

TECHNICAL PERMETHRIN

Full specification WHO/SIT/28.R1
Revised 10 December 1999

1. Specification

1.1 Description

The material shall consist of a mixture of the 1RS, 3RS (cis) and 1RS, 3SR (trans) diastereoisomers of 3 - phenoxybenzyl - 3 (2,2- dichlorovinyl) - 2,2 - dimethyl-cyclopropanecarboxylate in a nominal 1RS, 3RS/1RS, 3SR (cis/trans) ratio within the range 25:75 - 40:60. It shall be in the form of a yellow-to-brown solid of low melting-point or a liquid, free from visible extraneous matter or added modifying agents.

1.2 Chemical and physical requirements

The material, sampled from any part of the consignment (see method WHO/M/1.R1), shall comply with the requirements of section 1.1 and with the following requirements.

1.2.1 *Total permethrin content (g/kg basis)*

The total permethrin content shall be declared (not less than 900 g/kg) and, when determined by the method described in section 2.1, the mean measured content not be lower than declared content.

1.2.2 *1RS,3RS/1RS,3SR isomer ratio*

The 1RS,3RS/1RS,3SR (cis/trans) isomer ratio shall be declared, and determined by the method described in section 2.1

For a declared ratio above and up to 40/60, the permitted tolerance shall be $\pm 10\%$.

1.2.3 *Acidity*

The acidity as determined by the CIPAC method MT 31 (CIPAC Handbook F, p.96), shall not be higher than 1.5 g/kg, calculated as H₂SO₄.

1.2.4 *Material insoluble in acetone*

The material, insoluble in acetone as determined by the CIPAC method MT 27 (CIPAC Handbook F, p.88), shall not be higher than 1 g/kg.

1.2.5 *Water content*

The water content, determined by the method described in WHO/M/7.R1, shall not be higher than 1 g/kg.

1.3 **Packing and marking of packages**

The technical permethrin shall be packed in suitable clean containers, as specified in the order.

All packages shall bear, durably and legibly marked on the container the following:

Manufacturer's name
Technical permethrin
Actual 1RS,3RS/1RS,3SR (cis/trans) isomer ratio of the batch
Batch or reference number, and date of test
Net weight of contents
Date of manufacture

and the following minimum cautionary notice:

Permethrin is a pyrethroid that acts predominantly on the central nervous system; high dosages have been found to lead to tonic seizures in experimental animals. A high concentration in air may be an irritant to eyes, skin and mucous membranes. It may be hazardous if swallowed. Avoid skin contact; wear protective gloves, clean protective clothing and a face-mask when handling the material. Wash hands and exposed skin thoroughly after handling.

Keep containers out of the reach of children and well away from foodstuffs and animal feed and their containers.

Permethrin is toxic to aquatic wildlife. Avoid accidental contamination of water.

If poisoning occurs, call a physician. Treatment is symptomatic.

2. **Methods of determining chemical and physical properties**

2.1 **Permethrin content**

2.1.1 *Outline of method*

The sample is dissolved in 4-methylpentan-2-one containing n-octacosane as internal standard. Separation is carried out by gas-liquid chromatography on a column of Chromosorb W-HP coated with silicone OV 210. The permethrin, isolated as two isomer peaks, is determined by comparison with calibration solutions.

2.1.2 *Apparatus*

1. *Gas-liquid chromatograph.* Capable of operating over the range 100 to 300⁰C, fitted with a flame ionization detector, injection port heater and on-column injection system and equipped with a suitable recorder or electronic integrator.
2. *Chromatographic column.* Glass column 1 m long, 4 mm internal diameter packed with 3% silicone OV 210 on Chromosorb W-HP (100-120 mesh), or equivalent.

Before use condition a freshly prepared column by purging with nitrogen overnight at about 275⁰C. During this operation the column must not be connected to the detector to avoid contamination by any initial "bleed" of the stationary phase.

2.1.3 Reagents

Permethrin working standard. Analytical grade of known purity, with a ratio of cis- to trans-isomer content, preferably similar to that of the sample being analyzed¹.

4-Methylpentan-2-one (methyl isobutyl ketone; MIBK).

Internal standard, n-octacosane. Select for use a batch which, when chromatographed under the conditions given below for the determination of permethrin, gives no peak with a similar retention time to either of the cis- or trans-isomer peaks.

2.1.4 Preparation of standard solutions

Internal standard solution. Dissolve 1 g n-octacosane in 1 litre MIBK. As the reagent dissolves slowly in the solvent, it may be necessary to use an ultrasonic bath or to warm the solution. (Before use, allow the solution to return to room temperature).

Permethrin calibration solution. Crystallization may occur at ambient temperature, so the analytical standard must be homogenized before use. Warm the bottle at between 40 and 50⁰C until no crystals remain and then shake thoroughly. Weigh in duplicate (to the nearest 0.1 mg) about 0.1 g (M_A and M_B g) of homogeneous standard into separate 100 mL conical flasks. Add 25.0 mL of n-octacosane internal standard solution and shake to dissolve the permethrin. (Solutions C_A and C_B). Prepare a solution of about 0.1 g of homogeneous standard in 25 mL of solvent MIBK (solution C_O).

2.1.5 Operating conditions for gas-liquid chromatography

¹ Certified standards of cis-permethrin (purity 99.1% m/m) and trans-permethrin (purity 99.5% m/m) are available from the Office of Reference Materials, National Physical Laboratory, Department of Trade and Industry, Teddington, Middlesex, TW11 OLW, United Kingdom, or any other sources of reference standards. These materials should be used to calibrate the working standard.

The conditions given below are typical values and may have to be adjusted to obtain optimum results from a given apparatus.

Temperatures

Oven	Use any set temperature between 190-220 ⁰ C and control to $\pm 0.5^0$ C throughout the analyses.
Injection port	260 ⁰ C
Detector	250 ⁰ C

Gas flow rates

Hydrogen and air	Optimally set up as recommended for the detector by the manufacturer.
Carrier gas:	nitrogen (oxygen - free, i.e. containing less than 10 mg/L 50 mL.min ⁻¹).

Approximate retention times

Permethrin <u>cis</u> -isomer peak	7.9 min
Permethrin <u>trans</u> -isomer peak	9.3 min
Internal standard peak	4.2 min

2.1.6 *Sample preparation*

Sampling. Homogenize the bulk material by heating to about 50⁰C and mixing thoroughly until no crystals remain before taking at least about 25g as a sub-sample for analysis.

Preparation of the sample solutions. Homogenize the material by the method given here above for sampling.

Weigh (to the nearest 0.1 mg) in duplicate sufficient sample (w g) to contain 0.1 g of permethrin into 100 mL conical flasks. Add to each flask 25.0 mL of n-octacosane internal standard solution from the same pipette as used to prepare the permethrin calibration solution and shake the flasks thoroughly to dissolve the permethrin (Solutions S_A and S_B). Prepare a solution without internal standard by dissolving about 0.1 g of permethrin in 25 mL of solvent MIBK (solution S_O).

2.1.7 *Equilibration of the system*

Inject at least 3 x 1.5 μ L of one of the permethrin calibration solution C to equilibrate the system and use the data from these chromatograms to set the integrator parameters if one is being used and also to assess the stability of the system.

Inject 1.5 μ L portions of the internal standard solution, and C_O and S_O solutions and check whether there are any interfering peaks from impurities. If there are, make any necessary corrections.

2.1.8 Analysis of sample

Carry out injections of 1.5 μ L of the permethrin calibration solutions C_A and C_B and sample solutions S_A and S_B in the following sequence and record either the integrated areas of the peaks or measure by triangulation from the product of $EL \times JK^2$ (height \times base).

Injection sequence: $C_{A1}, S_{A1}, S_{A2}, C_{B1}, C_{A2}, S_{B1}, S_{B2}, C_{B2}$.

Calculate the relative response factors (f_1, f_2 , etc.) for the pair of permethrin calibration injections which bracket the sample injections, e.g. use C_{A1} and C_{B1} for sample injection S_{A1}, S_{A2} etc., and obtain the mean response factor f

$$\text{Relative response factor} = \frac{H_s}{I_r \times M \times P}$$

Where H_s = Total area of the permethrin cis-isomer and trans-isomer peaks from the permethrin calibration solution.

I_r = Area of n-octacosane peak of the permethrin calibration solution.

M = Mass of permethrin analytical standard in the permethrin calibration solution(g).

P = Purity of the permethrin analytical standard (g/kg).

The mass of internal standard is common to both permethrin calibration and sample solution and has therefore been omitted.

Successive measurements of the response factors should agree to within $\pm 0.5\%$ of their mean value. If not repeat the analysis.

2.1.9 Calculation

Calculate the permethrin content for each sample injection, e.g. S_{A1} , by the following equation:

$$\text{Total permethrin content (g/kg)} = \frac{H_m}{f \times I_q \times \underline{w}}$$

² If triangulation is used as a method of measurement of peak areas, it is essential that the peaks from the permethrin and the n-octacosane in the "calibration" and in the "sample chromatogram" should be of similar height. The recorder chart speed (25 mm/min), attenuation and sample size should be initially adjusted so that the peak heights are about 3/4 of the chart width and not less than 180 mm. The distance between the intercepts of the tangents on the base-line should be not less than 30 mm. The base-line should be parallel to, or coincide with, the electrical base-line.

Where f = mean relative response factor.
 H_m = area (X) of the permethrin cis-isomer + area (Y) of the trans-isomer peaks in the sample solution.
 I_q = areas of the n-octacosane peak, in the sample solution
 w = mass of sample (g).

The cis-isomer: trans-isomer ratio is X/Y.

Where X is the area of the permethrin cis-isomer peak in the sample solution.
Y is the area of the permethrin trans-isomer peak in the sample solution.

Take the mean of the four values corresponding to the four injections S_{A1} , S_{A2} , S_{B1} , S_{B2} .

Calculate the total permethrin content of the sample as the mean of the four determinations as follows:

Sample injection	Use relative response factor from	Permethrin
S_{A1}	C_{A1} and C_{B1}	Q%] U%
S_{A2}	C_{A1} and C_{B1}	R%]
S_{B1}	C_{A2} and C_{B2}	S%] V%
S_{B2}	C_{A2} and C_{B2}	T%]

Q and R, S and T should agree to within $\pm 0.5\%$ of their respective mean values (U and V). U and V should agree to within $\pm 1\%$ of their mean value. Take the mean of the two values U and V as the total permethrin content.

PERMETHRIN

EMULSIFIABLE CONCENTRATE

Full specification WHO/SIF/50.R1
Revised 10 December 1999

1. Specification

1.1 Description

The material shall consist of technical permethrin, complying with the requirements of WHO specification WHO/SIT/28.R1, dissolved in suitable solvents, together with other necessary formulants. It shall be in the form of a stable homogeneous liquid free from visible suspended matter and sediment to be applied as an emulsion after dilution in water.

1.2 Chemical and physical requirements

The material, sampled from any part of the consignment (see method WHO/M/1.R1), shall comply with the requirements of section 1.1 and with the following requirements.

1.2.1 Total permethrin content (g/kg basis)

The total permethrin content, determined by the method described in section 2.1, shall not differ from the declared content by more than the following amounts:

<i>Declared content</i>	<i>Tolerance permitted</i>
Above 25 up to 100 g/kg	$\pm 10\%$ of the declared content
Above 100 up to 250 g/kg	$\pm 6\%$ of the declared content
Above 250 up to 500 g/kg	$\pm 5\%$ of the declared content

Higher declared contents are not currently available. The average content of all samples taken shall not be lower than the declared content.

1.2.2 1RS,3Rs/1Rs,3SR isomer ratio

The 1RS,3Rs/1Rs,3SR (cis/trans) isomer ratio shall be declared and determined by the method described in section 2.1.

For a declared actual ratio up to 40/60 the permitted tolerance shall be $\pm 15\%$, and for a declared ratio above 40/60, the permitted tolerance shall be $\pm 10\%$.

1.2.3 *Water content*

The water content, determined by the method WHO/M/7.R1 shall not be higher than 3 g/kg.

1.2.4 *Acidity*

The acidity as determined by the CIPAC method MT 31 (CIPAC Handbook F, p.96), shall not be higher than 1.5 g/kg, calculated as H₂SO₄.

1.2.5 *Cold test*

No separation of solid or oily material shall occur when the concentrate is tested as described in CIPAC method MT 39 (CIPAC Handbook F, p.128).

1.2.6 *Flash point*

The flashpoint of the product, determined by the CIPAC method MT 12 (CIPAC Handbook F, p.31) shall not be lower than 38⁰C and shall comply with all national and/or international transport regulations.

1.2.7 *Stability of the emulsion*

In WHO standard soft water. Any separation, including creaming/oiling at the top and oiling/sedimentation at the bottom, of 100 mL of emulsion prepared in WHO standard soft water (WHO/M/29) with 5 mL of concentrate shall not exceed 2 mL when tested as described in WHO/M/13.R4.

In WHO standard hard water. Any separation including creaming/oiling at the top and oiling/sedimentation at the bottom, of 100 mL of emulsion prepared in WHO standard hard water (WHO/M/29) with 5 mL of concentrate shall not exceed 2 mL when tested as described in WHO/M/13.R4.

1.2.8 *Persistent foam*

In WHO standard soft water: When tested by the CIPAC method MT 47.2 (CIPAC Handbook F, p.152) a maximum of 60 mL of foam shall be observed after 1 minute.

1.2.9 *Heat stability*

The concentrate, after treatment as described in section 2.3, shall comply with the requirements of sections 1.2.1, 1.2.4 and 1.2.7 of this specification.

1.3 Packing and marking of packages

The permethrin emulsifiable concentrate shall be packed in suitable clean containers, as specified in the order.

All packages shall bear, durably and legibly marked on the container the following:

Manufacturer's name
Permethrin emulsifiable concentrate
Permethrin ... g/kg
Actual 1RS,3RS/1RS,3SR (cis/trans) isomer ratio of the batch
Batch or reference number, and date of test
Net weight of contents
Date of manufacture
Instruction for use

and the following minimum cautionary notice:

Permethrin is a pyrethroid that acts predominantly on the central nervous system; high dosages have been found to lead to tonic seizures in experimental animals. A high concentration in air may be an irritant to eyes, skin and mucous membranes. It may be hazardous if swallowed. Do not inhale spray mist. Avoid skin contact; wear protective gloves, clean protective clothing and a face-mask when handling this concentrate. Wash hands and exposed skin thoroughly after handling.

Keep containers out of the reach of children and well away from foodstuffs and animal feed and their containers.

Permethrin is toxic to aquatic wildlife. Avoid accidental contamination of water. If poisoning occurs, call a physician. Treatment is symptomatic.

2. Methods of determining chemical and physical properties

2.1 Permethrin content

2.1.1 *Outline of method*

The sample is diluted with 4-methylpentan-2-one containing n-octacosane as internal standard. Separation is carried out by gas-liquid chromatography on a column of Chromosorb W-HP coated with silicone OV 210. The permethrin, isolated as two isomer peaks, is determined by comparison with calibration solutions.

2.1.2 *Apparatus*

1. *Gas-liquid chromatograph.* Capable of operating over the range 100 to 300⁰C, fitted with a flame ionization detector, injection port heater and on-column injection system and equipped with a suitable recorder or electronic integrator.
2. *Chromatographic column.* Glass column 1 m long, 4 mm internal diameter packed with 3% silicone OV 210 on Chromosorb W-HP (100-120 mesh), or equivalent.

Before use condition a freshly prepared column by purging with nitrogen overnight at about 275⁰C. During this operation the column must not be

connected to the detector to avoid contamination by any initial "bleed" of the stationary phase.

2.1.3 Reagents

Permethrin working standard. Analytical grade of known purity with a ratio of cis- to trans-isomer content, preferably similar to that of the sample being analyzed¹.

4-Methylpentan-2-one (methyl isobutyl ketone; MIBK).

Internal standard, n-octacosane. Select for use a batch which, when chromatographed under the conditions given below for the determination of permethrin, gives no peak with a similar retention time to either of the cis- or trans-isomer peaks.

2.1.4 Preparation of standard solutions

Internal standard solution. Dissolve 1 g *n*-octacosane in 1 litre MIBK. As the reagent dissolves slowly in the solvent, it may be necessary to use an ultrasonic bath or to warm the solution. (Before use, allow the solution to return to room temperature).

Permethrin calibration solution. Crystallization may occur at ambient temperature, so the analytical standard must be homogenized before use. Warm the bottle at between 40 and 50°C until no crystals remain and then shake thoroughly. Weigh in duplicate (to the nearest 0.1 mg) about 0.1 g (M_A and M_B g) of homogeneous standard into separate 100 mL conical flasks. Add 25.0 mL of *n*-octacosane internal standard solution and shake to dissolve the permethrin. (Solutions C_A and C_B). Prepare a solution of about 0.1 g of homogeneous standard in 25 mL of solvent MIBK (solution C_O).

2.1.5 Operating conditions for gas-liquid chromatography

The conditions given below are typical values and may have to be adjusted to obtain optimum results from a given apparatus.

Temperatures

Oven	Use any set temperature between 190-220°C and control to $\pm 0.5^\circ\text{C}$ throughout the analyses.
Injection port	260°C
Detector	250°C

¹ Certified standards of cis-permethrin (purity 99.1% m/m) and trans-permethrin (purity 99.5% m/m) are available from the Office of Reference Materials, National Physical Laboratory, Department of Trade and Industry, Teddington, Middlesex, TW11 OLW, United Kingdom, or any other sources of reference standards. These materials should be used to calibrate the working standard.

Gas flow rates

Hydrogen and air	Optimally set up as recommended for the detector by the manufacturer.
Carrier gas:	nitrogen (oxygen - free, i.e. containing less than 10 mg/l: 50 mL.min ⁻¹).

Approximate retention times

Permethrin <u>cis</u> -isomer peak	7.9 min
Permethrin <u>trans</u> -isomer peak	9.3 min
Internal standard peak	4.2 min

2.1.6 Sample preparation

Sampling. Homogenize the bulk material by heating to about 50°C and mixing thoroughly until no crystals remain before taking at least 25g as a sub-sample for analysis.

Preparation of the sample solutions. Homogenize the material by the method given here above for sampling.

Weigh (to the nearest 0.1 mg) in duplicate sufficient sample (w g) to contain 0.1 g of permethrin into 100 mL conical flasks. Add to each flask 25.0 mL of n-octacosane internal standard solution from the same pipette as used to prepare the permethrin calibration solution and shake the flasks thoroughly to dissolve the permethrin. (Solutions S_A and S_B). Prepare a solution without internal standard by dissolving about 0.1 g of permethrin in 25 mL of solvent MIBK (solution S_O).

2.1.7 Equilibration of the system

Inject at least 3 x 1.5 µL of one of the permethrin calibration solution C to equilibrate the system and use the data from these chromatograms to set the integrator parameters if one is being used and also to assess the stability of the system.

Inject 1.5 µL portions of the internal standard solution, and C_O and S_O solutions and check whether there are any interfering peaks from impurities. If there are, make any necessary corrections.

2.1.8 Analysis of sample

Carry out injections of 1.5 µL of the permethrin calibration solutions C_A and C_B and sample solutions S_A and S_B in the following sequence and record either the integrated areas of the peaks or measure by triangulation from the product of EL x JK² (height x base).

² If triangulation is used as a method of measurement of peak areas, it is essential that the peaks from the permethrin and the n-octacosane in the "calibration" and in the "sample chromatogram" should be of similar height. The

Injection sequence: C_{A1}, S_{A1}, S_{A2}, C_{B1}, C_{A2}, S_{B1}, S_{B2}, C_{B2}.

Calculate the relative response factors (f₁, f₂, etc.) for the pair of permethrin calibration injections which bracket the sample injections, e.g. use C_{A1} and C_{B1} for sample injection S_{A1}, S_{A2} etc., and obtain the mean response factor f

$$\text{Relative response factor} = \frac{H_s}{I_r \times M \times P}$$

Where H_s = Total area of the permethrin cis-isomer and trans-isomer peaks from the permethrin calibration solution.

I_r = Area of n-octacosane peak of the permethrin calibration solution.

M = Mass of permethrin analytical standard in the permethrin calibration solution(g).

P = Purity of the permethrin analytical standard (g/kg).

The mass of internal standard is common to both permethrin calibration and sample solution and has therefore been omitted. Successive measurements of the response factors should agree to within $\pm 0.5\%$ of their mean value. If not repeat the analysis.

2.1.9 Calculation

Calculate the permethrin content for each sample injection, e.g. S_{A1}, by the following equation:

$$\text{Total permethrin content (g/kg)} = \frac{H_m}{f \times I_q \times \underline{w}}$$

Where f = mean relative response factor.

H_m = area (X) of the permethrin cis-isomer + area (Y) of the trans-isomer peaks in the sample solution.

I_q = areas of the n-octacosane peak, in the sample solution

w = mass of sample (g).

The cis-isomer: trans-isomer ratio is X/Y. X is the area of the permethrin cis-isomer peak in the sample solution. Y is the area of the permethrin trans-isomer peak in the sample solution.

Take the mean of the four values corresponding to the four injections S_{A1}, S_{A2}, S_{B1}, S_{B2}. Calculate the total permethrin content of the sample as the mean of the four determinations as follows:

recorder chart speed (25 mm/min), attenuation and sample size should be initially adjusted so that the peak heights are about 3/4 of the chart width and not less than 180 mm. The distance between the intercepts of the tangents on the base-line should be not less than 30 mm. The base-line should be parallel to, or coincide with, the electrical base-line.

Sample injection	Use relative response factor from	Permethrin
S _{A1}	C _{A1} and C _{B1}	Q%] U%
S _{A2}	C _{A1} and C _{B1}	R%]
S _{B1}	C _{A2} and C _{B2}	S%] V%
S _{B2}	C _{A2} and C _{B2}	T%]

Q and R, S and T should agree to within $\pm 0.5\%$ of their respective mean values (U and V). U and V should agree to within $\pm 1\%$ of their mean value. Take the mean of the two values U and V as the total permethrin content.

2.2 Heat stability treatment

54°C \pm 2°C for 14 days (CIPAC method MT 46.1, CIPAC Handbook F, p.149), unless other temperatures and times are requested (FAO Manual on the development and use of FAO specifications for plant protection products, n° 149, p.33).

After completion of the heat stability treatment, the samples should not be exposed to heat, bright sunshine, or atmospheric humidity.

If required the test should be conducted in the commercial type pack.