS
indeno(1,2,3-cd)pyrene	1.37	0.86	63.1%	PASS
naphthalene	8.26	4.49	54.4%	PASS
phenanthrene	1.82	1.61	88.7%	PASS
pyrene	1.95	1.66	85.0%	PASS

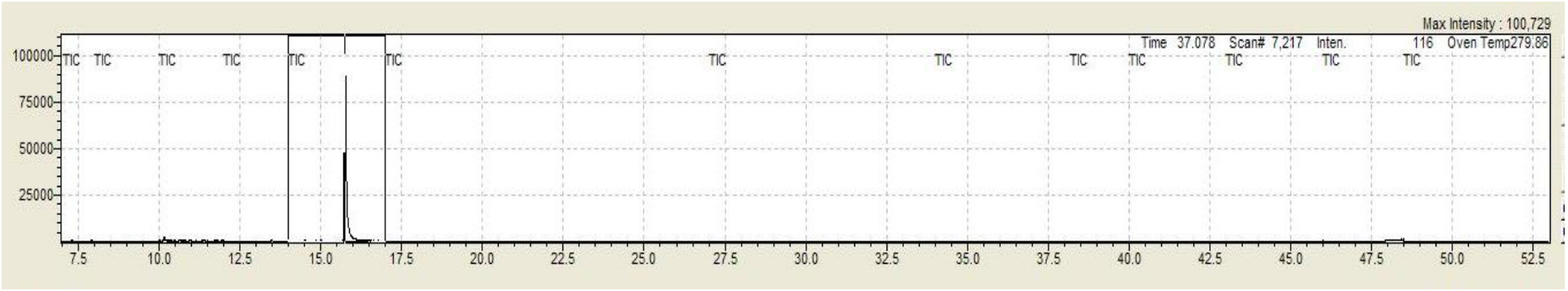
HDVB MEPS Blank



ID#	Ret.Time	Name	Conc	Unit	m/z	Area	S/N	Mode
1	15.739	phenanthrene-d10	500.000	pg	188.00	486657	1861.57	Auto
2	7.286	naphthalene	27.035	pg	128.00	7661	38.39	Auto
3	8.378	2-methylnaphthalene	8.850	pg	142.00	2415	23.70	Auto
4	8.700	1-methylnaphthalene	9.328	pg	142.00	2450	22.44	Auto
5	10.986	acenaphthylene	2.306	pg	152.00	1483	9.92	Auto
6	11.282	acenaphthene	4.077	pg	154.00	2116	7.83	Auto
7	12.654	fluorene	5.896	pg	166.00	4672	36.98	Auto
8	15.815	phenanthrene	17.319	pg	178.00	18609	48.10	Auto
9	15.916	anthracene	2.211	pg	178.00	2658	7.05	Auto
10	21.927	fluoranthene	1.782	pg	202.00	1837	13.15	Auto
11	24.423	pyrene	3.192	pg	202.00	3610	38.20	Auto
12	31.640	benzo(a)anthracene	0.732	pg	228.00	1011	9.79	Auto
13	31.936	chrysene	0.159	pg	228.00	221	2.47	Auto
14	35.702	benzo(b)fluoranthene	0.924	pg	252.00	1201	18.00	Auto
15	35.854	benzo(k)fluoranthene	1.531	pg	252.00	2078	9.17	Auto
16	35.921	benzo(j)fluoranthene	0.325	pg	252.00	495	3.98	Auto
17	37.479	benzo(a)pyrene	0.126	pg	252.00	163	3.31	Auto
18	38.597	3-methylcholanthrene	0.217	pg	268.00	153	3.33	Auto
19	42.175	dibenzo(a,h)acridine	0.084	pg	279.00	86	4.00	Auto
20	42.325	dibenzo(a,j)acridine	0.131	pg	279.00	126	2.83	Auto
21	43.067	indeno(1,2,3-cd)pyrene	0.254	pg	276.00	217	2.63	Auto
22	43.367	dibenzo(a,h)anthracene	0.150	pg	278.00	176	2.54	Auto
23	44.967	benzo(g,h,i)perylene	0.069	pg	276.00	89	3.43	Auto
24	46.958	7H-dibenzo(c,g)carbazol	0.347	pg	267.00	296	6.20	Auto
25	50.311	dibenzo(a,e)pyrene	0.297	pg	302.00	344	6.06	Auto
26	50.833	dibenzo(a,i)pyrene	0.240	pg	302.00	258	2.67	Auto
27	51.099	dibenzo(a,h)pyrene	0.610	pg	302.00	709	6.56	Auto

Param's | Results | GroupParam's | GroupResults

DCM Blank



ID#	Ret.Time	Name	Conc	Unit	m/z	Area	S/N	Mode	Noise From	Noise To
1	15.747	phenanthrene-d10	500.000	pg	188.00	416877	2866.43	Auto	15.491	15.591
2	7.304	naphthalene	3.885	pg	128.00	943	4.17	Auto	7.643	7.743
3	8.405	2-methylnaphthalene	0.466	pg	142.00	109	2.63	Auto	8.083	8.183
4	8.444	1-methylnaphthalene	0.124	pg	142.00	28	1.10	Auto	8.740	8.840
5	10.945	acenaphthylene	0.717	pg	152.00	395	1.89	Auto	11.170	11.270
6	11.321	acenaphthene	0.531	pg	154.00	236	1.27	Auto	11.280	11.380
7	12.673	fluorene	0.467	pg	166.00	317	2.24	Auto	12.757	12.857
8	15.830	phenanthrene	2.073	pg	178.00	1908	9.33	Auto	15.363	15.463
9	15.830	anthracene	1.852	pg	178.00	1908	8.62	Auto	16.010	16.110
10	21.990	fluoranthene	1.151	pg	202.00	1016	8.27	Auto	21.796	21.896
11	24.508	pyrene	1.355	pg	202.00	1313	18.67	Auto	24.802	24.902
12	31.644	benzo(a)anthracene	0.372	pg	228.00	440	5.47	Auto	31.337	31.437
13	31.880	chrysene	0.258	pg	228.00	307	2.61	Auto	32.270	32.370
14	35.720	benzo(b)fluoranthene	1.329	pg	252.00	1479	11.32	Auto	35.432	35.532
15	35.720	benzo(k)fluoranthene	1.309	pg	252.00	1521	11.53	Auto	35.431	35.531
16	35.873	benzo(j)fluoranthene	1.188	pg	252.00	1550	13.00	Auto	35.432	35.532
17	37.433	benzo(a)pyrene	0.050	pg	252.00	56	1.93	Auto	37.555	37.655
18	38.546	3-methylcholanthrene	0.285	pg	268.00	172	8.00	Auto	38.815	38.915
19	42.266	dibenzo(a,h)acridine	0.107	pg	279.00	94	6.00	Auto	42.111	42.211
20	42.375	dibenzo(a,j)acridine	0.115	pg	279.00	95	5.75	Auto	42.110	42.210
21	43.165	indeno(1,2,3-cd)pyrene	0.435	pg	276.00	318	4.67	Auto	43.092	43.192
22	43.416	dibenzo(a,h)anthracene	0.064	pg	278.00	64	3.00	Auto	43.675	43.775
23	45.150	benzo(g,h,i)perylene	0.650	pg	276.00	714	13.80	Auto	44.850	44.950
24	47.000	7H-dibenzo(c,g)carbazol	0.222	pg	267.00	162	2.71	Auto	46.478	46.578
25	50.169	dibenzo(a,e)pyrene	0.310	pg	302.00	308	2.80	Auto	50.375	50.475
26	50.692	dibenzo(a,i)pyrene	0.299	pg	302.00	275	4.16	Auto	50.375	50.475
27	51.169	dibenzo(a,h)pyrene	0.323	pg	302.00	322	4.50	Auto	51.425	51.525

Param's | Results | GroupParam's | GroupResults

Summary

- MEPS enables a convenient format for miniaturization of SPE
  - Manually
  - Semi-automated (eVol)
  - Fully automated (autosampler)
- Sample prep time is significantly reduced
  - eVol extraction was ~6min
- Sample usage and waste generation reduction
  - Waste generated ~2mL
- Extraction and injection can be combined in one process
  - PTV or LVI for GC; HPLC
- Cartridge may be reused 40 to 100 times

* ANALYTE & MATRIX DEPENDENT*