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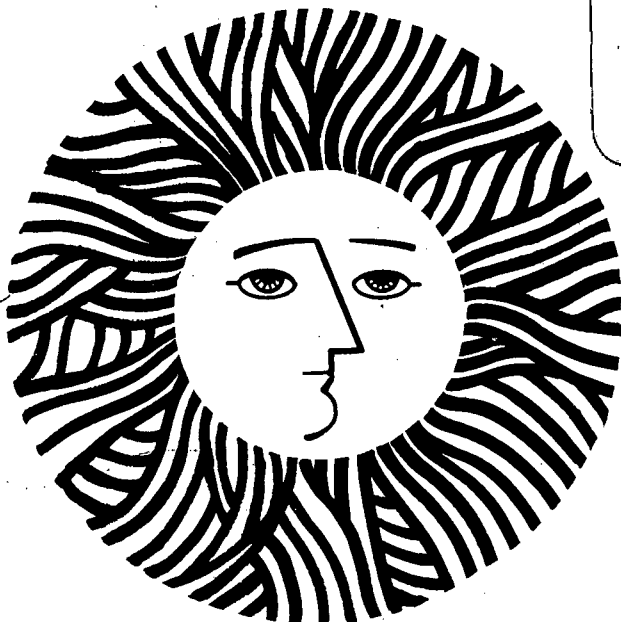
TRACE ORGANICS IN OFFICES

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TRACE ORGANICS IN OFFICES

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October 1980

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ABSTRACT

The presence of trace organics in indoor air may be responsible for poor air quality, particularly in new buildings where windows are hermetically sealed. In response to complaints from workers, air quality was monitored in four office spaces at the Lawrence Berkeley Laboratory (LBL). Formaldehyde and other organic compounds were collected and analyzed, formaldehyde by a special procedure developed at LBL and other organic compounds by either gas chromatography-mass spectroscopy or gas chromatography with flame ionization detection. Indoor levels of several organic compounds were found to be considerably higher than outdoor levels. The concentrations of the major organic contaminants observed ranged from 1 to 100 ppb, well below existing OSHA standards established for the workplace environment. It is concluded that, while below OSHA standards, these levels may have cumulative or synergistic health effects not yet fully understood.

Keywords: air pollution, formaldehyde, indoor air quality, office buildings, organics.

TRACE ORGANICS IN OFFICES

In the past few years, office workers throughout the country have registered numerous complaints of "bad air". These complaints come most frequently from workers occupying new office buildings with hermetically sealed windows. Although various government agencies have investigated these problems, the etiological agent(s) has frequently remained unidentified. Most often, indoor air quality problems have been remedied by increasing the ventilation rate in the affected area; however, this remedy is in conflict with strategies for reducing energy consumption by lowering ventilation rates. To resolve this conflict, designers and occupants need to be informed about indoor air pollution sources and characteristics so that appropriate (i.e., energy efficient) strategies can be implemented for the prevention, distribution and/or removal of indoor pollutants.

One of the primary contributors to poor indoor air quality may be organic contaminants, which have numerous indoor sources: building materials, cleaning products, tobacco smoking, furnishings, common consumer products, and building occupants themselves. To date, however, there has been relatively little research on this topic ^{1,2}. The present study was initiated in response to occupants of office trailers and remodelled office spaces at Lawrence Berkeley Laboratory (LBL) who complained about the poor indoor air quality.

Air from four offices was sampled (see Table 1 for site characteristics). Air samples were collected and analyzed for formaldehyde using procedures developed at LBL;³ these results are given in Table 2. Other

organic compounds were collected on Tenax, a porous polymer sorbent, using the sampling cartridge arrangement shown in Figure 1. Office air was drawn through the Tenax cartridge and the organic components were adsorbed on the Tenax; after the Tenax cartridge was returned to the laboratory, the organic compounds were released by thermal desorption for analysis.

Samples were collected at a flow rate of 1.0 standard liters per minute (slpm) for one hour. The flow rate was controlled using a #22 hypodermic needle as a critical orifice.⁴ At each site, indoor and outdoor air was sampled simultaneously, and from three to six sets of parallel samples were taken. A blank was handled in a manner identical to the indoor samples except that no air was drawn through it. The blank and one sample from each site were analyzed by gas chromatography-mass spectroscopy (GC-MS) using a Finnigan 4023 GC-MS, equipped with the NIH/NBS spectral library to identify the compounds collected. The remaining samples were analyzed on a Varian 3700 gas chromatograph equipped with a flame ionization detector (FID) and a CDS 111 microprocessor. For both GC-MS and GC-FID analyses, the samples were introduced onto the chromatographic column from the solid sorbent via a NuTech Model 320 Thermal Desorption System. The NuTech apparatus contains a heated desorption block, a six-port valve and a capillary cryogenic trap (see Figure 2).

Figure 3 shows comparative gas chromatograms of an indoor air sample (Building 90, Room 3145) and an outdoor air sample taken simultaneously at the same building. By assuming a constant per-carbon response for the FID, relative peak areas were used to estimate relative concentra-

tions. Figure 4 shows a reconstructed ion chromatogram in which representative peaks are identified (The peak labelled "siloxane" is an experimental artifact resulting from the use of silanated glass wool in the Tenax cartridges). Table 3 lists identified compounds for which the indoor concentration was at least five times as great as the outdoor concentration and identifies those compounds for which standards of exposure have been promulgated by the Occupational Safety and Health Administration (OSHA) for the workplace environment.⁵

For a few compounds, estimates of concentration levels were made by comparing the integrated peak areas on the chromatograms with the peak areas of standards loaded onto the Tenax tubes by liquid injection. Because this method of calibration provides no information about collection efficiency or sample stability, concentrations obtained in this way provide only rough estimates. Estimates made in this manner indicated that major indoor organic contaminants were present in concentrations ranging from 1 to 100 ppb; these concentrations are all well below existing occupational exposure limits established by OSHA.

The potential health hazard from the combined effects of the organic compounds found in these samples cannot be assessed at this time, nor was any single compound present in high enough concentration to be singled out as a health hazard by existing OSHA criteria. On the other hand, it is important to note that those criteria were established for the workplace environment where unusually high exposures to a single compound are encountered. The possibility cannot be overlooked that cumulative exposure to low levels of several compounds, or synergistic health effects, may explain the symptoms reported by occupants.

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Table 1. Description of office sites at Lawrence Berkeley Laboratory

<u>Site</u>	<u>Type</u>	<u>Characteristics</u>
90 H	Office Trailer	carpeting, partitions
67 C	Office Trailer	open office space, carpeting, one smoker
90-3143	Office/Work space	fabric wall coverings, some electrical equipment
90-3145	Office space	open office space with a few partitions, carpeting, fabric wall coverings

Table 2. Formaldehyde concentrations in LBL offices.

(Concentrations in ppb)

<u>Site</u>	<u>Indoor</u>	<u>Outdoor</u>
90H	--	--
67C	35	3
90-3143	13	1
90-3145	19	1

Table 3. Organics detected in LBL offices.

	LBL 67C	LBL 90H	LBL 90-3143	LBL 90-3145	OSHA Permissible Exposure Limit (ppm)
HYDROCARBONS					
n-hexane	x	x	x		500
n-heptane			x		500
n-octane			x	x	500
n-nonane			x	x	
n-undecane			x	x	
2-methylpentane	x	x			
3-methylpentane		x			
2,5-dimethylheptane			x		
methylcyclopentane	x	x	x		
ethylcyclohexane			x	x	
methylcyclohexane			x		500
pentamethylheptane			x	x	
AROMATICS					
benzene		x	x		1
xylenes	x				100
toluene		x	x	x	200
HALOGENATED HYDROCARBONS					
trichloroethane	x	x	x	x	350
trichloroethylene	x		x	x	100
tetrachloroethylene			x	x	100
MISCELLANEOUS					
hexanal		x			
methylethylketone	x				200

Sampling Cartridge

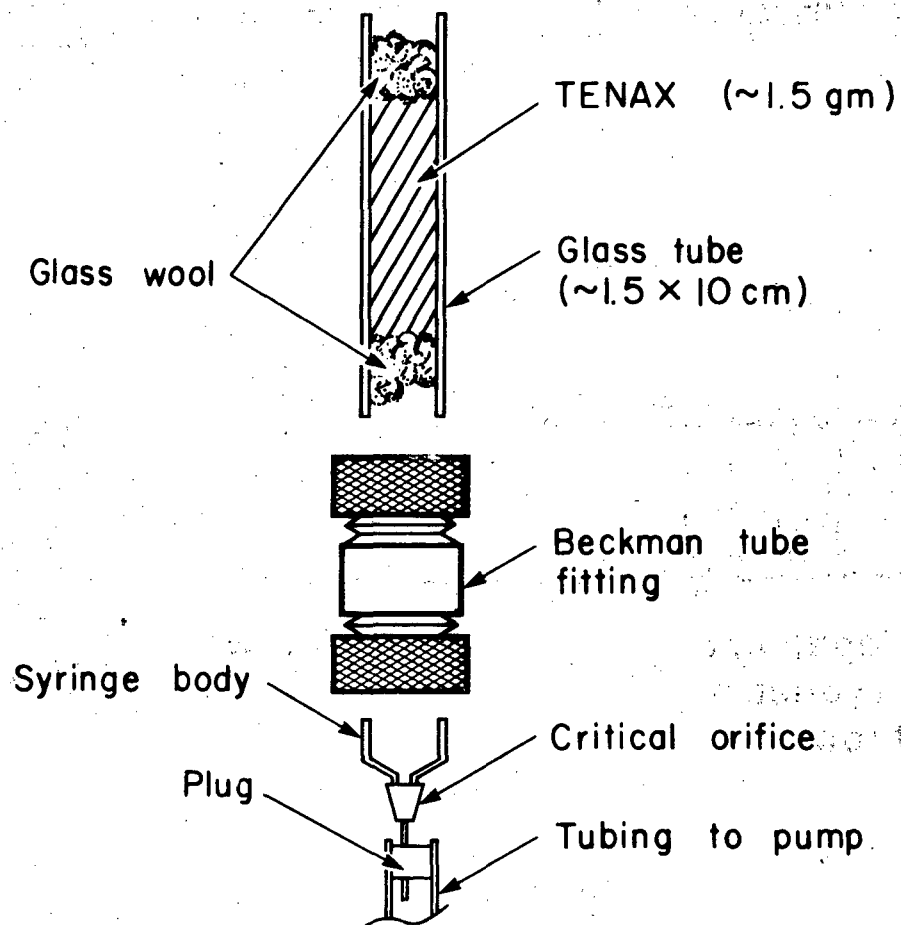
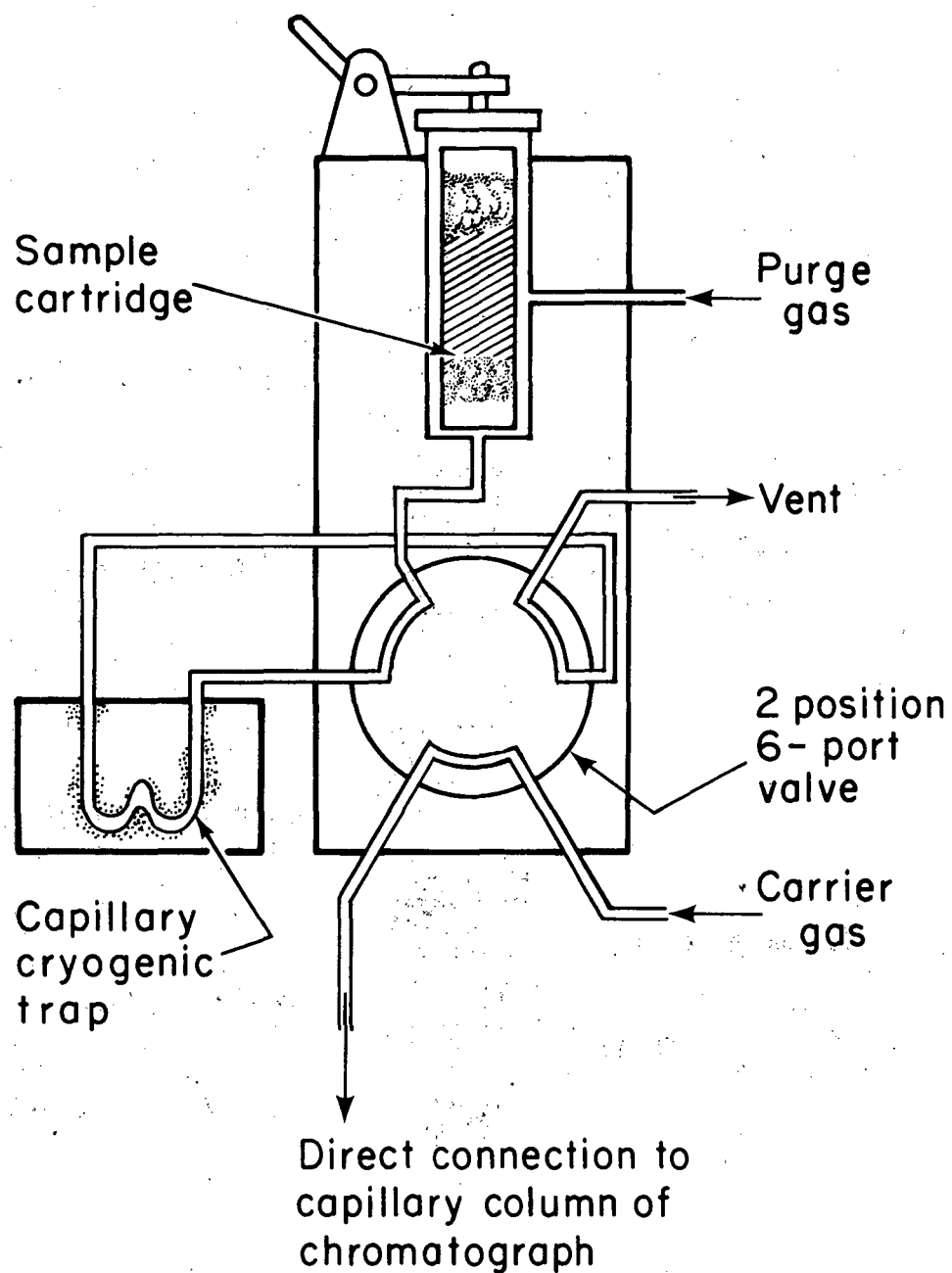


Figure 1. Tenax Field Sampling Apparatus

Thermal Desorption Device

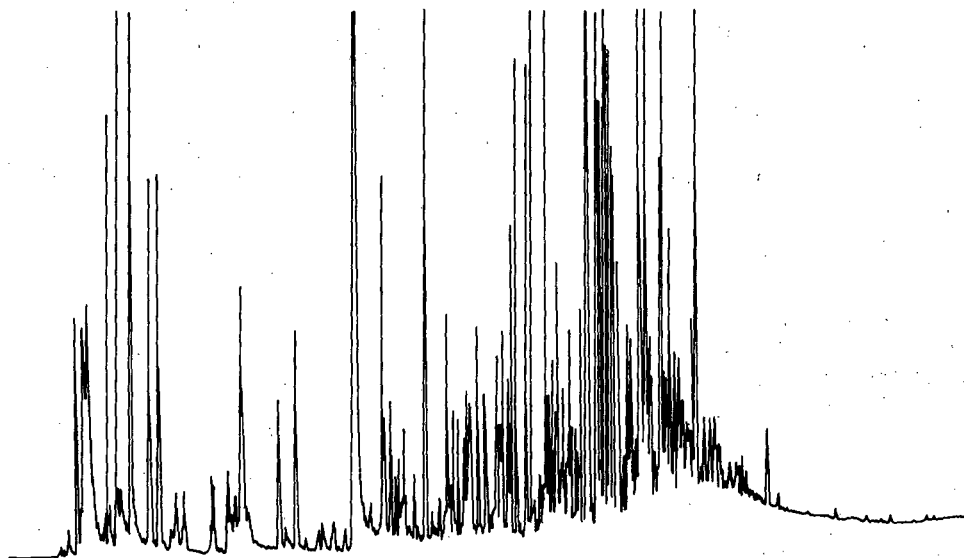


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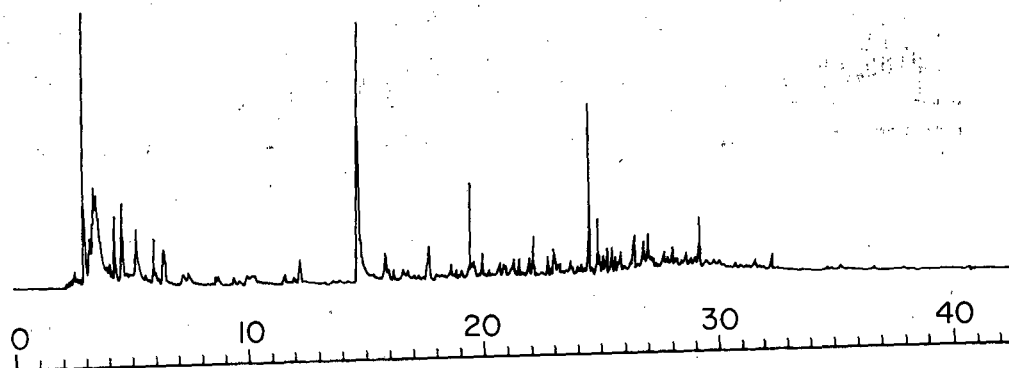
Figure 2. Schematic of NuTech Thermal Desorption Device

Comparison of Trace Organics in Indoor and Outdoor Air at an Office Site

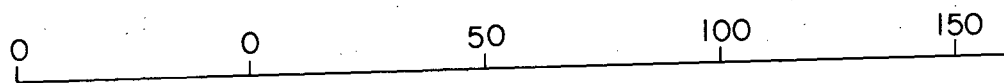
Indoor



Outdoor



Time (minutes)

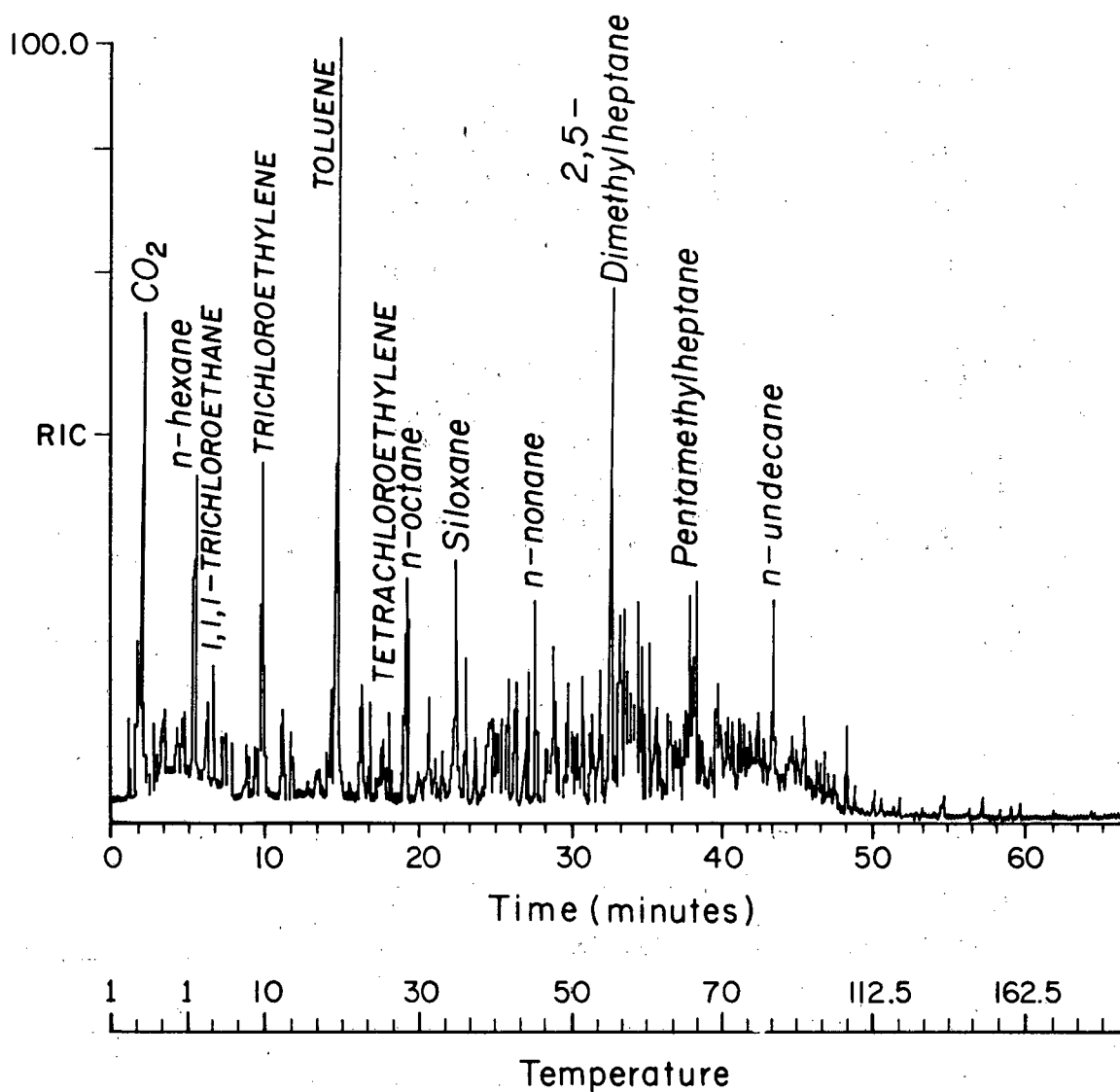


Temperature

XBL808-1727

Figure 3. A Comparison of Chromatograms
of Samples taken inside Room 3145,
Building 90 and outside Building 90

Trace Organics in Indoor Office Air



XBL 808-1726

Figure 4. A Labelled Chromatogram of an Indoor Air Sample taken in Room 3145, Building 90

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