IEC 60811-406 Miscellaneous Tests â€“ Resistance to Stress Cracking of Polyethylene and Polypropylene Compounds â€“ Testing Equipment

Description

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:

â€“ for less severe conditions: Method A;

â€“ 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.

4.2.2 Apparatus

The apparatus shall comprise the following elements:

a) Clean, sharp, undamaged blanking die with blanking press suitable for cutting test pieces (38,0 Â± 2,5) mm Ã— (13,0 Â± 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/cm2 to 8 N/cm2.
c) Notching devices as in Figure 1 with blades as in Figure 2.
NOTE The blade is made of â€œGemâ€• blades as in Figure 2 â€“ 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, Ã˜ 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 Â± 0,5) Â°C by means of suitable equipment and the thermal capacity shall be high enough to ensure that the temperature does not drop below 49 Â°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 Â°C to 70 Â°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.

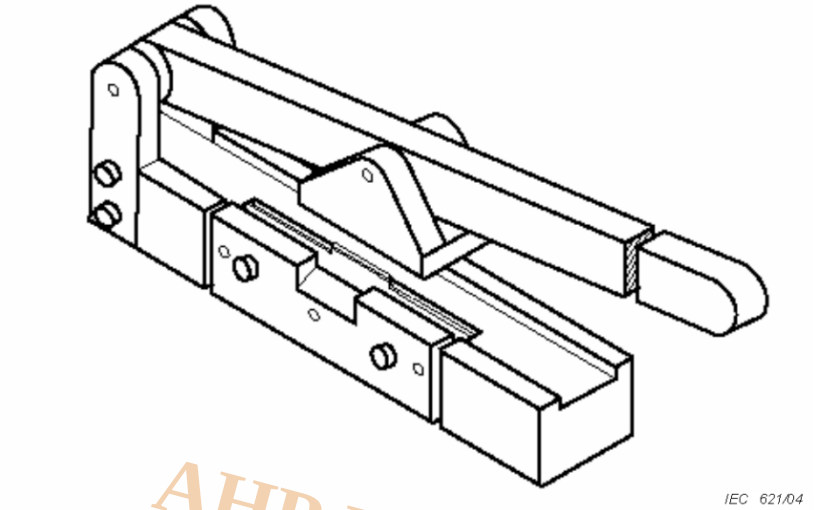


Figure 1 – Notching device

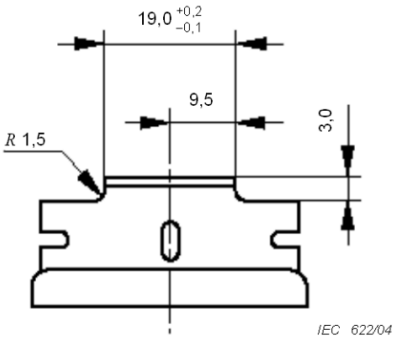
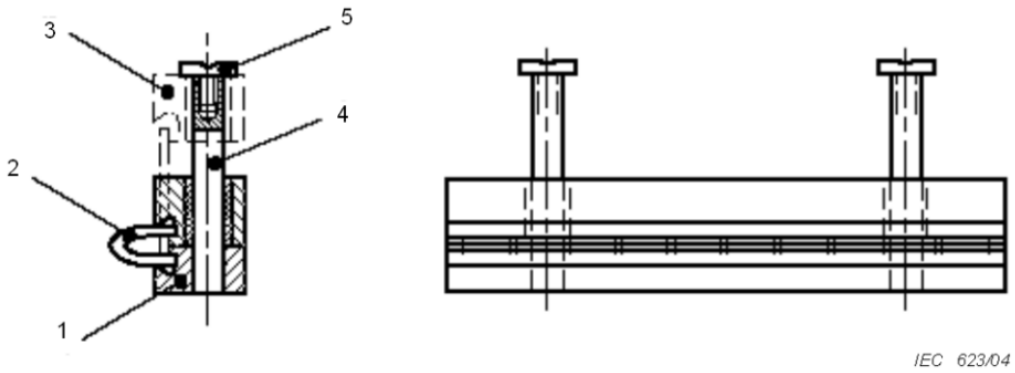


Figure 2 – Blade



Key

1	rear clamp	4	guide bar
2	insert test piece	5	screw
3	front clamp		

Figure 3 – Bend clamp assembly

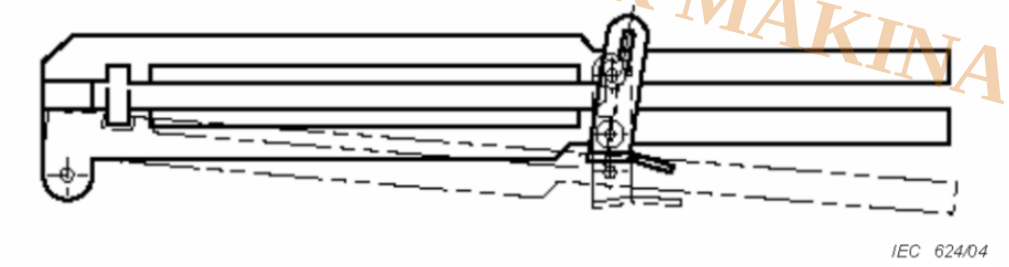
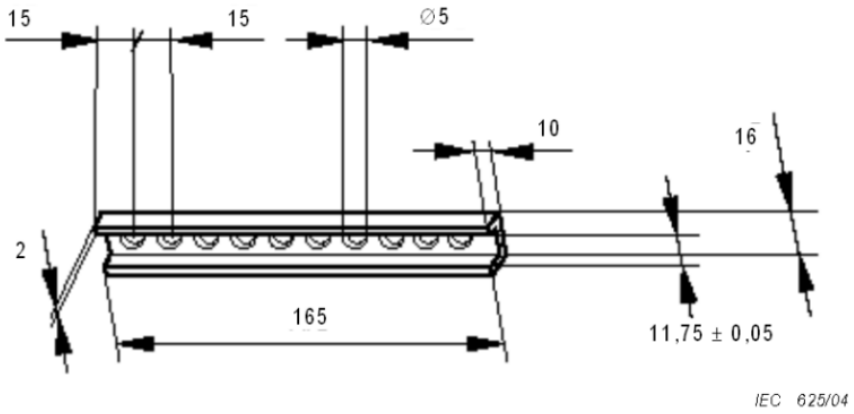


Figure 4 – Transfer tool assembly

Dimensions in millimetres



NOTE The dimension (11,75 ± 0,05) mm is the channel internal width.

Figure 5 – Brass channel test piece holder

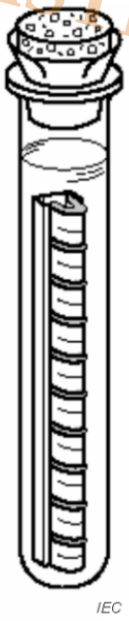


Figure 6 – Test tube with inserted brass channel test piece holder as in 4.2.2 h)), containing ten test pieces

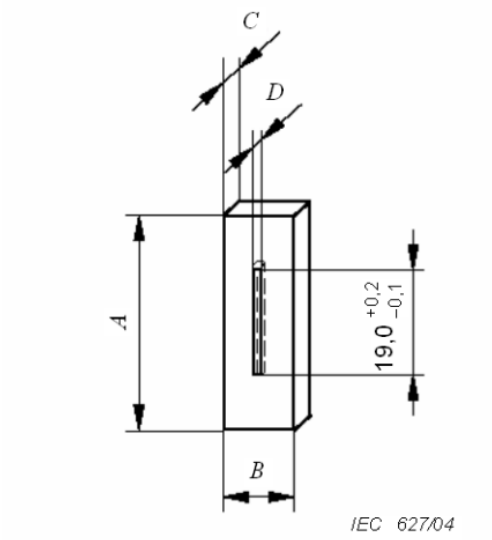


Figure 7 – Notched test pieces

Annex A

Test sheet preparation

A.1 Apparatus

The apparatus shall comprise the following elements:

a) Heatable press for producing moulded test sheets, with platens which are larger than the backing plates.

b) Two rigid metal backing plates (6,0 Â± 0,5) mm thick and about 200 mm Ã— 230 mm in area, each drilled with a hole from one edge so that a temperature sensor can be located within 5 mm of the centre of the plate.

c) Two separator sheets, about 200 mm Ã— 230 mm, for instance aluminium foil 0,1 mm to 0,2 mm thick.

d) Suitable moulding chases for producing test sheets, 150 mm Ã— 180 mm Ã— (3,3 Â± 0,1) mm with internal corners rounded to a radius of 3 mm.

e) Electrically heated air oven with forced air circulation and programming device which lowers temperature at a rate of (5,0 Â± 0,5) K/h.

A.2 Preparation of the test sheets

For preparing a test, a clean separator foil as in Clause A.1 c) shall be placed on the backing plate as in Clause A.1 b), the moulding chase as in Clause A.1 d). The chase shall be filled with (90 Â± 1) g of granules or mill-massed material forming a uniform layer on top of which the second separator foil and then the second backing plate shall be placed. No release agent shall be used.

The mould assembly shall be placed in the moulding press as in Clause A.1 a), preheated to 170 Â°C, and the press shall be closed, using a force â‰¤1 kN.

When the temperature, as indicated by the sensors in the backing plate, has reached 165 Â°C to 170 Â°C, a full force in the range 50 kN to 200 kN shall be applied to the mould by means of the press, for a period of 2 min during which the sensors shall continue to indicate values in the range 165 Â°C to 170 Â°C. On completion of the full force phase, the heating of the mould assembly shall be stopped either by removing from the press or by fast cooling in the press under full force.

A.3 Conditioning of the test sheets
Conditioning of test sheets shall be agreed between the interested parties since it may substantially affect the test results. If such an agreement does not exist, the treatment given in this clause shall be used as a reference treatment.
After removing the backing plates without disturbing the separator foil, the moulded test sheet shall be placed in an oven, as in Clause A.1 e), so as to permit free circulation of air around it. The moulding shall be well supported on thermally conducting horizontal surfaces and a good contact maintained between the separator foils and the polyethylene.
The temperature, as measured not further than 5 mm above the centre of the horizontal surface of the moulded sheet, shall then be controlled as follows:

The oven test temperature shall be maintained for 1 h at 145 Â°C Â± 2 Â°C for low-density polyethylene, 155 Â°C Â± 2 Â°C for medium-density polyethylene, and 165 Â°C Â± 2 Â°C for high-density polyethylene. Cooling shall be at the rate of (5 Â± 2) K /h until it reaches 29 Â°C Â± 1 Â°C. It is also permissible to cool the moulded test sheets while in the press. The actual cooling rate shall be recorded by a graphical recorder.

A.4 Visual examination of the test sheets
The sheet shall exhibit a smooth surface and shall not contain any bubbles, lumps or sink marks except within 10 mm of the edge.

ESCR Tester According to IEC 60811-406

- According to ASTM IEC 60811-406
- Digital timer
- PID temperature controller
- Water circulation system
- Brass sample holder (brass channels) 10pcs (as per customer request)
- Glass tube 10pcs (as per customer request)
- Sample cutting punch
- Sample notch press

- Sample bending clamp
- Transfer tool
- Temperature circulation system for temperature homogeneity inside the bath
- Temperature display resolution 0.1C

ESCR Test Method According to ASTM D 1693

Environmental Stress Cracking Resistance Tester (ESCR)

Category

1. Equipment for Standards
2. Standards