Indoor Air Chemistry
and
Health Implications

September 28, 2006

Air Resources Board
California Environmental Protection Agency
Indoor Air Chemistry: Cleaning Agents, Ozone and Toxic Air Contaminants

- **Objectives:**
  1) Identify and measure emissions of TACs from cleaning products & air fresheners
  2) Identify and measure reaction products when cleaning agents with reactive compounds are exposed to ozone

- UC Berkeley, William W. Nazaroff, PhD.
Published Work Resulting from This Study


- BC Singer *et al.*, Cleaning products and air fresheners: emissions and resulting concentrations of glycol ethers and terpenoids. *Indoor Air* 2006, 16, 179-191


Methods

- Task 1 – screened 21 products for chemical components
- Task 2 – measured emissions of 6 products in room-sized chamber
- Task 3 – studied 3 products with ozone in small and large chambers for secondary emissions
  - Large chamber tests: 120 ppb ozone introduced; 60 ppb available for reaction
How many scientists does it take to mop a floor?

6
Results – Primary Emissions

- 3 TACs were released during cleaning
  - 2-butoxyethanol
  - 2-hexyloxyethanol
  - m- and p-xylene

- 2-Butoxyethanol levels were below OEHHA acute reference exposure level of 14 mg/m³

- Direct emissions of TACs do not appear to pose a risk

- 12 products contained ozone-reactive compounds (terpenes) up to 26%
What are Terpenes?

- A class of VOCs from plant oils
  - Pine – $\alpha$-pinene
  - Citrus – $d$-limonene
- Pleasant odors
- Favorable solvent properties
- Generally recognized as safe (GRAS)
- Oxidants (e.g. ozone) react with terpenes to produce more irritating and toxic compounds
Results – Secondary Emissions

- **Formaldehyde**
  - Increased 9 – 16 ppb for 4 hours post cleaning
  - Exceeded OEHHA’s chronic reference exposure level of 2.4 ppb
  - Exceeded Prop 65 no significant risk level for cancer of 1.6 ppb

- **Particles**
  - Emitted as ultrafines
  - Increased the estimated mean PM2.5 mass by 30 – 90 µg/m³ for 12-hour period
  - National 24-hour standard of 35 µg/m³ (new)

- Modeled exposure scenarios showed user exposure may exceed health benchmarks
Implications

- Primary emissions of TACs generally below health benchmarks
- Secondary emissions may pose a previously unrecognized exposure and health risk
- Continue to recommend further research on secondary indoor emissions
- Support further reductions of outdoor ozone levels and indoor ozone emissions
Thank You
How many scientists does it take to mop a floor?