

## 1994-96 Indoor and Outdoor VOC Assessment

The purpose of this air quality monitoring study was to measure and assess indoor and outdoor concentrations of volatile organic compounds during the period when ethanol-blended gasoline was being used in Anchorage. This study was conceived to help address concerns about possible health impacts of using ethanol-blended gasoline in a sub-arctic climate and to gather baseline information on indoor VOC exposures and sources within the home.

Eighteen different volatile organic compounds (VOCs) were measured in this study. Ambient monitoring was performed for 24-hours every twelve days at three outdoor sites during the 14-month study. These three outdoor sites were located at three of the permanent CO stations (Garden, Benson, and Sand Lake) to investigate the relationship between VOC concentrations and CO. Indoor sampling was also performed in Anchorage homes following an identical one-in-twelve day schedule. Three to five homes were sampled during each sampling period. During the course of the study, samples were collected from 137 homes in Anchorage.

The 18 VOCs measured in this study included the class of hydrocarbons known as carbonyls (these include the aldehydes and ketones) and the non-polar BETX (benzene, ethyl benzene, toluene, and xylene) compounds.

Benzene, formaldehyde and acetaldehyde were of particular interest because EPA has classified them as known (Group A) or probable (Group B) human carcinogens. Ethanol-blended fuels have been shown to increase emissions of some aldehydes. The addition of ethanol may also increase the vapor pressure of gasoline and thus change its evaporative characteristics. For this reason, there was some concern about possible increases in evaporative emissions of benzene.

### Results of Outdoor Monitoring

Average benzene concentrations measured at the Garden, Benson and Sand Lake CO stations ranged from 1.74 to 3.57 ppbv during the December 1994 - February 1996 study period. These average concentrations were approximately 30% lower than those measured during the 1993-94 VOC study conducted 18 months earlier. This decline may be due in part to favorable meteorology (i.e. generally better atmospheric dispersion during the 1994-96 study) and to a decrease in the average benzene content in gasoline. Gasoline benzene content was reduced through the introduction of ethanol-blended gasoline (the addition of 10% ethanol effectively reduced benzene through dilution). In addition, one of the major gasoline retailers was reported to have reduced the benzene content of its "base" (pre-blended) gasoline.

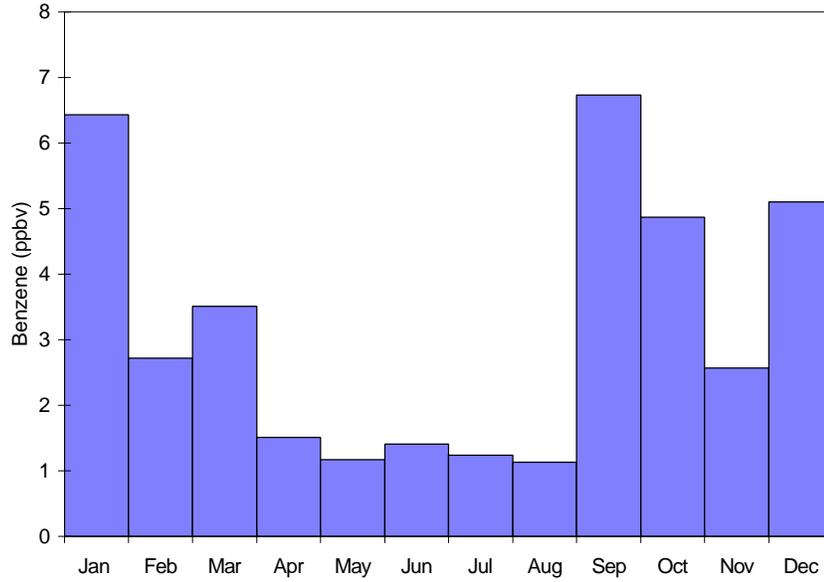
The average formaldehyde concentration measured at the Garden CO station was 2.38 ppbv and 2.08 ppbv at the Benson station during this 14-month study. The average acetaldehyde concentration at Garden was 1.08 ppbv while Benson averaged 1.02 ppbv. These values appear to be lower, on average, than other urban areas in the U.S. Average formaldehyde and acetaldehyde concentrations in Anchorage were about half the average measured in a twelve-city EPA study conducted in 1990.

Data from the study suggest that motor vehicle emissions are a major contributor to benzene, formaldehyde, acetaldehyde and other VOCs measured in the ambient air. Concentrations of these compounds were highest in the winter months of the study and were strongly correlated with carbon monoxide (CO) measurements. The strong associations observed between VOCs and CO implicate motor vehicle emissions as a major contributor to ambient VOCs because motor vehicle emissions account for an estimated 84% of all CO emissions in Anchorage.

Monthly average formaldehyde and benzene concentrations at the Benson SLAMS site are plotted in Figures 8-3 (a-b). Concentrations of carbonyls and BETX tended to be higher in the winter months and lower in summer. A similar seasonal pattern was also observed at the Garden site.

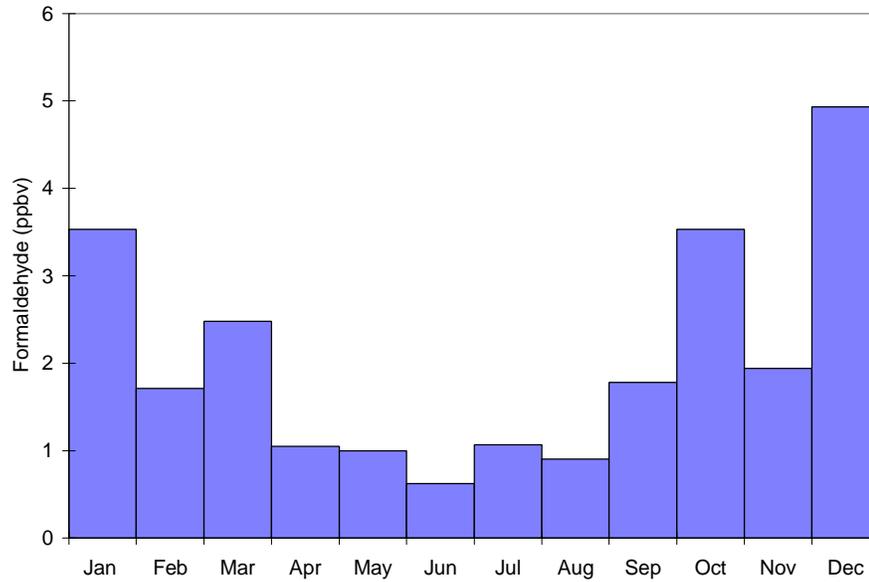
**Figure 8-3(a)**

Mean Benzene Concentrations by Month  
Benson SLAMS Site



**Figure 8-3(b)**

Mean Formaldehyde Concentrations by Month  
Benson SLAMS Site

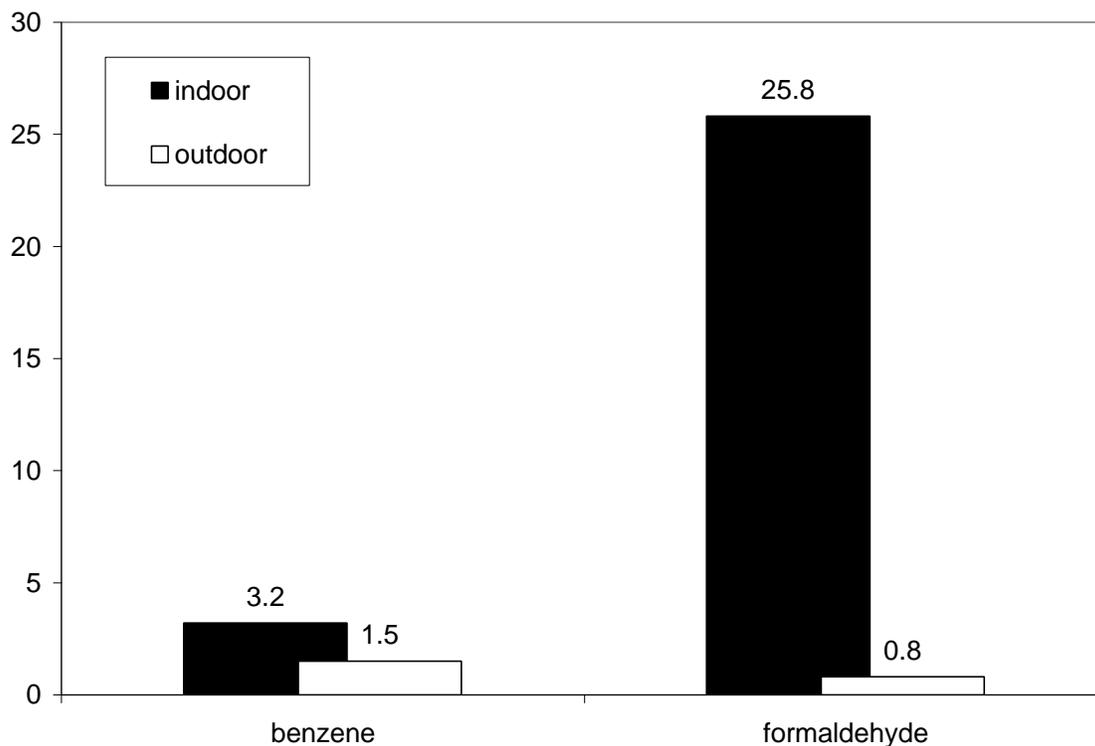


## Results of Indoor Monitoring

Indoor concentrations of VOCs were 2 to 50 times higher than those measured outside. Indoor and outdoor concentrations of benzene and formaldehyde are compared in Figure 8-4.

**Figure 8-4**

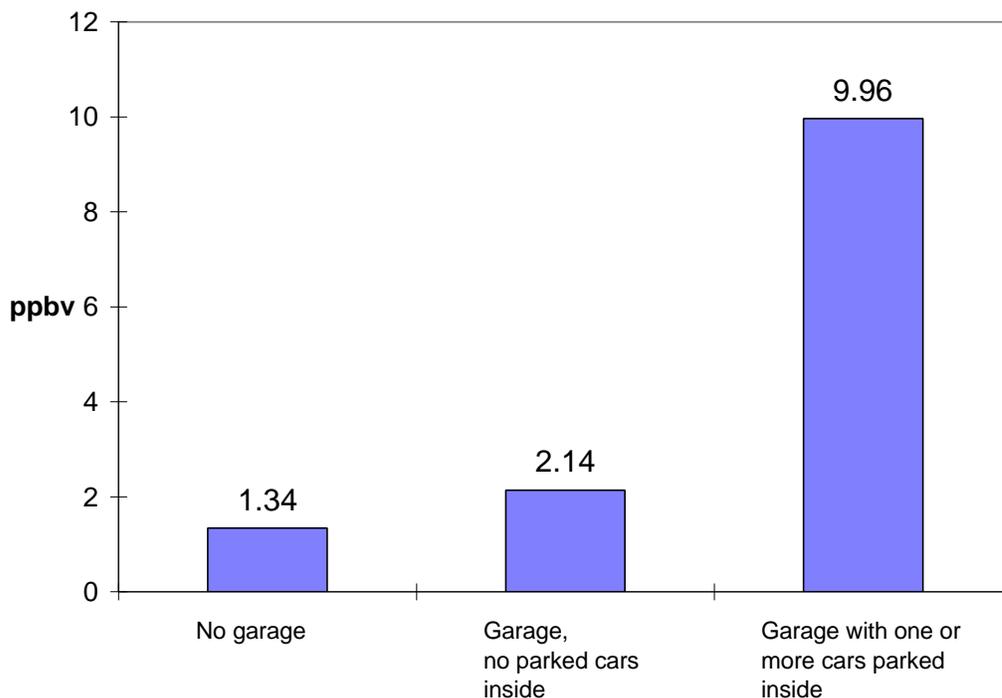
Comparison of Median Indoor and Outdoor VOC Concentrations  
Benzene, Formaldehyde



Because people typically spend 90% or more of their time indoors, the majority of personal exposure to benzene, formaldehyde, acetaldehyde and other VOCs is most likely to be in the home or other indoor environments. The highest concentrations of BETX compounds were observed in homes with attached garages, especially if cars were parked inside. Figure 8-5 shows that the median concentration of benzene measured in households with attached garages is higher than those without. Concentrations are especially high if the attached garage is used for parking. Evaporative emissions of gasoline from cars parked in these attached garages were implicated as the primary source of benzene and other BETX compounds.

**Figure 8-5**

Comparison of Median Benzene Concentrations in Anchorage Homes by Garage Configuration



The data suggest that motor vehicle and/or gasoline-related emissions are not a source of indoor carbonyls, however. Carbonyls (e.g. formaldehyde and acetaldehyde) were not correlated with the indoor BETX measurements. This indicates that the carbonyls have a different source than the BETX compounds and indoor exposures to these compounds would probably be unaffected by changes in gasoline composition. Thus, adding ethanol to gasoline would be expected to have little or no effect on personal exposures to formaldehyde or acetaldehyde.