INDOOR AIR VOC POLLUTION CAUSED BY GASOLINE SPILL

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ABSTRACT

Due to a gasoline spill in the Alvdal area in Norway, the concentrations of organic compounds in indoor air in six buildings were measured. The spill occurred in July 1990. In January 1992, the total concentration of the included components was as high as 53 640 $\mu g/m^3$ in the building closest to the site of the spill. The remediating steps taken and the movement of the gasoline have reduced the concentrations to the extent that in December 1992 the highest total concentration that was measured was 1675 $\mu g/m^3$.

INTRODUCTION

In July 1990, a leak in one of the tanks at a petrol station in Alvdal, Norway was detected. The tank was removed on the 18. July. There was, however, reason to believe that about 17 m^3 of gasoline had already been emitted to the ground. Just before Christmas 1990, people living in the homes that were located between the site of the leakage and the river, started complaining about odours in their homes. Measurements of concentrations of selected organic compounds in indoor air were started in April 1991, and in the following year, sampling and analysis were carried out at irregular intervals. Since June 1992, measurements have been carried out monthly.

METHODS

The measurements were done by collecting grab samples in internally electropolished stainless steel flasks and subsequent analysis with a gas-chromatograph with flame ionisation detector (GC-FID) (1,2,3).

After sampling, the flasks were sent to NILU for analysis.

RESULTS

Measurements where carried out at the following seven places in six buildings:

1) The kitchen of a one-family home.
2) The ground floor of a one-family home.
3) The kitchen of a one-family home.
4) The basement and the ground floor of a house that was only in use during the holidays.

5) The ground floor of a one-family home.
6) The basement of a school building.

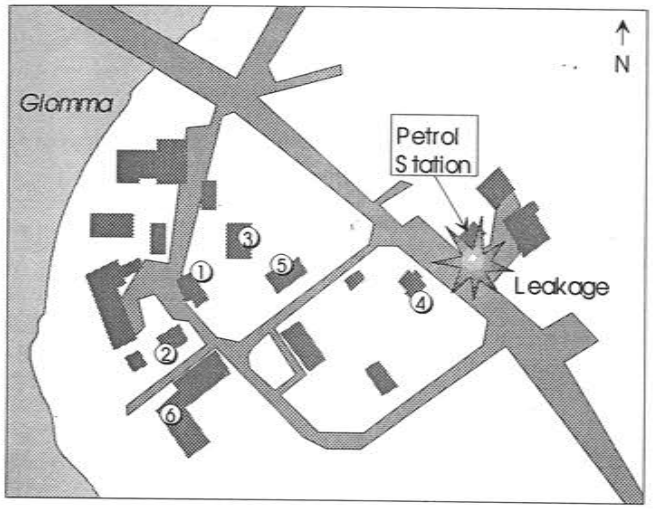

Figure 1. Map of the Alvdal area where the gasoline spill occurred. The leakage site and the six houses where measurements have been carried out are marked.

The components that have been included in the measurements are shown in Table 1.

Table 1. Components included in the measurements.

Component	Molecular formula	Component	Molecular formula
ALKANES:		ARENES:	
2-Methylbutane	C_5H_{12}	Benzene	C_6H_6
Pentane	C_5H_{12}	Methylbenzene (toluene)	C_7H_8
2-Methylpentane	C_6H_{14}	Ethylbenzene	C_8H_{10}
3-Methylpentane	C_6H_{14}	1,3- and 1,4-Dimethylbenzene (m- and p-xylene)	C_8H_{10}
Hexane	C_6H_{14}	1,2-Dimethylbenzene (o-xylene)	C_8H_{10}
Heptane	C_7H_{16}		
Octane (sum)	C_8H_{18}	CYCLOALKANES:	
		Cyclohexane	C_6H_{12}
ALKENES:			
Pentene (sum)	C_5H_{10}		

The site of the leakage and the six buildings are shown in Figure 1. The gasoline is slowly moving through the ground down towards the river (Glomma). It has, however, been difficult

to calculate the movement of the gasoline. The distances from the site of the leakage to building 4 and to the river are roughly 25 m and 200 m, respectively.

In Table 2 are shown the measured total concentrations of all the included components in the indoor at the seven places where measurements have been carried out.

Table 2. Measured total indoor air concentrations of the included components ($\mu g/m^3$).

Date	1. Ground floor	2. Ground floor	3. Ground floor	4. Base-ment	4. Ground floor	5. Ground floor	6. Base-ment
June 1991	755	105	210	-	-	-	-
Jan. 1992	290	205	3060	53640	-	105	60
Mar. 1992	-	-	-	4920	266	-	-
May 1992	465	475	250	4280	315	35	-
June 1992	-	-	-	725	-	-	-
July 1992	120	475	125	5060	255	165	-
Aug. 1992	-	75	140	7640	875	-	50
Sept. 1992	-	-	70	2890	935	65	-
Oct. 1992	-	330	70	2680	315	-	-
Dec. 1992	340	445	295	1675	185	260	-

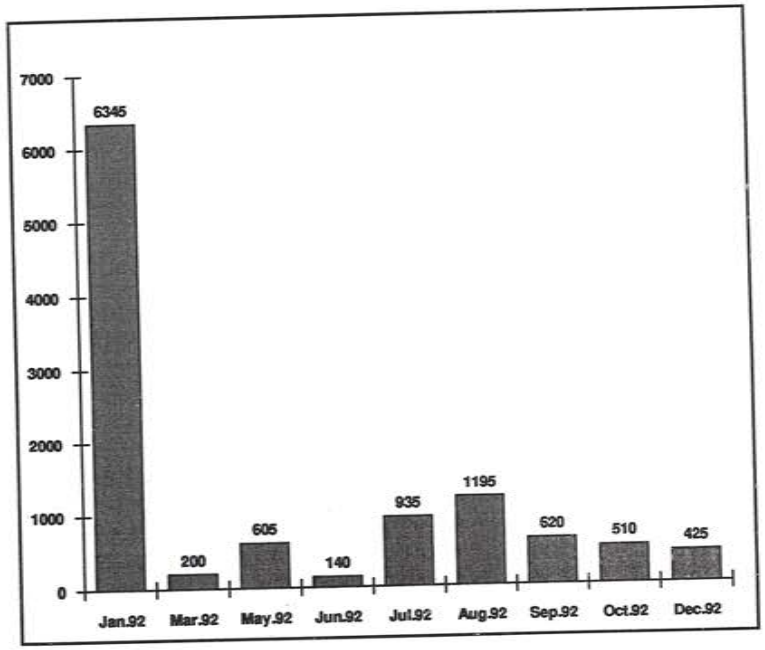

Figure 2. Measured indoor air concentrations ($\mu g/m^3$) of methylbenzene in the basement of building 4.

Table 2 clearly shows that the highest total concentrations have been measured in the basement of building 4. Figure 2 and 3 show the concentrations of methylbenzene and 3-methylpentane at the same place.

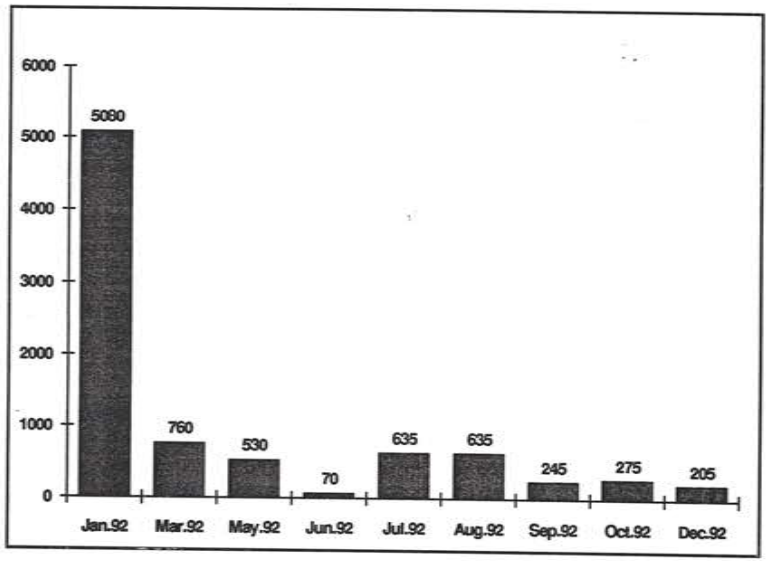

Figure 3. Measured indoor air concentrations ($\mu g/m^3$) of 3-methylpentane in the basement of building 4.

Measurements in outdoor air in the area showed that the total concentration of all the included components where 20 - 45 $\mu g/m^3$.

DISCUSSION

The measurements reported in this paper started in June 1991. Earlier measurements in April 1991 had indicated that the total concentrations of the included components in buildings 1, 2 and 3 were as high as about 10 000 $\mu g/m^3$. The concentrations in these three buildings had therefore presumably decreased substantially in the period between April and June 1991 when the total concentrations were lower than 800 $\mu g/m^3$. The reason for this may either be that the remediating steps that were taken in order to reduce the indoor air concentrations started to take effect in this time period or that the bulk of the gasoline had passed the buildings in June 1991. However, the measurements in building 4 indicate that the most plausible explanation is that the remediating steps took effect.

In building 4, which is the closest to the site of the leakage, measurements started in November 1991. The highest total concentration, 53 640 $\mu g/m^3$, where measured in January 1992, and this concentration was substantially higher than the concentration measured in November 1991. This indicates that a large quantity of gasoline was still present in the ground beneath

this building in the beginning of 1992. The total indoor air concentration in the basement of building 4 in the beginning of 1992 was considerably higher than what was to be expected when taken into account that this was 18 months after the spill occurred and that the distance between the building and the site of the spill was about 25 m. The reason for this may be geological conditions or the rather low precipitation rate in the area. The remediating steps taken and the movement of the gasoline have reduced the concentrations in the basement of building 4 during 1992.

Figure 2 and 3 show the measured concentrations of methylbenzene and 3-methylpentane in the basement of building 4. It can be seen that the two components varied very much in the same way with the highest concentrations occurring in January 1992. In January 1992, the concentration of benzene in the basement of building 4 was 4500 $\mu g/m^3$. The low concentrations in June 1992 were probably due to extensive ventilation in this period.

The reason for the differences between the measured concentrations in building 1, 2, 3, 5 and 6 was presumably differences in the geological conditions, but differences in air exchange rates in the buildings may also have contributed.

Moseley and Meyer (4) measured concentrations of organic components in the indoor air of an elementary school in USA. The ground beneath the school had been contaminated with petroleum. Before measurements were carried out, the school was completely closed and the ventilation system shut off. The total concentrations of hydrocarbons were 530 - ~2600 ppb in the classrooms. This corresponds to 2000 - 10 000 $\mu g/m^3$ (calculated as methylbenzene) which are in the same range as the measured total concentrations in the buildings in Alvdal in Norway.

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