



# P42 - EXPOSURE CHARACTERIZATIONS OF THREE FRAGRANCED PRODUCTS

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## ABSTRACT #108

Simulated exposure studies were conducted on 3 surrogate products with 9 common fragrance materials chosen for volatility, chemical structure, toxicity and volume of use—benzyl acetate, eugenol, hexylcinnamaldehyde, 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylcyclopenta-γ-benzopyran, hydroxycitronellal, β-ionone, d-limonene, linalool, and methyl dihydrojasmonate—at 0.06% each in an aerosol, 8.89% each in a plug-in, and 2.2% each in a fine fragrance. Aerosol results indicated peak total fragrance air concentration at adult breathing zone (5 ft) of 2165 μg/m<sup>3</sup> at 1 min At child breathing zone (1.5 ft), peak concentration of total fragrance was 1753 μg/m<sup>3</sup> at 6 min. After 2 hrs, concentrations ranged from 105 to 64 μg/m<sup>3</sup> at the adult and child heights, respectively, and the Mean Aerodynamic Diameter (MAD) of airborne particles was 1.5 μm. Plug-in study results showed peak concentration of total fragrance was 1768 μg/m<sup>3</sup> at 1 hr and declined to 137 μg/m<sup>3</sup> after 701 hrs. Fine fragrance study results showed peak concentration in the adult zone of 1030 μg/m<sup>3</sup> at 10 min, 0 ft from a mannequin; 1042 μg/m<sup>3</sup> at 5 min, at 1.5 ft distance; 881 μg/m<sup>3</sup> at 10 min, at 5 ft distance. At the child zone, peak concentration was 711 μg/m<sup>3</sup> at 5 min, 0 ft from the mannequin; 2065 μg/m<sup>3</sup> at 5 min, at 1.5 ft distance; 681 μg/m<sup>3</sup> at 10 min, at 5 ft distance. After 5 hrs, at both zones, concentrations decreased to <250 μg/m<sup>3</sup> with some concentrations below 100 μg/m<sup>3</sup> and particle MAD was 1.0 μm. Results will be used to design a clinical exposure assessment.

## INTRODUCTION

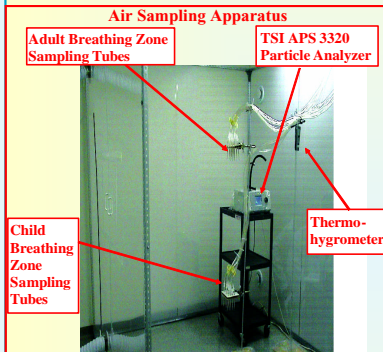
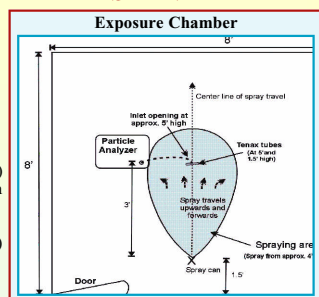
A series of studies was conducted to determine typical human exposure to 9 common fragrance materials in different product forms. The materials were selected for their importance in fragranced products, range of physico-chemical properties, and known irritant properties.

Benzyl acetate (BA) CAS# 140-11-4	Eugenol (EU) CAS# 97-53-0	d-Limonene (d-L) CAS# 5989-27-5	HHCB CAS# 1222-05-5	Hydroxycitronellal (HO-C) CAS#107-75-5	Linalool (LL) CAS# 78-70-8	β-Ionone (β-I) CAS# 14901-07-6	α-Hexylcinnamaldehyde (HCA) CAS# 101-86-0	Methyl dihydrojasmonate (MDJ) CAS# 24851-98-7

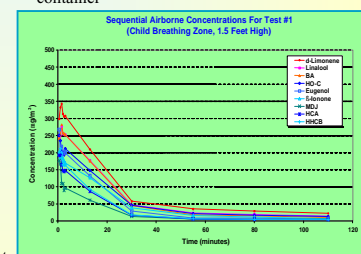
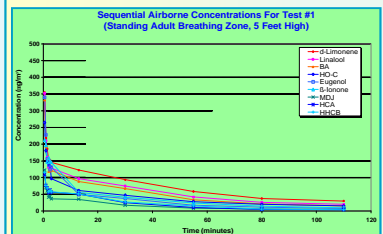
## PRESSURIZED AEROSOL AIR FRESHENER

### METHODS AND MATERIALS

- Exposure area:**
- 8 ft x 8 ft x 8 ft, (14.5 m<sup>3</sup>)
  - Temperature: 72 ± 4°F,
  - Relative humidity: 50 ± 10%
  - Air changes per hour: 0.6 ± 0.1
- Analytical Measurement:**
- Analytical equipment:
    - Tenax® TA sorbent tubes (thermally preconditioned)
    - Dynathem Inc. ACEM 900 Thermal Desorption System (TDS) coupled to Agilent 6890 GC/5973 MS system
  - Aerosol Characterization:
    - Instruments - TSI 3320 Aerodynamic Particle Sizer (APS)



- Air Sampling Apparatus**
- Adult Breathing Zone Sampling Tubes
  - TSI APS 3320 Particle Analyzer
  - Thermo-hygrometer
- Test Substance:**
- Formulation:
- Actives: 0.06% of each fragrance material
  - Purities of actives: 97.5–99.8%
- Other ingredients:
- 0.2% butylated hydroxyanisole (BHA)
  - 0.5% food grade emulsifier
  - 29.0% hydrocarbon propellant
  - 69.8% water
  - Purities of other ingredients: > 95%
- Control Substance:**
- Equal amts of water replaced each fragrance material
  - 0.2% BHA, 0.5% emulsifier, 10.0% hydrocarbon propellant, 89.3% water
- Substance Application:**
- After shaking, test material released in upwards direction with slight sweeping motion for approx. 5 seconds
  - Experiment repeated in triplicate using same container

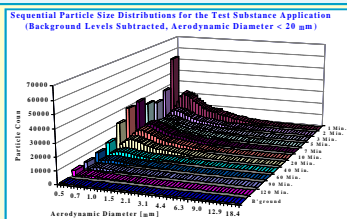


- Sequential Airborne Concentrations For Test #1 (Standing Adult Breathing Zone, 5 Feet High)**
- Sequential Airborne Concentrations For Test #1 (Child Breathing Zone, 1.5 Feet High)**
- Sampling Locations:**
- Breathing zones Adult (5 ft) and child (1.5 ft)
- RESULTS**
- Avg material released 4.9 g Control and 5.4 g Test
  - Higher volatility resulted in higher airborne concentration
  - At adult ht, maximum fragrance concentrations occurred immediately following application
  - At child ht, delay of 6 min between application and peak concentrations
  - Peaks for each of 9 fragrance materials: 108-347 μg/m<sup>3</sup> (adult zone); 118-295 μg/m<sup>3</sup> child zone
  - Most control samples were Not Detectable (ND)
  - > 90% of airborne particles were respirable (<2.5 μm)

- 60-70% of aerosols were in sub-micron (<1.0 μm) and ultra-fine ranges
- Mean Aerodynamic Diameter (MAD) of airborne particles was 1.5 μm

### DISCUSSION

- Base propellant formulation did not interfere with sampling or analysis
- Random characteristic of turbulent mixing explains replicate differences
- Turbulent mixing, passive ventilation, surface deposition and other particle deposition are likely mechanisms of particle decay patterns
- Majority of particles were respirable size; concentrations and decay patterns suggest little pulmonary exposure after first 30 mins post-release
- Peak concentrations were seen within 10 min after application. At 2 hrs post-application airborne concentrations for all materials decreased substantially
- Differences between adult and child hts were associated with volatilities. Greater amt collected in child zone. At beginning of spray, larger and heavier particles began to settle. Settling particles volatilized, lost some mass and remained suspended in air longer resulting in accumulation of materials at the lower ht



Maximum and Minimum Air Concentrations of Each Fragrance Material, at Both Hts at the Beginning of Sampling (Max) and After 2 Hrs (Min)

Fragrance Materials	Adult Breathing Zone		Child Breathing Zone	
	Max	Min	Max	Min
BA	381	15	242	8
Eugenol	410	8	267	5
α-HCA	125	4	193	3
HHCB	123	4	202	3
HO-C	299	13	251	11
β-Ionone	274	10	196	6
d-Limonene	396	28	298	15
Linalool	414	20	244	10
MDJ	128	3	177	3

## HEATED OIL PLUG-IN AIR FRESHENER

### METHODS AND MATERIALS

- Test Substance:**
- Formulation:
- Actives: 8.9% of each fragrance material
  - Purities of actives: 97.5–99.8%
- Other ingredients:
- 20.0% vehicle-dipropylene glycol monomethyl ether
  - BHA preservative at 0.3% in HCA
  - Purities of other ingredients: 99%
  - Wt of test solution – 21 g
- Analytical Measurement:**
- Tenax® sorbent tubes (thermally preconditioned)
  - Desorber - Perkin-Elmer Turbo Matrix
  - Gas chromatograph - Hewlett-Packard 6890
  - Mass selective detector - Hewlett-Packard 5973

### Chamber Evaluation:

- Plug-in device placed in an 8.2 ft x 4.9 ft x 4.9 ft (5.9 m<sup>3</sup>) stainless steel environmental chamber 48 in above the chamber floor (approx breathing zone ht)
- Concurrent duplicate test of a second plug-in air freshener conducted in a 5.5 m<sup>3</sup> (2.4 m x 1.5 m x 1.5 m, approx) stainless steel environmental chamber with rounded corners; a third replicate was conducted in the 5.9 m<sup>3</sup> chamber
- Temperature: 73 ± 4°F,
- Relative humidity: 50 ± 5%
- Air changes per hour: 1

### RESULTS

- Amts of material released averaged 2.3 g after 701 hrs
- Avg total fragrance concentration after 1 hr, 2245 μg/m<sup>3</sup>; after 701 hrs was 490 μg/m<sup>3</sup>
- Emissions data fit the model of a decaying source, with an initial steep decay for the most volatile fragrance materials, followed by a shallow or near-constant decay out to the 701 hr point

### DISCUSSION

- Amts of materials released demonstrated a consistency of emissions between the first 2 heated oil plug-in devices used; variation with the 3rd plug-in
- With this type of product form (intended to last 6-8 wks), it is not uncommon to have fluctuations in air concentrations over short periods of time
- Release rates variations caused by ambient temperature changes, changes in the electrical energy reaching the heated reservoir altering the heating cycle, fluctuations in air pressure, changes in air flow, and mixing within the sample reservoir
- Volatilities have effects on the individual air concentrations of each of the fragrance materials
- Air concentrations affected by differences in polarities of the fragrance materials and their inability to escape the nonpolar glycol solvent

## SURROGATE FINE FRAGRANCE

### METHODS AND MATERIALS

- Exposure area:**
- 8 ft x 8 ft x 8 ft, (14.5 m<sup>3</sup>)
  - Temperature: 72 ± 4°F,
  - Relative humidity: 50 ± 10%
  - Air changes per hour: 0.6 ± 0.1
- Analytical Measurement:**
- Analytical equipment:
    - Tenax® TA sorbent tubes (thermally preconditioned)
    - Dynathem Inc. ACEM 900 Thermal Desorption System (TDS) coupled to Agilent 6890 GC/5973 MS system
  - Aerosol Characterization:
    - Instruments - TSI 3320 Aerodynamic Particle Sizer (APS)



### Test Substance:

- Formulation:
- Actives: 2.2% of each fragrance material
  - Purities of actives: 97.5–99.8%
  - Vehicle: 80% ethanol/water (80%/20%)
  - Purities of other ingredients: > 95%

### Control Substance:

- Formulation-80% ethanol, 20% deionized water

### Application:

- Two actuations of pump at 3 locations on manikin
- Spray was released towards the left ear, right ear, breast plate at 3.5 in from each area
- Bottles weighed before/after use; avg amt released per pump actuation: ~ 0.1 g

### APPLICATION OF TEST MATERIAL

#### Airborne Fragrances Sampling and Analysis:

- Background Sampling:
  - Within 2 hrs pre-application for 30 min (100 ml/min) both adult and child hts
- Sampling locations:
  - Breathing zones Adult (5 ft) and child (1.5 ft)
  - 0 ft, 1.5 ft, and 5.0 ft from manikin

### RESULTS

- 0.6g of test material released after 6 actuations
- Peak total concentrations observed within first hr
- Concentrations for all materials decreased with time and distance from manikin
- Peak concentrations of volatile materials (d-L, LL, BA) observed within first hour at adult ht. Highest concentration was 621 μg/m<sup>3</sup> for d-L at 1.5 ft from manikin

### DISCUSSION

- Sampling locations focus on the individual user (0 distance), person near user (1.5 ft), and person in workplace (5.0 ft)

- Data show behavior of different materials due to volatilities and responses to airflow in exposure chamber, similar to real-life exposure. The effect of mixing is seen at the 1.5 ft ht and 1.5 and 5 ft distances
- d-L long lasting; high concentrations at 5 ft distance demonstrates effect of air movement on a volatile, not seen with less volatile materials
- The data shows die-away phase of each material suggesting that after several hours, measurable fragrance material is reduced by more than an order of magnitude, although the concentrations of more volatile materials remained high
- Analysis shows small particle size increasing the likelihood of inhalation and the intended stimulation of the olfactory system
- Larger particles represent less volatile materials
- At 1.5 ft ht the variation in the concentration of each material resulted from volatilization of particles; they become lighter and remain suspended
- The less volatile materials have flatter curves, reflecting their less volatile nature
- Early time period data at the adult ht are higher at 1.5 ft than 0 ft from the manikin due to "overspray" of the test material reaching the sampling tubes more directly
- At the later time periods, the measurements reflect the exposure of an individual close to the fragrance user

### CONCLUSIONS

#### Aerosol Study

- Total fragrance peak concentration-2165 μg/m<sup>3</sup> was seen at 1 min at adult ht-5.0 ft. At 1 hr concentration decreased to 247 μg/m<sup>3</sup>
  - At child ht, total peak fragrance concentration-1753 μg/m<sup>3</sup> was seen at 6 min. At 1 hr, concentration decreased to 129 μg/m<sup>3</sup>
  - Majority of particles were respirable
- Fine Fragrance Study**
- Highest total fragrance concentration at 1.5 ft distance was seen at 5 min post spray at both adult (1042 μg/m<sup>3</sup>) and child (2065 μg/m<sup>3</sup>) hts
  - Majority of particles were respirable
- Plug-in Study**
- Peak concentration of 1768 μg/m<sup>3</sup> for the plug-in was seen at 1 hr

While airborne levels of the nine fragrances were reproducible, the physiological interpretation of these concentrations is unknown at this time. One possible starting point for the biological significance of these results could be the ACGIH guidelines for Particulates Not Otherwise Classified of 10 mg/m<sup>3</sup> for inhalable particles and 3 mg/m<sup>3</sup> for respirable particles. These data provide an understanding of modeling for standard exposure conditions and show that any assessment of exposure from different fragranced product forms is influenced by the product form. The information will be useful in the design of future clinical studies in normal and sensitive subpopulations to assess the potential effects of inhaled fragrance materials.

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