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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds

**Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques –
Partie 406: Essais divers – Résistance des mélanges polyéthylène et polypropylène aux craquelures**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC AND OPTICAL FIBRE CABLES – TEST METHODS FOR NON-METALLIC MATERIALS –

Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds

FOREWORD

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International Standard IEC 60811-406 has been prepared by IEC technical committee 20: Electric cables.

This Part 406 of IEC 60811 cancels and replaces Clause 8 of IEC 60811-4-1:2004, which is withdrawn. Full details of the replacements are shown in Annex A of IEC 60811-100:2012.

There are no specific technical changes with respect to the previous edition, but see the Foreword to IEC 60811-100:2012.

The text of this standard is based on the following documents:

FDIS	Report on voting
20/1290/FDIS	20/1339/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part of IEC 60811 shall be used in conjunction with IEC 60811-100.

A list of all the parts in the IEC 60811 series, published under the general title *Electric and optical fibre cables – Test methods for non-metallic materials*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The IEC 60811 series specifies the test methods to be used for testing non-metallic materials of all types of cables. These test methods are intended to be referenced in standards for cable construction and for cable materials.

NOTE 1 Non-metallic materials are typically used for insulating, sheathing, bedding, filling or taping within cables.

NOTE 2 These test methods are accepted as basic and fundamental and have been developed and used over many years principally for the materials in all energy cables. They have also been widely accepted and used for other cables, in particular optical fibre cables, communication and control cables and cables for ships and offshore applications.

ELECTRIC AND OPTICAL FIBRE CABLES – TEST METHODS FOR NON-METALLIC MATERIALS –

Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds

1 Scope

This Part 406 of IEC 60811 gives the procedure for evaluating the resistance to stress cracking of polyethylene and polypropylene compounds which are typically used for communication and optical fibre cables.

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.

IEC 60811-100:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 100: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60811-100 apply.

4 Test method

4.1 General

This part of IEC 60811 shall be used in conjunction with IEC 60811-100.

Unless otherwise specified, tests shall be carried out at room temperature.

Two test procedures can be applied to materials, depending on cable system conditions and environments; a summary of test conditions is given in Table 1:

– for less severe conditions: Method A;
– for more severe conditions: Method B.

These test procedures apply only to the original granules used as sheathing materials.

Table 1 – Summary of test conditions and requirements

Conditions and/or requirements		Method A	Method B
Preparation of the test sheets:			
– Temperature	°C	165 to 170	
– Force	kN	50 to 200	
– Time	min	2	
Conditioning of test sheets:			
– Temperature range	°C	See [a]	
– Cooling rate	K/h	5 ± 2	
Test conditions:			
– Reagent [b] – Concentration	%	100	10
– Temperature	°C	50,0 ± 0,5	
– Duration (minimum)	h	24	48
Requirements:			
– Failure rate	Max.	5 test pieces (F 50)	0 test pieces (F 0)

[a] Starting temperature varies according to polymer type:

- (145 ± 2) °C for low-density polyethylene;
- (155 ± 2) °C for medium-density polyethylene;
- (165 ± 2) °C for high-density polyethylene.

Final temperature (29 ± 1) °C.

[b] Igepal CO-630 or any other reagent having the same chemical composition.

4.2 Method A

4.2.1 Reagent

The reagent is a solution of 100 % Igepal CO-630 (Antarox CO-630) or any other reagent having the same chemical composition (see Notes 1 and 2 below and Annex B).

NOTE 1 The reagent should not be used more than once.

NOTE 2 In the case of unexpectedly short failure times, the reagent should be checked for water content as small increases in water content beyond the specified maximum of 1 % will cause a significant increase in reagent activity.

4.2.2 Apparatus

The apparatus shall comprise the following elements:

a) Clean, sharp, undamaged blanking die with blanking press suitable for cutting test pieces (38,0 ± 2,5) mm × (13,0 ± 0,8) mm or other suitable devices.

b) Dial gauge, with plane gauging faces 4 mm to 8 mm in diameter and a gauging pressure of 5 N/cm^2 to 8 N/cm^2.

c) Notching devices as in Figure 1 with blades as in Figure 2.

NOTE The blade is made of “Gem” blades as in Figure 2 – see also Annex A.

d) Bending clamp assembly as in Figure 3 with a vice or other suitable device ensuring the symmetrical closing of the clamping jaws.

e) Transfer tool assembly as in Figure 4 for shifting in one operation the bent test piece(s) from the bending clamp to the brass channel.

f) Brass channel test piece holder as in Figure 5 for accommodating ten bent test pieces.

g) Hard glass test tubes (L = 200 mm, Ø 32 mm) for accommodating the brass channel test piece holder with the bent test pieces. The tubes are plugged by suitable aluminium foil wrapped corks (see Figure 6).

h) A heated container of sufficient size and depth to accept racks which will hold the filled test tubes (see Figure 6). The temperature shall be maintained at (50 ± 0,5) °C by means of suitable equipment and the thermal capacity shall be high enough to ensure that the temperature does not drop below 49 °C even when the test tubes are inserted.

4.2.3 Test pieces preparation

Using the blanking die and blanking press as in 4.2.2 a) or other suitable devices, ten test pieces according to Table 2 and Figure 7 shall be cut from the test sheet more than 25 mm from the edges of the sheet, prepared according to Annex A, so that the web between the holes after removal of the test pieces is not damaged during handling.

The thickness of the test pieces determined using the dial gauge as in 4.2.2 b) shall be in accordance with Table 2 and Figure 7. The test pieces shall be cut with square edges. Bevelled edges may lead to erroneous results.

Table 2 – Notched test pieces size according to polyethylene density

Density of PE-sheathing compounds [a]	*A* mm	*B* mm	*C* mm	*D* [b] mm
≤0,940 g/cm^3	38,0 ± 2,5	13,0 ± 0,8	3,00 to 3,30	0,50 to 0,65
>0,940 g/cm^3	38,0 ± 2,5	13,0 ± 0,8	1,75 to 2,0	0,30 to 0,40

[a] The density is for the unfilled resin, according to Clause 5 of IEC 60811-100:2012.

[b] The depth D shall be uniform along its length.

4.2.4 Test procedure

Shortly before placing into the reagent, each of the test pieces shall be given a notch (see Figure 7) using the notching device as in 4.2.2 c). The blade shall be neither dull nor damaged and, therefore, shall be replaced as required. Even under favourable conditions, it should not be used for more than 100 notches.

Ten test pieces shall then be placed, with the notch up, in the bending clamp as in 4.2.2 d) The clamp shall be closed for 30 s to 35 s by means of a vice or a motor-driven arbor press at a constant speed.

The bent test pieces shall be lifted with the transfer tool as in 4.2.2 e) from the bending clamp and placed in the brass channel as in 4.2.2 f). If some test pieces are riding too high in the holder, they shall be forced down by manual pressure.

The holder shall be inserted in a tube as in 4.2.2 g), 5 min to 10 min after the test pieces have been bent. The test tube shall be filled with the appropriate reagent as in 4.2.1 until all the test pieces are covered by the liquid, and shall be closed by a cork.

The filled test tube shall be placed immediately in a rack in the heated container as in 4.2.2 h) during 24 h. Care shall be taken so that the test pieces do not touch the test tube during the test. The moment of insertion in the heated container shall be noted.

4.2.5 Evaluation of results

In general, stress cracking starts at the notch and runs at right angles to it. The first sign of a crack when examined with normal or corrected vision without magnification, constitutes a failure of the test piece.

After 24 h, in the heated container no more than five test pieces shall have failed. If six test pieces have failed, the test is to be considered as not passed. The test may be repeated once using ten test pieces from a new test sheet and no more than five test pieces shall fail.

4.3 Method B

4.3.1 Reagent

The reagent is a solution of 10 % solution (by volume) in water of Igepal CO-630 (Antarox CO-630) or any other reagent having the same chemical composition (see Notes 1, 2 and 3 below and Annex B).

NOTE 1 The reagent should not be used more than once.

NOTE 2 In the case of unexpectedly short failure times, the reagent should be checked for water content as small increases in water content beyond the specified maximum of 1 % will cause a significant increase in reagent activity.

NOTE 3 Water solution of Igepal CO-630 or similar material should be prepared by paddle-stirring the mixture at 60 °C to 70 °C for at least 1 h. The solution should be used within one week of preparation.

4.3.2 Apparatus

See 4.2.2

4.3.3 Test pieces preparation

See 4.2.3

4.3.4 Test procedure

Follow the test procedure as described in 4.2.4, but the test tube shall be filled with reagent as in 4.3.1 until all the test pieces are covered by the liquid and shall be closed by a cork.

The filled test tube shall be placed immediately in a rack in the heated container as in 4.2.2 h) during 48 h. Care shall be taken so that the test pieces do not touch the test tube during the test. The moment of insertion in the heated container shall be noted.

4.3.5 Evaluation of results

In general, stress cracking starts at the notch and runs at right angles to it. The first sign of a crack, when examined with normal or corrected vision without magnification, constitutes a failure of the test piece.

After 48 h in the heated container, no test pieces shall have failed. If one test piece has failed, the test is to be considered as not passed. The test may be repeated once using ten test pieces from a new sheet and no test piece shall fail.

5 Test report

The test report shall be in accordance with that given in IEC 60811-100.

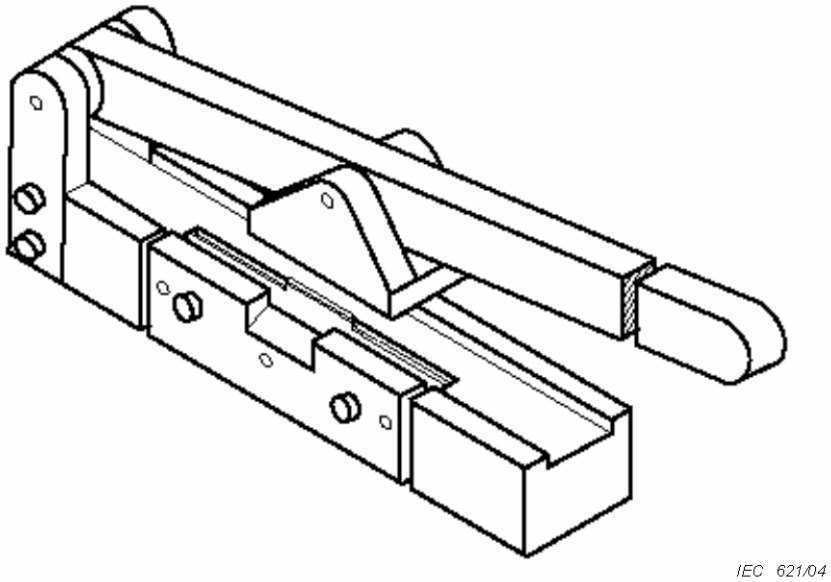

Figure 1 – Notching device

Dimensions in millimetres

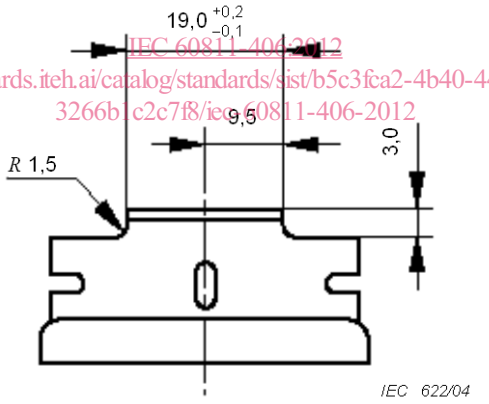

Figure 2 – Blade