Odorous Compounds Monitoring, Olfactometry, Human Noses? Which Option Should You Choose?

Dispersion study, real-time odour impact, community odour assessment

Odor strategy
Louis VIVOLA
Louis.vivola@Chromatotec.com
Chromatotec : Who are we ?

✓ French manufacturers of autoGC analyzers and all-in-one package solution for gas & odor monitoring

✓ Expert in gas analysis on following markets :
  ▪ Ambient Air
  ▪ Industrial Air
  ▪ Emission CEMS
  ▪ Water Surveillance
  ▪ Gas Process
  ▪ Pure gases
  ▪ Natural gases

✓ Sales repartition:
  ▪ More than 100 analyzers sold per year
  ▪ More than 90% at Export / around 10% in France
Worldwide Presence

Saint-Antoine (33), France
- Chromatotec Group Holding
- Airmotec AG SAS: sales, R&D
- Chromatotec®: cust. & admin. services

Virsac (33), France
- Chromato-Sud SARL – Production site

Houston (USA)
Chromatotec Inc: Sales and cust. service

Beijing (China)
Chromatotec Trading Co., Ltd.: Sales and cust. service
Expert in Gas & Odor analysis

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- Chemist specialized in physicochemical analyses in the Environment sector
- 15 years experience in the management of odours: control, measurement, audit
- Working on field solutions
- X 43 F Expert membership
- Management of customer projects – odour measurement: France, Europe, South America, China, Japan, Korea, India
Solutions provided by Chromatotec

- Modular autonomous autoGC analyzers
  - On-line monitoring 24h/7d
- Automatic analyzer
  - Embedded autocalibration
  - Automatic validation of results
  - Low maintenance
- Sensitive analyzers
  - ppm
  - ppb
  - ppt and now ppq!
- All main existing detectors in the markets
  - FID, PID, TCD, Mass Spectrometry, DID, FTUV...etc
  - Exclusive wet cell detector for Sulfurs, FPD
- Turnkey solutions with all-in-one solution
- Air generators, multi calibration, multiplexer...
Solutions provided by Chromatotec

• Auto GC / Sulfurs analysers
  - Total Sulfurs
  - H2S, SO2, Mercaptans (MM, EM, PM...), DMS, DMDS

• VOC analysers
  - BTEX,
  - Hydrocarbons, C2 to C12 / C10 to C20
  - More than 120 molecules targetted:
    • PAMS + TO 14 & 15...
    • Aromatics
  - Methane and non methanic total hydrocarbons

• Ammonia analyzer
Worldwide recognition with certifications relating to the relevant standards, performed by:


- EN 14662-3 (2013): Method to establish the performance criteria for the measurement of Benzene concentration using an automated sampling pump with in-situ gas chromatography.
  - Laboratory and on-site tests have been passed successfully by the NPL
  - Benzene and 12 other VOCs have been tested

Airmotec/Chromatotec®: Unique manufacturer with EN 14662-3
- En 14662-3: compulsory for ambient air monitoring in Europe
Odorous Compounds Monitoring, Olfactometry, Human Noses? Which Option Should You Choose?

Dispersion study, real-time odour impact, community odour assessment

Odor strategy
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Measuring at the source and modeling the impact
Physicochemical approach

• Sensors
  – Pollutant-specific sensors (ppm): H2S, SO2, NH3…
    • Control of odour treatment facilities based on chemical thresholds

• Electronic noses
  – Continuous odour monitoring to define odor concentration

• On line Gas Chromatography
  – Continuous monitoring of multiple compounds to define both odor concentration and gas consumption
Measuring at the source and modeling the impact

Odor approach

- Olfactometry
  - On site sampling
  - Analysis by dynamic olfactometry

- Sulfurs analyser in specific application (WWTP / pulp & paper / mines...)
  - Continuous monitoring of odour index
  - Continuous monitoring of odour, H2S, MM, EM, IPM, DMS, DMDS, THT...
Measuring in the Environment
Continuous measurement – Chemical approach

- **Sensors indicators**
  - Pollutant-specific sensors (ppm)
    - H₂S, RSH
    - NH₃

- **Online Gas Chromatography (ppb)**
  - Continuous monitoring of multiple components with TRS Medor:
    - Odor index
    - H₂S, SO₂
    - Mercaptans (MM, EM, PM, ..etc)
    - DMS, DMDS...etc
Measuring in the Environment
Spot measurement – Odour approach

- Odour mapping – intensity gauging
  - Nose jury on site

- Community odour assessment
  - Reporting of odour from local residents
    - Manual
    - Automatic

- Portable olfactometer
  - 1 port
  - 2 ports
  - 8 ports
Odor & Odorants Measurement challenges

- Reach human nose sensitivity (ppb)
- Offer reliable results with auto datavalidation
- Correlate:
  - with reference methods Dynamic olfactometry EN 13725 or ASTM E679
  - with perception of neighborhood
- Low maintenance

- Why?
  - To have a reliable data to understand what is wrong in the process
  - To manage automatically the process to treat odors
  - To be alerted and warned when odor or odorants exceed specific values at source or environment
Odor & Odorants Measurement challenges

- Find a solution to face to limitation of current method for sulfurs emissions site
- Chemical approach to quantify leakage around the site as the solutions are sensitive on same level than human nose
- Automatic calibration and validation of data
- Correlate with olfactometry and neighborhood perception, when complaints occur
- Capabilities to check process performances
- Capabilities to use reliable results with unique instrument and multiplexer
The vigiODOR® interface is dedicated for monitoring odorous and chemical panches in industrial zones.

Associated with gas analyzers trsMEDOR, airmoVOC and vigi-eNose, this interface provides easily a monitor for concentrations of gas, sulfured, and odor concentration.

The operator is noticed in case of overrun of concentration thresholds for one or more pollutants.
• Vigi e-NOSE is the analytical device of vigiODOR solution

• The analyzer is the most sensitive GC Electronic nose on the market for sulfurs quantification (ppt/ ppq)
  – Includes trsMEDOR with SSD & VOC detector
  – Allows to measure:
    – Total Sulfurs
    – H₂S, SO₂, Mercaptans (Me-SH, Et-SH...)
    – Sulfides (DMS, DMDS)
    – VOC detector (PID or FID)
  – It provides individual quantification of sulfurs & tVOC with a global chemical and olfactory fingerprint
  – Correlation with sensory evaluation

• Local weather station
• Modular modeling software
• Complaints Management tools
vigiODOR solution: a compliant solution for specific legislation

International Method
- ASTM D7493 08
- ISO 19739

Monitoring of Each Odorous Component
- H$_2$S
- OSC (Organic Sulphur Compounds)
- DMS, DMDS, Methyl Mercaptan, Ethyl Mercaptan, DES, ...
- tVOC (Total Volatile Organic Compounds)
- Option for NH$_3$ (Ammonia)

Unsurpassed Performances
- Lower detection limits: < 1 ppb for H$_2$S & DMS
- Interferences free
- Large ranges from ppb to hundreds of ppm concentrations
vigiODOR solution: all-in-one solution with peripherals management

- Multiplexer for multiple points collection
- Automatic Calibration and results validation
- Air generator
- Hydrogen generator

>> turnkey solution
vigiODOR: results at a glance

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Example of deployment in WWTP
Results

- **Spectrum with 14 compounds**

  - Hydrogen Sulphide: $H_2S$
  - Methyl Mercaptan (MM or MTM): $CH_3-SH$
  - Ethyl Mercaptan (EM or ETM): $CH_3CH_2-SH$
  - DiMethyl Sulphide (DMS): $CH_3-S-CH_3$
  - (Iso) 2-Propyl Mercaptan (IPM): $(CH_3)_2-CH-SH$
  - Ter Butyl Mercaptan (TBM): $(CH_3)_3-C-SH$
  - (N) 1-Propyl Mercaptan (NPM): $CH_3CH_2CH_2-SH$
  - TetraHydroThiophene (THT): $C_4H_8S$
  - DiEthyl Sulphide (DES): $C_2H_5-S-S-C_2H_5$
  - DiMethyl DiSulphide (DMDS): $CH_3-S-S-CH_3$
23/09/2015

vigioDOR solution
example of results in ambient air

- 24/7 unattended online air monitoring system dedicated on sulfur compounds quantification.
  - Mercaptans: Methyl Mercaptan (Me-SH), Ethyl Mercaptan (Et-SH)
  - Sulfurs: Diethyl sulfur (DES), dioxyde sulfur (SO₂), Di Méthyl-Sulfur (DMS)

\[
\begin{align*}
\text{DMDS} & \quad 63 \text{ ppb} \\
\text{H}_2\text{S} & \quad 60 \text{ ppb} \\
\text{SO}_2 & \quad 13 \text{ ppb} \\
\text{Methyl SH} & \quad 103 \text{ ppb} \\
\text{DMS} & \quad 273 \text{ ppb}
\end{align*}
\]

- Automatic datavalidation as trsMEDOR includes automatic calibration in standard with permeation tube using DMS at 25 ppb.

23/09/2015
Map for chemicals or Odors
Results - Identification of odor sources
Integration of complaints management with TOMS interface
vigiODOR: a dedicated odor solution

Interest of the vigiODOR solution

• Meet legislation requirements and designed according to the objectives
• Clear understanding of odor & odorants origins
• Facilitates communication with Residents, Associations & Authorities
• Be alerted when emissions limits are exceeded
• Anticipate nuisance and treat emissions before they affect neighborhood
• Optimize process operations in order to reduce chemical and odor emissions
• Have an auto validation of the results
vigiODOR®

On line quantification of Odor, VOC & Sulfurs

ppt/ppb/ppm

On line monitoring with trs MEDOR
Dispersion modeling software
Dynamic olfactometry

MEDOR analyzer for odorants

www.chromatotec.com / info@chromatotec.com
vigiODOR solution:
online sulfurs monitoring

- Online monitoring with trend profile over time and datahistorical access

- Sensitivity at ppb levels (ppt upon request)
vigiODOR solution – SULFUR Analyzer
Tests performances vs Human nose

<table>
<thead>
<tr>
<th>Sulfur Compounds</th>
<th>Compound</th>
<th>Characteristic odor</th>
<th>Olfactive odor threshold</th>
<th>µg/m³</th>
<th>ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydrogen sulfide</td>
<td>Rotten Egg</td>
<td>1 to 5</td>
<td>0.7 to 3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methylmercaptan</td>
<td>Cabbage, garlic</td>
<td>4 to 50</td>
<td>2 to 25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylmercaptan</td>
<td>Cabbage</td>
<td>0.3 to 3</td>
<td>0.12 to 1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dimethyl sulfide</td>
<td>Decayed vegetables</td>
<td>3 to 30</td>
<td>1.2 to 12</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Dimethyl disulfide</td>
<td>Putrid</td>
<td># 50</td>
<td># 13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diethyl sulfide</td>
<td>Ethereal</td>
<td>45 to 310</td>
<td>12 to 85</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Iso Propyl Mercaptan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**

- *trsMEDOR is a turnkey solution able to offer more sensitive level of concentration in comparison with human nose*
<table>
<thead>
<tr>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
<th>C9</th>
<th>C10</th>
<th>C11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Ethane = C2</td>
<td>3) Propane = C3</td>
<td>6) n-butane = C4</td>
<td>13) n-pentane = C5</td>
<td>22) n-hexane = C6</td>
<td>25) 2,4-dimethylpentane</td>
<td>44) n-nonane = C9</td>
<td>52) n-Decane = C10</td>
<td>52) n-Undecane</td>
<td></td>
</tr>
<tr>
<td>2) Ethene / ethylene</td>
<td>4) Propene</td>
<td>7) Acetylene</td>
<td>14) trans-2-pentene</td>
<td>23) isoprene</td>
<td>26) Benzene</td>
<td>45) iso propylbenzene</td>
<td>53) 1,2,3 trimethylbenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) isobutane (2-méthyl propane)</td>
<td>8) trans-2-butène</td>
<td>9) 1-butene</td>
<td>15) 1-pentene</td>
<td>24) 2-methyl-1-pentene</td>
<td>27) Cychohexane</td>
<td>46) n-propylbenzene</td>
<td>54) m-diethylbenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10) cis-2-butène</td>
<td>11) Cyclopentane</td>
<td>16) cis-2-pentène</td>
<td></td>
<td>28) 2-methylhexane</td>
<td>47) m-ethyltoluene</td>
<td>55) p-diethylbenzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12) Iso-pentane (2-methyl butane)</td>
<td></td>
<td>17) 2,2-dimethylbutane</td>
<td></td>
<td>29) 2,3-dimethylpentane</td>
<td>48) p-ethyltoluene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>18) methylcyclopentane</td>
<td>19) 2,3-dimethylbutane</td>
<td></td>
<td>30) 3-methylhexane</td>
<td>49) 1,3,5 trimethylbenzene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20) 2-methylpentane</td>
<td>21) 3-methylpentane</td>
<td></td>
<td>31) 2,2,4-trimethylpentane</td>
<td>50) o-ethyltoluene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>C7</td>
<td>C8</td>
<td>C9</td>
<td>C10</td>
<td>C11</td>
<td></td>
<td></td>
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<td>22) n-hexane = C6</td>
<td>25) 2,4-dimethylpentane</td>
<td>38) n-octane = C8</td>
<td>44) n-nonane = C9</td>
<td>52) n-Decane = C10</td>
<td>52) n-Undecane</td>
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</tr>
<tr>
<td></td>
<td>26) Benzene</td>
<td>39) Ethylbenzene</td>
<td>45) iso propylbenzene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27) Cychohexane</td>
<td>40) m-xylene</td>
<td>46) n-propylbenzene</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29) 2,3-dimethylpentane</td>
<td>42) Styrene</td>
<td>48) p-ethyltoluene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30) 3-methylhexane</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>51) 1,2,4 trimethylbenzene</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

>> 24/7 unattended online air monitoring system dedicated on VOC compounds quantification provided as trsMEDOR upgrade to provide full olfactive & chemical compounds overview
Example of results for VOC monitoring C2 – C6
Example of results for VOC monitoring C2 – C6
vigiODOR solution – VOC Analyzer Tests performances vs Human nose

<table>
<thead>
<tr>
<th></th>
<th>Compound</th>
<th>Characteristic odor</th>
<th>Olfactive odor threshold µg/m³</th>
<th>ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aldehydes</strong></td>
<td>Formaldehyde</td>
<td>Pungent</td>
<td>65 to 1200</td>
<td>53 to 978</td>
</tr>
<tr>
<td></td>
<td>Acetaldehyde</td>
<td>Fruit, apple</td>
<td>50 to 300</td>
<td>28 to 167</td>
</tr>
<tr>
<td></td>
<td>Propionaldehyde</td>
<td>Rancid</td>
<td>#20</td>
<td>#8.4</td>
</tr>
<tr>
<td></td>
<td>Butyraldehyde</td>
<td>Apple</td>
<td>20 to 50</td>
<td>7 to 17</td>
</tr>
<tr>
<td></td>
<td>Valeraldehyde</td>
<td>Fruit</td>
<td>20 to 70</td>
<td>5.7 to 20</td>
</tr>
<tr>
<td></td>
<td>Acetone</td>
<td>Sweet fruit</td>
<td>119 000</td>
<td>50 000</td>
</tr>
<tr>
<td><strong>Volatile Fatty Acids</strong></td>
<td>Acetic</td>
<td>Vinegar</td>
<td>#900</td>
<td>#366</td>
</tr>
<tr>
<td></td>
<td>Propionic</td>
<td>Rancid</td>
<td>#80</td>
<td>#26</td>
</tr>
<tr>
<td></td>
<td>Butyric</td>
<td>Rancid butter</td>
<td>4 to 50</td>
<td>1 to 14</td>
</tr>
<tr>
<td></td>
<td>Valeric</td>
<td>Perspiration</td>
<td>#5</td>
<td>#1.2</td>
</tr>
</tbody>
</table>

=> airmOZONE is a turnkey solution able to offer more sensitive level of concentration in comparision with human nose.
Odor analyzer

**VOCs**

- DMDS 63 ppb
- H₂S 60 ppb
- SO₂ 13 ppb
- Methyl SH 103 ppb
- DMS 273 ppb

**Sulfurs**

- DMDS 63 ppb
- H₂S 60 ppb
- SO₂ 13 ppb
- Methyl SH 103 ppb
- DMS 273 ppb

**Odor Index**

23/09/2015
vigiODOR

- Solution to manage measurement units with alerts and warning
- Validation of results including embedded permeation tube
- Capabilities to work from ppb to ppm with same equipment
- Correlation done with portable olfactometer or direct observatoire using complaints / sensory observation
- Reliable & objective results in WWTP to facilitate communication with neighborhood
  - Capabilities to integrate full package (dispersion & complaints management) to check impact and validity of prediction
  - Option: Correlation with EN 13725 in WWTP
Conclusion

• Very large range of products available and designed according to Market’s needs
  – VOC, Sulfurs, nitrogenous
  – 24h /7 days measurements

• Large range of concentration level from ppt to ppb and ppm

• Turnkey solutions:
  – Instruments
  – Multiplexers
  – Air generators

• Capability to work on hazardous area:
  – ATEX Ex II 3G Ex pz IIC T4
Conclusions

• Unique technology for sulfur quantification at low concentration levels
• Modular and innovative solutions according to your customer’s needs on hardware & software part
• Equipments 100 % Hand made and control with French Quality
• Solutions recognized as performant with amount of certifications
• Capabilities to check results with:
  – Automatic calibration on analyzers
  – Automatic complaints management
Thank you for your attention!

Come and visit our Chromatotec Booth

Come and visit our local partner Booth WESTECH

>> Contact: louis.vivola@chromatotec.com

>> know more: www.chromatotec.com