Irish Standard
I.S. EN IEC 62788-6-2:2020

Measurement procedures for materials used in photovoltaic modules - Part 6-2: General tests - Moisture permeation testing of polymeric materials

I.S. EN IEC 62788-6-2:2020

Incorporating amendments/corrigenda/National Annexes issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard — national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation — recommendation based on the consensus of an expert panel and subject to public consultation.

SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

This document replaces/revises/consolidates the NSAI adoption of the document(s) indicated on the CEN/CENELEC cover/Foreword and the following National document(s):

NOTE: The date of any NSAI previous adoption may not match the date of its original CEN/CENELEC document.

This document is based on:	*Published:*
EN IEC 62788-6-2:2020	2020-05-08

This document was published under the authority of the NSAI and comes into effect on:	ICS number:
2020-06-04	NOTE: If blank see CEN/CENELEC cover page

NSAI	T +353 1 807 3800	Sales:
1 Swift Square,	F +353 1 807 3838	T +353 1 857 6730
Northwood, Santry	E standards@nsai.ie	F +353 1 857 6729
Dublin 9	W NSAI.ie	W standards.ie

Údarás um Chaighdeáin Náisiúnta na hÉireann

National Foreword

I.S. EN IEC 62788-6-2:2020 is the adopted Irish version of the European Document EN IEC 62788-6-2:2020, Measurement procedures for materials used in photovoltaic modules - Part 6-2: General tests - Moisture permeation testing of polymeric materials

This document does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

For relationships with other publications refer to the NSAI web store.

Compliance with this document does not of itself confer immunity from legal obligations.

In line with international standards practice the decimal point is shown as a comma (,) throughout this document.

This page is intentionally left blank

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62788-6-2

May 2020

ICS 27.160

English Version

Measurement procedures for materials used in photovoltaic modules - Part 6-2: General tests - Moisture permeation testing of polymeric materials (IEC 62788-6-2:2020)

Procédures de mesure des matériaux utilisés dans les modules photovoltaïques - Partie 6-2: Essais génériques - Essais de perméation à l'humidité des matériaux polymères (IEC 62788-6-2:2020)

Messverfahren für Werkstoffe, die in Photovoltaik-Modulen verwendet werden - Teil 6-2: Allgemeine Prüfungen - Permeationsprüfung mit polymeren Materialien (IEC 62788-6-2:2020)

This European Standard was approved by CENELEC on 2020-04-23. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 82/1659/FDIS, future edition 1 of IEC 62788-6-2, prepared by IEC/TC 82 "Solar photovoltaic energy systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62788-6-2:2020.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2021-01-23
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2023-04-23

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

Endorsement notice

The text of the International Standard IEC 62788-6-2:2020 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61730-1	NOTE	Harmonized as EN IEC 61730-1

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
ISO 2528	-	Sheet materials - Determination of water vapour transmission rate - Gravimetric (dish) method	-	-
ISO 9932	-	Paper and board - Determination of water vapour transmission rate of sheet materials - Dynamic sweep and static gas methods	-	-
ISO 15106-1	-	Plastics - Film and sheeting - Determination of water vapour transmission Rate - Part 1: Humidity detection sensor method	EN ISO 15106-1	-
ISO 15106-2	-	Plastics - Film and sheeting - Determination of water vapour transmission Rate - Part 2: Infrared detection sensor method	EN ISO 15106-2	-
ISO 15106-3	-	Plastics - Film and sheeting - Determination of water vapour transmission Rate - Part 3: Electrolytic detection sensor method	EN ISO 15106-3	-
ISO 15106-4	-	Plastics - Film and sheeting - Determination of water vapour transmission Rate - Part 4: Gas-chromatographic detection sensor method	-	-
IEC/TS 61836	-	Solar photovoltaic energy systems - Terms, definitions and symbols	-	-
ASTM F1249-06	-	Standard test method for water vapour transmission rate through plastic film and sheeting using a modulated infrared sensor	-	-

This page is intentionally left blank

IEC 62788-6-2

Edition 1.0 2020-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Measurement procedures for materials used in photovoltaic modules – Part 6-2: General tests – Moisture permeation testing of polymeric materials

Procédures de mesure des matériaux utilisés dans les modules photovoltaïques – Partie 6-2: Essais génériques – Essais de perméation à l'humidité des matériaux polymères

IEC 62788-6-2:2020-03(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,…). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

IEC 62788-6-2

Edition 1.0 2020-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Measurement procedures for materials used in photovoltaic modules – Part 6-2: General tests – Moisture permeation testing of polymeric materials

Procédures de mesure des matériaux utilisés dans les modules photovoltaïques – Partie 6-2: Essais génériques – Essais de perméation à l'humidité des matériaux polymères

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 27.160

ISBN 978-2-8322-7921-2

CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms, definitions and symbols 7
3.1 Terms and definitions 7
3.2 Symbols 7
4 Apparatus 8
5 Test specimens 8
6 Procedure 9
7 Calculations 10
7.1 Determination of diffusivity and solubility of moisture 10
7.2 Determination of breakthrough constant 11
7.3 Variable temperature measurement 12
7.4 Variable relative humidity measurement 13
8 Test report 13
Annex A (informative) Example data 15
A.1 Example of Fickian diffusion 15
A.2 Example of failed measurement of Fickian diffusion 16
A.3 Example of non-Fickian diffusion 17
Bibliography 19

Figure 1 – Diagram of a diffusion cell 9
Figure A.1 – Example of Fickian diffusion in EVA at 85 °C and 100 % RH with a 2,84 mm thick film 16
Figure A.2 – Example of a failed data set for Fickian diffusion in polyethylene terepthalate at 22 °C and 100 % RH 17
Figure A.3 – Example of non–Fickian diffusion in a desiccant filled polyisobutylene material used as an edge seal 18

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 6-2: General tests – Moisture permeation testing of polymeric materials

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co–operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non–governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62788-6-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1659/FDIS	82/1690/RVD

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

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

A list of all parts in the IEC 62788 series, published under the general title *Measurement procedures for materials used in photovoltaic modules*, can be found on the IEC website.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 62788 describes methods to measure the permeation properties of polymeric materials. The degradation of PV modules is known to go through many different corrosion processes. These degradation processes may depend upon moisture ingress into the encapsulant, edge seal, frontsheet, or backsheet materials. Typical polymeric materials used include (amongst other polymers) ethylene-vinyl acetate (EVA) and polyolefins for encapsulants, polyisobutylene (PIB) for edge seals, and polyethylene terephthalate (PET), polyvinyl fluoride (PVF), or polyvinylidine fluoride (PVDF) for backsheets. Therefore, knowing the moisture permeation characteristics of polymeric materials is relevant for module design. These properties can be determined as a function of temperature and relative humidity. With these parameters, simple scaling rules for time and distance can be used to extrapolate to the use environments.

MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 6-2: General tests – Moisture permeation testing of polymeric materials

1 Scope

This document provides methods for measuring the steady-state water vapour transmission rate (WVTR), water vapour permeability (P), diffusivity (D), solubility (S), and moisture breakthrough time (T_{10}) (defined as the time to reach 10 % of the steady state WVTR) for polymeric materials such as encapsulants, edge seals, frontsheets and backsheets. These measurements can be made at selected temperatures and humidity levels as deemed appropriate for evaluation of their performance in PV modules. Measurement is accomplished by inspection of the transient WVTR curve and by fitting it to a theoretical Fickian model. This document is best applied to monolithic films. If multilayer films are used, the D and S values are only apparent values, but the steady-state values can still be measured.

This document was written for the measurement of water permeation, but it can equally be used for other permeants such as O_2. In this case the same diffusion equations, fitting procedures, and scaling arguments are used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 61836*, Solar photovoltaic energy systems – Terms, definitions and symbols*

ISO 2528, *Sheet materials – Determination of water vapour transmission rate (WVTR) – Gravimetric (dish) method*

ISO 9932, *Paper and board – Determination of water vapour transmission rate of sheet materials – Dynamic sweep and static gas methods*

ISO 15106-1, *Plastics – Film and sheeting – Determination of water vapour transmission Rate – Part 1: Humidity detection sensor method*

ISO 15106-2*, Plastics – Film and sheeting – Determination of water vapour transmission Rate – Part 2: Infrared detection sensor method*

ISO 15106-3, *Plastics – Film and sheeting – Determination of water vapour transmission Rate – Part 3: Electrolytic detection sensor method*

ISO 15106-4, *Plastics – Film and sheeting – Determination of water vapour transmission Rate – Part 4: Gas-chromatographic detection sensor method*

ASTM F1249-06, *Standard test method for water vapour transmission rate through plastic film and sheeting using a modulated infrared sensor*