

# Analysis of PAHs (Polycyclic Aromatic Hydrocarbons) by YL9100 Plus HPLC

- HPLC Application



## Abstract

Polycyclic aromatic hydrocarbons (PAHs) are organic compounds that contain two or more aromatic rings. PAHs are known for mutagen and carcinogen in terms of ecotoxicology. 17 PAHs including benzo(e)pyrene are regulated as priority pollutants by the U.S. Environmental Protection Agency (EPA), 33 PAHs (31 PAHs and 2 alkylated PAHs) are regulated by WHO.

Some low molecular weight PAHs can be biodegraded in natural environment, but most of the PAHs are stable and insoluble compounds having high melting and boiling point. The larger the number of aromatic rings, the lower its volatility. Therefore, they are found as a solid in soils or an adsorbate onto dust.

They are mainly produced from by-products of fuel combustion, industrial process, automobile exhausts and vehicle fuels, also can be generated naturally from volcanos, forest fires, and crude oils.

In this study, 18 PAHs are analyzed by YL9100 Plus HPLC/PDA referring to EPA 8310.

## Instruments and Software

item	Description	Part No.
Vacuum Degasser	YL9101 Vacuum Degasser	5611011000
Pump	YL9110 Plus Quaternary Gradient Pump	9361011120
Autosampler	YL9150 Plus LC Autosampler	9551011000
Column Compartment	YL9131 Column Compartment	5511011050
Detector	YL9160 Photo Diode Array Detector	2201011000
Install. Option	HPLC Performance Kit (Without LC C18 Column)	1601011890
CDS	YL-Clarity software for single instrument of YL HPLC	5301011000
	PDA module of YL-Clarity	5301011070
	Autosampler control of YL-Clarity	5301011040
Column	ZORBAX Eclipse PAH (4.6 mm x 250 mm x 5 µm)	990967-902

## Reagents and Standards

- Ultrapure water, 18.2 MΩ-cm resistivity
- Acetonitrile (CH<sub>3</sub>OH), HPLC Grade
- Polynuclear aromatic hydrocarbons standard mix (2000 µg/mL each component in benzene: dichloromethane = 50:50) :

acenaphthene, acenaphthylene, anthracen-e,  
benzo(a)anthracene, benzo(b)fluoranthene,  
benzo(k)fluoranthene, benzo(g, h, i)perylene,  
banzo(a)pyrene, chrysene, dibenzo (a,h)anthracene,  
fluoranthene, fluorene, in-deno(1, 2, 3-cd)pyrene,  
1-methylnaphthalene, 2-methylnaphthalene,  
naphthalene, phenanthrene, pyrene (CRM47543)



**Fig 1. YL9100 Plus HPLC**

**Table 1. LC conditions**

YL9100 Plus HPLC System	
Solvents	A : Water B : Acetonitrile
Column	ZORBAX Eclipse PAH (4.6 mm x 250 mm x 5 µm) (P/N 959990-918)
Gradient Programs	Shown in Table 2.
Flow Rate	2mL/min
Temperature	40°C
Injection Volume	25µl
Detection	PDA 220nm

**Table 2. Gradient programs for analytical pump**

Time (min)	% A (Water)	% B (ACN)
Initial	60	40
25	0	100
35	0	100
36	60	40
40	60	40

**Table 3. Sample information**

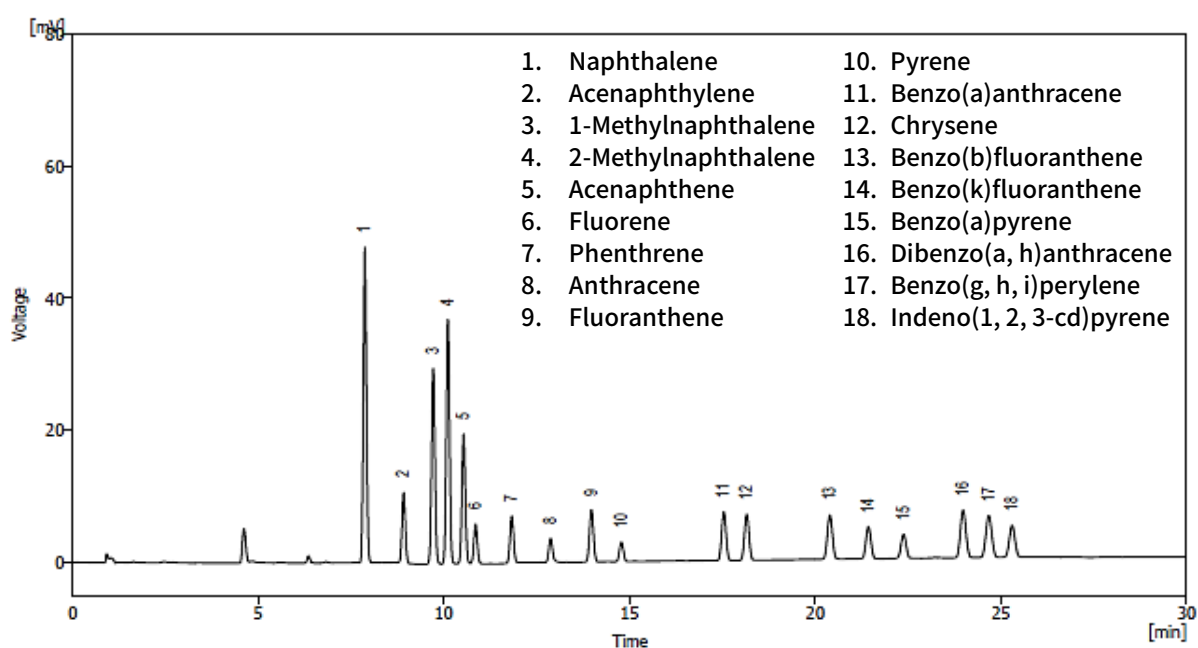
Formulas and Physical Properties of PAHs Standard Mix					
Compound	Formula	Weight	Compound	Formula	Weight
Naphthalene	C <sub>10</sub> H <sub>8</sub>	128.17	Pyrene	C <sub>16</sub> H <sub>10</sub>	202.25
Acenaphthylene	C <sub>12</sub> H <sub>8</sub>	152.19	Benzo(a)anthracene	C <sub>18</sub> H <sub>12</sub>	228.29
1-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	142.20	Chrysene	C <sub>18</sub> H <sub>12</sub>	228.29
2-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	142.20	Benzo(b)fluoranthene	C <sub>20</sub> H <sub>12</sub>	252.31
Acenaphthene	C <sub>12</sub> H <sub>16</sub>	154.21	Benzo(k)fluoranthene	C <sub>20</sub> H <sub>12</sub>	252.31
Fluorene	C <sub>13</sub> H <sub>10</sub>	166.22	Benzo(a)pyrene	C <sub>20</sub> H <sub>12</sub>	252.31
Phenanthrene	C <sub>14</sub> H <sub>10</sub>	178.23	Dibenzo(a, h)anthracene	C <sub>22</sub> H <sub>14</sub>	278.35
Anthracene	C <sub>14</sub> H <sub>10</sub>	178.23	Benzo(g, h, i)perylene	C <sub>22</sub> H <sub>12</sub>	276.33
Fluoranthene	C <sub>16</sub> H <sub>10</sub>	202.25	Indeno(1, 2, 3-cd)pyrene	C <sub>22</sub> H <sub>12</sub>	276.33

### Preparation of Standard Solution

Prepare polynuclear aromatic hydrocarbons mix (CRM47543) diluted with acetonitrile to the concentration of 50-1000 ppb as the calibration standards. The calibration curve is created using 50 ppb, 100 ppb, 500 ppb, 1,000 ppb of calibration standards in this study.

### Preparation of Water Sample

Mix 1L of ground water sample and 6mL of acetonitrile and extract it after shaking this mixture for 1-2 min. Leave it for 10 min to separate the organic layer from the extracts and concentrate it to a final volume of 1 mL for the analysis.

**Fig 2. PAHs chromatogram**

**Table 4. Validity of test method**

	Analyte	R.T. (min)	MDL (ppb)	Accuracy (%)	Precision (%)
1	Naphthalene	12.193	9.74	100.16	0.62
2	Acenaphthylene	13.227	11.67	101.13	0.74
3	1-Methylnaphthalene	14.050	13.10	101.35	0.82
4	2-Methylnaphthalene	14.430	13.53	101.66	0.85
5	Acenaphthene	14.870	14.94	101.27	0.94
6	Fluorene	15.100	13.83	101.24	0.87
7	Phenanthrene	16.023	20.92	101.3	1.32
8	Anthracene	17.013	19.15	100.83	1.21
9	Fluoranthene	17.980	15.98	101.21	1.01
10	Pyrene	18.780	27.83	101.30	1.75
11	Benzo(a)anthracene	20.987	27.41	101.18	1.73
12	Chrysene	21.573	34.41	101.73	2.15
13	Benzo(b)fluoranthene	23.417	27.75	101.42	1.74
14	Benzo(k)fluoranthene	24.307	27.62	100.17	1.76
15	Benzo(a)pyrene	25.183	47.59	100.51	3.02
16	Dibenzo(a, h)anthracene	26.337	53.37	102.79	3.31
17	Benzo(g, h, i)perylene	27.120	56.09	102.62	3.48
18	Indeno(1, 2, 3-cd)pyrene	27.603	30.75	102.87	1.90

\* Calculated values according to ES 04001.b QA/QC by Ministry of Environment of Korea

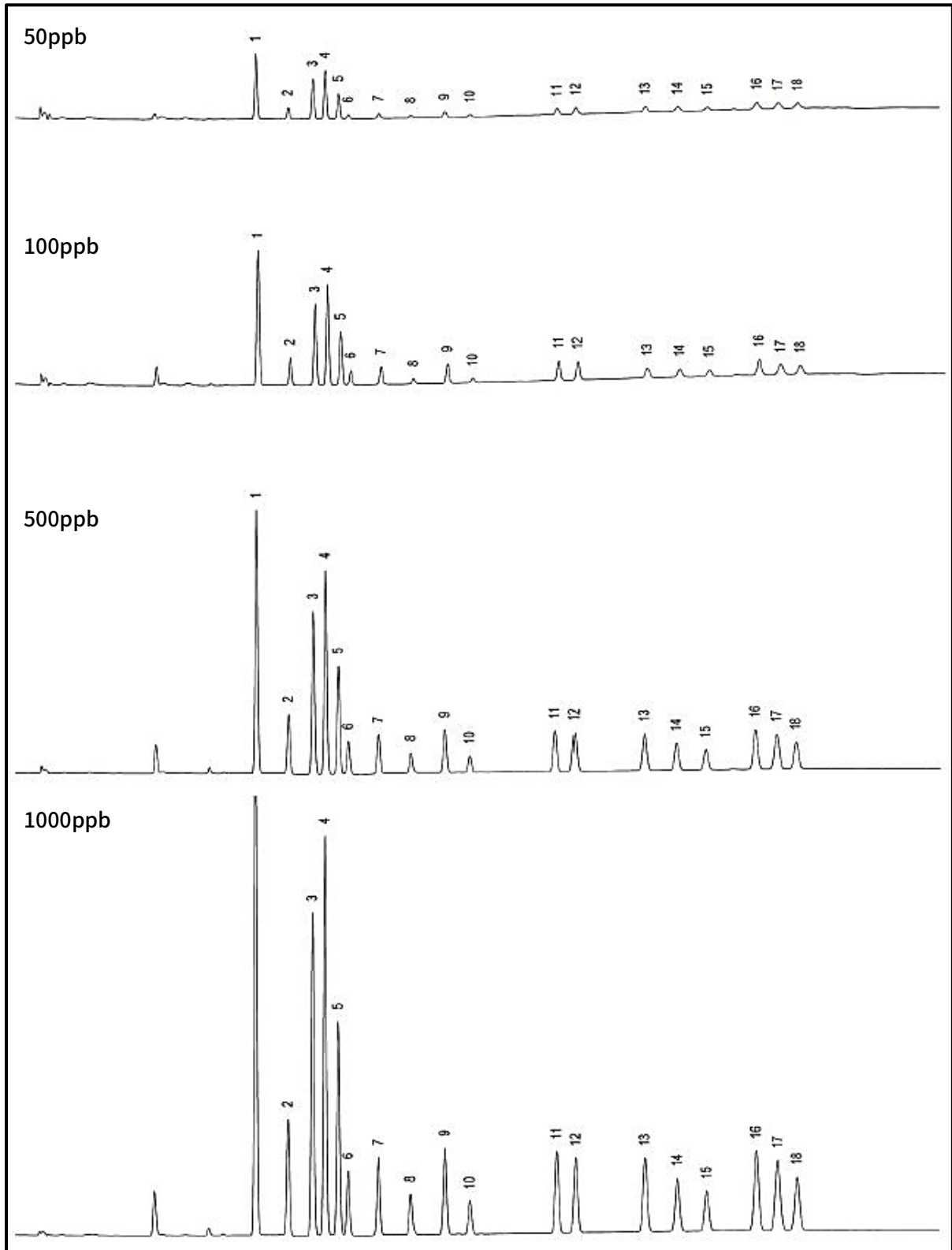
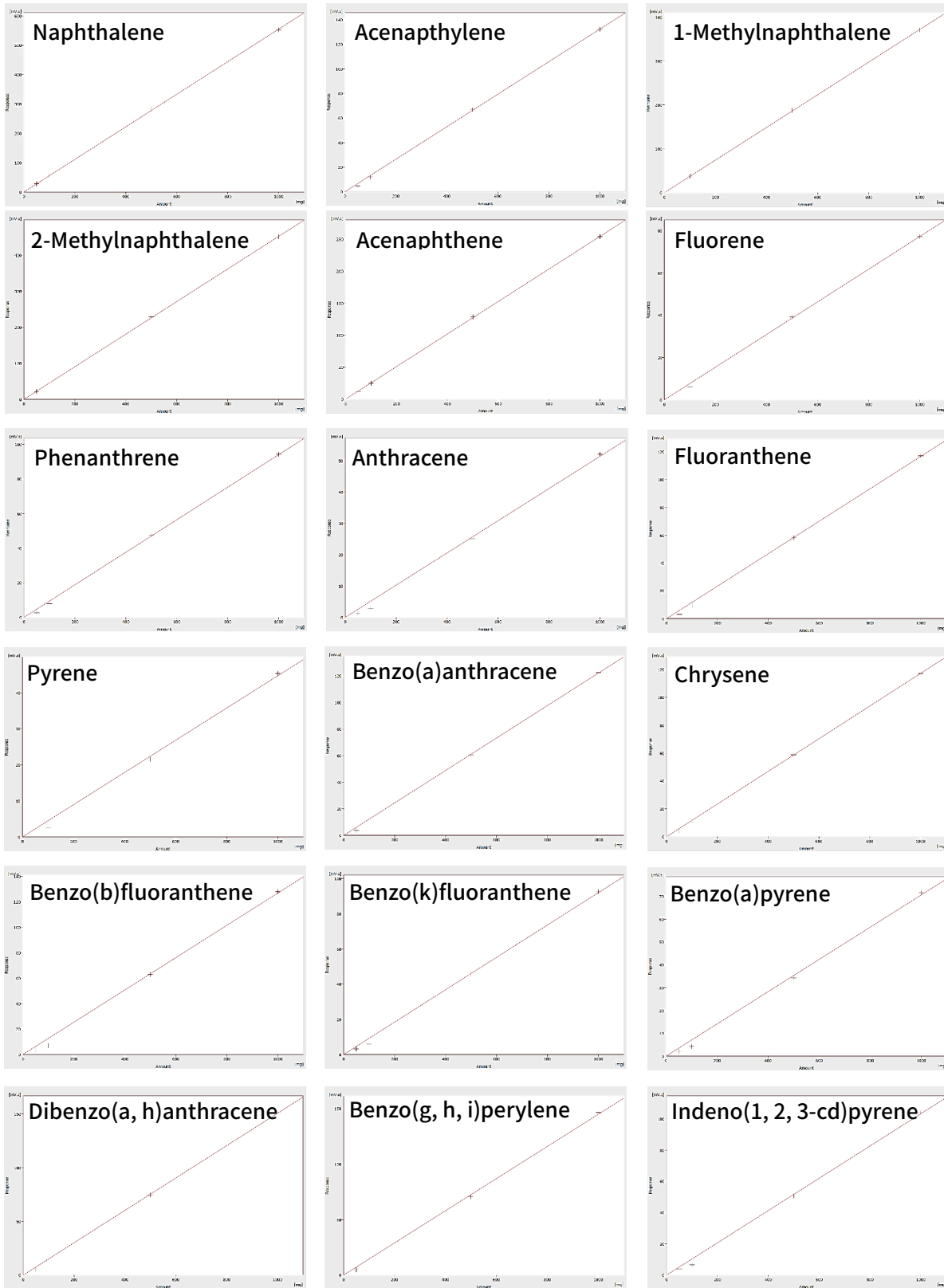


Fig 3. PAHs chromatogram by its concentration



**Fig 4. Calibration curves of PAHs**

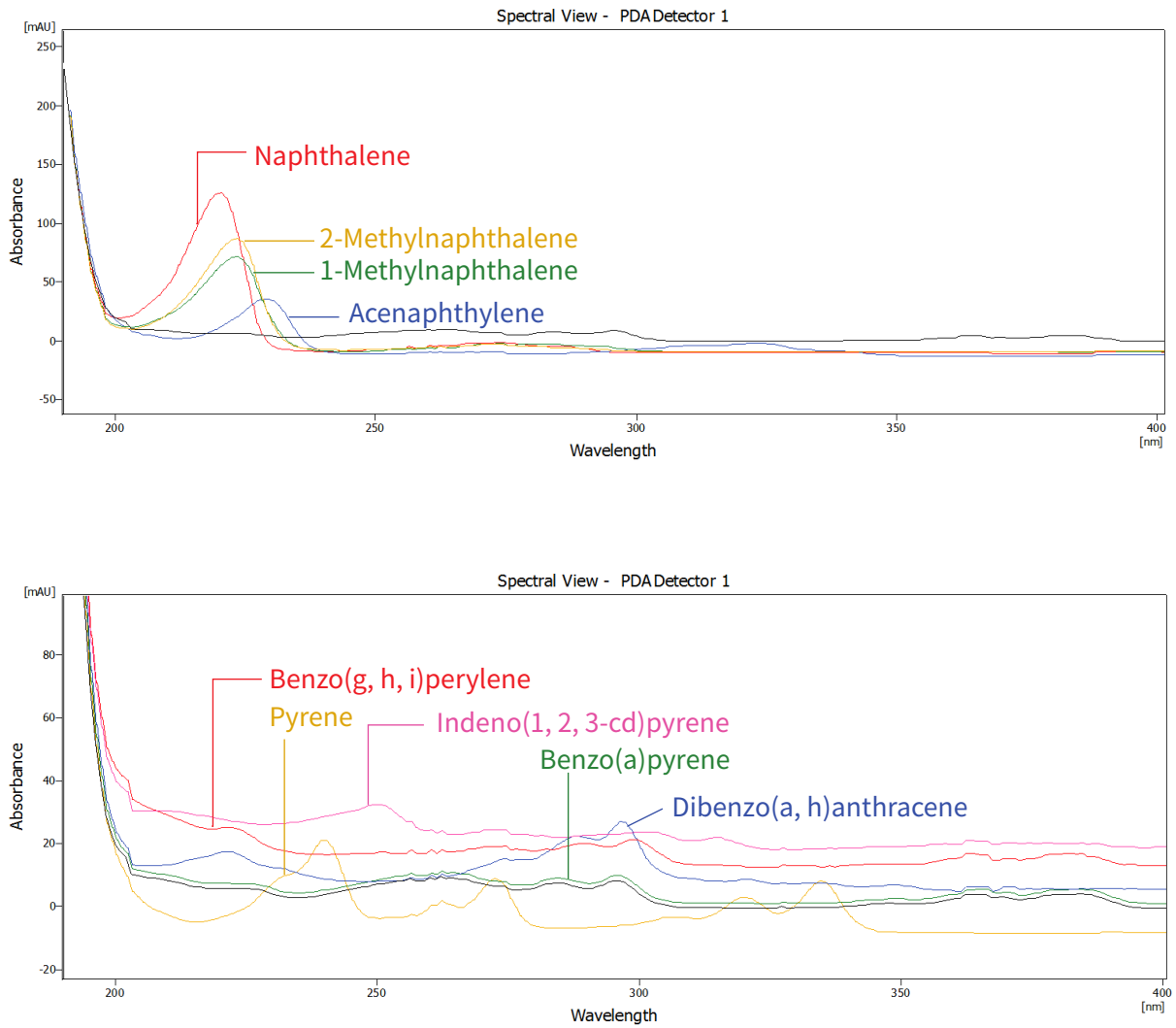


Fig 5. Spectral views of PDA detector



## Result

In order to confirm the validity of analysis results, we verified linearity, accuracy, precision (RSD%) and MDL(method detection limit). The linearity of the correlation coefficients for 18 PAHs in [Table. 4] and [Fig. 3] is all over 0.999. The accuracy is 99.86% and the precision is 2.62% based on benzo(a)pyrene.

## Conclusion

In this study, 18 PAHs are analyzed by YL9100 Plus HPLC/PDA referring to EPA 8310 which indicates the determination of certain polynuclear aromatic hydrocarbons (PAH) in ground water and waste. They were determined at ppb levels by PDA detector and you can have higher sensitivity (ppt levels) by fluorescence detector.

## Reference

- EPA 8310
- EPA 3510C
- “Risk Assessment of Polycyclic Aromatic Hydrocarbons in Food” (2018), National Institute of Food and Drug Safety Evaluation of Korea
- Choi YJ, *et al.*, Characteristics of polycyclic aromatic hydrocarbons (PAHs) distribution in busan soils. The Annual Report of Busan Metropolitan city Institute of Health&Environment 22(1): 216-234(2012)
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