DETERMINATION OF UPTAKE RATES FOR VOCs IN AMBIENT AIR BY USING AXIAL TYPE THERMAL DESORPTION PASSIVE TUBES

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OUTLINE

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  - Passive Tube Theory
- **Material & Methods**
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  - Sample Preparation&Handling
  - Analytical Techniques
  - Performance Evaluation
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  - Meteoroligical Parameters
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INTRODUCTION

- **Uptake rate for VOCs**

- **VOCs: Organic compounds having vapor pressure >10^{-4} atm @ 25 C^0 and 1 atm**

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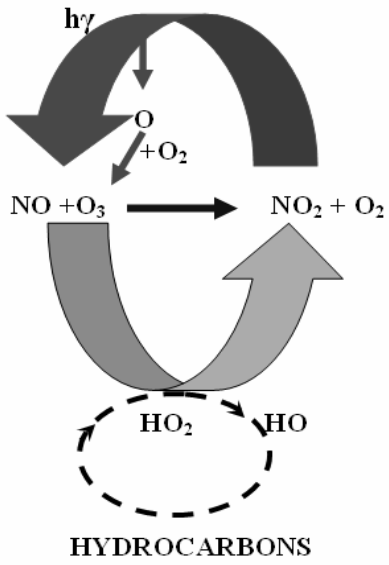
Introduction...

- VOCs are important because:
- Precursors of photochemical reactions with NO_x

O_3 ⇒ adverse health effects (iritation to noise and throat, asthama and bronchitis) and damage vegetation



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Introduction...

- toxic substances
- known or suspected carcinogen

- VOC Conc.

  exhaust emmisions
  industrial process
  evaporation

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Introduction...

- **Sampling and Analyzing Techniques:**
  - **Use near real time instrument (infrared spectrometers or portable GC)**
  - **sample from air using**
    - **Canister**
    - **Adsorbtion on selective sorbents (passive and active sampling)**

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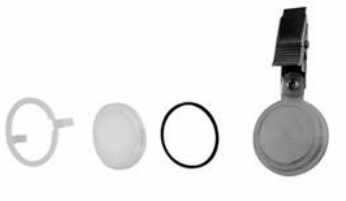
Introduction...

PASSIVE (DIFFUSIVE) SAMPLING:

taking samples by a physical process (diffusion and permeation)



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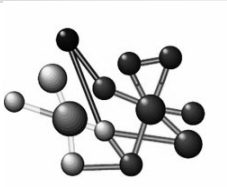
Introduction...



- **Passive Sampling Theory:**
  - **Adsorbtion of the sample onto adsorbent surface through the air movement**

- **Fick's First Law**

$$Analyte \quad Conc(ppm) = \frac{M_a(ng)}{U.R.(ng/ppm \times \min) \times t(\min)}$$

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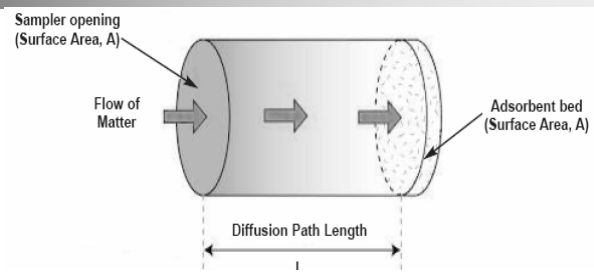
Introduction...



- **Uptake rate (UR):**
  - **Experimental U.R (exposure chamber or online GC system)**
  - **Ideal U.R (Diffusion Coefficent (D) is obtained from literature)**

$$Uptake\ Rate\ (ng/\ ppm \times \min) = \frac{D(cm^2/s) \times A\ (cm^2)}{L\ (cm)}$$

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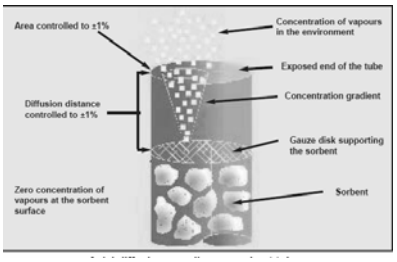
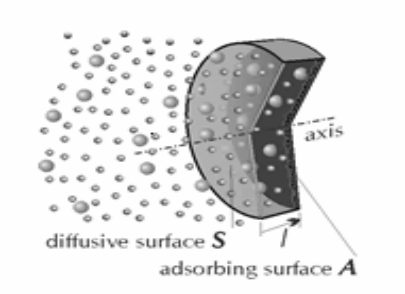
Introduction...





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MATERIALS & METHODS

- **Sampling Site**
  - **Bursa Station**
    - **Urban**
- **Sampling**
  - **Passive Sampling**
  - **Active Sampling (Hourly measurement)**

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Continous and un interrupted data obtained

Sample Preparation and Handling

Thermally desorber stainless steel passive tubes

Advantage:

- ✓ not require **solvent extraction**
- ✓ have chance to **select sorbent**
- ✓ leave long term in sampling area without breakthrough
- ✓ less affected from **relative humidity**

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Sample Preparation and Handling…

- Sorbent: **Chromosorb 106 by Supelco**
- **Characteristics:**
  - suitable analyte volatility range for VOC in concern
  - **Hydrophobic**
  - analyte volatility range boiling point **50 ^{0}C-200 ^{0}C**
  - maximum temperature: **250 ^{0}C**
  - specific surface area : **750 m^2/g**

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Sampling Methodology

- **Condition** of tubes
- **Swagelock**-type screw caps with combined PTFE ferrule
- Sealed glass tubes filled with **silica gel and charcoal** at the bottom
- **Deep-freeze** in the laboratory
- **Glass sealed** jar filled with activated charcoal

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Sampling Methodology …

- European Standard (EN) 13528
- **Shelters** made from aluminum
- Replacing the sampling cap with **diffusion part**
- placed between **1.6 - 2.0 m** from ground level
- **Field /Lab Blanks**

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Methodology...

- **Analysis of collected samples on sorbents**
- **Organics (VOCs) ⟹ GC-FID-Unity TD**

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Methodology...

- GC-FID coupled with Unity Air Server
  - Markes Unity-Air Server Thermal Desorber
  - HP 6890 Dual Column GC coupled to FID with Dean Switch System

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Methodology... (GC-FID)

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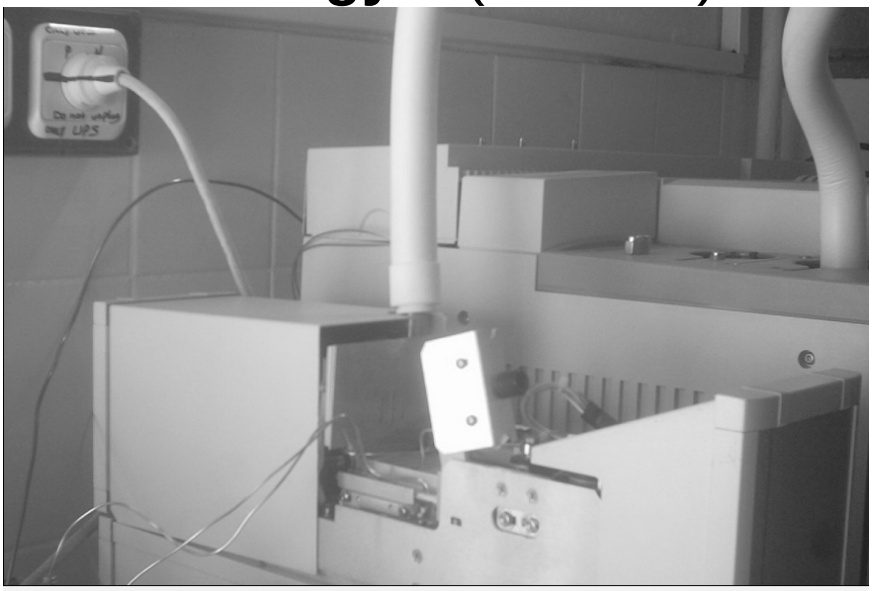
Methodology... (GC-FID)



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Methodology...

- Calibration **gas** standard:

  148 VOCs **(C_2-C_{12})** from AAQD of Environment Canada

  - ✓**5 point calibration**

- **Sorrogate** Standard:

  1-Bromoflourobenzene

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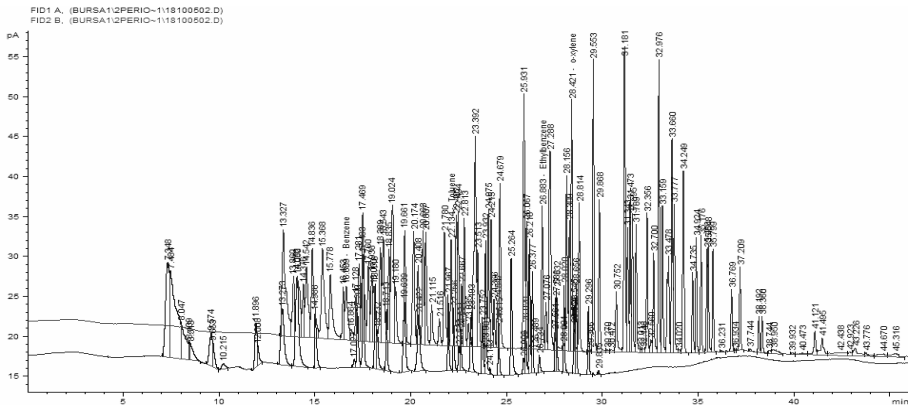
Methodology...



Typical Calibration Standard Chromotogram

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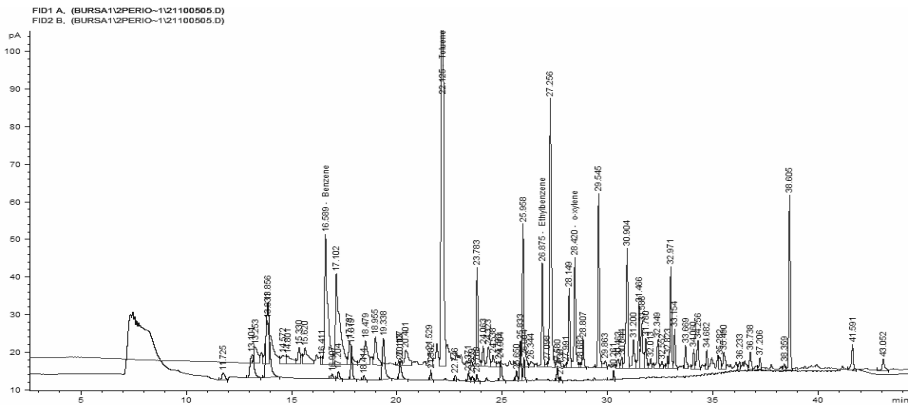
Methodology...



Typical Sample Chromotogram

Performance Evaluation

- **Detection Limit**

  0.21 μg m^{-3} (0.08 μg m^{-3} - 0.31 μg m^{-3})

- **Recovery/Desorption Efficiency**

  93.6% (80 - 100%)

Precision

7.7% (2.6 - 15.7%)

- **Sampling Stability ??**

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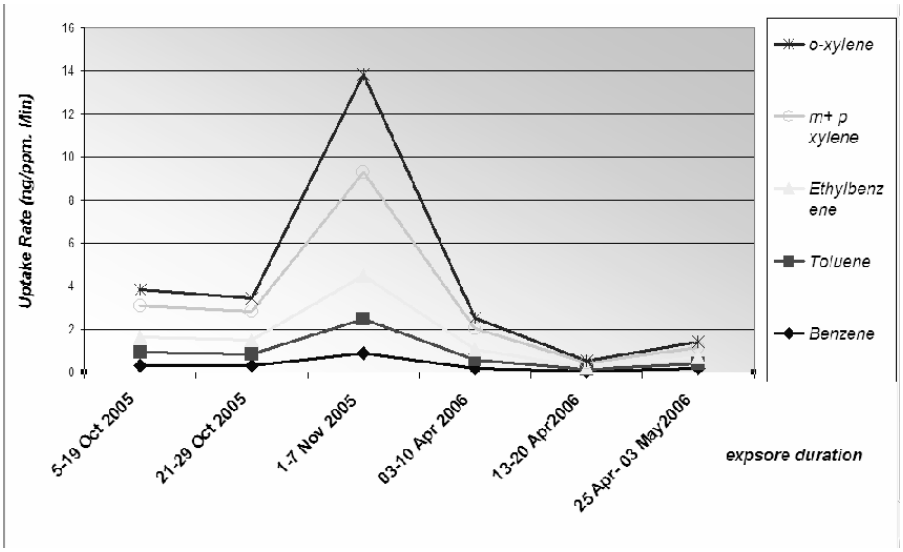
RESULT

Exposure Date	Number of active samples	Number of passive tubes
5-19 Oct.2005	258 (77%)	3
21-29 Oct.2005	173 (90%)	5
1-7 Nov.2005	84 (58%)	4
03-10 Apr.2006	144 (86%)	6
13-20 Apr2006	152 (90%)	4
25.Apr- 03 May.2006	181 (100%)	3

Uptake Rates for BTEX



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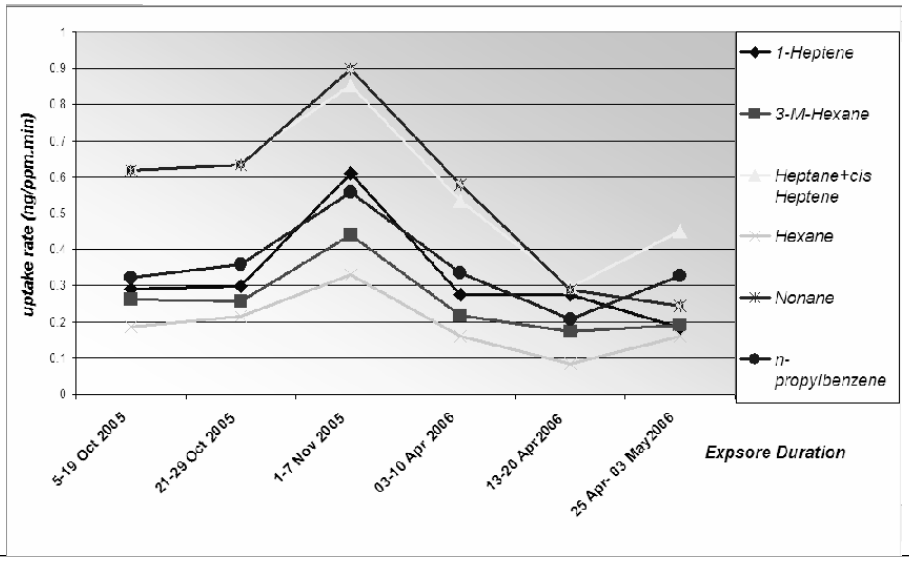
Uptake Rates for NMHCs



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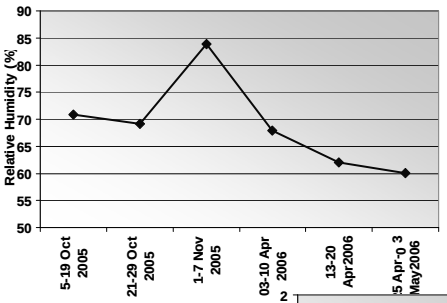
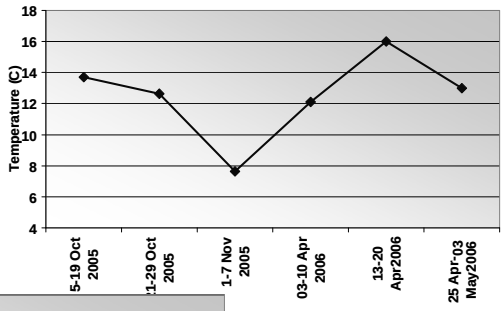
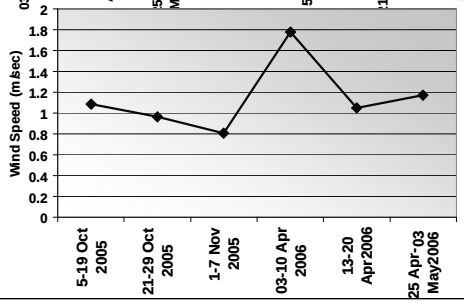
Meteorological Parameters:







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UPTAKE RATE

COMPOUND	UPTAKE RATE (ng $ppb^{-1}min^{-1}$)
Benzene	0.323
Toluene	0.562
Ethylbenzene	0.718
m&p-xylene	1.535
o-xylene	1.123

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UPTAKE RATE…

COMPOUND	UPTAKE RATE (ng $ppb^{-1}min^{-1}$)
1-Heptene	0.3219
3-M-Hexane	0.257
Heptane& cis-3-Heptene	0.568
n-Hexane	0.189
n-Nonane	0.543
n-Probylbenzene	0.351

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Future Works…

- Long term sampling with canister
- Meterological parameter
- QA/QC complete