

BS EN 13206:2017



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Plastics — Thermoplastic covering films for use in agriculture and horticulture

National foreword

This British Standard is the UK implementation of EN 13206:2017. It supersedes BS EN 13206:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/75, Plastics and rubber film and sheets.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Plastics - Thermoplastic covering films for use in agriculture and horticulture

Plastiques - Films de couverture thermoplastiques
pour utilisation en agriculture et horticulture

Kunststoffe - Thermoplastische Abdeckfolien für den
Einsatz in der Landwirtschaft und im Gartenbau

This European Standard was approved by CEN on 14 November 2016.

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European foreword

This document (EN 13206:2017) has been prepared by Technical Committee CEN/TC 249 “Plastics”, the secretariat of which is held by NBN.

This document supersedes EN 13206:2001.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2017, and conflicting national standards shall be withdrawn at the latest by July 2017.

The following technical changes have been made in comparison to EN 13206:2001:

- a minimum thickness of the film is fixed;
- the test methods have been updated as appropriate;
- this revision specifies also test methods for the determination of the chlorine and sulfur contents of the films subjected to use and defines guidelines for installation, use and disposal;
- the classification for the durability of the covering films is extended to a further class.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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1 Scope

This European Standard specifies the requirements related to dimensional, mechanical, optical and thermal characteristics of thermoplastic films used for covering permanent or temporary greenhouses and walking tunnels and low tunnels used for forcing and semi-forcing vegetable, fruit and flower crops.

Lay-flat perforated cover films are also in the scope of this European Standard.

It specifies a classification for the durability of covering films and the test methods referred to in this standard.

This European Standard specifies also test methods for the determination of the chlorine and sulfur contents of films subjected to use.

This European Standard is applicable to thermoplastic covering films used in agriculture and horticulture in Europe, in the thickness range 20 µm up to more than 250 µm, based on polyethylene and/or ethylene copolymers materials, of the following types: non-thermal films, thermal clear films and thermal diffusing films.

This European Standard also defines guidance for installation, use and disposal of covering films. It defines the conventional expected lifetime, as well as rules that allow evaluating the remaining use potential in the event of a failure before the normal end-of-use date.

NOTE These rules allow estimating the residual value of the films. These provisions only apply to the film itself and the damage it has undergone. Any other problem falls within the scope of professional practices and the general terms and conditions of sale.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10244-2, *Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 2: Zinc or zinc alloy coatings*

EN 13031-1, *Greenhouses - Design and construction - Part 1: Commercial production greenhouses*

EN 16472, *Plastics - Method for artificial accelerated photoageing using medium pressure mercury vapour lamps*

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1)*

EN ISO 527-3, *Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets (ISO 527-3)*

EN ISO 4892-2:2013, *Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps (ISO 4892-2:2013)*

EN ISO 4892-3:2016, *Plastics - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamps (ISO 4892-3)*

EN ISO 7765-1:2004, *Plastics film and sheeting - Determination of impact resistance by the free-falling dart method - Part 1: Staircase methods (ISO 7765-1:1988)*

ISO 4591, *Plastics — Film and sheeting — Determination of average thickness of a sample, and average thickness and yield of a roll, by gravimetric techniques (gravimetric thickness)*

ISO 4592, *Plastics — Film and sheeting — Determination of length and width*

ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*

ASTM D 1003-13, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 width

overall width of a film when laid flat

Note 1 to entry: It is expressed in millimetres.

3.2 nominal width

width of a film, as declared by the manufacturer/supplier

Note 1 to entry: It is expressed in millimetres.

3.3 nominal thickness

thickness of a film, as declared by the manufacturer/supplier

Note 1 to entry: It is expressed in micrometres (μm).

3.4 roll length

largest dimension of the film corresponding to the length of the unwinded roll

Note 1 to entry: It is expressed in metres.

3.5 nominal length

length of a film roll or sheet, as declared by the manufacturer/supplier

Note 1 to entry: It is expressed in metres.

3.6 nominal mass

mass of a roll or sheet, as declared by the manufacturer/supplier

Note 1 to entry: It is expressed in kilograms.

3.7 longitudinal direction MD

direction parallel to the roll length, corresponding to the extrusion direction

3.8 transverse direction TD

direction parallel to the width (at right angle to the length)

3.9

conventional expected lifetime

expected lifetime defined by agreement between the manufacturer/supplier and the customer or, by default, the minimum use duration that the film needs to satisfy

Note 1 to entry: It is expressed in years, months or seasons.

3.10

actual useful lifetime

time interval defined as beginning from the installation date of a film until its removal or an earlier date in case of its failure

Note 1 to entry: It is expressed in months, years or seasons.

3.11

use ratio

ratio of the actual useful lifetime of a film to its conventional expected lifetime

Note 1 to entry: It is expressed as a dimensionless ratio or as a percentage (%).

3.12

remaining use potential

difference between the conventional expected lifetime of a film and its actual useful lifetime

Note 1 to entry: It is expressed in months.

3.13

radiant exposure

H

time integral of irradiance, measured in joules per square metre (J/m²)

[SOURCE: ISO 9370:2009 [1], definition 3.27]

4 Types and use

The different types of covering films, their optical and thermal characteristics and use are given in Table 1.

Table 1 — Characteristics and use of covering films

Type	Optical and thermal characteristics	Use
Non-thermal (NTh)	Low IR effectiveness	Forcing and semi forcing crops
Thermal clear (ThC)	High transparency High IR effectiveness	Same use as normal film, when higher IR effectiveness is requested
Thermal diffusing (ThD)	Diffusing light High IR effectiveness	Same use as normal film, when higher IR effectiveness and diffusing light effect are requested

5 Material

Covering films according to this standard are usually manufactured from:

- low density polyethylene (PE-LD), linear low density polyethylene (PE-LLD) and their blends;
- ethylene vinyl acetate copolymers (EVAC) and their blends with PE-LD or PE-LLD;
- ethylene butyl acrylate copolymers (EBA) and their blends with PE-LD or PE-LLD.

6 Durability

The durability of covering films is characterized by the class N, A, B, C, D, E or F. This classification, given in Table 2, is depending on the duration of exposure of the film to an artificial weathering using xenon-arc lamps according to 8.9, which induces a decrease of the value of tensile strain at break equal or less than 50 % of the initial value.

The class of durability shall be declared by the manufacturer.

Table 2 — Resistance to weathering classification

Class	Minimum duration of exposure h	
	At irradiance (narrowband – 420 nm) 0,35 W/(m ² ·nm)	At irradiance (narrowband – 420 nm) 0,51 W/(m ² ·nm)
N	400	280
A	2 000	1400
B	3 500	2450
C	5 400	4070
D	6 800	4670
E	8 500	5830
F	10 700	7350

For films intended to be used outside of Europe, longer durations of exposures than this for Class F can be required. In this case, the minimum duration of exposure shall be defined by agreement between the manufacturer/supplier and the customer.

Other light sources may be used provided that a correlation between the test results obtained with these light sources and these obtained after a natural exposure can be demonstrated. This may be useful when the durations of the exposure to xenon-arc lamps as defined in Table 2 are too long. Details of these methods are given in Annex A (informative).

In case of dispute, the exposure to xenon-arc lamps according to 8.9 and the classification according to Table 2 shall be used.

NOTE An empirical correlation between durability of covering films for greenhouses exposed to artificial weathering and natural exposure is given in Annex B (informative). The correlation study has been performed at an irradiance in narrow band (420 nm) equal to 0,35 W/(m²·nm)

7 Requirements

7.1 General requirements

Non-thermal films, thermal clear films and thermal diffusing films shall fulfil the requirements of Tables 3 to 5, respectively.

Table 3 — Requirements for non-thermal films

Characteristics	Unit µm	Nominal thickness					Test method Subclause
		≥ 20 ^a	≥ 60 ^b	≥ 100 ^c	≥ 150 ^d	≥ 200	
Appearance	-	Shall conform to 7.2					7.2
Dimensional characteristics							
Tolerance of average thickness/nominal thickness	%	±5					8.1
Tolerance of single point thickness/nominal thickness	%	- 15, +25					8.1
Width tolerance/nominal width	%	0, +4					8.2
Flat film	%	0, +2,4					
Tubular film	%	0, +2,4					
Tolerance roll length/nominal length	%	0, +4					8.12
Mechanical characteristics on unexposed film							
Tensile stress at break (MD, TD)	MPa	≥ 19					8.3
Tensile strain at break (MD, TD)	%	≥ 250	≥ 300	≥ 350	≥ 400	≥ 450	8.3
Impact resistance							
Flat area	g	≥ 100	≥ 150	≥ 300	≥ 350	≥ 450	8.4.2
Fold area	g	≥ 75	≥ 100	≥ 150	≥ 200	≥ 250	8.4.3
Optical characteristic on unexposed film							
Visible light transmission	%	≥ 90	≥ 88	≥ 88	≥ 85	≥ 85	8.6
<p>^a 20 µm ≤ nominal thickness < 60 µm. ^b 60 µm ≤ nominal thickness < 100 µm. ^c 100 µm ≤ nominal thickness < 150 µm. ^d 150 µm ≤ nominal thickness < 200 µm.</p>							

Table 4 — Requirements for thermal clear films

Characteristics	Unit µm	Nominal thickness					Test method Subclause
		≥ 25 ^a	≥ 60 ^b	≥ 100 ^c	≥ 150 ^d	≥ 200	
Appearance	-	Shall conform to 7.2					7.2
Dimensional characteristics							
Tolerance of average thickness/nominal thickness	%	±5					8.1
Tolerance of single point thickness/nominal thickness	%	- 15, +25					8.1
Width tolerance/nominal width	%	0, +4					8.2
Flat film	%	0, +2,4					
Tubular film	%	0, +2,4					
Tolerance roll length/nominal length	%	0, +4					8.12
Mechanical characteristics on unexposed film							
Tensile stress at break (MD, TD)	MPa	≥ 20					8.3
Tensile strain at break (MD, TD)	%	≥ 300	≥ 350	≥ 400	≥ 450	≥ 550	8.3
Impact resistance							
Flat area	g	≥ 150	≥ 250	≥ 350	≥ 500	≥ 650	8.4.2
Fold area	g	≥ 75	≥ 100	≥ 200	≥ 350	≥ 400	8.4.3
Elongation under a steady load (MD)	%	≤ 30	≤ 30	≤ 30	≤ 30	≤ 30	8.5
Optical characteristic on unexposed film							
Visible light transmission	%	≥ 92	≥ 90	≥ 90	≥ 88	≥ 88	8.6
Haze	%	≤ 20	≤ 25	≤ 25	≤ 30	≤ 30	8.7
IR effectiveness	%	≥ 40	≥ 50	≥ 55	≥ 65	≥ 75	8.8
<p>a 25 µm ≤ nominal thickness < 60 µm.</p> <p>b 60 µm ≤ nominal thickness < 100 µm.</p> <p>c 100 µm ≤ nominal thickness < 150 µm.</p> <p>d 150 µm ≤ nominal thickness < 200 µm.</p>							

Table 5 — Requirements for thermal diffusing films

Characteristics	Unit μm	Nominal thickness					Test method Subclause
		≥ 25 ^a	≥ 60 ^b	≥ 100 ^c	≥ 150 ^d	≥ 200	
Appearance	-	Shall conform to 7.2					7.2
Dimensional characteristics							
Tolerance of average thickness/nominal thickness	%	±5					8.1
Tolerance of single point thickness/nominal thickness	%	- 15, +25					8.1
Width tolerance/nominal width	%	0, +4					8.2
Flat film	%	0, +2,4					
Tubular film	%	0, +2,4					
Tolerance roll length/nominal length	%	0, +4					8.12
Mechanical characteristics on unexposed film							
Tensile stress at break (MD, TD)	MPa	≥ 20					8.3
Tensile strain at break (MD, TD)	%	≥ 200	≥ 220	≥ 350	≥ 400	≥ 500	8.3
Impact resistance							
Flat area	g	≥ 100	≥ 160	≥ 300	≥ 400	≥ 500	8.4.2
Fold area	g	≥ 75	≥ 110	≥ 200	≥ 250	≥ 350	8.4.3
Elongation under a steady load (MD)	%	≤ 30	≤ 30	≤ 30	≤ 30	≤ 30	8.5
Optical characteristic on unexposed film							
Visible light transmission	%	≥ 88	≥ 85	≥ 85	≥ 80	≥ 80	8.6
Haze	%	≥ 30	≥ 30	≥ 30	≥ 35	≥ 35	8.7
IR effectiveness	%	≥ 40	≥ 55	≥ 60	≥ 70	≥ 75	8.8
<p>a 25 μm ≤ nominal thickness < 60 μm.</p> <p>b 60 μm ≤ nominal thickness < 100 μm.</p> <p>c 100 μm ≤ nominal thickness < 150 μm.</p> <p>d 150 μm ≤ nominal thickness < 200 μm.</p>							

7.2 Requirement for appearance

The free edges of the roll shall be sealed with adhesive tape or by some other similar means, in order to prevent its unwinding.

The edges shall be properly in line and there shall be sufficient tension to prevent the layers of the roll from transverse slipping when it is handled.

The film shall be homogeneous and free from visible defects which may affect the fitness for purpose of the film; check by unrolling at least 2 m of the film and examining it against the light holding it tight at arms length.

8 Test methods

8.1 Determination of thickness

The thickness of single points of the film shall be determined in accordance with ISO 4593. The average thickness of the film shall be determined in accordance with ISO 4591 or ISO 4593. Testing shall be performed using one strip of film cut in transverse direction of the roll (TD).

8.2 Determination of width

The width of the film shall be determined in accordance with ISO 4592.

8.3 Determination of tensile characteristics

The tensile characteristics shall be determined according to EN ISO 527-1 and EN ISO 527-3 using five test pieces type 2, with a width of 10 mm, cut in each direction of the film, longitudinal direction (MD) and transversal direction (TD), at a testing speed of 500 mm/min.

Calculate the arithmetic average value of the five measurements.

The arithmetic average value shall fulfil the requirements of Tables 3 to 5, as applicable.

8.4 Determination of impact resistance

8.4.1 General

NOTE Films which are wider than 2 000 mm are usually folded lengthwise at least once before winding on a reel. These folds are retained even when the film is laid out flat, and this may affect test results.

In case of a folded film, a distinction shall be made between the test pieces taken from the folds (fold area) and sample sheets taken from areas which have not been folded (flat area).

8.4.2 Flat area

The impact resistance (Dart drop test) in flat area shall be determined in accordance with EN ISO 7765-1:2004, method A.

Calculate the impact failure mass m_f , in grams, in accordance with EN ISO 7765-1.

The impact failure mass m_f shall fulfil the requirements of Tables 3 to 5, as applicable.

8.4.3 Fold area

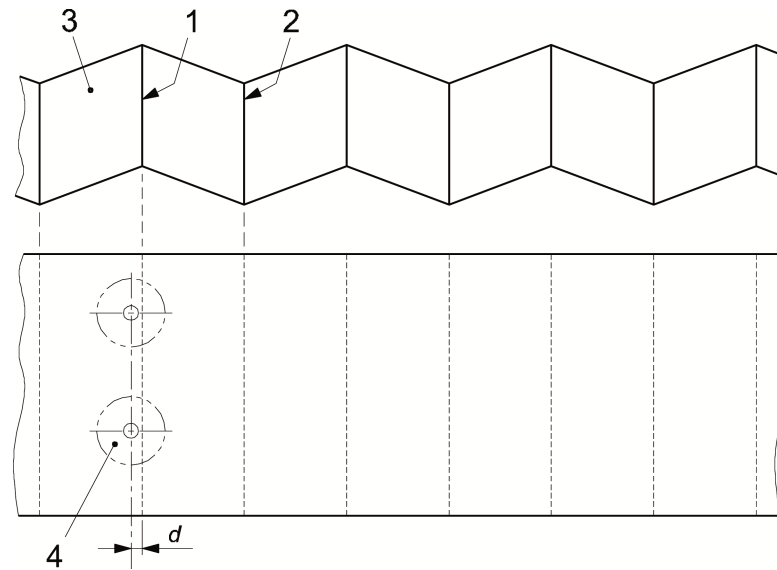
The impact resistance (Dart drop test) in fold area shall be determined using the apparatus specified in EN ISO 7765-1:2004, method A.

Spread out the film with the marked face onto the apparatus and test every folds tangentially twice, alternately internal and external folds, with a mass as specified in Tables 3, 4, 5, as applicable. The tangential test is obtained by shifting forward the fold of 13 mm from the vertical axle of the specimen clamp. See Figure 1.

If no failure occurs, the result is declared "pass".

If one failure occurs, carry out two additional tests on the fold which failed in the same position (internal or external fold). Then, if no failure occurs, the result is declared "pass" and if one or two failure(s) occur(s), the result is declared "fail".

If two failures occur, the result is declared "fail".



Key

- 1 external fold
 - 2 internal fold
 - 3 film
 - 4 vertical axle of the specimen clamps
- where:
 $d = 13 \text{ mm}$

Figure 1 — Position of impact on folds

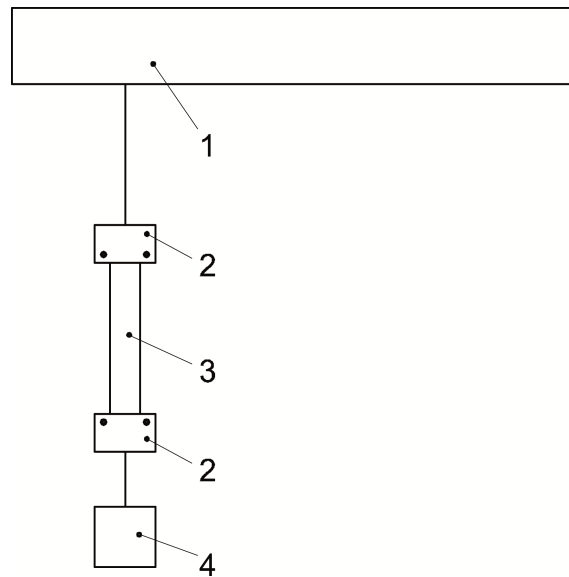
8.5 Determination of elongation under a steady load (creep test)

8.5.1 Principle

This test method is intended to measure the creep, expressed as the elongation of the film under a steady load in a vertical static position after a specified time period.

8.5.2 Apparatus

A typical arrangement for testing is shown in Figure 2. The test piece is hold by two grips, the upper grip is clamped to a fixed support and a weight is hung to the lower grip to provide a steady load on the test piece.



Key

- 1 Fixed support
- 2 Grips
- 3 test piece
- 4 Mass

Figure 2 — Typical apparatus

8.5.3 Test pieces

Cut three test pieces from the film in the longitudinal direction (MD), with the following dimensions:

- width: 10 mm;
- overall length: 140 mm;

Gauge marks are defined on each test piece. The distance between the marks (L_0) shall be 100 mm.

8.5.4 Test conditions

- a) Test temperature: $23\text{ °C} \pm 2\text{ °C}$.
- b) Stress to be applied: 4 MPa.
- c) Test period: 100 h.

8.5.5 Test procedure

For each test piece, measure the thickness and the minimum width and calculate the value of the steady load referring to the measured values.

Make two marks which defined the gauge length (L_0) on the test piece.

Set the test piece in the grips.

Adjust the mass of the test stress to the calculated value, e.g. by adding or removing lead shot.

Carefully hang the test piece with the grips and the test load to the fixed support, avoiding jerks and shocks.

During testing, the apparatus shall not be subjected to vibration or shocks which may influence the final measurement.

After 100 h, measure and record the distance between the two marks that define the gauge length (L).

Repeat the test procedure for each test piece.

8.5.6 Expression of results

Calculate the creep A , as a percentage, using the following formula:

$$A = \frac{L - L_0}{L_0} \times 100$$

where

L_0 is the measured initial gauge length, in mm;

L is the arithmetic average value, in mm, of the three measurements of the distance between the two marks that define the gauge length at the end of testing.

8.6 Determination of visible light transmission

The total visible light transmission is determined in accordance with ASTM D 1003-13 on five test pieces cut from the film.

Calculate the arithmetic average value of the five measurements.

The arithmetic average value shall fulfil the requirements of Table 3, 4 and 5, as applicable.

8.7 Determination of haze

The haze shall be determined in accordance with ASTM D 1003-13 on five test pieces taken from the film.

Calculate the arithmetic average value of the five measurements.

The arithmetic average value shall fulfil the requirements of Table 4 and 5 as applicable.

8.8 Determination of IR effectiveness (η_{ir}) (thermal clear and thermal diffusing films)

8.8.1 Principle

The method consists of measuring the IR transmission spectrum within wave numbers ranging from $1\,430\text{ cm}^{-1}$ to 770 cm^{-1} (between $7\text{ }\mu\text{m}$ and $13\text{ }\mu\text{m}$ wavelengths).

This range of wavelengths corresponds to the field of maximum emission of the energy irradiated by the earth's surface.

8.8.2 Apparatus

8.8.2.1 Infrared spectrophotometer allowing to measure and record continuously transmittance between $1\,500\text{ cm}^{-1}$ and 700 cm^{-1} ;

8.8.2.2 Analytical balance with an accuracy of 0,1 mg or planimeter.

NOTE The determination of IR effectiveness may also be made by using IR spectrophotometers equipped with software to integrate transmittance.

8.8.3 Test procedure

The measurement is performed on five test pieces cut from the film.

Put each test piece on the specimen holder of the spectrophotometer and record the spectrum of transmission from 1 500 cm⁻¹ to 700 cm⁻¹.

Measure the area between the line corresponding to a transmittance of 100 % and the curve of the spectrum with the help of a planimeter or by using the following weighing method.

Cut a sheet with the trace of the spectrum (or a copy of it) at 1 430 cm⁻¹ and 770 cm⁻¹, along the lines of 0 % and 100 % transmittance. Weigh this rectangle to an accuracy of 0,1 mg. This mass shall be stated as P_{100} .

Then cut along the outline of the spectrum and weigh the part representing the transmission.

This second mass shall be stated as P_t .

8.8.4 Expression of results

According to the “planimeter method” the percentage of the measured area of the spectrum in respect to the total area is the value of the IR effectiveness (η_{ir}).

According to the weighing method, the IR effectiveness (η_{ir}) in the range of wavelengths between 7 μ m to 13 μ m is given by the ratio:

$$\eta_{ir} = \frac{P_{100} - P_t}{P_{100}} \times 100$$

Calculate the arithmetic average value of the five measurements.

The arithmetic average value shall fulfil the requirements of Table 4 and 5, as applicable.

8.9 Determination of resistance to weathering

8.9.1 Principle

The variation of the tensile strain at break of specimens is determined before and after an exposure to xenon-arc lamps.

8.9.2 Exposure to xenon-arc lamps

Carry out the artificial weathering according to EN ISO 4892-2:2013, Method A, using one of the test conditions given in Table 6.

Table 6 — Exposure cycle and test conditions

Exposure period	Irradiance		Black-standard Temperature °C	Chamber Temperature °C	Relative humidity %
	Broadband (300 nm to 400 nm) W/m ²	Narrowband (340 nm) W/(m ² ·nm)			
102 min dry	40 ± 2	0,35 ± 0,02	65 ± 3	38 ± 3	50 ± 5
18 min water spray	40 ± 2	0,35 ± 0,02	—	—	—
102 min dry	60 ± 2	0,51 ± 0,02	65 ± 3	38 ± 3	50 ± 5
18 min water spray	60 ± 2	0,51 ± 0,02	—	—	—

8.9.3 Procedure

Expose the specimens according to 8.9.2 during the minimum duration of exposure specified in Table 2, corresponding to the class of durability of the film.

After the exposure, determine the tensile strain at break according to EN ISO 527-1 and EN ISO 527-3, using five type 2 test pieces, 10 mm wide, 150 mm long, taken longitudinally in the film (MD), at a test speed of 500 mm/min.

8.9.4 Calculation and expression of results

Calculate the arithmetic mean value of the five measurements performed on the test pieces cut from the exposed specimens and the arithmetic mean value of the five measurements performed on the test pieces cut from the unexposed specimens in longitudinal direction (MD) (see 8.3). Compare these two values.

The test is considered successful when the value calculated for specimens exposed to artificial weathering is equal or greater than 50 % of the value calculated for unexposed specimens.

8.10 Determination of the chlorine content of used films

The chlorine content of used films shall be determined in accordance with Annex C.

Alternative methods may be used if there is an agreement between the manufacturer and the customer. For example, the chlorine content may be determined by X-ray fluorescence method according to Annex E.

In case of dispute, the method as specified in Annex C shall be used.

8.11 Determination of the sulfur content of used films

The sulfur content of used films shall be determined in accordance with Annex D.

Alternative methods may be used if there is an agreement between the manufacturer and the customer. For example, the sulfur content may be determined by ultraviolet fluorescence method or by coulometry according to Annex F, or by X-ray fluorescence method according to Annex E.

In case of dispute, the method as specified in Annex D shall be used.

8.12 Determination of the roll/sheet length

The roll or sheet length shall be greater or equal to the nominal length of the roll or the sheet.

These control procedures are recommended in cases where there is uncertainty regarding the length of a roll or for survey testing. They are not recommended for goods acceptance inspections.

The inspection shall be carried out on a film roll that is complete and in its original packaging.

If the nominal length of the roll is 50 m or less, unwrap the roll and completely unroll it on a flat surface, then measure its length using a decametre.

If the nominal length of the roll is over 50 m, follow the procedure below to check the length:

- a) unwrap the roll;
- b) determine the mass of the complete roll, P_B , in kilograms, to the nearest 0,1 kg;
- c) at the beginning, middle and end of the roll, take three width samples, each measuring $100 \text{ cm} \pm 0,2 \text{ cm}$ when flat;
- d) where appropriate, determine the mass of the core, P_M , in grams. If there is no core: $P_M = 0 \text{ g}$;

- e) measure the total mass of the three samples, P , in grams.
- f) calculate the value of the length of the roll, L , using the following formula:

$$L = \frac{3(1000 \cdot P_B - P_M)}{P}$$

where:

- L is the roll length, in metres;
- P_B is the mass of the complete roll, in kilograms;
- P_M is the core mass, in grams;
- P is the total sample mass, in grams.

9 Film acceptance, storage and handling

9.1 Acceptance

Carefully examine the rolls or sheets upon delivery in order to find any apparent damage or anomalies. If a defect is found, take the necessary actions for the case. Whenever possible, it is recommended to take a photograph of the damage.

The rolls and sheets shall be carried, not dragged over the ground or any other surface.

9.2 Storage and handling of rolls

Keep the rolls in their original packaging and store them protected from direct exposure to sunlight and temperature source and rain.

For greenhouse covering films, the duration of storage by the end-user shall be contractually limited to less than three months.

It is recommended that rolls delivered with a cardboard core be stored in a dry location.

Handling should be performed horizontally.

10 Designation

The designation of the film shall include the following information:

- a) use of the film: COVERING FILM with the type according to Table 1;
- b) reference to this European Standard: EN 13206;
- c) nominal width of the film, in millimetres (mm) ;
- d) nominal thickness of the film, in micrometres (μm) if required;
- e) class of durability according to Table 2.
- f) manufacturer's trade mark;
- g) manufacturer's information (the production period, year and month, in figures).

All these information have to be put on the accompanying label.

EXAMPLE COVERING FILM NTh EN 13206 5000 150 A AnyCo 2016-06

Designation for a non-thermal film of PE-LD, 5 000 mm wide and 150 µm thickness and a duration of exposure to an artificial weathering conforming to 8.9 of 2100 h [at irradiance 0,35 W/(m²·nm)]

Where the labels accompanying the films/sheets indicate instructions for installation and use, these instructions are mandatory.

IMPORTANT — In order to ensure traceability, the end-user shall keep the labels accompanying the films/sheets or their packaging up to end-of-use. Keeping only the pallet label for homogeneous pallet deliveries is acceptable.

11 Marking

Marking printed along the edges of the film shall include the following information:

- a) type of film according to Table 1: NTh; ThC; ThD;
- b) reference to this European Standard, i.e. EN 13206;
- c) class of durability **and irradiance** according to Table 2;
- d) manufacturer's information (the production period, year and month, in figures);
- e) manufacturer's trade mark.

EXAMPLE: NTh EN 13206 A AnyCo 2016-06

12 Instructions for installation, use of covering films

The instructions of the film manufacturer for the conditions of installation and use, including durability aspects and maximum thresholds for residual sulfur and chlorine contents, shall be followed. In the absence of such instructions, guidance is given in G.1 for greenhouse covering films and in G.2 for low tunnel covering films.

13 Instructions for disposal and end-of-life of covering films

For the removal instructions, the recommendations given by local authorities in charge of waste management of post-used agricultural films shall be followed.

The minimum technical requirements issued by the companies/organizations that collect films are available on their websites.

In the absence of such recommendations, see G.3, as guidance.

Thermoplastic films are recyclable materials that can be re-processed in a material recovery process intended to save resources while minimizing harmful emissions into the air, water and soil, as well as their impacts on human health.

EN 15347 [2] provides a framework for characterizing plastic waste. EN 15343 [3] provides the procedures necessary for ensuring the traceability of recycled plastics. EN 15344 [4] provide data for characterizing polyethylene and polypropylene recyclates respectively.

ISO 15270 [6] provides guidelines for terminology and material recovery, through mechanical recycling in particular.

Annex A (informative)

Exposure to other light sources

A.1 Medium pressure mercury vapour lamps

A.1.1 Durability classification

In the case of an exposure to medium pressure mercury vapour lamps, the class of durability of covering films is given in Table A.1, depending on the duration of exposure of the film according to A.1.2, which induces a decrease of the values of tensile strain at break equal or less than 50 % of the initial values.

The class of durability shall be declared by the manufacturer.

Table A.1 — Durability classification

Class	Minimum duration of exposure h
N	100
A	450
B	750
C	1200
D	1 500
E	1 900
F	2 400

A.1.2 Exposure to medium pressure mercury vapour lamps

A.1.2.1 Exposure method

Carry out the exposure according to EN 16472 using the test conditions given in A.1.2.2 and A.1.2.3.

The exposure may be carried out in the presence of moisture in the form of water spray, condensation or by immersion cycles with or without light. In this case, test parameters shall be agreed between parties and recorded in the test report.

NOTE Information on the influence of water and additive migration can be found in ISO 10640 [7].

A.1.2.2 Irradiance

The irradiance at the surface of the test specimens shall be $(95 \pm 15) \text{ W/m}^2$ in the spectral passband 290 nm à 420 nm.

A.1.2.3 Temperature

NOTE An accurate control of the actual temperature of exposed specimens is critical since the thermal activation energy of photochemical processes leads to exponential variation of the degradation rate according to a type-Arrhenius law.

For apparatus including a platinum sensor in contact with a specimen attached to the specimen holder, the initial set point of the temperature shall be $(60 \pm 0,5)$ °C.

For apparatus including a platinum sensor inserted in a white thermally-controlled component, the initial set point of the temperature shall be $(58 \pm 0,5)$ °C.

As a given temperature set point can lead to different results depending on the apparatus, it is necessary to calibrate them. See A.1.2.4.

A.1.2.4 Apparatus calibration

The calibration of the apparatus shall be carried out relatively to the photochemistry by means of an actinometer made from a polyethylene reference specimens (PERS), as defined in ISO/TR 19032:2006 [8]

The calibration by means of a PERS allows controlling accurately the photochemical attack from both irradiance and temperature.

PERS shall be exposed during 72 h using test conditions specified in A.1.2.2 and A.1.2.3. The oxidation level shall be measured by using an infrared spectrometer in the transmission mode. The absorbance ratio (carbonyl index); A_r , shall satisfy the following condition:

$$1,8 \leq A_r = \frac{A_{1715}}{A_{2020}} \leq 2,4$$

where

A_r is the absorbance ratio (carbonyl index);

A_{1715} is the maximum absorbance at near $1\,715\text{ cm}^{-1}$;

A_{2020} is the maximum absorbance at near $2\,020\text{ cm}^{-1}$.

If the calculated absorbance ratio is out of the range as defined above, adjust the temperature set point and recalibrate until this condition is satisfied.

NOTE For detailed information on the method to determine the absorbance ratio see ISO/TR 19032:2006 [8], 4.1.

A.1.3 Procedure

The specimen shall be exposed according to A.1.2, for the duration corresponding to the relevant class given in Table A.1.

After the exposure, the tensile strain at break shall be determined according to EN ISO 527-1 and EN ISO 527-3, using five type 2 test pieces, 10 mm wide, 150 mm long, taken longitudinally in the film (MD), at a test speed of 500 mm/min.

A.1.4 Calculation and expression of results

Calculate the arithmetic mean value of the five measurements performed on the test pieces cut from the exposed specimens and the arithmetic mean value of the five measurements performed on the test pieces cut from the unexposed specimens in longitudinal direction (MD) (see 8.3). Compare these two values.

The test is considered successful when the value calculated for specimens exposed to artificial weathering is equal or greater than 50 % of the value calculated for unexposed specimens.

A.2 Fluorescent UV lamps

A.2.1 Durability classification

In the case of an exposure to fluorescent UV-A lamps, the class of durability of covering films is given in Table A.2, depending on the duration of exposure of the film according to A.2.2, which induces a decrease of the value of tensile strain at break equal or less than 50 % of the initial value.

The class of durability shall be declared by the manufacturer.

Table A.2 — Durability classification

Class of durability	Minimum duration of exposure h
N	240
A	1 200
B	2 160
C	3 250
D	4 200
E	5 100
F	6 450

A.2.2 Exposure to fluorescent UV lamps

Carry out the exposure according to EN ISO 4892-3, Method A, cycle 1, for the duration corresponding to the relevant class of durability given in Table A.2. The test method consists of an irradiance step (dry, with irradiance) and a condensation step (high humidity, without irradiation), with the following test conditions:

- irradiance shall be $(0,76 \pm 0,06)$ W/m², measured at 340 nm at the surface of the test specimen.
- the temperature of the test specimen shall be (60 ± 3) °C during irradiance and (50 ± 3) °C during condensation step. The temperature shall be measured with an uninsulated black-panel thermometer (BPT).

An accurate control of the effective temperature of the test specimen is of main importance. The thermal activation energy of photochemical processes leads to an exponential variation of the rate of degradation according to an Arrhenius type law.

A.2.3 Procedure

The sample shall be exposed according to A.2.2 for the duration corresponding to the relevant class of durability given in Table A.2.

After the exposure, the tensile strain at break shall be determined according to EN ISO 527-1 and EN ISO 527-3, using five type 2 test pieces, 15 mm wide, 150 mm long, taken longitudinally in the film (MD), at a test speed of 500 mm/min.

A.2.4 Calculation and expression of results

Calculate the arithmetic mean value of the five measurements performed on the test pieces cut from the exposed samples and the arithmetic mean value of the five measurements performed on the test pieces cut from the unexposed samples in longitudinal direction (MD) (see 8.3). Compare these 2 values.

The test is considered successful when the value calculated for samples exposed to artificial weathering is equal or greater than 50 % of the value calculated for unexposed samples.

Annex B (informative)

Empirical correlation between durations of covering films exposed to artificial weathering and a natural exposure

B.1 Exposure to xenon-arc lamps

The method specified in EN ISO 4892-2:2013, Method A, consists to expose covering films to radiations in the ultraviolet (UV) and visible regions of the spectrum that are very similar to the solar spectrum. For this reason it is reasonable to presume that a correlation exists between the artificial exposure and the natural exposure of a film to daylight.

This has been confirmed by tests carried out in laboratories that have compared the durations of UV stabilized polyethylene and ethylene vinyl acetate copolymers films in the two conditions of exposure.

In practice many factors reduce the correlation between the duration of a film used on a greenhouse and the duration of the same film exposed to artificial weathering. Among these it is appropriate to mention the use of anticryptogamics containing sulfur, that inhibits to some extent the protective action of HALS (Hindered Amine Light Stabilizer) and the contact of the film with the supports of the greenhouse that causes the overheating of the film and strongly reduce its duration.

Since the duration of a film on a greenhouse depends on the climatic characteristics of the zone in which the greenhouse is installed, it is useful to define three climatic zones, having different levels of global solar radiant exposure, as given in Table B.1.

An empirical correlation between durations of exposure to artificial weathering according to 8.9.2 using irradiance of $0,35 \text{ W}/(\text{m}^2 \cdot \text{nm})$ and durations of natural exposure of covering films on greenhouses is given in Table B.1 and Figure B.1.

Table B.1 — Correlation between the exposure to artificial weathering using xenon-arc lamps at $0,35 \text{ W}/(\text{m}^2 \cdot \text{nm})$ and natural weathering

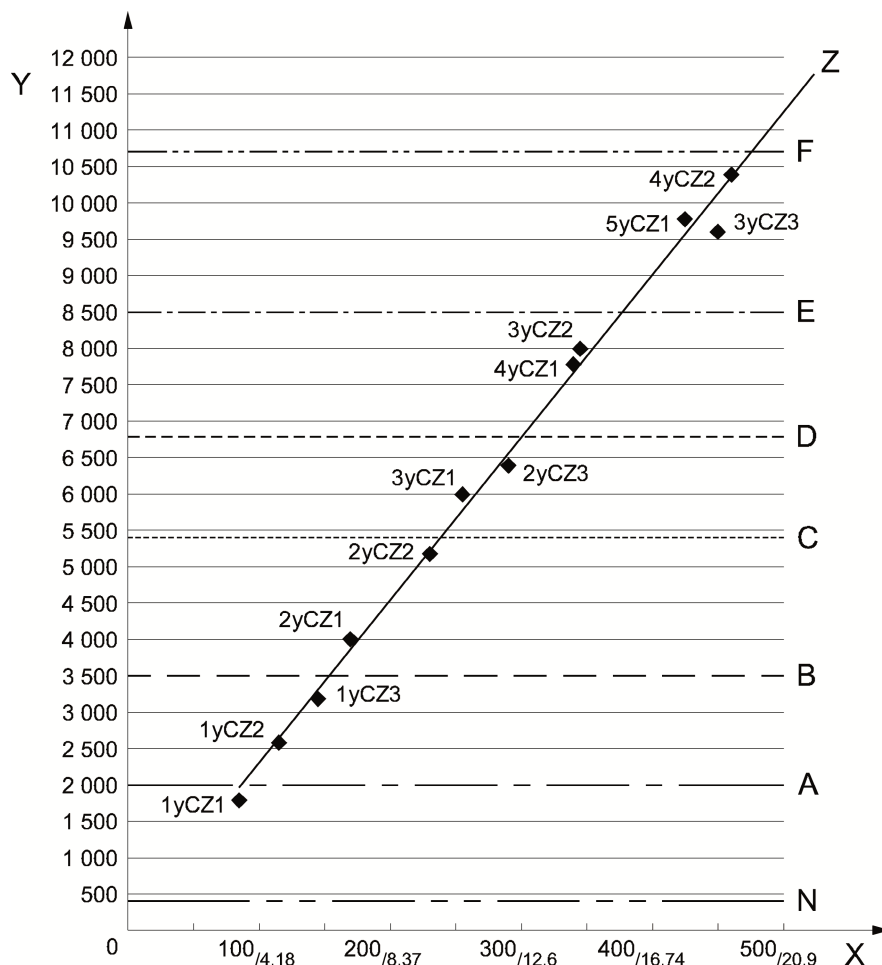
Climatic zone	Global solar radiant exposure $\text{GJ}/\text{m}^2/\text{year}$ (kLy/year)	Duration of exposure for an expected lifetime of			
		1 year (1y) h	2 years (2y) h	3 years (3y) h	4 years (4y) h
CZ1	up to 4,2 (up to 100)	2 000	4 000	6 000	7 800
CZ2	4,2 to 5,4 (100 to 130)	2 600	5 200	8 000	10 400
CZ3	5,4 to 6,7 (130 to 160)	3 200	6 400	9 600	—

1kLy = $0,04184 \text{ GJ}/\text{m}^2$

EXAMPLE Film classified D according to Table 2 with a thickness in the range $80 \mu\text{m}$ up to $200 \mu\text{m}$. When exposed to artificial weathering, the duration of the films according to 8.9 is 6 800 h.

For a natural exposure on greenhouses, the expected lifetime is:

- 3 years in the climatic zone CZ1;
- 2,5 years in the climatic zone CZ2;
- 2 years in the climatic zone CZ3.



Key

- X Global solar radiant exposure, expressed in kilolangleyes/gigajoules by square metre
- Y Duration of exposure to xenon-arc lamps, expressed in hours
- Z Linear correlation
- A, B, C, D, E, F, N Classes of resistance to weathering from Table 2

Point	Global solar radiant exposure		Duration of exposure to xenon-arc lamps h	Point	Global solar radiant exposure		Duration of exposure to xenon-arc lamps h
	kLy	GJ/m ²			kLy	GJ/m ²	
1yCZ1	85	3,55	1 800	4y CZ1	340	14,22	7 800
1yCZ2	115	4,81	2 600	3y CZ2	345	14,43	8 000
1yCZ3	145	6,07	3 200	5y CZ1	425	17,78	9 788
2yCZ1	170	7,11	4 000	3y CZ3	450	18,83	9 600
2yCZ2	230	9,62	5 200	4y CZ2	460	19,25	10 400
3yCZ1	255	10,67	6 000				
2yCZ3	290	12,13	6 400				

Figure B.1 — Correlation chart - Duration to exposure to xenon-arc lamps at 0,35 W/(m².nm) and global solar radiant exposure

Beside the class of durability as indicated in Table 2, the manufacturer should also provide threshold values of residual contaminants in films that shall not be exceeded in order to ensure that film characteristics are not adversely affected and that the durability guarantee is maintained. In case of early failure such contaminants residuals should be analysed on the failed area in order to establish whether the film has been exposed to chemical products and in which quantity. If one or more of the supplier provided threshold values are exceeded, the lower film duration cannot be ascribed to manufacturer's responsibility. Some typical contaminants are detected via chlorine and sulfur analysis

B.2 Exposure to medium pressure mercury vapour lamps

An empirical correlation between durations of exposure to artificial weathering according to A.1 and durations of natural exposure of covering films on greenhouses is given in Table B.2.

Table B.2 — Correlation between the exposure using medium pressure mercury vapour lamps and natural weathering

Climatic zone	Global solar radiant exposure GJ/m ² /year (kLy/year)	Duration of exposure for an expected lifetime of			
		1 year (1y) h	2 years (2y) h	3 years (3y) h	4 years (4y) h
CZ1	Up to 4,2 (Up to 100)	450	900	1 350	1 800
CZ2	4,2 to 5,4 (100 to 130)	600	1 200	1 800	2 400
CZ3	5,4 to 6,7 (130 to 160)	750	1 500	2 250	—

1kLy = 0,0418 4 GJ/m²

B.3 Exposure to fluorescent UV lamps

An empirical correlation between durations of exposure to artificial weathering according to A.2 and durations of natural exposure of covering films on greenhouses is given in Table B.3.

Table B.3 — Correlation between the exposure using fluorescent UV-A lamps and natural weathering

Climatic zone	Global solar radiant exposure GJ/m ² /year (kLy/year)	Duration of exposure for an expected life-time of			
		1 year h	2 years h	3 years h	4 years h
CZ1	Up to 4,2 (Up to 100)	1 362	2 724	4 086	5 448
CZ2	4,2 to 5,4 (100 to 130)	1 770	3 540	5 310	7 080
CZ3	5,4 to 6,7 (130 to 160)	2 180	4 360	6 540	8 720

1kLy = 0,04184 GJ/m².

Annex C (normative)

Determination of the chlorine content by coulometry

C.1 Principle

A sample of a thermoplastic film is subjected to an oxidative pyrolysis and the content of the chlorine detected in the gases given off is determined by coulometry. This test method applies to thermoplastics materials except for chlorinized polymers [9].

C.2 Apparatus and reagents

C.2.1 Elemental analyser apparatus¹⁾ with a module for the analysis of solid and liquid samples provided with a pyrolysis oven with input lines for gases (argon and oxygen of a purity higher than 99 %) and an automatic sample-holder introducer device that controls forward the movement in the oven and the dwell time in each area, a dehydrating tube and a gas collection system with reference electrodes and a titrator in a solution of glacial acetic acid buffered to pH 2 with sodium acetate.

Equivalent equipment may be used if they can be shown to lead to the same results

C.2.2 Ag counter electrode and reference electrode, regenerated and in contact with the respective solutions both in their interior and in their exterior.

C.2.3 Dehydrating solution.

C.2.4 Reference sodium chloride solution (N/200).

C.2.5 Chlorine reference, for example 2-chlorophenol (M = 128,45 (C₆H₅OCl), reference concentration (by weight): 500 mg/kg of 99,6 % richness in methanol).

C.2.6 Quartz boats.

C.3 Test procedure

C.3.1 General

The measuring system is absolute and the equipment testing described hereunder is only carried out in order to check that the system is operating properly.

The electrolytic balance potential is governed by Faraday's law:

$$E = E_0 + \frac{RT}{nF} \ln \frac{[Ag^+]}{[Ag]}$$

where

¹⁾ Model TOX-100 of Mitsubishi Chemical Corporation is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of this apparatus. Equivalent products may be used if they can be shown to lead to the same results.

E_o is the reference reduction-oxidation potential;

N is the number of electrons that reach the electrode;

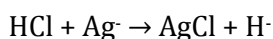
R is the gas constant;

F is Faraday's constant;

T is the temperature in Kelvin degrees, K.

The quantification of the total chlorine is carried out by introducing a sample in the pyrolysis tube under an argon gas atmosphere. The vaporization of the sample then takes place at high temperature (750 °C to 900 °C) and the chlorine is converted into hydrogen chloride (HCl). The product gases are dehydrated and cleaned in a dehydrating tube with the argon/oxygen carrier and they are conveyed to the titration cell.

When the hydrogen chloride is introduced in the cell, the following reaction takes place:



The changes in potential take place in accordance with Faraday's equation, the electrolytic current is applied to the working electrode in order to generate silver ions (Ag^+) and the titration is carried out:



The electrolysis current is balanced towards the base line when the titration has terminated.

C.3.2 Conditioning

The gas flows and oven temperatures are selected by choosing the most appropriate ones for the equipment used.

NOTE 1 Preferable conditions for the gas flows and oven temperatures are given in C.3.1.

The reference and working electrodes are prepared with their respective potassium nitrate and potassium chloride solutions and the titration cell with the acetic/acetate buffer.

The sulfuric acid dehydrating solution is purged with gas before starting the experiments so as to remove impurities. The titration cell is kept disconnected in order to avoid consumption of silver.

A suitable volume of NaCl is added to the titration cell (with continuous stirring) until a drop in potential takes place due to the presence of sufficient chlorine to start the titration.

Once the potential is regained, 10 µl of standard NaCl solution is added to the titration cell, the potential increases as the chlorine is titrated, and the system automatically detects the end of titration taking the values of final potential and gain as the analysis parameters.

The system is then ready to start the analyses.

The boat is cleaned.

The conditions for the introduction of the sample-holder shall be sufficient to achieve the cleanliness of the boat.

NOTE 2 Preferable conditions for the introduction of the sample holder are given in C.3.1.

C.3.3 Verification of the apparatus

The state of the system is verified by using a standard 2-chlorophenol solution.

10 µl of this solution is injected into the sample boat for the verification.

The conditions for the introduction of the automatic sample-holder shall be such that vaporization takes place before the pyrolysis.

NOTE Preferable conditions are given in C.3.1.

The concentration of chlorophenol in the solution, w , is calculated from the chlorine concentration obtained according to the following formula:

$$w = P \times \frac{M(\text{Chlorophenol})}{M(\text{Cl})}$$

where

P is Cl concentration in mg/kg

$M(\text{Chlorophenol})$ is the molecular weight of 2-chlorophenol $M = 128,45$ ($\text{C}_6\text{H}_5\text{OCl}$)

$M(\text{Cl})$ is the molecular weight of Cl $M = 35,453$ (Cl)

The concentration of chlorophenol obtained shall be within +10 % of the concentration by weight specified in the certificate of the reference or of the weight used. This test is performed in triplicate.

C.3.4 Sample analysis

The test sample shall have a weight between 10 mg and 20 mg, knowing that the smaller the weight is, the larger the number of repetitions of the test for each sample shall be. The detection limit of this test is 0,5 mg/kg.

The system automatically gives the chlorine content in μg .

Each sample shall be analysed at least in duplicate.

The conditions of introduction of the sample shall be the most appropriate ones according to C.3.2.

NOTE Preferable conditions are given in C.3.1.

C.4 Calculation and expression of the results

On the basis of the energy used for the determination, the quantity of chlorine ($\mu\text{g-Cl}$) is shown digitally on the basis of Faraday's Law.

The result is expressed as mg/kg of chlorine (Cl) in the sample if the concentration is lower than 1 000 mg/kg and as a percentage if it is higher than 1 000 mg/kg.

C.5 Test report

The test report shall include the following information:

- a) reference to this annex of EN 13206;
- b) complete identification of the sample tested;
- c) date of testing;
- d) sample analysis conditions;
- e) chlorine content value in mg/kg and/or %.

C.6 Precision

The precision of this test method is not known because inter-laboratory data are not available. When inter-laboratory data do become available, it is intended that a precision statement be added to a revision of this document.

C.7 Determination of chlorine in the presence of benzotriazole

In the case of presence of the UV absorbent additive benzotriazole (CAS no. 3896-11-5), in the sample to be analysed, the amount of chlorine from the (non-reactive) additive shall be quantified and subtracted from the total chlorine analysed in the sample. The result of this sum will be the chlorine content from external treatments which, due to its reactive nature may have an effect on the premature degradation of the covers and is that which have to be considered [10].

To determine whether or not a sample contains benzotriazole in its formula a UV spectrophotometry test shall be carried out on the sample. Should a UV absorption curve with two peaks of 315 and 360nm be observed, the presence of said additive will have been indicated.

To be able to quantify the amount of chlorine in the benzotriazole the content, p_1 , of the latter should first be calculated from the formula:

$$p_1 = \frac{A_a}{0,0644 \times \frac{200}{t}}$$

where

p_1 is Benzotriazole concentration in (mg/kg)

A_a is the area of UV Absorbance (ranging between 272 nm to 410 nm)

t is the sample thickness in μm

The amount of chlorine, p_2 , present in the benzotriazole will be calculated from the formula:

$$p_2 = p_1 \times 0,11$$

Annex D (normative)

Determination of the sulfur content by ICP- OES technique

D.1 Scope

The purpose of this method is the determination of S content in plastic materials using the ICP-OES technique [11].

D.2 Instruments and reagents

D.2.1 Instruments

- Microwave oven
- ICP Optical Emission Spectrometer equipped with autosampler and, possibly, a specific pumping system for internal standard addition
- Analytical balance

D.2.2 Reagents

- Concentrated nitric acid (65 %), Suprapur.
- Concentrated hydrochloric acid (36 %), Ultrapure.
- Ultrapure water (18 M Ω m).
- Certified reference monoelement sulfur (S).
- Certified reference monoelement yttrium (Y).
- Series of pipettes at different volume.
- A class pipette.
- Disposable test tubes for ICP autosampler.

D.3 Method of analysis

D.3.1 General principles of ICP-OES

In ICP-OES (Inductively Coupled Plasma-Optical (or Atomic) Emission Spectrometry), the sample is in liquid form and converted in aerosol (nebulization) once directed in the plasma. Subsequently, it is dissolved, vaporized, atomized and/or ionized.

Plasma consists of a highly ionized gas that contains neutral atoms, molecules (air/argon) and an equivalent number of ions and electrons.

As a result of the excitation, atoms and ions emit radiation at characteristic wavelengths; the radiation is converted into an electrical signal as a function of the concentration of the analyte in the sample.

D.3.2 Instrumental conditions

It is necessary to set all parameters according to the characteristics of the ICP-OES equipment (as example, see D.9.2):

- Plasma flow (argon);
- Auxiliary flow (argon);
- Nebulizer flow (argon);
- RF Power;
- Peristaltic pump;
- Temperature of the optics.

The optical part of the instrument has to be fluxed with nitrogen one hour before the analysis and always during the analysis.

The plasma has to be lit at least 10 min to 15 min before performing the analysis.

D.4 References preparation and calibration

D.4.1 General

Instrument calibration consists of analysing the “Calibration Blank” and the known references in order to build a calibration curve, based on which the results shall be expressed.

D.4.2 Calibration Blank preparation

According to the instrument conditions prepare a calibration blank solution acidified with HNO₃ (as example, see D.9.2).

D.4.3 Internal standard solution

Prepare a Y internal reference solution at a certain concentration acidified with HNO₃ (see D.9.2 as example).

D.4.4 S calibration reference

Prepare a series of calibration reference solutions acidified with HNO₃ in the range 0,5 mg/kg to 10 mg/kg of S. If the instrument is not equipped with an automated pumping system, add a fixed quantity of internal reference Y solution in each solution.

In case of high concentration samples outside the calibration reference curve, an appropriate further dilution will be required.

The calibration curve is calculated directly by the instrument’s software with a linear calibration algorithm.

Recalculate the S concentration in the samples according to the Y internal standard. The S concentration, P_s , is expressed from the equation:

$$P_s = \frac{W_s}{P}$$

where

W_s is the weight of S in mg

P is the weight of plastic in kg

D.5 Sample preparation (digestion)

A fixed amount of sample is accurately weighted in the vessel and placed on the microwave turntable, then the following reagents are added in this order:

X cm³ of HNO₃, 65 %

Y cm³ of HCl, 36 %.

The volume of acids and the amount sample used in the extraction phase has to be adjusted according to the microwave equipment used.

The vessel is hermetically sealed, put in the turntable, and placed into the microwave oven. Initiate the microwave digestion of the sample according to the manufacturer's instructions, (see D.9).

At the end of the extraction process, the vessel content is transferred into the disposable test tube for the ICP autosampler. Wash the tube and the plug at least twice and place the washing solution into the same test tube. If the instrument is not equipped with the automated pumping system, add a fixed quantity of internal standard Y to each solution and adjust the volume with water. Be aware certain ICP equipment operates by adding the internal reference directly into the sample or calibration solution via a specific pumping system. Therefore work according to the manufacturer's instructions.

The dosing of the internal reference solution shall be reproducible; it is very important that the same amount of the internal standard solution is always added.

D.6 Sulfur measurement

The dedicated method consists of analysing the element at two characteristic wavelengths, namely 181,975 nm and 180,669 nm, performing an axial reading (analytical reading zone is in front of the plasma with horizontal orientation), operating according to the specific plasma condition.

It is recommended to maintain the same concentration of references and sample solution, optimizing the sample weight and final volume of the solution according to instrument and autosampler.

D.7 Expression of results

The analysis will be done at least twice, and the result will be the arithmetic mean of the values obtained from the two repetitions. The sulfur content is expressed as p_s .

D.8 Sulfur determination in case of presence of Ni quenchers

For films containing a Ni quencher, the quantity of sulfur due to this is subtracted; therefore an analysis to calculate the sulfur content on an unexposed original sample has to be determined using the above method.

This quantity of sulfur will be subtracted from the total content found in the exposed sample.

D.9 Examples of conditions

D.9.1 Instrumental conditions ICP-OES

- Plasma flow (argon) 15 l/min
- Auxiliary flow (argon) 0,2 l/min

- Nebulizer flow (argon) 0,8 l/min
- RF Power 1 500 W
- Peristaltic pump 1,5 ml/min
- Temperature of the optics 30 °C

Microwave oven

- a) 500 W for 2 min (fan at speed 1)
- b) from 500 W to 1 100 W in 6 min, ramp rate 10 W/min (fan at speed 1)
- c) 13 min at 1 100 W (fan at speed 1)
- d) to 0 W for 15 min (fan at speed 3)

D.9.2 Internal preparation and Calibration Blank preparation

D.9.2.1 General

- 5 cm³ HNO₃ 65 % - ultrapure water to a final volume of 50 cm³.

D.9.2.2 Internal reference solution

1 cm³ of certified standard mono-element Yttrium (Y) 1 000 mg/l + 10 cm³ of HNO₃ 65 % to a final volume of 250 ml using ultrapure water in a volumetric flask. This solution has to be added directly to the standard and sample solutions only if the instrument is not equipped with the automated adding system.

D.9.2.3 Calibration reference solution

The references are prepared as follows:

2,5 cm³ of the 1 000 mg/kg S reference is diluted to 50 cm³ with ultrapure water, giving a 50 mg/kg standard, known as the 'mother reference solution' (mss).

The following secondary references are obtained from the mother reference solution (mss):

- 0,5 cm³ mss for the 0,5 mg/kg standard
- 2,5 cm³ mss for the 2,5 mg/kg standard
- 5 cm³ mss for the 5 mg/kg standard
- 10 cm³ mss for the 10 mg/kg standard

To all of the standards add 5 cm³ of HNO₃ 65 % + 5 cm³ of the Y internal reference solution, then add ultrapure water to a final volume of 50 cm³. Certain ICP equipment operates via adding the internal reference directly into the sample or calibration solution via a specific pumping system. Therefore work according to the manufacturer's instructions.

Annex E (informative)

Alternative method for the determination of chlorine and sulfur contents by X-ray fluorescence

E.1 Principle

A sample of a thermoplastic film is exposed to short length X-ray and the content of chlorine or sulfur detected is determined by the energy of the emitted photon that is characteristic of the element and represents the abundances of chlorine or sulfur element, present in the sample.

E.2 Introduction

XRF (X-ray fluorescence spectroscopy or X-ray fluorescence) is a non-destructive analytical technique that permits to know the elementary composition of a sample.

E.3 Apparatus

E.3.1 Equipment

X-ray fluorescence analyser for example:

- ARL OPTIM X XRF or equivalent²⁾.

Equivalent equipment may be used if they can be shown to lead to the same results.

E.3.2 Sample holder

Cassette for solid or dust sample: The sample is placed and centred in the cassette. It is very important to put the cover on and to turn it clockwise until the stopper is reached. Then the cassette can be put onto the sample changer with the sample looking down.

E.4 Test procedure

The test procedure shall be followed according to the instructions of the equipment.

E.5 Calculation and expression of the result

When analysis is completed, the system gives the chlorine or sulfur content automatically after that mass and density of sample is inserted. The calculations are carried out with the calibration curve produced. The result is expressed as a percentage of chlorine or sulfur in the sample.

²⁾ ARL OPTIM X XRF of Thermo Fisher Scientific, Inc. is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of this apparatus. Equivalent products may be used if they can be shown to lead to the same results.

E.6 Test report

The test report shall include the following information:

- a) reference to this annex of EN 13206;
- b) complete identification of the sample tested;
- c) date of testing;
- d) sample analysis conditions;
- e) chlorine or sulfur content expressed in mg/kg.

Annex F (informative)

Alternative methods for the determination of sulfur content by ultraviolet fluorescence method or by coulometry

F.1 Principle

This annex describes two methods to detect the content of the sulfur in a sample of a thermoplastic film:

- Method A: Ultraviolet fluorescence method ;
- Method B: Coulometry.

These test methods are applicable when the sulfur content is less than 10 %.

F.2 Ultraviolet fluorescence method

F.2.1 Principle

A sample of a thermoplastic film is subjected to an oxidative pyrolysis and the content of sulfur detected in the gases given off is determined by ultraviolet fluorescence.

F.2.2 Apparatus

F.2.2.1 Elemental analyser apparatus³⁾ with a module for the analysis of solid and liquid samples provided with a pyrolysis oven with input lines for gases (argon and oxygen of a purity higher than 99 %) and an automatic sample-holder introducer device that controls forward movement in the oven and the dwell time in each area in order to vaporize the sample, with a gas dehydration system and a sulfur detector.

F.2.2.2 Sulfur reference: dibutyl sulfur ($C_8H_{18}S$, $P_m = 146,15$ g/mol, when the richness is 96 %, its density is 0,838 g/l).

F.2.2.3 Quartz boats and tweezers.

F.2.2.4 25 µl microsyringes, 5 ml, 10 ml and 20 ml pipettes, 50 ml and 100 ml measuring flasks.

F.2.2.5 Toluene.

F.2.2.6 Analytical balance, with an accuracy of $\pm 0,05$ mg.

³⁾ Model TS-100 of Mitsubishi Chemical Corporation is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of this apparatus. Equivalent products may be used if they can be shown to lead to the same results.

F.2.3 Preparation of reference solutions

A series of reference solutions are prepared from dibutyl sulfide by dilution in toluene. Table F.1 gives, for example, possible series for the sulfur content, although there may be variations depending on the expected sulfur concentration and on the sensitivity that is going to be used in the apparatus.

Table F.1 — Reference solutions

Reference solutions µg/ml

Low sensitivity	Medium sensitivity
900	90
1 800	180
3 600	450
-	900

The volume of reference solution injected in the sample boat for the calibration is 10 µl, taking special care that there are no bubbles.

The conditions for introduction of the boat into the system shall be such that vaporizing occurs before the pyrolysis.

The system saves the calibration automatically. It is recommended to verify the correct operation of the system by periodic checks, paying special attention to the monitoring of the response by mass (counts/nanogram injected) and that there are no losses of sensitivity due to dirtying.

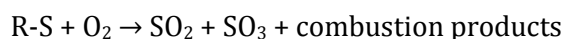
F.2.4 Preparation of samples

It is recommended to use pellet, extruded spaghetti or film to ensure the homogeneity of the sample. The weight of the sample to be tested shall be between 10 mg and 20 mg, taking into account that the lower the weight the higher the number of test repetitions will have to be for each sample (which will have to be done in duplicate at least).

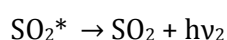
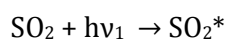
NOTE Preferable conditions for the introduction of the sample into the oven are given in F.2.5.

F.2.5 Test procedure

The detection of total sulfur is carried out by introducing the sample, at a constant rate, into the pyrolysis tube with an argon gas carrier current. The vaporization of the sample takes place at high temperature (800 °C to 1100 °C) and the sulfur present in the sample is pyrolyzed and oxidized in the presence of O₂ gas:



Once the gases have been dehydrated, the SO₂ gas is excited (SO₂^{*}) by means of irradiation with ultraviolet light with a wavelength of 190 nm to 230 nm (corresponding to a frequency ν_1). The SO₂^{*} emits energy (fluorescent radiation in ultraviolet) and recovers the initial state.



The ultraviolet radiation of frequency ν_2 is received in the photomultiplier, the value of the area is integrated by means of a mathematical process and the sulfur concentration is obtained using the calibration curve produced with references of known concentration.

F.2.6 Calculation and expression of results

When the analysis is completed, the system gives the sulfur content automatically.

The calculations are carried out with the calibration curve produced.

The result is expressed as mg/kg of sulfur in the sample if the concentration is lower than 10 000 mg/kg and as a percentage if it is higher than 10 000 mg/kg. When the nature of the sulfur compound that it contains is known, this sulfur value may be converted into compound content by applying its sulfur richness percentage.

F.2.7 Test report

The test report shall include the following information:

- a) reference to this annex of EN 13206 and to the Method A;
- b) complete identification of the sample tested;
- c) date of testing;
- d) sample analysis conditions;
- e) sulfur content value in mg/kg and/or %.

F.2.8 Precision

The precision of this test method is not known because inter-laboratory data are not available. When inter-laboratory data do become available, it is intended that a precision statement be added to a revision of this document.

F.3 Coulometry

F.3.1 Principle

A sample of a thermoplastic film is subjected to an oxidative pyrolysis and the content of sulfur detected in the gases given off is determined by coulometry.

F.3.2 Apparatus

F.3.2.1 Elemental analyser apparatus⁴⁾ with a module for the analysis of solid and liquid samples provided with a pyrolysis oven with input lines for gases (argon and oxygen of a purity higher than 99 %) and an automatic sample-holder introducer device that controls forward movement in the oven and the dwell time in each area in order to vaporize the sample, with a gas dehydration system and a sulfur detector.

F.3.2.2 Sulfur reference: dibutyl sulfur ($C_8H_{18}S$, $P_m = 146,15$ g/mol, when the richness is 96 %, its density is 0,838 g/l).

F.3.2.3 Quartz boats and tweezers.

⁴⁾ Model TOX-100 of Mitsubishi Chemical Corporation is an example of a suitable apparatus available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of this apparatus. Equivalent products may be used if they can be shown to lead to the same results.

F.3.2.4 25 µl microsyringes, 5 ml, 10 ml and 20 ml pipettes, 50 ml and 100 ml measuring flasks.

F.3.2.5 Toluene.

F.3.2.6 Analytical balance, with an accuracy of ± 0,05 mg.

F.3.2.7 Sensor electrode for sulfur and reference electrode, regenerated and in contact with the respective solutions.

F.3.2.8 Electrolyte, composed of acetic acid 0,1N, to which 0,05 % of sodium azide is added to buffer the medium and potassium iodide to establish the tri-iodo-ion-iodide redox balance which determines the oxidation of SO₂ to SO₃.

The end point of the test is established previously with sodium bisulfite.

F.3.2.9 Dehydrating solution, for combustion gases.

F.3.3 Preparation of reference solutions

A series of reference solutions are prepared from dibutyl sulfide by dilution in toluene. Table F.2 gives, for example, possible series for the sulfur content, although there may be variations depending on the expected sulfur concentration and on the sensitivity that is going to be used in the apparatus.

Table F.2 — Reference solutions

Reference solutions µg/ml

Low sensitivity	Medium sensitivity
900	90
1 800	180
3 600	450
-	900

The volume of reference solution injected in the sample boat for the calibration is 10 µl, taking special care that there are no bubbles.

The conditions for introduction of the boat into the system shall be such that vaporizing occurs before the pyrolysis.

The system saves the calibration automatically. It is recommended to verify the correct operation of the system by periodic checks, paying special attention to the monitoring of the response by mass (counts/nanogram injected) and that there are no losses of sensitivity due to dirtying

F.3.4 Preparation of samples

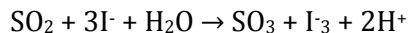
It is recommended to use pellet, extruded spaghetti or film to ensure the homogeneity of the sample. The weight of the sample to be tested shall be between 10 mg and 20 mg, taking into account that the lower the weight the higher the number of test repetitions will have to be for each sample (which will have to be done in duplicate at least).

NOTE Preferable conditions for the introduction of the sample into the oven are given in F.3.5.

F.3.5 Test procedure

Once dehydrated the combustion gases are conveyed to the titration cell with the carrier gas. The electrochemical equilibrium potential is governed by the Nernst equation.

The reaction which takes place is:



The changes in potential conform to the Nernst equation; the electrolytic current is applied to the working electrode to generate I_3^- ions. The current ceases when the determination has terminated.

The electrodes and titration cell are prepared with the respective solutions and the potential is adjusted.

The system is purged with gas and the boat is cleaned.

F.3.6 Calculation and expression of results

When the analysis is completed, the system gives the sulfur content automatically.

The calculations are carried out with the calibration curve produced.

The result is expressed as mg/kg of sulfur in the sample if the concentration is lower than 10 000 mg/kg and as a percentage if it is higher than 10 000 mg/kg. When the nature of the sulfur compound that it contains is known, this sulfur value may be converted into compound content by applying its sulfur richness percentage.

F.3.7 Test report

The test report shall include the following information:

- a) reference to this Annex of EN 13206 and to the Method B;
- b) complete identification of the sample tested;
- c) date of testing;
- d) sample analysis conditions;
- e) sulfur content value in mg/kg and/or %.

F.3.8 Precision

The precision of this test method is not known because inter-laboratory data are not available. When inter-laboratory data do become available, it is intended that a precision statement be added to a revision of this document.

Annex G (informative)

Guidance for installation, use and disposal of covering films

G.1 Greenhouse covering films

G.1.1 Installation instructions

G.1.1.1 Worksite preparation

The greenhouse structure shall comply with the following requirements:

- a) for metal frame greenhouses, the metal tubes shall be carefully trimmed and galvanized according to EN 13031-1. The tubes shall not have any sharp angles likely to cause tears in films and shall not be treated with chemicals that might alter the film properties;
- b) for wood frame greenhouses, the frame components shall be surfaced and sanded and shall not have any sharp angles. The user shall ascertain that the nature of the wood and its treatment products are not likely to alter the film properties;
- c) wire meshes or wires shall be galvanized and belong to class C according to EN 10244-2. Replace any wires that show traces of rust. Arrange the wires in accordance with the instructions provided by the structure manufacturer/supplier. They shall be sufficient in number for the film to fit as closely as possible to the hoop curve. Uniformly tighten the wires so that they do not vibrate against the film or risk perforating it;
- d) for plastic ties and straps, the same general principles regarding their arrangement, number and tightness apply;
- e) using black or dark-coloured ties and straps, which can lead to thermal degradation of the covering film, is to be avoided.
- f) If two tunnel greenhouses are to be installed adjacent to one another, plan for sufficient space between the two to allow the films to be entrenched, so that they can be properly stretched.

The grower shall demonstrate that the type of metal frames and wire meshes/wires as specified in a) or c), respectively, was used.

G.1.1.2 Film installation

Place the film in calm weather at a temperature between 15 °C and 30 °C.

Comply with the manufacturer/supplier instructions regarding the installation direction if there is a difference between the inside and outside surfaces of the film.

Before unrolling the roll or sheet, make sure there are no objects on the ground that are likely to cut or perforate the film. Remove them if necessary.

Do not walk directly on the film or set objects used for assembly, such as ladders, down on it.

The film should be sufficiently tight to avoid any flapping in the wind, but not excessively so. Inappropriate tightness can lead to premature mechanical degradation of the film.

For tunnels with installed across film, roll widths shall overlap by at least 50 cm and covering shall be patterned in the direction opposite to that of prevailing winds.

For tunnels with longitudinally installed film, distribute tension in the film evenly by using intermediate fasteners, tensioning devices or slatting.

For greenhouse-type tunnel enclosures, entrench the films at 50 cm to 60 cm from the sidewall.

NOTE If the film is installed too close to the greenhouse sidewall, it will have a tendency to slip back into the greenhouse during hilling.

If the film is to be nailed to a support, use a wooden strip that is at least as wide as the support, and galvanized or copper nails.

If the film is attached with clips, make sure it is not damaged during clip installation.

No equipment inside the greenhouse, such as irrigation or heating pipes, shall touch the film in order to avoid any risk of thermal degradation of the film.

The film installation date shall be recorded in the growth record/farm register.

For “parral” (Almería) type greenhouses, install the film between the two wire mesh, making sure that no wires or salient points can damage the film during the installation. Fix the film points to the structure with galvanized wire to prevent damage due to wind action. Do not stretch the film after having fixed these points of wire, because it can produce holes and tears in those areas.

Leave an overlap between the plies of at least 50 cm to avoid break due to wind.

If whitening is performed when the solar radiations are at their highest level, products shall have no detrimental effect on the durability of the thermoplastic material. The whitening cleaning should be done with water or non-acidic aqueous products.

G.1.1.3 Film protection

Immediately after installation, the outside surface of the film shall be protected straight on the supports, whatever their type, using an opaque layer of white, vinyl acrylic paint, especially designed for this purpose.

Emulsion paints using an organic solvent or a mixture of organic solvents shall not be used.

Painting shall take place in dry weather and a layer that is sufficiently opaque and homogeneous to mask the support shall be applied.

NOTE The paint layer prevents against heating up of the frame work and consequently of the film.

G.1.2 Use conditions

G.1.2.1 Ventilation

Appropriate ventilation of the greenhouse, even when no crops are present, is necessary to avoid excessive internal overheating, which would adversely affect film longevity outside the solarisation or fumigation period, if relevant.

CAUTION — For cross cladding tunnels, use spreaders that are not likely to damage the film.

G.1.2.2 Film tightness

Regularly inspect that the film is tight enough during its use, and if necessary re-stretch it to avoid wind flapping against the structure or to avoid water pockets.

Inappropriate tightness of films can lead to premature mechanical degradation.

G.1.2.3 Film maintenance

Visually verify that the layers of paint masking the structures are opaque.

Regularly check paint quality and repaint, if necessary.

Use preferably water to clean shading products.

G.1.2.4 Plant protection products

Avoid contact between the films and/or structures and pesticides or fumigants.

Care shall be taken during chemicals treatment of crops in order to prevent stagnation of chemicals on the wires.

For details on lifetime limits in relation with plant protection products, see G.1.3.4.

G.1.2.5 Periodical inspections

Inspect periodically the film and greenhouse appearance and implement the appropriate action correctives if necessary.

G.1.2.6 Pollinators

Some plastic greenhouse covering newly installed (up to four months to five months during the winter or to the second month to the third month in summer) have very high absorption of solar UV radiation, to ensure longevity. This can cause some initial disorientation of pollinators, which is solved once the insect appropriate to the medium and/or after that initial period.

The greater the duration of plastics, the greater is the absorption presented at the beginning of plastic life. In these conditions the initial disorientation that insects present, can be very high.

Some practices can help the pollinator to suit as fast as possible to these conditions when the cover film is new including:

- performing a film whitening if there is a high amount of direct light (very transparent film);
- try lowering the temperature of the greenhouse ventilating to near optimal pollination parameters: relative humidity 70 % and temperature of 15 °C to 30 °C. If the temperature of the hive is excessive, pollinators will work to ventilate it, without performing other functions (put a hat on top of the hive can solve this problem)
- an increase in the population (number of hives per surface) can correct initial deficiencies in pollination, if there is any.

Multiple factors can affect the bumble bee pollination efficiency among which are:

- crop flowering state: a bad flower development can cause poor pollination;
- climatology: humidity and temperature conditions different from optimal, can produce a bad pollination;
- pesticides: it is one of the most important factors that limit the use of pollinators. Many of pesticides act as repellents bees and bumblebees, and in some cases, can cause death of them;
- quality pollen: An excess of moisture will cause caking of pollen, making it difficult to remove;
- hives location: hives shall be in an accessible location and a comfortable height.

G.1.3 Durability of greenhouse covering films

G.1.3.1 General

Annex A provides information on the empirical correlation between durations of covering films exposed to artificial ageing and a natural exposure.

According to professional practices, the durability (or time to failure) of greenhouse covering films is expressed in years ("2-year" films, "3-year" films, etc.) or seasons ("2-season" films, "3-season" films, etc.), as defined in G.1.3.2.

G.1.3.2 Convention for seasons

For greenhouse covering films, the following convention applies:

- summer period: period starting on 1st June and finishing on 31st August of the same year;
- winter period: period starting on 1st September and finishing on 31st May of the next year;
- "*n*-season" film: film with a conventional expected lifetime of *n* winter periods plus *n*-1 summer periods.

G.1.3.3 Abnormal weather conditions

Abnormal weather conditions are defined as follows:

- the wind force exceeds gale force 8 on the Beaufort scale (mean speed of 62,4 km/h and maximum gust speeds below 73,6 km/h);
- loads resulting from snow are above those defined in EN 13031-1;
- wind causes ice to be projected, which can cut the films; this ice can come from a layer of water frozen on the outside surface of greenhouse films, or;
- violent hail storms.

If necessary, information regarding meteorological conditions at a given date can be obtained from an official meteorological station closed to the installation site.

G.1.3.4 Durability of greenhouse covering films

Unless agreed between the manufacturer/supplier and the customer, the remaining use potential is assessed as follows.

The conventional expected lifetime of covering films shall correspond with the value specified by the manufacturer/supplier, expressed in years or seasons, as relevant. In the event of abnormal weather conditions, as defined in G.1.3.3, or non-compliance with recommendations for installation and use, mentioned by the manufacturer or defined in G.1.1 and G.1.2, the remaining use potential is considered as zero.

If for any reason (film failure, accident, non-compliance with installation and use conditions, etc.) the film is not used during the expected useful lifetime of *n*-years, the remaining use potential is the ratio of the remaining lifetime to the conventional expected lifetime, expressed in months.

If for any reason (film failure, accident, non-compliance with installation and use conditions, etc.) the film is not used for the conventional expected lifetime of *n*-seasons, the use ratio and the remaining use potential are defined by prorating the conventional expected lifetime expressed as a number of seasons for the *n*-1 first seasons and as a monthly proportion for the last season.

EXAMPLE 1 “4-season” film

During the period between installation month and installation month + 12 months, the film use ratio is 0 % and the remaining use potential is three seasons.

During the period between 1st July of year (A+1) and 30th June of year (A+2), the film use ratio is 25 % and the remaining use potential is two seasons.

During the period between 1st July of year (A+2) and 30th June of year (A+3), the film use ratio is 50 % and the remaining use potential is one season.

During the period between 1st July of year (A+3) and 31st May of year (A+4), the use ratio of the film is expressed in proportion of the number of months that have passed since 1st September of year A.

The conventional expected lifetime of covering films shall correspond with the value specified by the manufacturer/supplier expressed in years, seasons or months.

If the conventional expected lifetime is expressed in season(s) the conversion in months is as follow:

$$n \text{ seasons} = [(12 \times n) - 3] \text{ months}$$

i.e. 4-seasons = 45 months; 3-seasons = 33 months; 2-seasons = 21 months; 1-season = 9 months

Unless agreed between the manufacturer/supplier and the end-user/customer the remaining use potential (RUP) is assessed as following:

- a) Case 1: in the event of abnormal weather conditions, as defined in G.1.3.3, or non-compliance with the installation instructions according to G.1.1 or use conditions according to G.1.2, the remaining use potential (RUP) = 0.
- b) Case 2: in case of failure of the film in normal weather conditions (see G.1.3.3) and if installation instructions according to G.1.1 and use conditions according to G.1.2 haven been met, the remaining use potential (RUP) is calculated as following:

- 1) Step 1: determination of the installation months for n -seasons films

For a n -seasons film installed during the year A, by convention:

- if the film is installed before the 1st of September, year A; the installation month is considered as September, year A-1,
- if the film is installed between the 1st of September, year A and the 31st of December, year A, the installation month is considered as September, year A.

- 2) Step 2: calculation of remaining use potential (RUP)

If the film failure appears N months after the installation month as defined in step 1, the remaining use potential (RUP) is calculated as follows:

- For a n -seasons film: $RUP = [[(12 \times n) - 3] - N] / [(12 \times n) - 3]$

- For a n -years film: $RUP = [(12 \times n) - N] / (12 \times n)$

If the value obtained by this calculation is negative then $RUP = 0$

The RUP value has to be used to determine the residual value of film in case of premature degradation.

EXAMPLE 2

4-seasons film installed on a greenhouse in July 2010;

If a film failure in compliance with the requirements specified in G.1.3.3, G.1.1 and G.1.2 appears in September 2012, then the installation month is September 2009;

$$RUP = [[(12 \times 4) - 3] - 36] / [(12 \times 4) - 3] = (45-36)/45 = 9/45 = 0,2$$

With $n = 4$ and $N = 36$ (number of months between Sept 2009 and Sept 2012)

EXAMPLE 3

3-years film installed on a greenhouse in October 2010;

If a film failure in compliance with the requirements specified in G.1.3.3, G.1.1 and G.1.2 appears in November 2012, then the installation month is October 2010;

$$RUP = [(12 \times 3) - 25] / (12 \times 4) = (36-25)/48 = 11/48 = 0,30$$

The calculation is not modified if the film is removed during summer periods, which is often the case for “2-season” films, i.e. a durability guarantee of 18 months. The use potential is 18 consecutive months starting from the date of the first installation.

If films are uninstalled during the summer period, roll up the film once it is dry and store it away from sunlight and heat. The presence of humidity combined with exposure to sunlight can damage the films, e.g. difficulty unrolling it.

G.1.3.5 Crop protection products

The use of crop protection products (herbicide, fungicides, insecticides, nematicides) can release chemical compounds that adversely affect the effectiveness of the stabilizers against UV radiation and base polymer effectiveness. It is important to follow certain recommendations:

- comply with the dosages and frequencies of treatment recommended, limiting to the minimum the use of pesticides, particularly those who have in their composition sulfur and / or chlorine;
- perform the applications of pesticides on the crop and not on the plastic films. Prevent accumulation of pesticides in the contact points of the structure of the greenhouse with the films;
- ventilate greenhouse as quickly, as possible;
- cover the ground with plastic film that have barrier properties to prevent the attack of the disinfectant to the plastic cover, if the soil chemical disinfection is effectuated;
- ventilate the greenhouse when removing the film for disinfection.

The threshold values of residual sulfur and chlorine contents in films shall not exceed those that have been agreed between the manufacturer and the customer, in order to ensure that film characteristics are not adversely affected and that the guarantee of durability is maintained.

The residual sulfur and chlorine contents shall be determined according to the methods as specified in 8.10 and 8.11, respectively.

G.2 Low tunnel covering films

G.2.1 Use

These films are intended for covering low tunnels, i.e. row covers with a height lower than 1 m, that provide temporary crop covering (semi-forcing).

G.2.2 Installation instructions

G.2.2.1 Worksite preparation

Check the surface condition of the hoops and remove any rough edges, including rust, that might perforate or cut the film.

G.2.2.2 Installation of the film

Install the film, either manually or mechanically, in calm weather at a temperature between 10 °C and 25 °C.

Adjust the film tension (see G.1.1.2) according to the temperature: the film tension will be higher by cold weather and lower in hot weather.

Stretch the film sufficiently over the arches to avoid any flapping against the arches. If the film is improperly tightened, mechanical resistance of the film will be affected.

The maximum space between two consecutive arches shall comply with manufacturer/supplier recommendations.

Arches shall be installed and set at the same height.

The film installation date shall be recorded in a growth record/farm register.

G.2.3 Use conditions

G.2.3.1 Ventilation

Make sure not to fold the film too tightly when it is lifted to provide tunnel ventilation in order to prevent the risk of sticking.

G.2.3.2 Removal for subsequent use

PRECAUTIONS FOR REMOVAL — carefully roll up the dry film and store it away from sunlight and heat.

The presence of humidity combined with exposure to sunlight can cause the film to deteriorate, e.g. difficulty unrolling it.

G.2.3.3 Regular inspections

Check the condition of film and low tunnel on a regular basis and take the necessary protective measures if there is a fault.

G.2.3.4 Durability of low tunnel covering films

Annex A provides information on the empirical correlation between durations of covering films exposed to artificial ageing and a natural exposure.

The conventional expected lifetime of low tunnel covering films shall correspond with the value specified by the manufacturer/supplier, except in the event of abnormal weather conditions, as defined in G.1.3.3. The maximum conventional lifetime is:

— six months after laying out date for “1-season films”;

- twice six months for “2-season” films, with removal and storage during summer period (1st June to 30th September) under the conditions specified in G.2.3.2.

If for any reason (film failure, accident, noncompliance with installation and use conditions, etc.) the film is not used for the entire useful lifetime, the use ratio and remaining use potential are defined as a proportion of the conventional useful lifetime.

G.3 Removal instructions

For the recovery of used plastic films and sheets, whatever the means [material recovery through mechanical recycling (reclaiming) or energy recovery through direct and controlled combustion], contaminants inherent to the use of films and sheets in agriculture and horticulture (primarily water, plant material, soil particles that cling to the films/sheets) should be reduced to a minimum. To that end, care shall be taken when the plastic films and sheets are removed.

The presence of other contaminants, such as metals, wood, pebbles, paper, cardboard, adhesives, tyres, textiles, grease or paint found around farms shall also be proscribed.

To optimize recovery, measures shall be implemented to avoid:

- a) mixing films/sheets made from differing plastic materials, as these materials are not always compatible for material recovery;
- b) mixing coloured films/sheets (black, green, white, brown, etc.) with colourless or translucent films/sheets;
- c) mixing thin films/sheets with thick films/sheets where they are both present at the same farming site or at a pooling area; films and sheets shall be stored in application family groups, i.e. silage films, covering films, mulching films, etc.;
- d) dragging the films/sheets over the ground.

Wherever possible, films/sheets should be removed in dry weather.

Films/sheets that have been removed shall be stored at the farming site on pallets or in very large crates (pallet boxes) in a location protected from adverse weather conditions.

Films/sheets that have been removed shall be stored at pooling sites on cement surfaces or in coated and fenced-in areas to prevent films from being dispersed in the environment.

Film/sheet removal instructions are given in this subclause keeping in mind that minimum technical requirements issued by the companies/organizations that collect films are available on their websites.

Do not mix yellow films with colourless films.

Fold the films (like bed sheets) or roll them up after first reducing their size through folding in one, or even both directions. The films that have thus been folded or rolled can then be secured with ties (e.g. made of polypropylene) that keep them in place.

For removal of films installed on tunnels, the entrenched parts of the films shall be separated and shall not be mixed with the recovered films. Furthermore, spreaders should not be collected along with the films.

For films removed from greenhouse units, clipping accessories should not be collected.

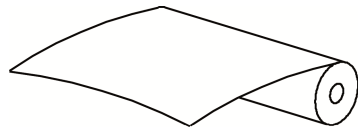
Annex H
(informative)

Industrial standard formats of films

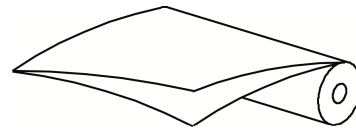
Films are supplied in the following industrial standard formats:

a) in rolls: flat film (Figure H.1a), centre-folded film (Figure H.1b), tubular film (Figure H.1c), film or tubular film folded in four (or gusseted) (Figure H.1d), film or tubular film folded in eight (Figure H.1e), film folded in C-shape in four (Figure H.1f), film folded in C-shape in six (Figure H.1g) or film folded in C-shape in eight (Figure H.1h);

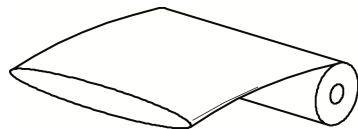
b) in sheets.



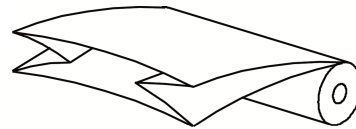
a) Flat film



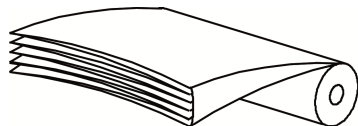
b) Centre-folded film



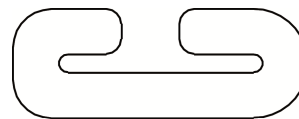
c) Tubular film



d) Film or tubular film folded in four



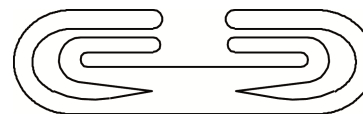
e) Film or tubular film folded in eight



f) Film folded in C-shape in four



g) Film folded in C-shape in six



h) Film folded in C-shape in eight

Figure H.1 — Industrial standard film formats

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