

The complete verification procedure also includes a method for analysing various sample materials where no preliminary preparation of the samples is necessary. This technique is known as headspace gas chromatography and has not been described previously in connection with verification of alleged use of chemical warfare agents. The great advantage of this technique is that almost all kinds of sample materials may be used. Samples are collected in small glass vials, which are sealed with stoppers and transported to the laboratory for analysis. The vials can then be inserted directly into the headspace instrument where the sample is heated to generate a vapour concentration of any volatile chemical contaminant present in the sample. Finally, a gas sample is injected onto the gas chromatograph connected to the headspace instrument. This can be automated after the conditions for analysis have been decided. The probability of positive analysis by this technique will depend on the type of sample material and the chemical agent to be analysed, and optimal analytical conditions will have to be evaluated in each individual case. Optimal conditions for the heating block with regard to temperature and time are important factors in order to obtain a positive analysis by means of the headspace technique.

Laboratory experiments

Laboratory experiments have been carried out using the headspace technique to develop optimal analytical procedures for analysing the nerve agents tabun, sarin and soman, the blister agent mustard gas, and a production by-product of sarin, diisopropyl methylphosphonate. Analytical procedures have also been developed and tested for 10 different sample materials, including water, soil, sand, grass, neoprene, silicone, butyl rubber, paper, polyester/cotton fabric and polyurethane foam with activated charcoal.

Field trials

The headspace method was tested in two field exercises during the winter of 1988-1989 and the spring of 1989. The first exercise took place in February during a period when the temperature varied between 0 and +10°C, while the second was carried out in April-May with temperatures varying between +5 and +30°C. In both trials, samples were spiked with chemical warfare agents and placed outdoors in order to expose them to the prevailing weather conditions.

In the first exercise a limited number of samples were tested in order to get an idea of the usefulness of the technique. The sample materials used were water, soil, butyl rubber and polyester/cotton fabric. All samples were contaminated with 1 mg of each of the nerve agents sarin and soman. The samples were then left outdoors for exposure to the prevailing weather conditions. Samples were collected after 1, 2, 5, 7, 14 and 28 days and analysed in the laboratory by the headspace method. Such frequent intervals were chosen in order to get an idea of the deterioration rate of chemical agents in environmental samples.

In the second exercise the number of agents was increased to five and included tabun, sarin, soman, mustard gas, and diisopropyl methylphosphonate. Furthermore, the number of sample materials in the exercise was increased to 10, including water, soil, sand, grass, neoprene, silicone, butyl rubber,