METHIDATHION
(SUPRACIDE)

Method no.	PV2074
Matrix:	Air
Target Concentration:	0.02 ppm (0.25 mg/m³) (arbitrary). There is no OSHA permissible exposure level (PEL) or ACGIH threshold limit value (TLV) for methidathion.
Procedure:	Samples are collected by drawing known volumes of air through OSHA versatile sampler (OVS-2) tubes, containing a glass fiber filter and two sections of XAD-2 adsorbent. The samples are desorbed with an extracting/desorbing solution and analyzed by gas chromatography (GC) using an electron capture detector (ECD).
Recommended air volume and sampling rate:	60 L at 1.0 L/min
Detection limit of the overall procedure (based on the recommended air volume and the analytical detection limit):	17 µg/m³
Special precautions:	None
Status of method:	Partially validated method. This method is presented for information and trial use only.

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1. General Discussion

1.1 Background

1.1.1 History of procedure

This evaluation was undertaken because the OSHA Salt Lake Technical Center laboratory received samples requesting the analysis of methidathion. This report describes the analytical method developed for the sampling and the analysis of methidathion.

1.1.2 Toxic effects (This section is for information only and should not be taken as the basis of OSHA policy.)

Methidathion is a hydrazine derivative (thiadiazole).Hydrazine derivatives retain some of hydrazine's toxicity. This is the basis for perhaps the fastest growing use of hydrazine derivatives as pesticides in agriculture. Hundreds, perhaps thousands, of hydrazine derivatives have been suggested or patented for pesticidal applications. (Ref.5.1)

Methidathion is also an organophosphate (cholinesterase-inhibiting) insecticide and its toxicity is related to the organophosphate properties.

Symptoms of acute exposure

Symptoms of organophosphate poisoning include headache, giddiness, blurred vision, weakness, nausea, diarrhea, cramps, discomfort in the chest, nervousness, sweating, miosis (pinpoint), tearing, salivation, uncontrollable muscle twitches, convulsions, coma, and loss of reflexes and sphincter control. If swallowed and aspirated into lungs, chemical pneumonia can occur. (Ref. 5.2)

Chronic toxicity studies

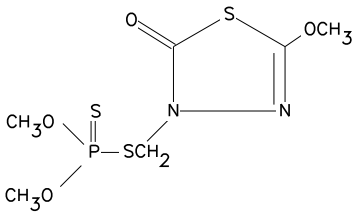
In long term feeding studies with mice, rats and dogs, high doses of Methidathion Technical caused hepatotoxic effects. In mice, lifetime feeding at high doses produced liver tumors. In a reproductive study with rats, cholinesterase inhibition caused impaired mating performance, decreased pup body weights and decreased pup viability at the highest dose level administered. Methidathion was not teratogenic in rats or rabbits, and various mutagenicity studies show that methidathion is not genotoxic. (Ref. 5.2)

1.1.3 Potential workplace exposure

Methidathion is an insecticide and acaricide. It is used to control alfalfa weevils and certain other insects in alfalfa, scales in citrus, spider mites, bollworms, budworms, lygus bug, pink bollworms, and whiteflies in cotton. It is also used on sunflower, artichokes, apples, almonds, cherries, apricots, pears, nectarines, plums, prunes, walnuts, peaches and pecans. (Ref. 5.3) There was no information available on the number of workers potentially exposed to methidathion.

1.1.4 Physical properties (Refs. 5.3 and 5.4 unless otherwise noted)

Chemical name: *O,O*-dimethyl phosphorodithioate, *S*-ester with 4-(mercaptomethyl)-2-methoxy-Δ^2-1,3,4-thiadiazolin-5-one; Phosphorodithioic acid *O,O*-dimethyl ester S-ester with 4-(mercaptomethyl)-2-methoxy-Δ^2-1,3,4-thiadiazolin-5-one; dithiophosphoric acid *O,O*'-dimethyl-S-[(2-methoxy-1,3,4-thiadiazol-5(4H)-on-4-yl)-methyl] ester; dithiophosphoric acid *O,O*'-dimethyl-S-[(5-methoxy-1,3,4-thiadiazol-2(3H)-one-3-yl)methyl] ester; *O,O*'-dimethyl-S-[(2-methoxy-1,3,4-thiadiazole-5(4H)-one-4-yl)methyl] dithiophosphate

Common name:	Methidathion
Synonyms:	Ultracide; Supracide; somonil; Fisons NC 2964; DMTP; ENT 27193
CAS number:	950-37-8
Molecular formula:	$C_6H_{11}N_2O_4PS_3$
Structural formula:	
Molecular weight:	302.31
Melting point:	39-40°C
Vapor pressure:	3.33×10^{-7} kPa (2.5×10^{-6} mmHg) at 25°C (technical)
Solubility:	Readily soluble in benzene, acetone, methanol, xylene and other organic solvents; solubility in water less than 1%
Description:	Colorless crystals
Stability:	Relatively stable to hydrolysis in neutral or slightly acidic media, less stable in more acidic (pH 1) or alkaline media (pH 13, 50% loss in 30 min @ 25°C.) (Ref. 5.5)

1.2 Limit defining parameters

1.2.1 The detection limit of the analytical procedure

The detection limit of the analytical procedure is 0.33 pg per injection. This takes into account a split ratio of 11 to 1. This is the amount of analyte which gives a peak whose height is approximately five times the baseline noise. Note: The p-chlorobiphenyl (ISTD) is off scale and the other peaks are part of the extracting/desorbing solution.

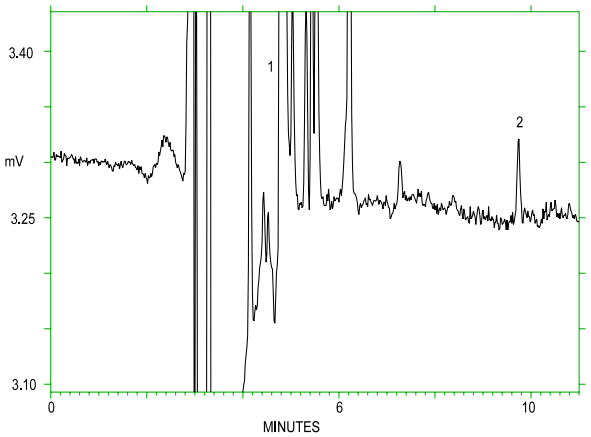


Figure 1.2.1. Chromatogram of the analytical detection limit. (Key: 1=*p*-chlorobiphenyl, 2=methidathion)

1.2.2 Detection limit of the overall procedure

The detection limit of the overall procedure is 1.0 ng per sample. This is the amount of analyte spiked on an OVS-2 tube that, upon analysis, produces a peak similar in size to that of the detection limit of the analytical procedure. See note in Section 1.2.1.

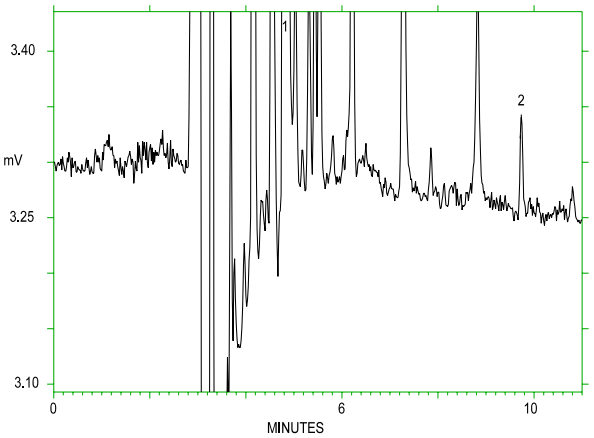


Figure 1.2.2. Chromatogram of the detection limit of the overall procedure. (Key: 1=*p*-chlorobiphenyl, 2=methidathion)

2. Sampling Procedure

2.1 Apparatus

2.1.1 Samples are collected using a personal sampling pump that can be calibrated within ± 5% of the recommended flow rate with the sampling device attached.

2.1.2 Samples are collected with OVS-2 tubes, which are specially made 13-mm o.d. glass tubes that are tapered to 6-mm o.d. Each tube is packed with a 140-mg backup section and a 270-mg sampling section of XAD-2 resin and a 13-mm diameter glass fiber filter. The backup section is retained by two foam plugs and the sampling section is between one foam plug and the glass fiber filter. The glass fiber filter is held in place next to the sampling section by a polytetrafluoroethylene (PTFE) retainer. These tubes are commercially available from SKC and Forest Biomedical.

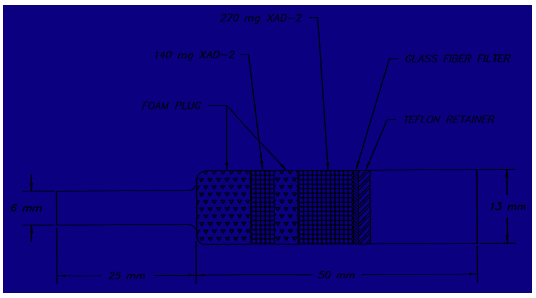


Diagram of an OVS-2 sampler.

2.2 Reagents

No sampling reagents are required.

2.3 Sampling technique

2.3.1 Attach the small tubing adapter of the sampling tube to the sampling pump with flexible, tubing such that the large, front section of the sampling tube is exposed directly to the atmosphere. Do not place any tubing in front of the sampler. The sampler should be attached vertically (large end down) in the worker's breathing zone in such a manner that it does not impede work performance.

2.3.2 After sampling for the appropriate time, remove the tube and reseal the tube with plastic end-caps. Wrap each sample end-to-end with an OSHA seal (Form 21).

2.3.3 Record the air volume for each sample and list any possible interferences.

2.3.4 Submit at least one blank for each set of samples. The blank is handled in the same manner as the samples except no air is drawn through it.

2.3.5 Submit bulk samples for analysis in a separate container from the air samples.

2.4 Combined extraction/desorption efficiency

Each equivalent sampling section (the glass fiber filter (GFF) and the 270-mg resin of XAD-2) from eighteen OVS-2 tubes was transferred to a 7-mL vial. Three groups of six sampling sections were each liquid spiked (GFF) with 3 µL, 16 µL, and 33 µL of a 0.4566 µg/µL solution of methidathion. This represent 0.1, 0.5, and 1 times the target concentration respectively. All of these samples were sealed with silicon rubber-lined caps and allowed to equilibrate overnight on a table at room temperature. The next day the samples were analyzed as per Section 3.0. The results are listed in Tables 2.4.1, 2.4.2, and 2.4.3. The average results in Tables 2.4.1, 2.4.2, and 2.4.3 are 0.990, 1.006, and 0.990 respectively.

Table 2.4.1
Desorption Efficiency of Methidathion
at 0.1× Target Concentration

sample i.d.	µg spiked	µg recovered	recovery (decimal)
1	1.370	1.353	0.988
2	1.370	1.389	1.014
3	1.370	1.383	1.010
4	1.370	1.347	0.983
5	1.370	1.308	0.955
6	1.370	1.356	0.990

Table 2.4.2
Desorption Efficiency of Methidathion
at 0.5× the Target Concentration

sample i.d.	µg spiked	µg recovered	recovery (decimal)
7	7.306	7.221	0.988
8	7.306	7.269	0.995
9	7.306	7.362	1.008
10	7.306	7.434	1.018
11	7.306	7.335	1.004
12	7.306	7.464	1.022

Table 2.4.3
Desorption Efficiency of Methidathion
at 1× the Target Concentration

sample i.d.	µg spiked	µg recovered	recovery (decimal)
13	15.07	14.77	0.980
14	15.07	14.83	0.984
15	15.07	14.90	0.989
16	15.07	14.97	0.993
17	15.07	14.98	0.994
18	15.07	15.05	0.999

2.5 Retention efficiency

To test the ability of the sampler to retain the analyte, four samplers were each liquid spiked with 50 µL of a 1.2507 µg/µL solution of methidathion. All tubes were sealed with end-caps and allowed to equilibrate overnight on a table at room temperature. The next day 120 L of humid air (≈82% relative humidity) were drawn through each of the sample tubes @ 1 L/min. The samples were analyzed as per section 3.0. The results are listed in Table 2.5. The average retention efficiency from the four samplers was 0.967. Two reference sections of the sampling tubes contained less than 1.0% of the analyte while the remaining reference sections had nothing in them. The amounts found on the reference section were added to the corresponding sampling results.

Table 2.5
Retention Study of Methidathion
at 4.17× Target Concentration

sample i.d.	µg spiked	µg recovered	recovery (decimal)
RS-1	62.534	58.806	0.940
RS-2	62.534	60.738	0.971
RS-3	62.534	60.741	0.971
RS-4	62.534	61.590	0.985

2.6 Sample storage

The storage samples were generated by liquid spiking each of twenty four OVS-2 tubes with 12 µL of a 1.2507 µg/µL solution of methidathion. All tubes were sealed with end-caps and allowed to equilibrate overnight on a table at room temperature. The next day 60 L of humid air (≈83% relative humidity) were drawn through each of the sample tubes @ 1 L/min. The storage test samples were

then stored in a freezer (- 5.0°C), after which six samples at a time were analyzed as per section 3.0. The results are listed in Table 2.6. The average recovery for the storage study was 0.989. One reference section from the seventh day sampling tubes contained 3.6% of the analyte while fifteen other reference sections contained less than 1.0% of the analyte and the eight remaining reference sections had nothing in them. The amounts found on the reference section were added to the corresponding sampling results.

Table 2.6
Storage Test of Methidathion
at the Target Concentration

Days of Storage	Recovery						Average Recovery
7	0.987	0.976	0.996	0.997	1.021	0.999	0.996
14	0.932	0.937	0.963	1.002	1.003	1.002	0.973
21	0.955	0.983	0.958	1.000	1.012	1.029	0.990
33	0.936	0.962	0.962	1.018	1.038	1.059	0.996

2.7 Recommended air volume and sampling rate

2.7.1 The recommended air volume is 60 L.

2.7.2 The recommended flow rate is 1.0 L/min.

2.8 Interferences (sampling)

It is not known if any compounds will interfere with the collection of methidathion. Any suspected interferences should be reported to the laboratory.

2.9 Safety precautions (sampling)

2.9.1 Attach the sampling equipment in such a manner that it will not interfere with work performance or employee safety.

2.9.2 Follow all safety practices that apply to the work area being sampled.

3. Analytical Procedure

3.1 Apparatus

3.1.1 A balance capable of weighing to the nearest hundredth of a milligram. A Mettler AE240 balance was used in this evaluation to prepare the concentrated standards.

3.1.2 Volumetric flasks, pipets, and syringes of various convenient sizes for preparing standards, making dilutions and making injections.

3.1.3 Glass vials, 7-mL with silicone rubber-lined caps.

3.1.4 Glass vials, 2-mL with polytetrafluoroethylene(PTFE)-lined septa.

3.1.5 A Hewlett Packard (HP) 5890 GC equipped with an autosampler and ECD detector was used in this evaluation.

3.1.6 A GC column capable of separating methidathion from any interferences. An SPB™-1 60-m × 0.32-i.d., with 1.0 µm film thickness was used in this evaluation.

3.1.7 An electronic integrator, or some other suitable means for measuring detector response. The Waters 860 Data System was used in this evaluation.

3.2 Reagents

3.2.1 HPLC grade toluene. The solvent used in this evaluation was Optima® grade, obtained from Fisher Scientific, Inc.

3.2.2 Methidathion. Methidathion was obtained from EPA (6340) with a purity of 99.26%.

3.2.3 *p*-Chlorobiphenyl was obtained from ICN. This was used as the internal standard (ISTD) in the extracting/desorbing solution. The solution is prepared by adding 30 mg of *p*-chlorobiphenyl to 1 L of toluene.

3.3 Standard preparation

3.3.1 Prepare stock standards by adding toluene to preweighed amount of methidathion. Include the percent purity in the calculation.

3.3.2 Prepare analytical standard by injecting microliter amounts of diluted methidathion stock standard into vials containing 3.0 mL of extracting/desorbing solution. Correct the concentration for volume differences.

3.4 Sample preparation

3.4.1 Transfer each section of the sample to a separate 7-mL vial. Place the front GFF in the vial with the front section of the OVS-2 resin tube. Place the middle foam plug together with the reference section of the OVS-2 resin tube in a separate vial.

3.4.2 Add 3.0 mL of extracting/desorbing solution to each vial and seal with a silicone rubber-lined cap.

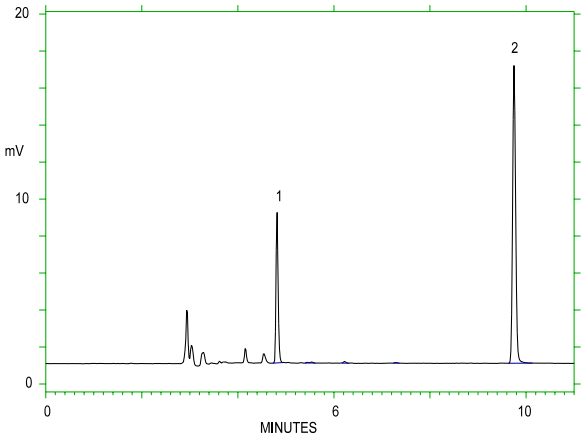
3.4.3 Allow the samples to extract/desorb for 30 minutes. Shake the vials on a mechanical shaker during the desorption time.

3.4.4 If necessary, transfer the samples to 2-mL vials for use on an HP autosampler, and seal with PTFE-lined septa.

3.5 Analysis

3.5.1 Instrument conditions

Column: SPB™-1 60-m × 0.32-i.d., 1.0 µm df
Head pressure: 15 psi
Carrier gas: 2.00 mL/min (hydrogen)
Injection split: 11 to 1
Zone temperatures: 260 °C (column)
280 °C (injector)
300 °C (detector)
Injection volume: 1.0 µL
Retention time: 4.1 min (ISTD); 9.750 min (analyte)
Chromatogram:



Chromatogram at the target concentration. (Key: 1=*p*-chlorobiphenyl, 2=methidathion)

3.6 Interferences (analytical)

3.6.1 Any collected compound having a retention time similar to that of the analyte is a potential interference.

3.6.2 GC conditions may generally be varied to circumvent interferences.

3.6.3 Retention time on a single column is not proof of chemical identity. Analyte identity should be confirmed by mass spectrometry.

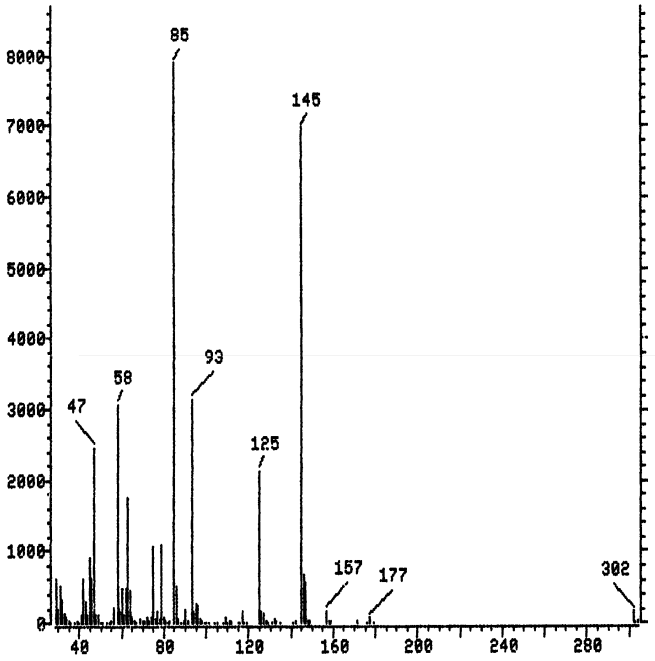


Figure 3.6.3. Mass spectrum of methidathion. (Ref. 5.6.)

3.7 Calculations

3.7.1 Construct a calibration curve by plotting detector response versus concentration (µg/mL) of methidathion.

3.7.2 Determine the µg/mL of methidathion in each section of the samples and blank from the calibration curve.

3.7.3 Blank correct each sample by subtracting the µg/mL found in each section of the blank from the µg/mL found in the corresponding sections of the samples and then add the results together for the total µg/mL for each sample.

3.7.4 Determine the air concentration by using the following formulae.

$$mg/m^3 = \frac{(\mu g/mL,\ blank\ corrected)(extraction\ volume,\ mL)}{(air\ volume,\ L)(extraction\ efficiency,\ decimal)}$$

$$ppm = \frac{(mg/m^3)(24.46)}{302.31}$$

where: 24.46 = molar volume (liters) at 101.3 kPa (760 mmHg) and 25°C
302.31 = molecular weight of methidathion

3.8 Safety precautions (analytical)

3.8.1 Avoid skin contact and air exposure to methidathion.

3.8.2 Avoid skin contact with all solvents.

3.8.3 Wear safety glasses at all times in the laboratory.

4. Recommendation for Further Study

4.1 If possible, select a better internal standard that comes out after the analyte.

4.2 A room temperature storage study needs to be done..

4.3 The stability of the analyte should be tested under conditions that may cause hydrolysis. These products of hydrolysis should be determined as well as their ability to be quantitatively analyzed.

4.4 This method needs to be fully validated.

5. References

5.1 Schiessel, Henry W. in "Kirk-Othmer Encyclopedia of Technology" 3rd ed.; Grayson, M. Ed.; John Wiley & Sons, New York, 1980, Vol. 12, p 763-764.

5.2 CIBA-GEIGY Corporation: Material Safety Data Sheets (MSDS) for Superacide 2E, June 10, 1991.

5.3 Meister, R.T., Ed. "Farm Chemical Handbook '89", 75th ed.; Meister Publishing: Willoughby, OH, 1989

5.4 Windholz M., Ed. "Merck Index", 10th ed.; Merck and Co.: Rahway, NJ, 1989, p 942.

5.5 OSHA Computerized Information System Database, Hazardous Substances Data Base (HS) Supracide, Revision Date 05/16/85, OSHA SLTC, Salt Lake City, UT.

5.6 EPA/NIH Mass Spectral Data Base, Supplement 1, 1980 p 4823.