

Insulating and sheathing materials for electric cables - Common test methods - Part 4: Methods specific to polyethylene and polypropylene compounds - Section 1: Resistance to environmental stress cracking - Wrapping test after thermal ageing in air - Measurement of the melt flow index - Carbon black and/or mineral content measurement in PE (IEC 60811-4-1:1985 + corrigendum May 1986 + A2:1993)

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English version

Insulating and sheathing materials of electric cables
Common test methods
Part 4: Methods specific to polyethylene and polypropylene
compounds
Section 1: Resistance to environmental stress cracking —
Wrapping test after thermal ageing in air — Measurement of the
melt flow index
Carbon black and/or mineral content measurement in PE

(IEC 811-4-1 : 1985 + corrigendum May 1986 + A2 : 1993)

Matériaux d'isolation et de gainage des câbles électriques
Méthodes d'essais communes
Part 4: Méthodes spécifiques pour les mélanges polyéthylène et
polypropylène
Section 1: Résistance aux craquelures sous contraintes dues à
l'environnement — Essai d'enroulement après vieillissement
thermique dans l'air — Mesure de l'indice de fluidité à
chaud — Mesure dans le PE du taux de noir de carbone et/ou des
charges minérales
(CEI 811-4-1 : 1985 + corrigendum mai 1986 + A2 : 1993)

Isolier- und Mantelwerkstoffe für Kabel und isolierte Leitungen
Allgemeine Prüfverfahren
Teil 4: Besondere Methoden für Polyäthylen und Polypropylen
Compounds
Hauptabschnitt 1: Spannungsrißbeständigkeit Wickelprüfung nach
thermischer Alterung in Luft — Messung des Schmelzindex
Bestimmung des Ruß- und/oder Füllstoffgehalts in PE
(IEC 811-4-1 : 1985 + Corrigendum Mai 1986 + A2 : 1993)

This European Standard was approved by CENELEC on 1995-03-06. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of the International Standard IEC 811-4-1 : 1985, with its corrigendum May 1986 and its amendment 2 : 1993 (including amendment 1 : 1988), prepared by IEC TC 20, Electric cables, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60811-4-1 on 1995-03-06 without any modification.

This European Standard supersedes HD 505.4.1 S2 : 1990. Where reference is made to HD 505.4.1 S2 : 1990 in another standard, users should refer to this EN 60811-4-1 for the current information.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-03-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-12-01

Annexes designated 'normative' are part of the body of the standard. Appendices and annexes designated 'informative' are given for information only. In this standard, annex ZA is normative and appendices A and B are informative. Annex ZA has been added by CENELEC.

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COMMON TEST METHODS FOR INSULATING AND SHEATHING MATERIALS OF ELECTRIC CABLES

Part 4: Methods specific to polyethylene and polypropylene compounds

SECTION ONE – RESISTANCE TO ENVIRONMENTAL STRESS CRACKING – WRAPPING TEST AFTER THERMAL AGEING IN AIR – MEASUREMENT OF THE MELT FLOW INDEX – CARBON BLACK AND/OR MINERAL FILLER CONTENT MEASUREMENT IN PE

1. Scope

This standard specifies the test methods to be used for testing polymeric insulating and sheathing materials of electric cables for power distribution and telecommunications including cables used on ships.

This Section One of Part Four gives the methods for measurement of the resistance to environmental stress cracking, for wrapping test after thermal ageing in air, for measurement of melt flow index and for measurement of carbon black and/or mineral filler content, which apply to PE and PP compounds, including cellular compounds and foam skin for insulation.

2. Test values

Full test conditions (such as temperatures, durations, etc.) and full test requirements are not specified in this standard; it is intended that they should be specified by the standard dealing with the relevant type of cable.

Any test requirements which are given in this standard may be modified by the relevant cable standard to suit the needs of a particular type of cable.

3. Applicability

Conditioning values and testing parameters are specified for the most common types of insulating and sheathing compounds and of cables, wires and cords.

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4. Definitions

For the purpose of these tests, a distinction shall be made between low density, medium density and high-density PE:

Low-density polyethylene	$\leq 0.925 \text{ g/cm}^3$	} 23 °C
Medium-density polyethylene > 0.925	$\leq 0.940 \text{ g/cm}^3$	
High-density polyethylene	$> 0.940 \text{ g/cm}^3$	

Note. – These densities refer to unfilled resins as determined by the method specified in Clause 8 of Publication 811-1-3: Common Test Methods for Insulating and Sheathing Materials of Electric Cables, Part 1: Methods for General Application – Section Three: Method for Determining the Density – Water Absorption Tests – Shrinkage Test.

5. Type tests and other tests

The test methods described in this standard are primarily intended to be used for type tests. In certain tests, where there are essential differences between the conditions for type tests and those for more frequent tests, such as routine tests, these differences are indicated.

6. Pre-conditioning

All the tests shall be carried out not less than 16 h after the extrusion or vulcanization (or cross-linking), if any, of the insulating or sheathing compounds.

7. Median value

When several test results have been obtained and ordered in an increasing or decreasing succession, the median value is the middle value if the number of available values is odd, and is the mean of the two middle values if the number is even.

8. Resistance to environmental stress cracking

8.1 General

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

Procedure A

Applies to materials which will encounter less severe cable system conditions and environments.

Procedure B

Applies to materials which will encounter more severe cable system conditions and environments.

8.2 Apparatus

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

8.2.2 Two rigid metal backing plates 6 ± 0.5 mm thick and about 200 mm \times 230 mm 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.

8.2.3 Two separator sheets, about 200 mm \times 230 mm, for instance aluminium foil 0.1 mm to 0.2 mm thick.

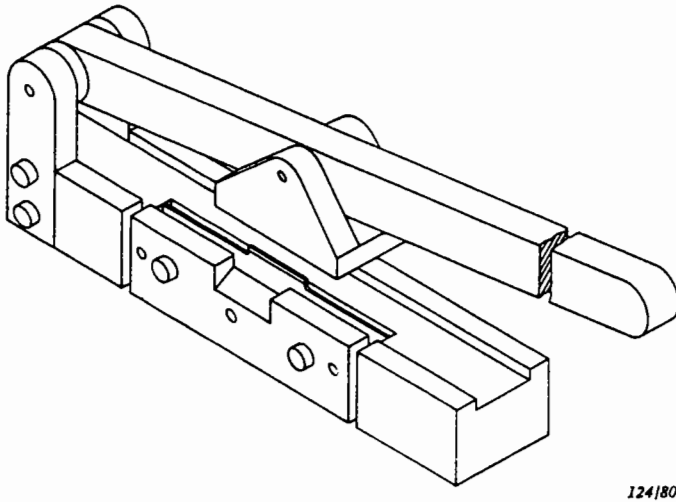
8.2.4 Suitable moulding chases for producing test sheets, 150 mm \times 180 mm \times 3.3 ± 0.1 mm with internal corners rounded to a radius of 3 mm.

8.2.5 Electrically heated air oven with forced air circulation and programming device which lowers temperature at a rate of 5 ± 0.5 °C/h.

8.2.6 Clean, sharp, undamaged blanking die with blanking press suitable for cutting test pieces 38.0 ± 2.5 mm \times 13.0 ± 0.8 mm or other suitable devices.

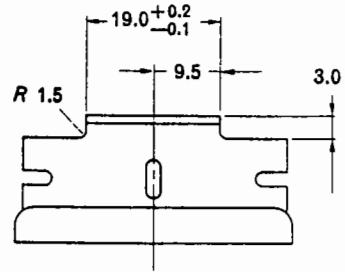
8.2.7 Dial gauge, with plane gauging faces 4 mm to 8 mm in diameter and a gauging pressure of 5 N/cm² to 8 N/cm².

8.2.8 Notching device as in Figure 1 with blades as in Figure 2.



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Dimensions in millimetres



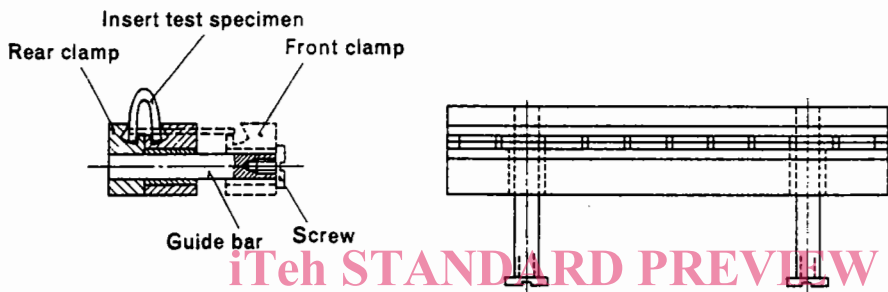
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The blade is made of "Gem" blades as in Figure 2 (see also Appendix A).

FIGURE 1

FIGURE 2

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



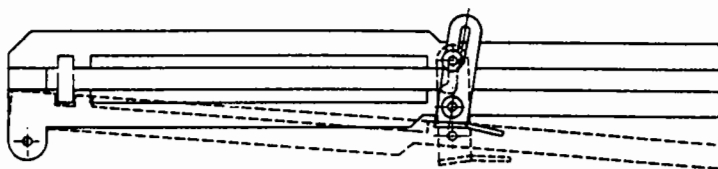
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FIGURE 3

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8.2.10 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.



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FIGURE 4

8.2.11 Brass channel specimen holder as in Figure 5 for accommodating ten bent test pieces.

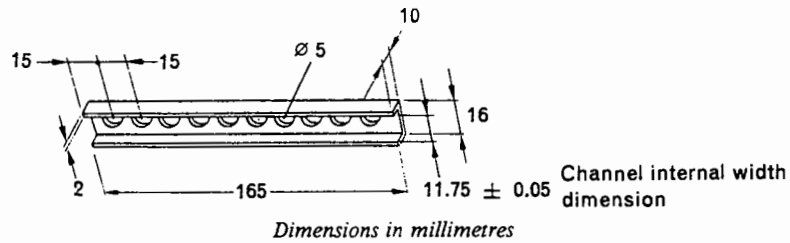


FIGURE 5

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8.2.12 Hard glass test tubes 200 mm × 32 mm for accommodating the brass channel specimen holder with the bent test specimens. The tubes are plugged by suitable aluminium foil wrapped corks (see Figure 6).

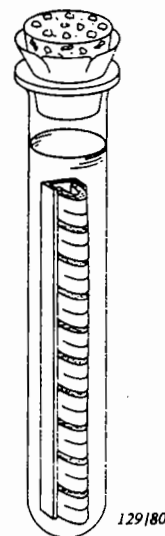


FIG. 6.— Test tube with inserted brass channel specimen holder as in Sub-clause 8.2.11, containing ten test specimens.

8.2.13 Reagents

Procedure A

100% Igepal CO-630 (Antarox CO-630) or any other reagent having the same chemical composition (see Notes 1 and 2 and Appendix A).

Procedure B

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 and Appendix A).

Notes 1. — The reagent must not be used more than once.

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.

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.

8.2.14 A heated container of sufficient size and depth to accept racks which will hold the filled test tubes (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.

8.3 Preparation of the test sheets

8.3.1 For preparing a test, a clean separator foil as in Sub-clause 8.2.3 shall be placed on the backing plate as in Sub-clause 8.2.2, the moulding chase as in Sub-clause 8.2.4. The chase shall be filled with 90 ± 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.

8.3.2 The mould assembly shall be placed in the moulding press as in Sub-clause 8.2.1, preheated to 170°C , and the press shall be closed, using a force ≤ 1 kN.

8.3.3 When the temperature, as indicated by the sensors in the backing plates has reached 165°C to 170°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 should continue to indicate values in the range 165°C to 170°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.

8.4 Conditioning of the test sheets*

After removing the backing plates without disturbing the separator foil, the moulded test sheet shall be placed in an oven as in Sub-clause 8.2.5 so as to permit free circulation of air around it, so that the moulding is well supported on thermally conducting horizontal surfaces and so that good contact is 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 $145^\circ\text{C} \pm 2^\circ\text{C}$ for low-density polyethylene, $155^\circ\text{C} \pm 2^\circ\text{C}$ for medium density polyethylene, and $165^\circ\text{C} \pm 2^\circ\text{C}$ for high-density polyethylene. Cooling shall be at the rate of $5^\circ\text{C}/\text{h} \pm 2^\circ\text{C}/\text{h}$ until it reaches $29^\circ\text{C} \pm 1^\circ\text{C}$. 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.

Note. — Conditioning of the test sheets should be optional. In case of dispute, a conditioned specimen should be used.

8.5 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.

8.6 Test procedure

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8.6.1 Preparation of the test pieces

Using the blanking die and blanking press as in Sub-clause 8.2.6 or other suitable devices, ten test pieces as in 8.6.2 shall be cut from a test sheet more than 25 mm from the edges of the sheet so that the web between the holes after removal of the test pieces is not damaged during handling.

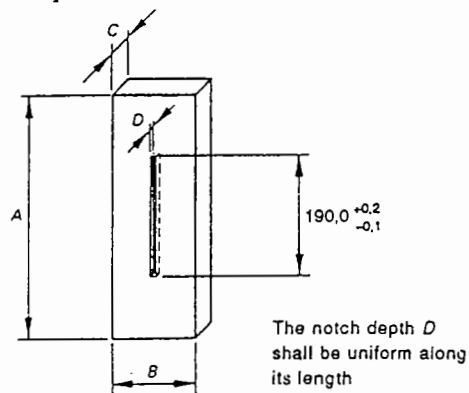
The thickness of the test pieces determined using the dial gauge as in Sub-clause 8.2.7 shall be in accordance with 8.6.2. The test pieces shall be cut with square edges. Bevelled edges may lead to erroneous results.

8.6.2 Notching and inserting of the test pieces

Shortly before placing into the reagent, each of the test pieces shall be given a notch (Figure 7) using the notching device as in Sub-clause 8.2.8. The blade shall be neither dull nor damaged and,

* Conditioning of test pieces 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 sub-clause shall be used as a reference treatment.

therefore, shall be replaced as required. Even under favourable conditions it should not be used for more than 100 notches.



Density of PE-sheathing compounds	A mm	B mm	C mm	D mm
$\leq 0,940 \text{ g/cm}^3$	$38 \pm 2,5$	$13,0 \pm 0,8$	3,00 to 3,30	0,50 to 0,65
$> 0,940 \text{ g/cm}^3$	$38 \pm 2,5$	$13,0 \pm 0,8$	1,75 to 2,0	0,30 to 0,40

FIGURE 7

Ten test pieces shall then be placed, with the notch up, in the bending clamp as in Sub-clause 8.2.9. 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 Sub-clause 8.2.10 from the bending clamp and placed in the brass channel as in Sub-clause 8.2.11. 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 Sub-clause 8.2.12, 5 min to 10 min after the test pieces have been bent. The test tube shall be filled with the appropriate reagent as in Sub-clause 8.2.13 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 Sub-clause 8.2.14. Care shall be taken that the test pieces do not touch the test tube during the test. The moment of insertion in the heated container shall be noted.

8.7 Evaluation of results

In general, environment 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.

Procedure A

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.

Procedure B

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.