CONTINUOUS MONITORING TECHNOLOGY FOR PM2.5 AND ELEMENTS IN AMBIENT AIR

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CONTENT

- PM2.5 and Why we develop this technology by HORIBA PX-375?
- Continuous Monitoring Technology for PM 2.5 and elements in ambient air
- Case studies
PM2.5 AND WHY WE DEVELOP THIS TECHNOLOGY BY HORIBA PX-375 ?
What is PM2.5

Total PM2.5 means total amount of suspended particulate matters of which the aerodynamic diameter is ≤ 2.5 um (QCVN 05: 2013/BTNMT).

The aerodynamic diameter is: The diameter of a sphere like a dust particle with a density of 1 g/cm3 having the same falling speed as a dust particle gravity at quiet air conditions under temperature conditions, Normal humidity and air pressure. (TCVN 6753 : 2000 or ISO 7708 : 1995)

PM 2.5 can go deep into the breath, circulatory system and brain... Therefore, more research is needed on the composition of dust with elements such as elements. Pb, S, Ti, Cr, Mn, Ni, Cu, Zn, Al, Si, K, Ca, V, Fe, As... serving human health impact research, environmental study and other applications...is necessary and important.
Conventional Analysis Method for PM composition

- Expert analysis is expensive
- Long time from sampling to result acquisition
- Difficult to grasp trends with high frequency
## Benefits of PX-375 comparing with conventional method

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<thead>
<tr>
<th></th>
<th>ICP/AAS</th>
<th>PX-375</th>
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</thead>
<tbody>
<tr>
<td><strong>Time resolution</strong></td>
<td>24 hours</td>
<td><strong>30 minutes</strong> (Shortest)</td>
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<tr>
<td><strong>Pre-treatment</strong></td>
<td>Need (professional)</td>
<td><strong>None</strong></td>
</tr>
<tr>
<td><strong>No. of data</strong></td>
<td>Less</td>
<td>Many</td>
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<tr>
<td><strong>Promptness</strong></td>
<td>~2 weeks</td>
<td><strong>Near real time</strong></td>
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</tbody>
</table>

### What specifically can we do?

- Analysis of pollution by time of day
- Capture a short-term rapid increase in concentration
- Easy to install
- Reduction of man-hours required for analysis
- Improved analysis accuracy of modelling… etc.
- **Smooth verification**
- **Immediate measures, breaking news alarm**
MoE Japan, data comparison of auto and manual

Captures a rapid increase in concentration

Ti
Auto analysis (PX-375) -4h-

 Manual analysis (ICP-MS) -24h-
CONTINUOUS MONITORING TECHNOLOGY FOR PM2.5 AND ELEMENTS IN AMBIENT AIR BY HORIBA PX-375
Ambient Multi-Elemental Monitor PX-375

PX-375 features

- Sampling,
  PM mass concentration (β-ray attenuation), metal concentration (XRF) all in ONE!
- Automatic near-real time analysis (Shortest 30 minutes)
- Continuous monitoring and visualizing time trend
Auto analysis of particulate matter mass and metal

Element analyzer
X-ray fluorescence
Recommended by US EPA Method IO 3.3

Mass analyzer
B-ray attenuation
VSCCTM US EPA reference method
CASE STUDIES
Case study of national wide scale pollution source analysis

Simultaneous observation of particle metal and Oxidative Ratio (OR)
Analysis of PM2.5 high-concentration events
PM2.5 high conc. event analysis  
From PM metal composition and Oxidative Ratio (OR)

Capture element ratio changes with high time resolution!

- PM2.5 mass concentration increase and the influence from continental does not always match.  
  (When Pb / Zn > 0.44, it is said that the continental influence is large)
- Regional pollution time is clear!

Reference: Naoki Kaneyasu. Estimation of PM2.5 Emission Sources in the Tokyo Metropolitan Area by Simultaneous Measurements of Particle Elements and Oxidative Ratio in Air.
PM2.5 high conc. event analysis
From PM metal composition and Oxidative Ratio (OR)

Focus on OR

Coal-derived time zone and petroleum-derived time zone are revealed!

Reference: Naoki Kaneyasu. Estimation of PM2.5 Emission Sources in the Tokyo Metropolitan Area by Simultaneous Measurements of Particle Elements and Oxidative Ratio in Air.
Case study of regional pollution analysis
Case study

Analysis by metal composition

Analysis by elemental ratio

Countermeasure
Analysis by metal composition
Two potential pollution sources

Facility A
Oil combustion facility

Facility B
Copper smelter
Analysis by metal composition

Install PX-375 and start sampling

Facility A
- Oil combustion facility

Facility B
- Copper smelter
Analysis by metal composition

Analysis starts!

Facility A
Oil combustion facility

Facility B
Copper smelter
Analysis by metal composition

Facility A is most probably the pollution source!

21 Jan. PM 12
Metal composition

possibly oil combustion facility

Facility A
Oil combustion facility

Facility B
Copper smelter

Metals

<table>
<thead>
<tr>
<th></th>
<th>V</th>
<th>Ni</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil combustion</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Copper smelter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Metal composition (%)

Fe, Ca, Al, Cu, Ni, V
Analysis by elemental ratio
Element ratio in regional pollution analysis

Elemental ratio = element A / element B

Useful in case like...

• There are multiple combustion equipment of the same type on the company's premises
• There is the same type of combustion equipment around your factory
Analysis by elemental ratio

- Identify elemental ratio for each pollution source in advance
- In this case study, 4 for Facility A, and 2 for Facility B
Analysis by elemental ratio

Cu/Ni = Elemental ratio

Facility A
Cu/Ni = 4

Facility B
Cu/Ni = 2

Copper smelter

AM 9
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A
Cu/Ni = 4
Copper smelter

Facility B
Cu/Ni = 2
Copper smelter

AM 10
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A
Cu/Ni = 4
Copper smelter

Facility B
Cu/Ni = 2
Copper smelter
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A: Copper smelter (Cu/Ni = 4)

Facility B: Copper smelter (Cu/Ni = 2)

PM 12
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A
Cu/Ni= 4
Copper smelter

Facility B
Cu/Ni= 2
Copper smelter

PM 1
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A
Cu/Ni = 4
Copper smelter

Facility B
Cu/Ni = 2
Copper smelter

PM 4
Analysis by elemental ratio

Cu/Ni Elemental ratio

Facility A
Cu/Ni = 4
Copper smelter

Facility B
Cu/Ni = 2
Copper smelter

PM 5
Countermeasure
Potential pollution source facility operation load

Operation load and pollution level are syncing

Cu conc. (ng/m3)
<table>
<thead>
<tr>
<th>Time</th>
<th>Work</th>
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<tbody>
<tr>
<td>8:30-9:30</td>
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<tr>
<td>9:30-11:30</td>
<td>●●●●</td>
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<tr>
<td>Break</td>
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<tr>
<td>12:30-15:00</td>
<td></td>
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<tr>
<td>15:00-17:00</td>
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</tbody>
</table>
Countermeasure

1. Review site work
2. Review emission route
   (Install fan, hood etc...)
3. Review process control
4. Investment in treatment system
Particulate matter multi metal monitor PX-375
Auto analysis of particulate matter mass and metal

Data management system
Remotely! Supports a wide range of analysis!

Supported by the data analysis,
Specific countermeasures
Smooth decision making
PX-375 supports Pollution Source Analysis
CONCLUSION

• Pollution Source Apportionment Analysis and countermeasure.

• Continuous Monitoring of PM 2.5 and the elements in the ambient air for cross-border pollution, forest fire, Volcano, biomass burning emission….

• Continuous Monitoring of PM and the elements in the ambient air for integration in national ambient monitoring station networks.
Thank you
**Detectable Elements**

<table>
<thead>
<tr>
<th>H</th>
<th>Li</th>
<th>Be</th>
<th>Na</th>
<th>Mg</th>
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<tbody>
<tr>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
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<tr>
<td>Cr</td>
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<td>Cu</td>
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<td>Rb</td>
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<td>Mo</td>
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<td>Ru</td>
<td>Rh</td>
<td>Pd</td>
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<tr>
<td>Ag</td>
<td>Cd</td>
<td>In</td>
<td>Sn</td>
<td>Sb</td>
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<td>Te</td>
<td>I</td>
<td>Xe</td>
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<td>Cs</td>
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<td>Os</td>
<td>Ir</td>
<td>Pt</td>
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<td>Bh</td>
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<td>Uus</td>
<td>Uno</td>
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</table>

- **lanthanoid**
- **actinoid**

* ○—Standard parameters, calibrated by standard calibration materials.
* For measurement of element concentration calibration by standard calibration materials is needed.
* Please contact separately about elements, marked as non-detectable.
## Lowest Detection Limit (Example) (2σ) (ng/m³) (Table 1)

<table>
<thead>
<tr>
<th>Element</th>
<th>Analysis time (sec.)</th>
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<tr>
<td></td>
<td>100</td>
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<tr>
<td>Ti</td>
<td>26.5</td>
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<tr>
<td>Cr</td>
<td>4.5</td>
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<tr>
<td>Mn</td>
<td>5.8</td>
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<tr>
<td>Cu</td>
<td>5.7</td>
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<tr>
<td>Zn</td>
<td>3.0</td>
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<tr>
<td>Se</td>
<td>3.4</td>
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<tr>
<td>Ag</td>
<td>15.8</td>
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<tr>
<td>Cd</td>
<td>35.9</td>
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<tr>
<td>Sn</td>
<td>38.4</td>
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<tr>
<td>Hg</td>
<td>7.7</td>
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<tr>
<td>Pb</td>
<td>5.3</td>
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</table>
Each pollution source has its own metal composition characteristics. The source can be estimated by analyzing the metal composition!

<table>
<thead>
<tr>
<th>Metals</th>
<th>Na</th>
<th>Al</th>
<th>Si</th>
<th>K</th>
<th>Ca</th>
<th>Sc</th>
<th>Ti</th>
<th>V</th>
<th>Cr</th>
<th>Mn</th>
<th>Fe</th>
<th>Co</th>
<th>Ni</th>
<th>Cu</th>
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<th>Sb</th>
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<td>Incineration</td>
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