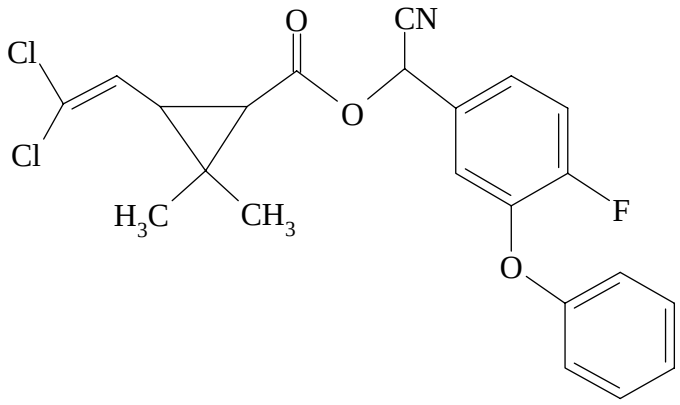
BETA-CYFLUTHRIN
482



ISO common name	Beta-cyfluthrin
Chemical names	(*RS*)-α-Cyano-(4-fluoro-3-phenoxybenzyl)-(1*RS*, 3*RS*; 1*RS*, 3*SR*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylate)(IUPAC); cyano-[(4-fluoro-3-phenoxyphenyl)methyl] 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane-carboxylate] (CA; *68359-37-5*)(See Note)
Empirial formula	$C_{22}H_{18}Cl_2FNO_3$
RMM	434.3
m.p.	cis II isomer: 81 °C; trans II isomer: 106 °C
Vapour pressure	cis II isomer: 1.4×10^{-8} Pa; trans II isomer: 8.5×10^{-8} Pa at 20 °C
Solubility	Water at 20 °C: 2 µg/l; readily soluble in toluene, acetone, dichloromethane
Description	Whitish to yellowish powder
Stability	Stable under normal storage conditions
Formulations	Emulsifiable concentrates and suspension concentrates

Note: Beta-cyfluthrin is a mixture of four enantiomeric pairs in the approximate ratio 1:36:2:61, each of which is present as a pair of enantiomers. The four diastereoisomers are designated as follows: cis I: 1*R*,3*R*,α*R* + 1*S*,3*S*,α*S*; cis II: 1*R*,3*R*,α*S* + 1*S*,3*S*,α*R*; trans I: 1*R*,3*S*,α*R* + 1*S*,3*R*,α*S*; trans II: 1*R*,3*S*,α*S* + 1*S*,3*R*,α*R*

BETA-CYFLUTHRIN TECHNICAL
*482/TC/M/-

1 Sampling. Take at least 100 g.

2 Identity tests

2.1 HPLC. Use the HPLC method below. The relative retention times of the peaks in the sample solution with respect to isomer 1 should not deviate by more than 2 % from that of the calibration solution and the intensities of the cyfluthrin isomers should give the same pattern as in the calibration solution.

2.2 TLC. Carry out thin layer chromatography of the sample and the calibration solution using the following conditions:

TLC plate	Coated with silica gel 60 F_{254}, 0.25 mm (Merck, Darmstadt, art no. 5729 or equivalent)
Solvent	*n*-heptane-acetone, 3 + 2 (v/v)
Sample solution	Weigh into a conical flask sufficient sample to contain about 200 mg beta-cyfluthrin and dissolve in acetone (10 ml). Centrifuge or filter if necessary.
Reference solution	Weigh into a conical flask about 200 mg beta-cyfluthrin reference standard and dissolve in acetone (10 ml).
Loading	5 µl (about 100 µg) applied in a line at the origin
Separation	Develop the chromatogram in two steps, drying the plate between each step; first step: 5 cm; second step: 10 cm.
Visualisation reagent	Dissolve *o*-toluidine (0.16 g) in acetic acid (30 ml), add potassium iodide (1 g), dissolve and dilute to 500 ml with distilled water.
Visualisation	Dry the plate under a fume hood. Examine the separation in UV light (254 nm). Put the plate in a chamber filled with chlorine gas (produced by adding concentrated hydrochloric acid to potassium permanganate in a chromatography tank) for 30 s. Dry the plate in a stream of cold air. Then, immerse the plate in the visualisation solution.
R_F *value*	approximately 0.5 (mean value for the double spot).

* CIPAC method 1996. Prepared by the German PAC (DAPA). Chairman: W Dobrat. Based on a method supplied by Bayer AG, Germany.

A bluish-grey coloured double spot is obtained for the active ingredient by reaction with the *o*-toluidine reagent. To distinguish the product from cypermethrin, reference standards of beta-cyfluthrin and cypermethrin should be chromatographed on the same plate. The TLC method is not suitable for differentiating between beta-cyfluthrin and cyfluthrin.

2.3 Infrared. Dissolve 55 mg quantities of the sample and of beta-cyfluthrin reference standard in 1 ml carbon tetrachloride. Transfer the solutions to 100 µm NaCl cells and scan the solutions from 600 to 4000 cm^{-1}. The spectrum obtained from the sample solution should not differ significantly from that of the standard solution.
Note: Beta-cyfluthrin (Fig. 3) cannot be distinguished from cyfluthrin by infrared spectroscopy, but cypermethrin shows a slightly different spectrum (Fig. 4).
2.4 ^{1}H-NMR spectroscopy. Dissolve 2 mg quantities of the sample and of beta-cyfluthrin reference standard in 2 to 3 ml deuterodichloromethane containing tetramethylsilane as internal standard. Using a 200 MHz instrument, record the NMR-spectrum at 21 °C in a 5 mm NMR-tube. The NMR-spectra of beta-cyfluthrin, cyfluthrin and cypermethrin display the following characteristics:

a) Beta-cyfluthrin (2 diastereomers)
trans II: doublet at 5.66 ppm
cis II: doublet at 6.18 ppm

b) Cyfluthrin (4 diastereomers)
trans I: doublet at 5.63 ppm
trans II: doublet at 5.66 ppm
cis I: doublet at 6.17 ppm
cis II: doublet at 6.15 ppm

c) Cypermethrin (4 diastereomers)
The aromatic protons of cypermethrin and beta-cyfluthrin (6.95 - 7.05 ppm) have different coupling constants. Beta-cyfluthrin shows a significant doublet at 7.00 ppm, which can be used to distinguish beta-cyfluthrin from cypermethrin (Fig. 13, p. 120).

3 Beta-cyfluthrin

SCOPE The method is intended for the determination of beta-cyfluthrin and its diastereoisomer ratio.

OUTLINE OF METHOD Beta-cyfluthrin is determined by normal phase high performance liquid chromatography using UV detection at 235 nm and external standardisation.

REAGENTS

Beta-cyfluthrin working standard with known contents of the two diastereoisomers

n-Heptane HPLC quality

tert-Butyl methyl ether (TBME), HPLC quality

Tetrahydrofuran (THF), HPLC quality

Eluent *n*-heptane/TBME, 950 + 50 (v/v)

Calibration solution. Weigh (to the nearest 0.1 mg) in duplicate beta-cyfluthrin reference standard (about 100 mg, *s* mg) into two volumetric flasks (50 ml). The quantities weighed should differ by about 10 %. Add TBME (15 ml) and place the flasks in an ultrasonic bath for 5 min. Fill the flasks to 1 cm below the mark with *n*-heptane and place them in a water bath at 22 °C for 5 min. Make up to volume with *n*-heptane and mix well (Solutions C_1 and C_2). The solutions are stable for 24 h at room temperature.

APPARATUS

High performance liquid chromatograph equipped with an ultraviolet spectrophotometric detector and an injection system capable of injecting 5 or 10 µl

Column stainless steel, 250 × 4 or 3 mm (i.d.), LiChrospher Si 60, 5 µm or equivalent

Electronic integrator or *data system*

Ultrasonic bath

Centrifuge

PROCEDURE

(a) Conditions of chromatography (typical):

Column temperature	40 °C or room temperature
Flow rate	1.8 ml/min, or 1 ml/min for a 3 mm diameter column
Measuring wavelength	235 nm
Injection volume	5 µl
Run time	approximately 20 min
Retention times	isomer cis II: about 6 min isomer trans II: about 7 min

(b) Sample preparation. Homogenise the sample. Weigh (to the nearest 0.1 mg) in duplicate sufficient sample to contain about 100 mg (*w* mg) beta-cyfluthrin into two volumetric flasks (50 ml). The quantities weighed should differ by about 10 %. Add TBME (15 ml) and place the flasks in an ultrasonic bath for 5 min. Fill the flasks to 1 cm below the mark with *n*-heptane and place them in a water bath at 22 °C for 5 min. Make up to volume with *n*-heptane and mix well (Solutions S_1 and S_2). The solutions

are stable for 24 h at room temperature.

Equilibration of the system. Pump sufficient eluent through the column to equilibrate the system. When a new column is installed, equilibrate the system at least overnight. Inject 5 µl portions of the calibration solution and repeat the injections until retention times and peak areas vary by less than 0.5 % of the mean for successive injections.
If before the beta-cyfluthrin determination system has been used in the reversed phase mode, replace the column by a capillary tube. If the piston backside has a rinsing system, flush it with methanol and dry it with a stream of dry air. Then rinse the system by pumping successively water, TMBE and eluent, during 30 min at 4 ml/min. Replace the capillary by the normal phase column and continue as above.
(d) Determination. Inject 5 µl portions of the calibration solutions (C_1 and C_2) and the sample solutions (S_1 and S_2) in the following sequence: C_1, S_1, S_2, C_2. Determine the peak area of each individual isomer. Calculate the mean of the response factors (f_i) of the calibration solutions bracketing the injections of the sample solutions and calculate the content. If individual measurements vary by more than 0.8 %, prepare new solutions.

(e) Calculation

$$f_i = \frac{s \times c_i}{H_{si}}$$

Content of the *i*th beta-cyfluthrin isomer (Y_i) $= \frac{H_{wi} \times f_i}{w}$ g/kg

Total beta-cyfluthrin content $= \sum Y_i$ 1 g/kg (*i=1-4*)

Ratio of the *i*th beta-cyfluthrin isomer $= \frac{Y_i}{\sum Y_i}$ (*i=1-4*)

where:
f_i = response factor of the *i*th beta-cyfluthrin isomer
H_{si} = peak area of the *i*th beta-cyfluthrin isomer in the calibration solution
H_{wi} = peak area of the *i*th beta-cyfluthrin isomer in the sample solution
s = mass of beta-cyfluthrin in the calibration solution (mg)
w = mass of sample taken (mg)
c_i = content of the *i*th isomer in the beta-cyfluthrin standard (g/kg)
Y_i = content of the *i*th isomer in the sample (g/kg)

Repeatability r = 30 g/kg at 950 g/kg active ingredient content
Reproducibility R = 33 g/kg at 950 g/kg active ingredient content

BETA-CYFLUTHRIN EMULSIFIABLE CONCENTRATES
*482/EC/M/-

1 Sampling. Take at least 500 ml.

2 Identity tests

2.1 HPLC. As for beta-cyfluthrin technical **482**/TC/M/2.1.

2.2 TLC. As for beta-cyfluthrin technical **482**/TC/M/2.2.

2.3 Infrared. Take sufficient sample to contain about 0.5 g beta-cyfluthrin and evaporate to dryness at a water bath at 40 to 50 °C. Suppress any foaming by adding a small amount of sodium chloride. Treat the residue with dichloromethane (40 ml). Filter, dry the solution the solution with sodium sulphate and evaporate the solvent. Dissolve the residue in dichloromethane (2 ml) and isolate the active ingredient by chromatography over a silica gel column (glass, with sintered frit and ground in stopcock, 15 × 1.3 mm (i.d.), R_F = 0.89, DC). Evaporate the solvent with in a stream of clean dry air and continue as for beta-cyfluthrin technical **482**/TC/M/2.3.

2.4 ^{1}H-NMR. Use the extraction procedure as for 2.3, above, and continue as for beta-cyfluthrin technical **482**/TC/M/2.4.

3 Beta-cyfluthrin. As for beta-cyfluthrin technical **482**/TC/M/3 except:

REAGENTS

Calibration solution. Prepare calibration solutions C_1 and C_2 as for **482**/TC/M/3. Transfer by pipette from each solution 5.0 ml to separate volumetric flasks (50 ml). Add THF (15 ml) and fill to the mark with *n*-heptane (Solutions C_3 and C_4).

(a) Operating conditions
Injection volume 5 µl

(b) Sample preparation. Homogenise the sample. Weigh (to the nearest 0.1 mg) in duplicate into two volumetric flasks (50 ml) sufficient sample to contain about 10 mg (*w* mg) beta-cyfluthrin. Dissolve in THF (15 ml), add *n*-heptane (30 ml) and mix. Allow to cool to room temperature and fill to the mark with *n*-heptane (Solutions S_1 and S_2).

(d) Determination. Inject 5 µl portions of the calibration solutions (C_3 and C_4) and the sample solutions (S_1 and S_2) in the following sequence: C_3, S_1, S_2, C_4. Continue as for **482**/TC/M/3*(d)*.

* CIPAC method 1996. Prepared by the German PAC (DAPA). Chairman: W Dobrat. Based on a method supplied by Bayer AG, Germany.

(e) Calculation

$$f_i = \frac{s \times c_i}{H_{si} \times 10}$$

$$\text{Content of the } i\text{th beta-cyfluthrin isomer } (Y_i) = \frac{H_{wi} \times f_i}{w} \text{ g/kg}$$

$$\text{Total beta-cyfluthrin content} = \sum Y_i \text{ g/kg } (i=1\text{-}4)$$

Repeatability r = 0.7 g/kg at 15.7 g/kg active ingredient content
Reproducibility R = 0.95 g/kg at 15.7 g/kg active ingredient content

BETA-CYFLUTHRIN SUSPENSION CONCENTRATES
[*]**482**/SC/m/-

1 Sampling. Take at least 500 ml.

2 Identity tests
2.1 HPLC. As for beta-cyfluthrin technical **482**/TC/M/2.1.
2.2 TLC. As for beta-cyfluthrin technical **482**/TC/M/2.2.
2.3 Infrared. As for beta-cyfluthrin emulsifiable concentrates **482**/EC/M/2.3.
2.4 ^{1}H-NMR. As for beta-cyfluthrin emulsifiable concentrates **482**/EC/M/2.4.

3 Beta-cyfluthrin. As for beta-cyfluthrin technical **482**/TC/M/3 together with:

APPARATUS

Centrifuge or *PTFE disposable filter* (e.g. Gelman Acrodine CR, PTFE, 0.45 µm, 25 mm diameter)
Note: The injection volume must not be larger than 5 µl to achieve a sufficient separation. Use smaller injection volumes for the a column with a diameter of 3 mm.

and except:

[*] Tentative CIPAC method 1996. Prepared by the German PAC (DAPA). Chairman: W Dobrat. Based on a method supplied by Bayer AG, Germany.

REAGENTS

Calibration solution. Weigh (to the nearest 0.1 mg) in duplicate beta-cyfluthrin working standard (about 100 mg, *s* mg) into two volumetric flasks (50 ml). The weighings should differ about 10 %. Add THF (30 ml) and place the flasks in an ultrasonic bath for 5 min. Fill the flasks to 1 cm below the mark with THF and place them in a water bath at 22 °C for 5 min. Make up to volume with THF and mix well (Solutions C_1 and C_2). The solutions are stable for 24 h at room temperature.

(b) Sample preparation. Homogenise the sample. Weigh (to the nearest 0.1 mg) in duplicate sufficient sample to contain about 100 mg (*w* mg) beta-cyfluthrin into two volumetric flasks (50 ml). The quantities should differ about 10 %. Add THF (about 40 ml), shake vigorously and place the flasks in an ultrasonic bath for 5 min. Make up to volume with THF and homogenise (Solutions S_1 and S_2). Allow to settle any insoluble material. If necessary centrifuge the solutions or filter through a disposable PTFE filter (0.45 µm).

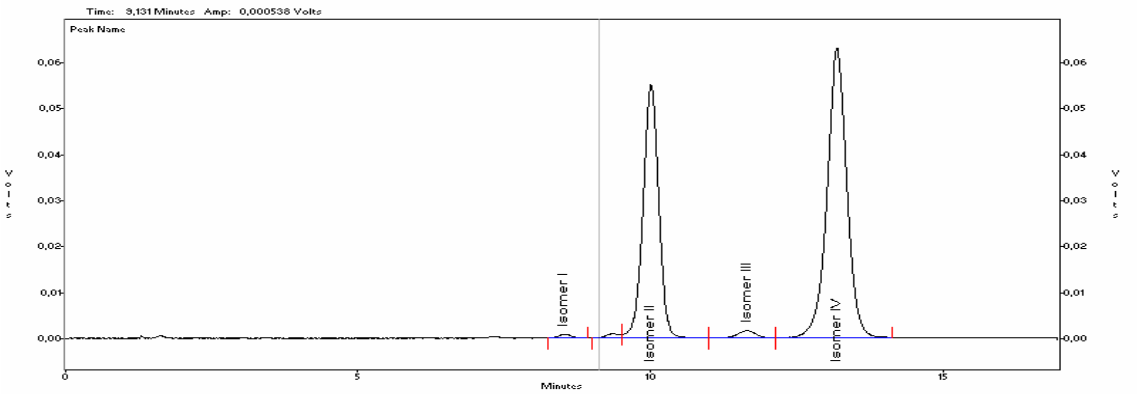


Fig. 2 Chromatogram of beta-cyfluthrin

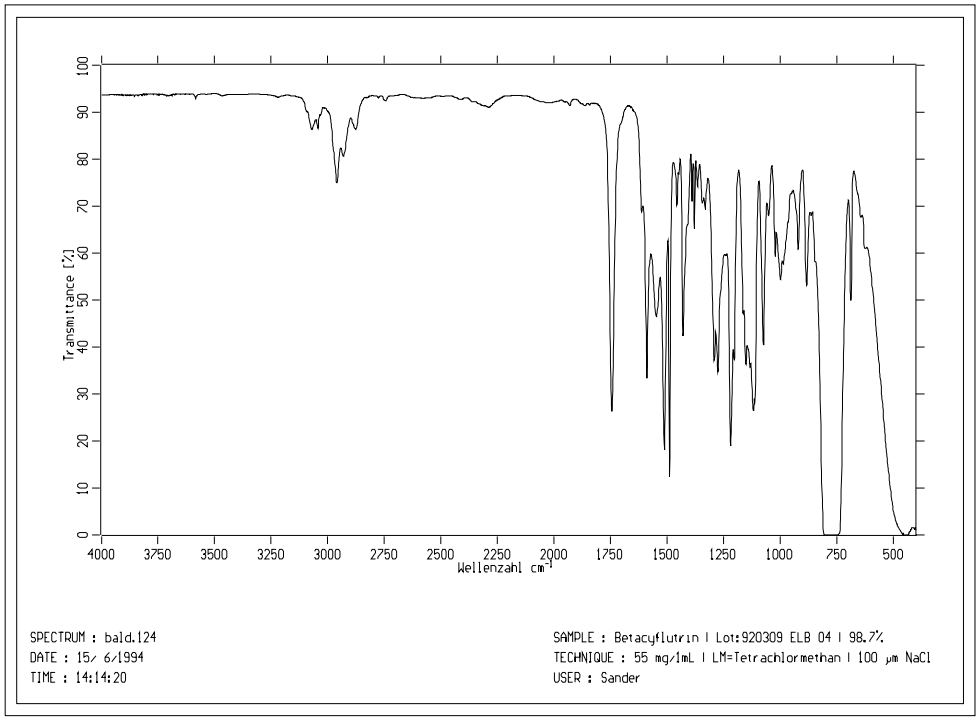


Fig. 3 Infrared spectrum of beta-cyfluthrin

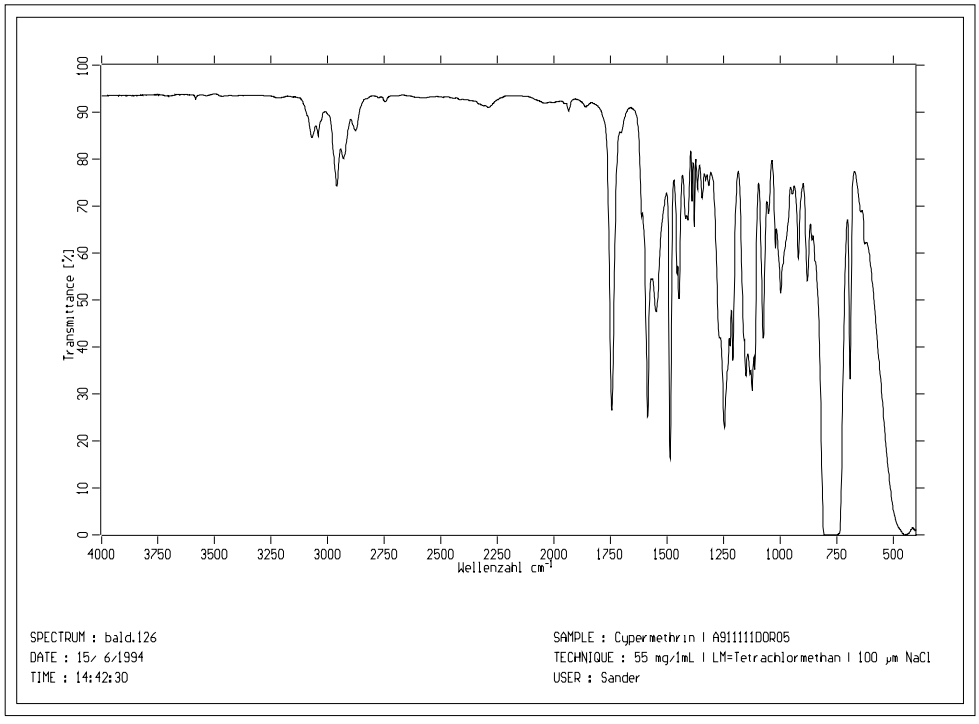


Fig. 4 Infrared spectrum of cypermethrin