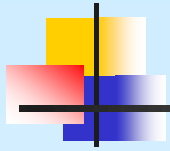


Microtrap Technology

for



Real-time Air Monitoring



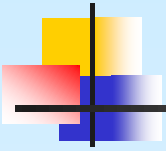
Advantages of Microtrap Technology

- **Fast on-line extraction and concentration (from CH₄, CFCs to VOCs)**
- **Low detection limits**
- **Simple instrumentation, automated operation**
- **Interface for sensors, GC and GC-MS**
- **C-NMOC is excellent technique for total VOCs.**

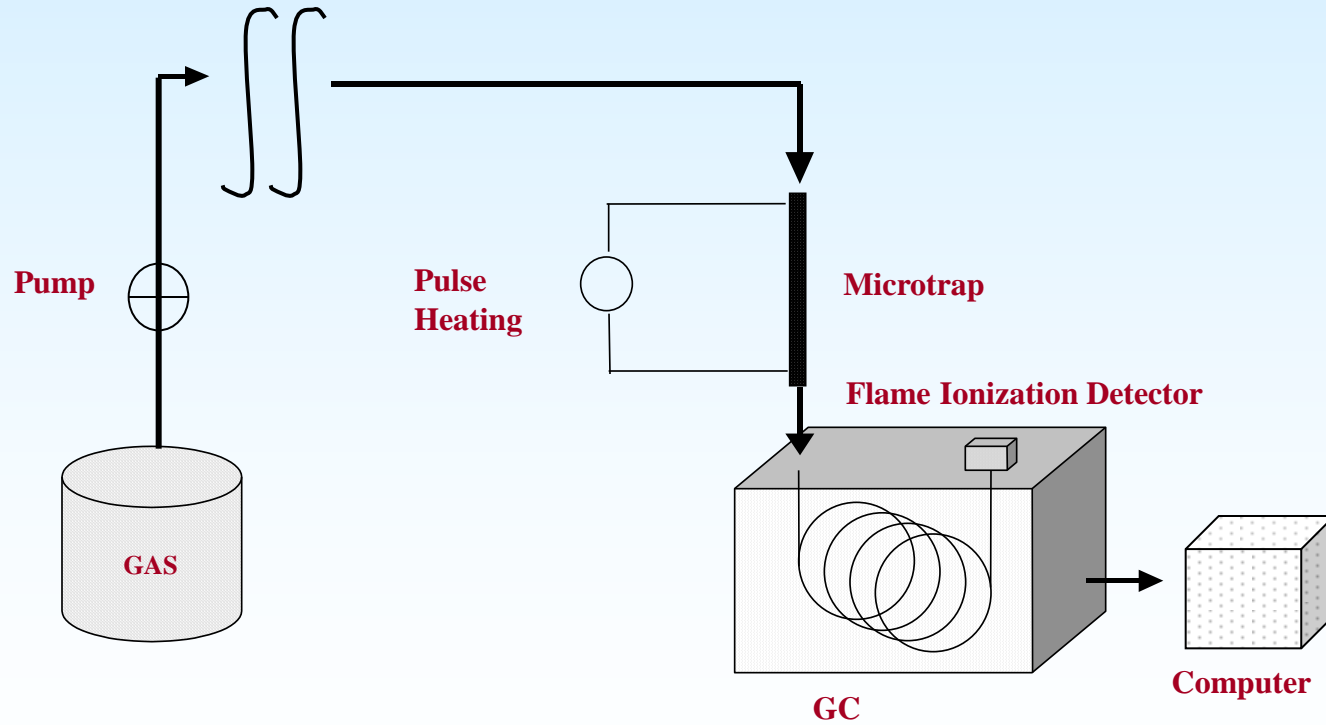


Some Representative Papers

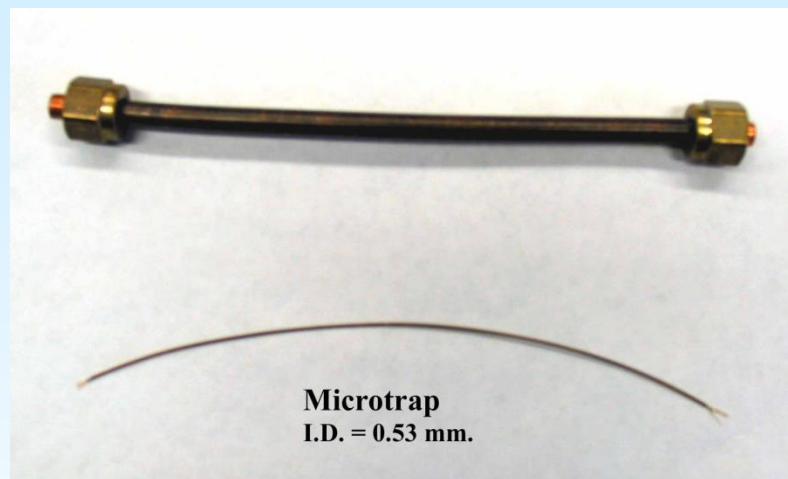
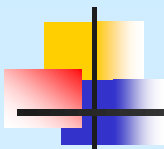
1. "Enhanced preconcentration of selected chlorofluorocarbons on multiwalled carbon nanotubes with polar functionalities". Chutarat Saridara, Chaudhery Mustansar Hussain, Smruti Rangunath, Somenath Mitra. *J. Sep. Sci.* (2015), 38, 426–432.
2. "Carbon Nanotubes as Sorbents for the Gas Phase Preconcentration of Semivolatile Organics in a Microtrap". Chaudhery Mustansar Hussain, Chutarat Saridara, and Somenath Mitra. *Analyst*, **133**, 1076–1082 (2008).
3. "Methane Preconcentration in a Microtrap using Multiwall Carbon nanotubes as Sorbents". Chutarat Saridara, Smruti Rangunath, Yong Pu and Somenath Mitra. In press. *Anal. Chim. Acta.* **2010**, 677, 50-54, 54.
4. "Micropreconcentration Units based on Carbon Nanotubes". Chaudhery Mustansar Hussain, Somenath Mitra. In press. *Anal. and Bioanal. Chem.* **2010**, 399(1), 75-89.
5. "Modifying the Sorption Properties of Multi-Walled Carbon Nanotubes via Covalent Functionalization". C. Mustansar, C. Saridara and S. Mitra. *Analyst*, **2009**, 134, 1928-1933.
6. "A Sequential Valve-Microtrap Injection System for Continuous, On-line GC Analysis at Trace Levels", S. Mitra, and Arthur Lai, *J. Chromatogr. Sci.* **1995**, 33, 285-289.
7. "Characteristics of Microtrap Based Injection Systems for Continuous Monitoring of Volatile Organic Compounds by GC". S. Mitra, Y. Xu, W. Chen, and A. Lai., *J. Chromatogr. A.* **1996**, 727, 111-118.
8. "Two-stage microtrap as an injection device for continuous on-line, GC monitoring". C. Feng and S. Mitra. *J. Chromatogr. A.*, **1998**, 805, 169-176.
9. "Application of microtrap-GC for continuous monitoring of organic emissions from a catalytic incinerator". W. Chen, Y. H. Xu and S. Mitra, *J. Micro. Col. Sep.* 1998, 11 (3), 239-245.
10. "Breakthrough and desorption characteristics of a microtrap". C. Feng and S. Mitra, *J. Micro. Col. Sep.* **2000**, 12(4), 267-275.
11. "Microtrap modulated flame ionization detector for on-line detection of methane". C. Thamakhet, P. Thavarungkul, R. Brukh, S. Mitra and P. Kanatharana. *J. Chromatogr. A.* **2005**, 1072, 243-248.



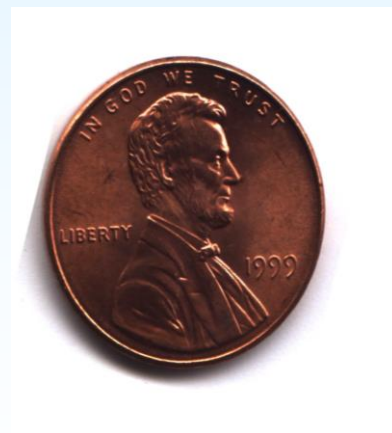
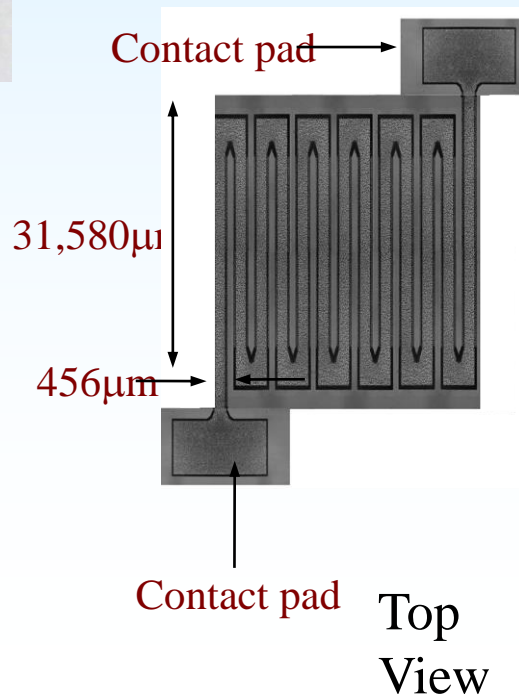
Real-time Air Monitoring: Microtrap Pulsed FID

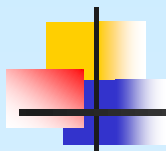


Microtrap Conventional and Micro Fabricated

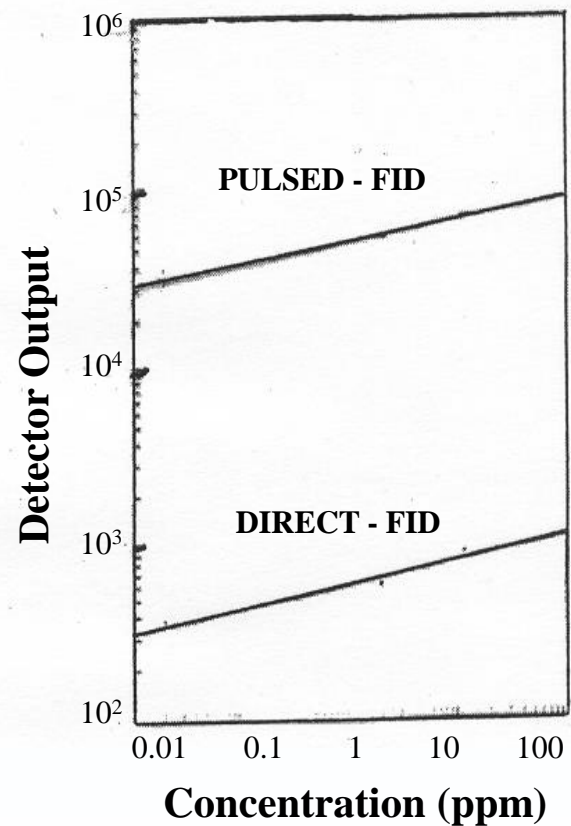
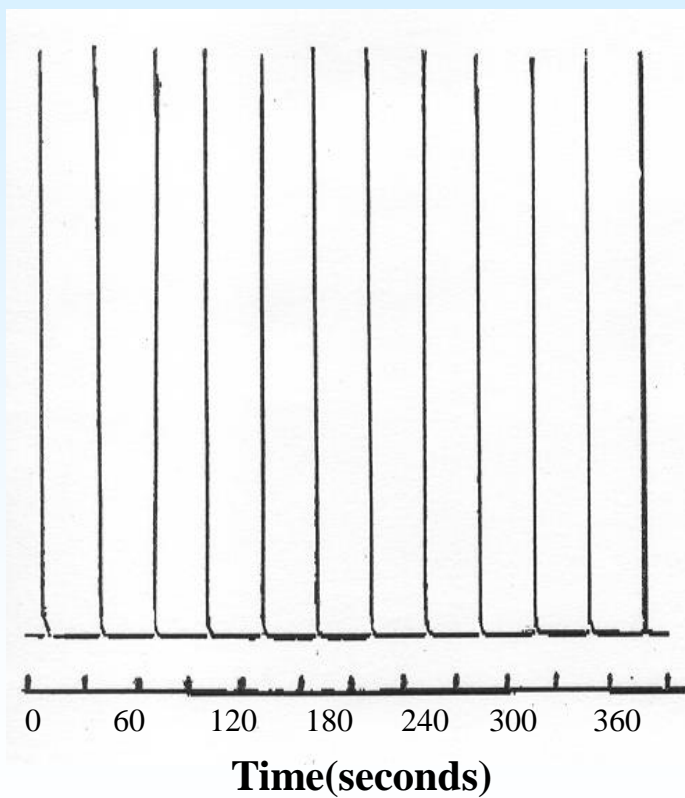


"A microfabricated microconcentrator for sensors and gas chromatography". M. Kim and S. Mitra, *J. Chromatogr. A.* **2003**, 996 (1-2), 1-11.



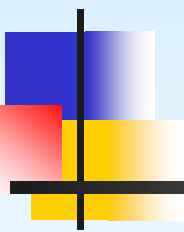


Response of the Microtrap Pulsed FID



Real Time Monitoring of Non methane Organic Carbon (NMOC)

An Alternate to Direct FID Analysis

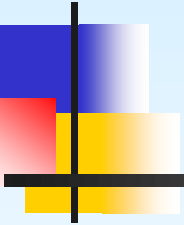
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1. "Development of instrumentation for continuous on-line monitoring of non-methane organic carbon in air emissions". S. Mitra, Y. H. Xu. W. Chen and G. McAllister, *J. Air Waste Management*. **1998**, 48 (8), 743-746.
 2. "Monitoring Effluents from an Air Toxic Control Device Using Continuous Non-Methane Organic Carbon (C-NMOC) Analyzer". Tai-Chiang Yu, Gary McAllister and Somenath Mitra, *Am. Ind. Hyg. Assoc. J.* **2000**, 61, 16-21.



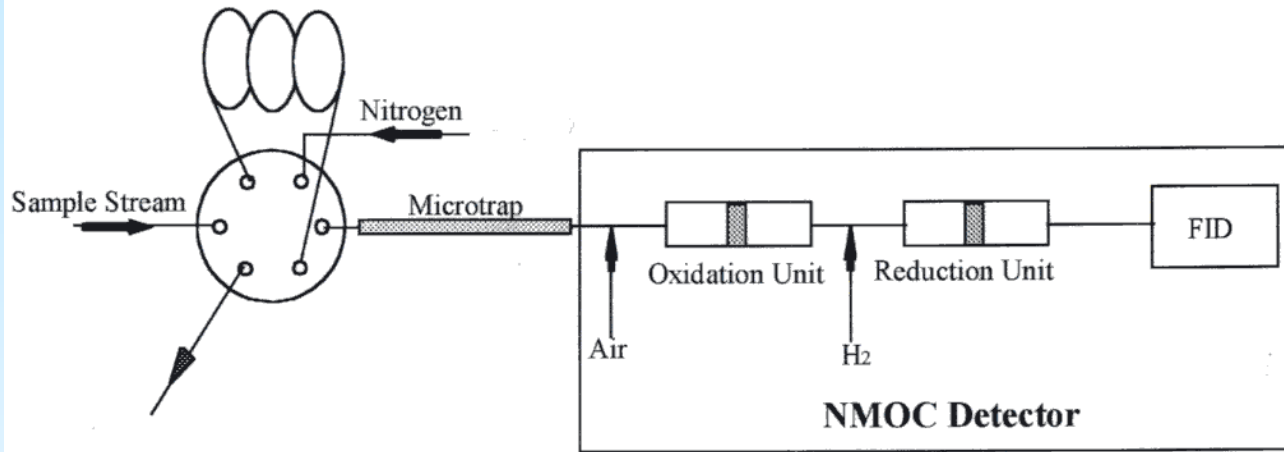
Real-time Direct FID – EPA Method 25

- Widely used technique to monitor Total VOCs- Emission Sources and Ambient Air
- Limitation is that response factors depend upon the organic species
- Detection limits - ppm
- NMOC measurements to account for methane

Continuous Monitoring of Non Methane Organic Carbon

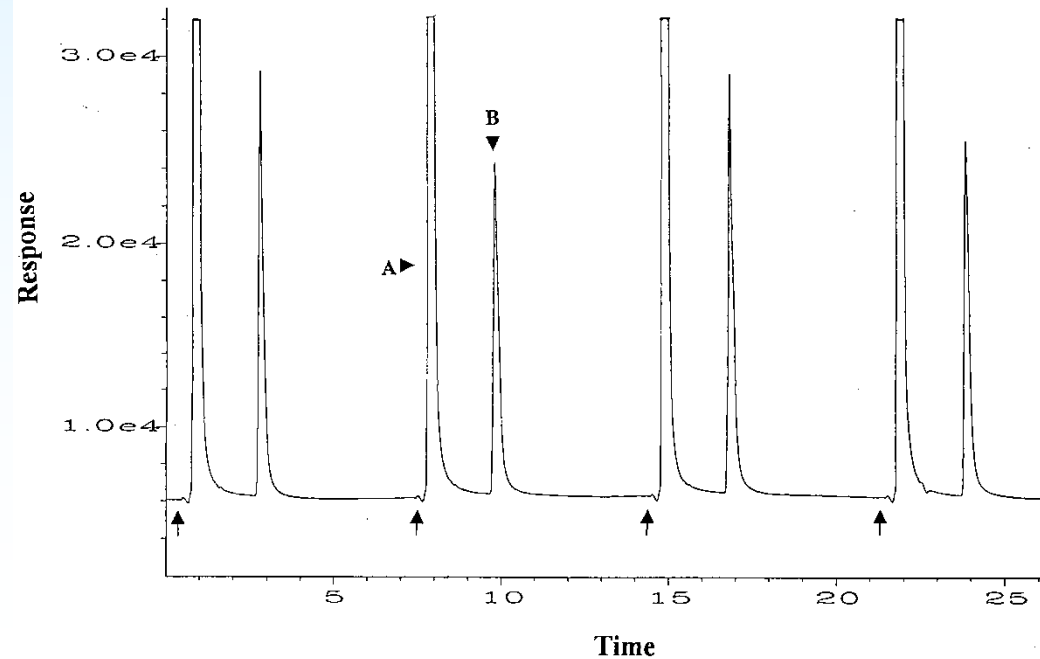
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- **Separate CO, CO₂ and CH₄ from NMOC**
 - **No column is used**
 - **Injected into an FID through Catalytic oxidizer-reducer**
 - **Pre concentration on a microtrap provides low detection limits (ppb)**

C-NMOC



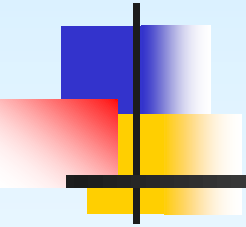
A- CO, CO₂, CH₄

B- Organics

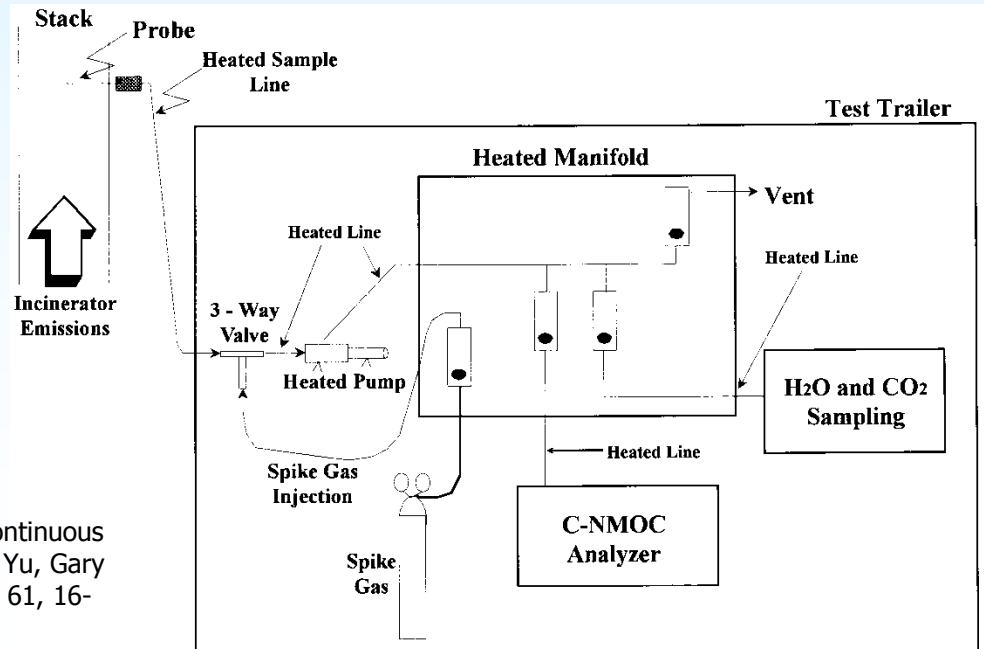
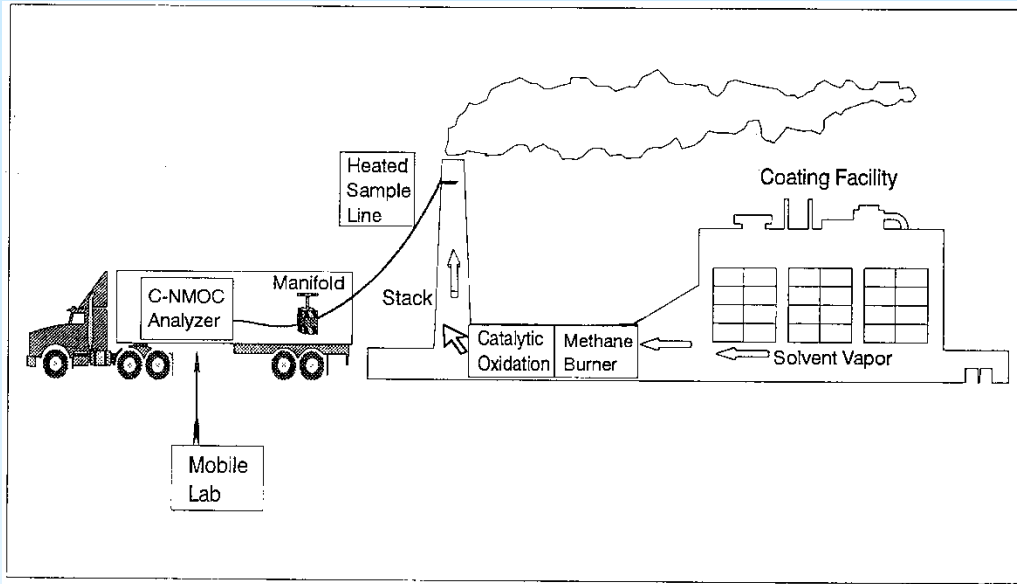


"Development of instrumentation for continuous on-line monitoring of non-methane organic carbon in air emissions". S. Mitra, Y. H. Xu, W. Chen and G. McAllister, *J. Air Waste Management*. **1998**, 48 (8), 743-746.

Stack Monitoring at an Industrial Site

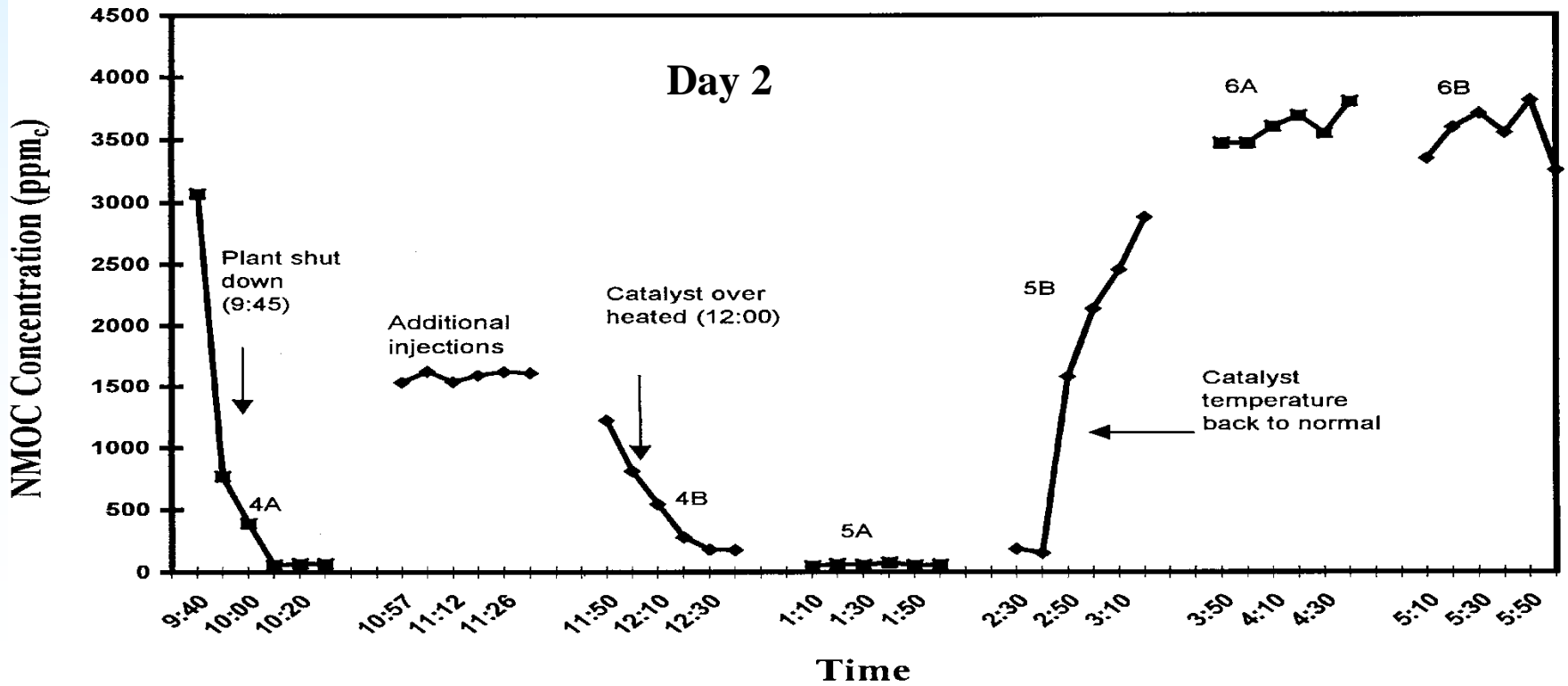
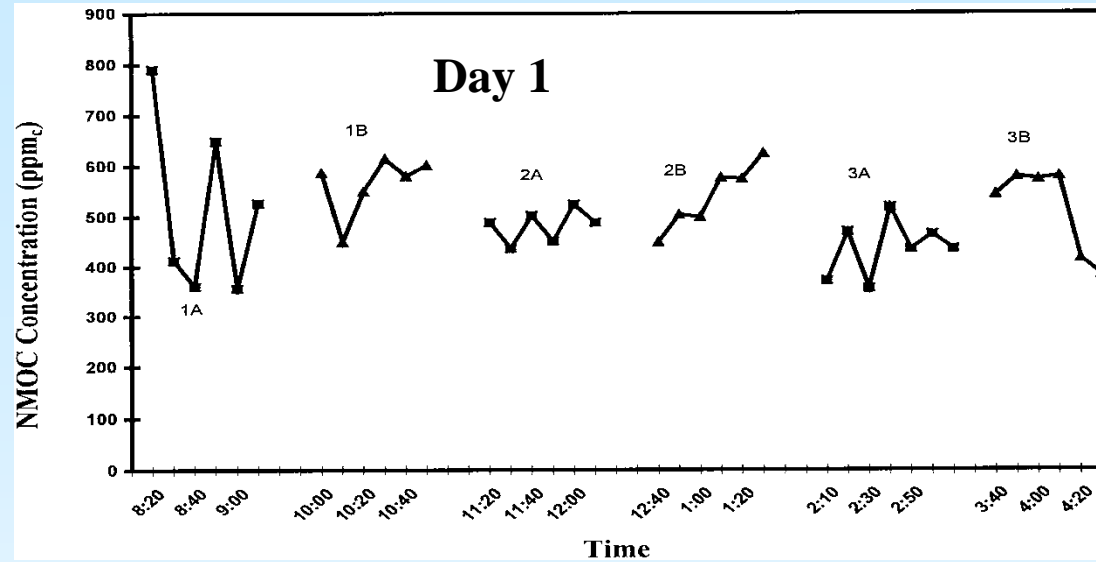


C-NMOC



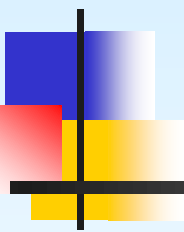
1. "Monitoring Effluents from an Air Toxic Control Device Using Continuous Non-Methane Organic Carbon (C-NMOC) Analyzer". Tai-Chiang Yu, Gary McAllister and Somenath Mitra, *Am. Ind. Hyg. Assoc. J.* **2000**, 61, 16-21.

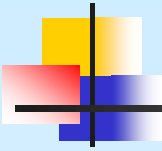
C-NMOC



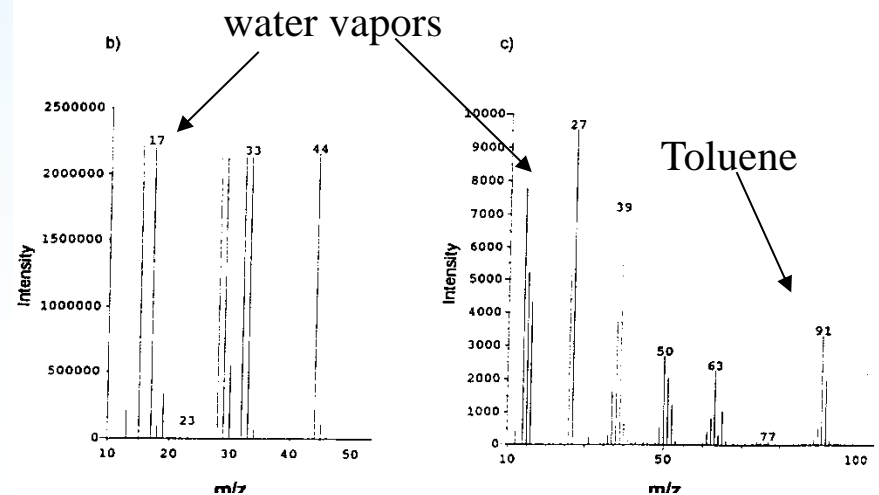
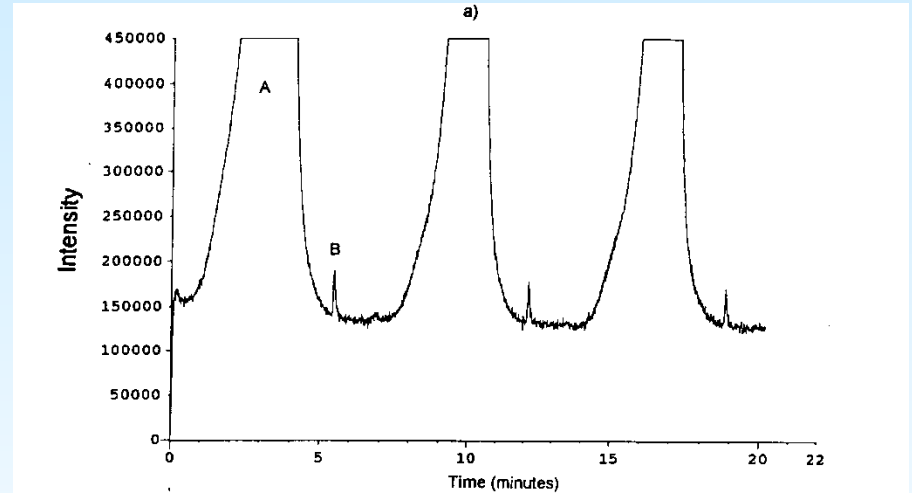
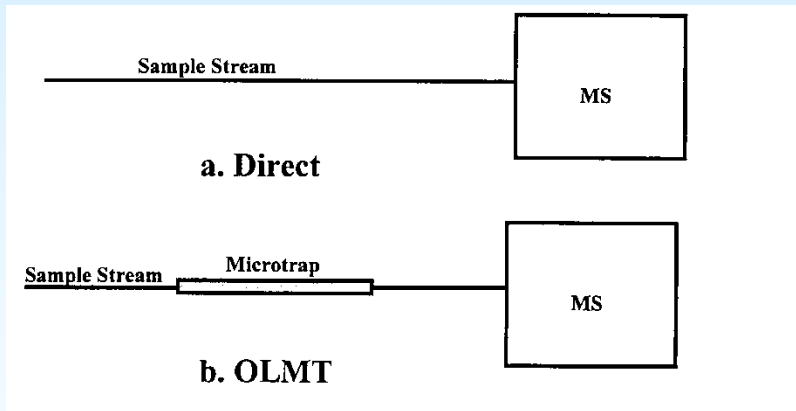
On-line Mass Spectrometry

Removing Moisture and Other Interfering Species in Air

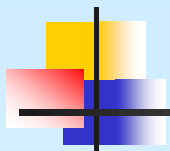
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1. "A microtrap interface for On-line mass spectrometric monitoring of air emissions". Somenath Mitra, Chao-hua Feng, Lizhong Zhang, and Wenpin Ho, Gary McAllister, *J. Mass Spectrom.* **1999**, 34 (5), 478-485.



Direct Introduction Mass Spectrometry (DIMS)



Feng and Mitra. J. of Mass Spectrometry (1999)



DIMS

