

CASE REPORT

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Gas Residues of Engine Starting Fluid in Postmortem Sample from an Arsonist

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ABSTRACT: Diethyl ether was found in samples of the blood, urine, and lung from a fire victim. Because the lung also carried a number of low-boiling paraffins, it was inferred that the detected compounds came from engine starting fluid, which the victim apparently had been exposed to while he intentionally used it as an accelerant to start the fire. The reported death illustrates the value of searching post mortem samples for highly volatile residues of possible arson accelerants.

KEYWORDS: forensic science, criminalistics, arson, fire investigation, engine starting fluid, low-boiling accelerants, post mortem specimens, diethyl ether, paraffins, headspace, capillary gas chromatography, ion-trap detection

To reveal an arson where some highly volatile accelerant has been used is often difficult or impossible. The reason is that residues of such agents cannot be found in the ashes, unless they have been protected from evaporation during the fire. Organs and body fluids from a fire death may, then, provide the necessary evaporation shield, a circumstance that should favor the arson analysis of such a material. This was also shown in a study, in which certain highly volatile additives or components of gasoline were found in post mortem samples from victims of violent fires (1). In the present paper, I report on a combination of low-boiling organics that were found in the post mortem samples of a death, and that could explain the start of an explosion-like car fire.

Case Description

While driving his car in the near Stockholm, a motorist saw in the side mirror a bright flash of light and a vehicle suddenly run off the road. The car came to a full stop in a field after about 20 m. It was immediately engulfed in flames and soon totally destroyed in a violent fire. One of the few identifiable remains at the scene of the event was the body of a male. It was severely burnt: No clothing left, all soft tissues charred, the intestines exposed, both of the hands as well as the parietal bones burnt off, and no more than about half of the brain remained and then only as charred tissue.

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The deceased was later identified as a 38-year-old divorcee, who soon before the accident had stabbed his two children to death while he was baby-sitting in his ex-wife's home. Even though the circumstances of the car fire, thus, pointed to a suicide, the police wanted to exclude the possibility of an accidental fuel tank explosion, and to determine whether or not any accelerant had been used. As a result of the destruction of the car, this question could, however, not be answered by a conventional fire investigation of the ashes. The only site where possible accelerant residues might have survived the fire was the interior fluids or tissue of the body.

Experimental

Blood (1.5 mL), urine (1.5 mL), or lung tissue (2.40 g) were added to a 22.4 mL headspace vial containing 1.8 g of sodium chloride. The analysis was done by extracting the volatile organics from the sample with static headspace, separating the gaseous components with gas chromatography in a capillary column with an apolar stationary phase, and monitoring the compounds with mass spectrometry with an ion-trap detector run in the scan mode (2). The instruments and their settings used are shown in Table 1.

In the survey of the raw data using the Datamaster II program (version 1.3), Finnigan MAT, the analytes were first spotted after an unbiased search for unknown peaks in chromatograms reconstructed with each of the 213 ions monitored in the mass range 29 to 241 μ . Based on its mass spectrum and retention index, whose matches were searched in an on-line library, respectively in the literature, the compound generating an observed peak was next identified. The retention indices were calculated from the retention times of the analyte and of the hydrocarbons in the n-alkane series with three to 13 carbon atoms. All these procedures are described elsewhere in more detail (2). The identity of diethyl ether was further confirmed by comparing the retention time and mass spectrum (Fig. 1) of the analyte with the corresponding data of the reference substance.

To see whether or not lung tissue from victims of non arsons could contain diethyl ether or low-boiling paraffins, control samples from 13 deaths due to accidental fires without any chemicals involved and from 16 fatal intoxications of various types were randomly chosen from the laboratory's pool of routine investigations during the two-year-period 1994-1995. In a retrospect study of the data files, diethyl ether was searched for at m/z 59 and at the retention index 491-499, and the paraffins at m/z 57 in the retention index range 450-700.

TABLE 1—*Experimental Conditions.*

Headspace Extraction (Hewlett-Packard Model 19395A and 18906B)		Gas Chromatography (Hewlett-Packard Model 5890 and J&W Scientific DB-1)		Ion Trap Detection (Finnigan MAT Model ITD800)	
Equilibration temperature:	80°C	Capillary measures:	30 m by 0.25 mm (ID)	Sample introduction:	direct coupling
Equilibration time:	26 min	Coating:	1 μm of methylsiloxane	Transfer line temperature:	220°C
Valve/loop temperature:	85°C	Carrier gas flow rate:	18 mL/min of He	Ionization mode:	EI (50–80 eV)
Auxiliary gas pressure:	130 kPa	Column head pressure:	75 kPa	Multiplier voltage:	1700 V
Vial pressurization time:	15 s	Injector temperature:	120°C	Automatic gain control:	on
Sample loop volume:	1 mL	Oven temperature program:		Background mass ejected:	<29 μ
Sweep gas flow rate:	70 mL/min of He	Initial value:	40°C	Analytical scan rate:	0.5 s/scan
Injection mode:	split	Initial hold:	4 min	Microscans/analytical scan:	4
Vent/loop fill time:	1 s	Ramp to 200°C:	10°C/min	Acquisition time:	1.45–20 min
Injection time:	2 s	Ramp to 250°C:	≈50°C/min	Mass range examined:	29–241 μ

Results and Discussion

Among the organics detected in the lung and shown in Fig. 2, diethyl ether and 2-methylbutane boil at around 30°C, and most of the other hydrocarbons at less than 100°C. Yet 18 such compounds could clearly be seen and also identified, even though the matrix they were residing in probably had been exposed to very high temperatures during the fire. None of the controls of accidental fires or various intoxications contained diethyl ether nor low-boiling paraffins. From this study one may, thus, learn that post

mortem samples should not be overlooked as a test material in an arson analysis, particularly if an accelerant with low-boiling components is searched for.

Such compounds in post mortem samples have previously been used as arson indicators (1), i.e., methyl *tert*-butyl ether, an octane boosting additive in motor gasoline, and certain isoparaffins, which are constituents of the pollution-reducing fuel sometimes called "alkylate distillate." Both of these oil products are used by arsonists. The combination of agents shown in Fig. 2 points to another type of accelerant, i.e., engine starting fluid. This product is used

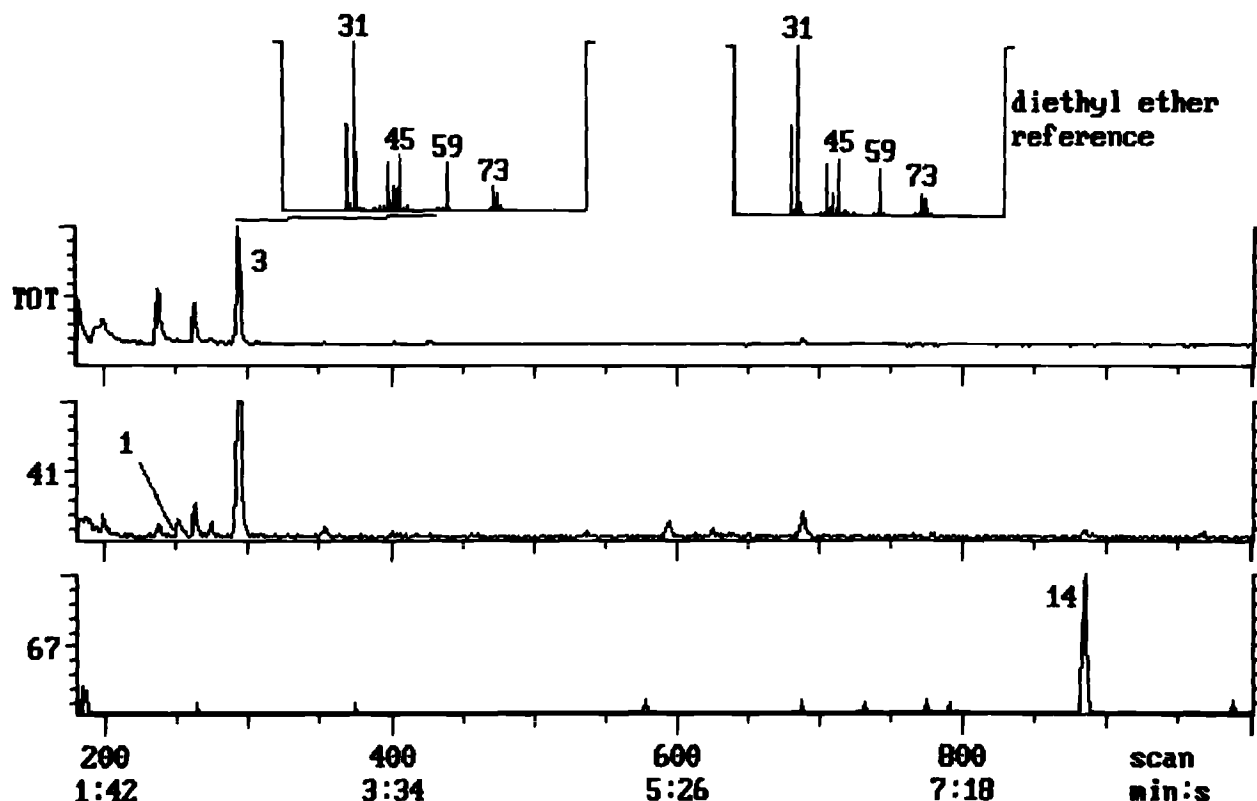


FIG. 1—Reconstructed mass chromatogram of volatile organics in the urine of a fire victim. The numbers on the x-axis indicate the retention time and those on the y-axis the mass numbers selected. Peaks: 1 (not detectable), 3 and 14 = legend of Fig. 2. The right mass spectrum phase was formed from the reference substance, diethyl ether, which appeared at the same retention time as peak 3.

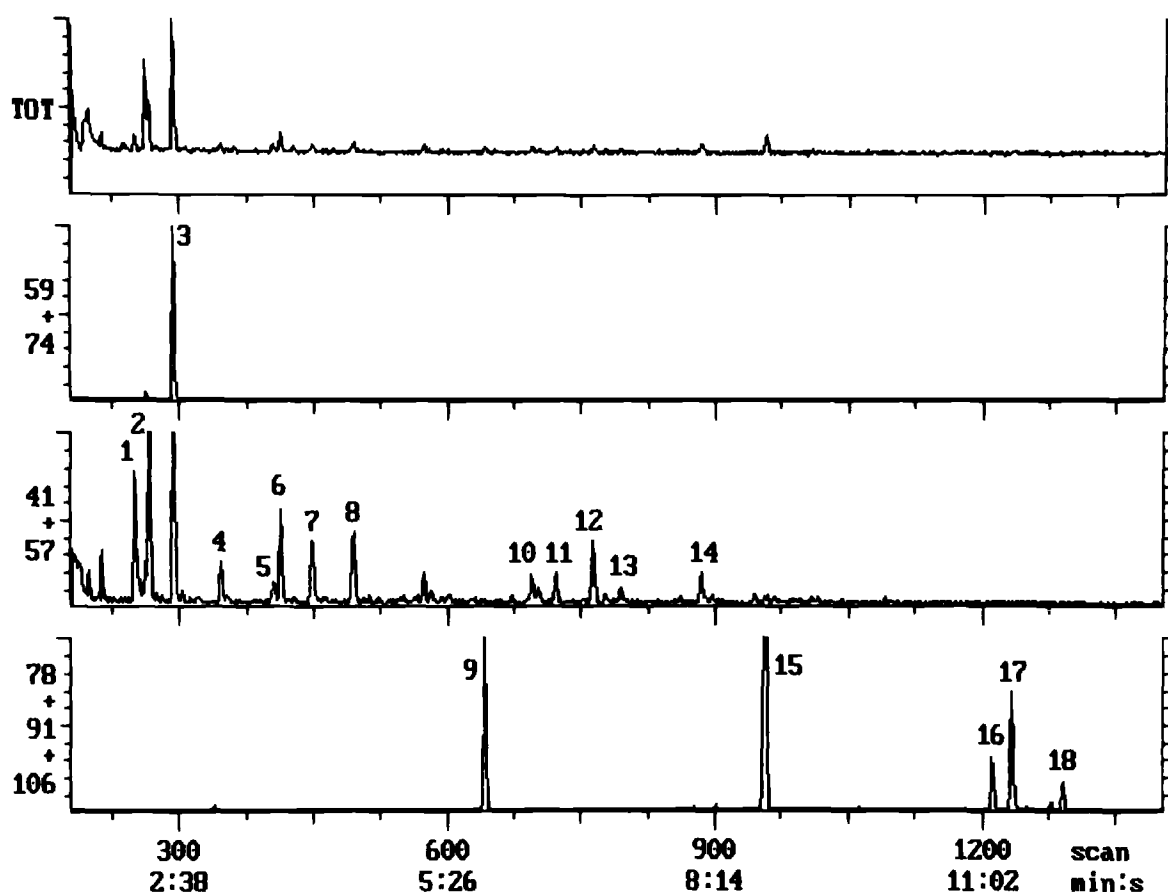


FIG. 2—Reconstructed mass chromatogram of volatile organics in the lung of a fire victim. The numbers on the x-axis indicate the retention time and those on the y-axis the combination of mass numbers selected. Peaks: 1 = acetonitrile, 2 = 2-methylbutane, 3 = diethyl ether, 4 = 2,2-dimethylbutane, 5 = 2,3-dimethylbutane, 6 = 2-methylpentane, 7 = 3-methylpentane, 8 = hexane, 9 = benzene, 10 = 2-methylhexane, 11 = 3-methylhexane, 12 = 2,2,4-trimethylpentane, 13 = heptane, 14 = pyrrole, 15 = toluene, 16 = ethylbenzene, 17 = *m-p*-xylene, and 18 = *o*-xylene.

for facilitating the start of a motor with ignition problems, and it is delivered in 300 mL pressurized aerosol spray cans with diethyl ether as the igniting compound and the hydrocarbons as the lubricants. Because the product is sold at most gas stations in Sweden, it is easily available. A search of post mortem samples for the combination of diethyl ether and low-boiling paraffins could, hence, assist a fire investigation.

The biological samples, like the fire debris outside the body, often contain residues of fire gases from pyrolyzed solid material, and some of these may even mimic an accelerant (1,3). An example of a likely pyrolysis product, spotted in the victim's lung (Fig. 2), was acetonitrile. That also diethyl ether (Fig. 2) was such a pyrolysis product inhaled by the victim during the fire seems, however, to be rather improbable. For, unlike acetonitrile, diethyl ether was present also in the blood and urine (Fig. 1). This suggests that some time must have elapsed between the ether exposure and the death for it to be found in the victim's body fluids. He probably discharged the can with the ether and inhaled it before the fire started. Whether the empty can, which never was found at the fire scene, was tossed before the volatiles were ignited or disintegrated during the event cannot be decided. Considering the intensity of the fire, the victim was certainly rapidly killed in the flames, and did not have time to breathe in any large amounts of fire gases. This was also indicated by the find of 0% of carbon monoxide bound hemoglobin and no detectable acetonitrile in the urine (Fig. 1). Because pyrrole, spotted in the lung (Fig. 2), should not be a

constituent in ignition fluid, one would expect it to come from pyrolyzed materials. Its presence also in the urine (Fig. 1) could, thus, challenge the hypothesis of a short exposure of the victim to fire gases before he died. Yet pyrrole was not detectable in the blood, and may, therefore, not have been inhaled. Perhaps it was formed post mortem during the fire from some endogenous compound, e.g., proline or proline containing proteins.

The variety of arson accelerants is abundant. Moreover, the body of a fire victim may contain a large number of unforeseen compounds, derived both from the fire gases he inhaled and from the substances formed after death due to the intense heat a body often is submitted to during the event. Arson analysis of the remains, thus, requires a sophisticated method with a high sensitivity and broad selectivity to make it apt for both spotting and identifying trace amounts of the volatile "general unknown." The combination of techniques (Table 1) used in the present work seems to meet these demands. By allowing a targeted extraction of the main bulk of volatile organics from the test material, direct headspace sampling in the presence of sodium chloride to decrease the partition coefficient favors the screening procedure. This is further helped by the ion-trap detector, which, unlike a "conventional" mass spectrometer, can be run in the scan mode and still offer nearly the same high sensitivity as when focused on a single selected ion. Even though a complete mass spectrum, thus, can be obtained, this evidence is often rather indiscriminate for trace amounts of low-molecular-mass compounds. The identification of

these may, therefore, be somewhat uncertain. The limited specificity was, however, compensated for by the use of retention indices as a complementary identification marker (2). To get access to retention index values in the literature for the maximum number of compounds, the separation was done in a capillary column with an apolar stationary phase (4). Of current methods reported in the literature for the determination of volatile organics in biological materials (5), the approach used in the present work seems to be the most suited one for arson analysis of body remains. It has also recently been further developed to allow quantification of fire gas residues in heterogenous samples (6), a circumstance that perhaps could raise the possibility of assessing the time course of a fire event.

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