Monitoring the Air for Toxic and Genotoxic Compounds

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Why Are We Interested in Monitoring Toxic Vapors?

- Industrial Contamination
  Deliberate
  Accident

- Homeland Security
Why Toxicity Monitoring?

• Simple
• Rapid
• Sensitive
• Adaptable from Commercial Sector
• Biochemical / Physiological Relevance
What Compounds Are of Interest?

- Toxic Industrial Chemicals (TICs)
  - High Risk
  - Toxic Gasses
  - Medium Risk
  - Toxic Volatiles

- Chemical Warfare Agents (CWAs)
- Non-Traditional Agents (NTAs)
Adapt Waste Water Screening Assays for Air Monitoring

• Acute Toxicity
  Microtox
  IQ-Tox *Daphnia magna*

• Genotoxicity
  DNA Melting/Annealing Analysis
Direct Microtox Assay

Dilution in Microtox Assay Reagent

Neat TIC

Stock in DMSO

Vapor Accumulation Assay

Exposure Chamber

Dilution in Microtox Assay Reagent

Neat TIC

Stock in Methanol

EC$_{50}$

AppEC$_{50}$
SPMD
How Does It Work

• Low Density Polyethylene
  – 10A pores

• Biological Mimic
  – Triolein, DMSO, Carbon

• After Deployment
  – Direct assay
  – Extract with solvent
SPMD in 40 mL and 4L Exposure Chambers
Microtox Reagent (bacterium)
*Photobacterium vibrio*
Diketene
Phosphorus oxychloride
Acrolein
Trichloroacetyl chloride
Methanesulfonyl chloride
Stilbene
1-Octanethiol
Sulfuryl chloride
Formaldehyde
Allylamine
Methyl chloroformate
Chloroacetone
Methylchlorosilane
Diisopropyl fluorophosphate
Methylhydrazine
Acetone cyanohydrin
1,2-Dibromoethane

EC-50 (ppmv)
More Effective with 15 min. Assay

- Zinc Sulfate
- Diketene
- Acrolein
- Acetone cyanohydrin
- Chloroacetone
- Methylhydrazine
- Formaldehyde
- Methylhydrazine
- Chloroacetone
- Acrolein
- Diketene
- Zinc Sulfate

More Effective with 5 min. Assay

- Phenol
- Methylchlorosilane
- Methylchloroformate
- 1,2-Dibromoethane
- 1-Octanethiol
- Stilbene
- Listerine
- Allylamine
- Formaldehyde
- Methylhydrazine
- Chloroacetone
- Acrolein
- Diketene
- Zinc Sulfate

% Relative Change in EC50 Between 5 and 15 min.
Daphnia magna Used in the IQ-Tox Test
Concentration of DNA (ng/mL)

Relative Fluorescence (%)

0 10 20 30 40 50 60 70 80 90 100

10 50 100 150 200 250
Control, Acrolein, Allylamine, Chloroacetone, Formaldehyde, Acrylonitrile, Bromoethane, Crotonaldehyde

Toxic Industrial Chemical (100 mM)

Percent decrease in fluorescence
Summary

• Air Sampling

• Toxicity
  Microtox
  IQ-Tox

• Genotoxicity
  DNA Melting Annealing Analysis
Future Directions

• Sampling
  – Carbon Fabric
    • Sensitivity

• Bioassay
  – Genetically Engineered Yeast
    • Cytotoxicity & Genotoxicity

• Environmental Pollutants
  – Nanaomaterials

• Environmental Applications
  – Vapor, Water, Sediment
Acknowledgements

- Kumar Ramanathan  NRC-Postdoc
- Srividia Kailasam  NRC-Postdoc
- Stacey Harper  EPA-Postdoc
- Jim Petty  USGS, CERC, MO
- Jim Huckins
- Robert Gale