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Project Summary

Sampling of Automobile Interiors for Organic Emissions

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A study was undertaken to determine the concentrations of N-nitrosamines (specifically N-nitrosodimethylamine and N-nitrosomorpholine) and hydrogen cyanide, as well as to identify other volatile organic compounds that were emitted from the interiors of the new cars tested, before, while, and after the cars were heated. The three cars tested were placed in an enclosed shed and then heated by using infrared tungsten lamps focused on their interiors to simulate the heating effect of sunlight. The gasoline tanks of the cars were removed and their fuel lines emptied for safety reasons and to eliminate gasoline vapors from interfering with any of the analyses. The air inside the cars and inside the shed was sampled during the entire temperature rise or "heat buildup" cycle (from ambient to 60°C). The air samples were pulled through cartridges containing absorbents such as Thermosorb (used specifically to collect N-nitrosamines) and Tenax (used to collect volatile organic compounds), as well as through impingers and into Tedlar bags to analyze for hydrogen cyanide.

The results obtained revealed low concentrations of N-nitrosodimethylamine and N-nitrosomorpholine in the car interiors during the heating process, but higher concentrations of these N-nitrosamines outside of the cars (in the shed). No hydrogen cyanide was detected inside or outside the two cars tested for this compound. Peaks on the GC/MS system that were associated with residual gasoline vapors and laboratory solvents such as methylene chloride and tetrachloroethylene indicated that no meaningful comparison could be made between the car interior and shed interior emissions.

This Project Summary was developed by EPA's Atmospheric Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Low concentrations of potentially carcinogenic organic vapors such as vinyl chloride, N-nitrosamines, and benzene have previously been identified in the interiors of many cars driven in this country. The emissions of these vapors have been attributed to the materials and adhesives used in the interiors of cars for seating, dashboard, and trim. Many different types of plastics, rubber, vinyl fabrics, and adhesives are used in a diversity of manufacturing processes to reduce the costs of producing new cars, and to reduce the weight of these cars (for improved gas mileage). It is, therefore, useful to investigate the potentially carcinogenic interior emissions from these cars. The purpose of this study was to identify and quantitate the N-nitrosamines and hydrogen cyanide and to survey the other volatile organic compounds produced from the interior emissions of the new (1980-81) model cars.

Procedure

Three cars, a 1980 Buick Skylark, 1980 Mazda GLC, and 1981 Plymouth Horizon, were tested. These cars were chosen because of their availability. Each car was placed in an enclosed shed; and air samples from the interior and exterior (shed air) of the car were taken before, while, and after the car was heated. The cars were heated by six tungsten filament heat lamps focused on the interior to simulate the "heat buildup" caused by exposure to sunlight.

The enclosed shed (Figure 1) used for testing provided a controlled environment with a reduced potential for outdoor air contamination. To prevent gasoline vapor contamination the gas tanks of the cars were removed and their fuel lines were emptied.

The nominal temperature rise in the interior of a car on a typical hot summer day was determined by placing a car outside in the parking lot and monitoring the interior and outdoor temperature each day for 3 days. This temperature range was then used as the basis for setting up the six tungsten heat lamps to heat the cars. Exposing the cars to a 2-day heating and cooling cycle without purging the interior air was performed to simulate a "worst case" *situation in which the N-nitrosamine* and hydrogen cyanide emissions might be increased.

A Thermosorb sampling system was used to collect potential N-nitrosamine emissions, specifically N-nitrosodimethylamine (NDMA) and N-nitrosomorpholine (NMOR). This system has been demonstrated as the method of choice for retaining 100 percent of any pre-loaded nitrosamines. Tenax G.C. has been in general use for the trapping of volatile organic compounds and thermal desorption of the trapped material onto a GC/MS system to obtain a qualitative analysis. Two methods for the trapping or collecting and analysis of hydrogen cyanide have been attempted. By one method, air is collected in impinger-type scrubbers containing 25 ml of 0.625 NNaOH and analyzed for HCN using a colorimetric procedure. By the other method, air is collected in a Tedlar bag, and an aliquot of the bag contents is then analyzed by using a gas chromatograph coupled to *a* chemiluminescent detector. Both these methods were modified and adapted for this program to analyze for hydrogen cyanide in automobile exhaust.

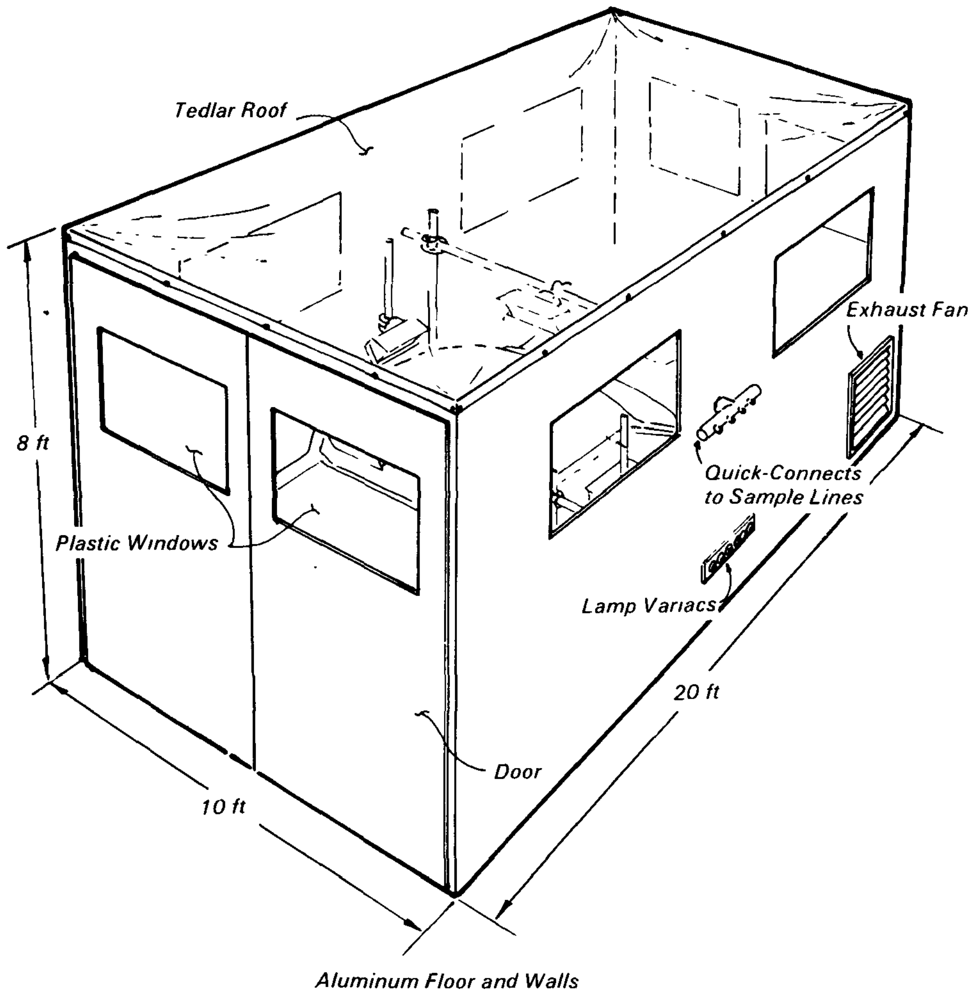

Figure 1. *Shed, Horiba, Inc., model EPS76, volume: 1600ft³.*

Conclusions

N-nitrosamines were detected in the interior air of all the cars tested while the cars were heated and at the steady-state 60°C (interior) temperature. The levels of N-nitrosamines measured inside the cars ranged from an average of <0.04 to 0.37 $\mu g/m^3$ for NDMA and from an average of ≤0.06 to 0.25 $\mu g/m^3$ for NMOR; the limits of detection were ≤0.04 $\mu g/m^3$ for NDMA and ≤0.06 $\mu g/m^3$ for NMDR. The concentrations of these N-nitrosamines measured in the shed, however, were an average 2 times greater than those measured in the interior. The N-nitrosamine levels measured when the cars were subjected to the "worst case" conditions were higher in most cases than the interiors were heated for the 1 day test cycle. The levels of the N-nitrosamines measured in the shed were, again, usually greater than those measured in the interior. Measurements of N-nitrosamines in the trunk of the Buick Skylark were on average 1.5 to 2 times greater than the concentration measured in the shed. These values, however, were obtained even when the spare tire was removed, indicating that other possible sources of N-nitrosamines must be present. Available resources would not permit a comprehensive, statistical significant examination of the N-nitrosamine emissions in the interiors of new cars.

No HCN was detected in either the interior of the cars tested or in the shed during the entire heating cycle.

No conclusion could be made concerning the emission of other volatile organic compounds due to the high background obtained from laboratory solvent emissions, high concentrations in the testing area of Freon contaminant and other hydrocarbons, especially residual gasoline vapors.

Recommendations

In future testing, emissions, of compounds such as vinyl chloride, aldehydes, and ketones should also be measured in this type of controlled environment. Instead of purging the shed and car interior with air from the room surrounding the shed, hydrocarbon-free air, nitrogen, or helium should be used in order to define the volatile organic emissions.

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The complete report, entitled "Sampling of Automobile Interiors for Organic Emissions," (Order No. PB 85-172 567/AS; Cost: $8.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
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