

HOONE ELEMENTIDE JA PIIRDETARINDITE SOOJUS- JA  
NIISKUSTEHNILINE TOIMIVUS. NIISKUSLEVI  
HINDAMINE NUMBRILISE MODELLEERIMISEGA

Hygrothermal performance of building components  
and building elements - Assessment of moisture  
transfer by numerical simulation

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

|  |   |
|--|---|
| <p>See Eesti standard EVS-EN 15026:2023 sisaldab Euroopa standardi EN 15026:2023 ingliskeelset teksti.</p> <p>Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.</p> <p>Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 26.07.2023.</p> <p>Standard on kättesaadav Eesti Standardimis- ja Akrediteerimiskeskusest.</p> | <p>This Estonian standard EVS-EN 15026:2023 consists of the English text of the European standard EN 15026:2023.</p> <p>This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.</p> <p>Date of Availability of the European standard is 26.07.2023.</p> <p>The standard is available from the Estonian Centre for Standardisation and Accreditation.</p> |
|--|---|

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 91.120.01

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele. Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis- ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis- ja Akrediteerimiskeskusega: Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation: Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

EUROPEAN STANDARD

**EN 15026**

NORME EUROPÉENNE

EUROPÄISCHE NORM

July 2023

ICS 91.120.01

Supersedes EN 15026:2007

English Version

## Hygrothermal performance of building components and building elements - Assessment of moisture transfer by numerical simulation

Performance hygrothermique des composants et parois de bâtiments - Évaluation du transfert d'humidité par simulation numérique

Wärme- und feuchtetechnisches Verhalten von Bauteilen und Bauelementen - Bewertung der Feuchteübertragung durch numerische Simulation

This European Standard was approved by CEN on 26 June 2023.

CEN 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 CEN 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 CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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

| <b>Contents</b>                |   | <b>Page</b> |
|--------------------------------|---|-------------|
| <b>European foreword</b> ..... |   | 5           |
| <b>Introduction</b> .....      |   | 6           |
| <b>1</b>                       | <b>Scope</b> .....  | 8           |
| <b>2</b>                       | <b>Normative references</b> .....   | 8           |
| <b>3</b>                       | <b>Terms, definitions, symbols and units</b> .....                                | 8           |
| <b>4</b>                       | <b>Hygrothermal formulae and material properties</b> .....                        | 10          |
| 4.1                            | <b>Assumptions</b> .....  | 10          |
| 4.2                            | <b>Balance formulae</b> .....   | 11          |
| 4.2.1                          | <b>General</b> .....  | 11          |
| 4.2.2                          | <b>Internal energy density</b> .....  | 11          |
| 4.2.3                          | <b>Additional source terms</b> .....  | 12          |
| 4.3                            | <b>Relations between driving potentials and conserved quantities</b> .....        | 12          |
| 4.4                            | <b>Transport of heat and moisture</b> .....                                       | 12          |
| 4.4.1                          | <b>General</b> .....  | 12          |
| 4.4.2                          | <b>Heat and enthalpy transport inside materials</b> .....                         | 12          |
| 4.4.3                          | <b>Moisture transport</b> .....   | 13          |
| 4.4.4                          | <b>Moisture transport across material interfaces/vapour retarders/foils</b> ..... | 14          |
| 4.4.5                          | <b>Internal air layers</b> .....  | 15          |
| 4.5                            | <b>Material properties</b> .....  | 15          |
| <b>5</b>                       | <b>Boundary and initial conditions</b> .....                                      | 15          |
| 5.1                            | <b>Inside conditions</b> .....  | 15          |
| 5.1.1                          | <b>Usage conditions</b> .....   | 15          |
| 5.1.2                          | <b>Parameters</b> .....   | 16          |
| 5.1.3                          | <b>Sources of data</b> .....  | 16          |
| 5.2                            | <b>Outside conditions</b> .....   | 16          |
| 5.2.1                          | <b>Sources of data</b> .....  | 16          |
| 5.2.2                          | <b>Climate parameters</b> .....   | 17          |
| 5.3                            | <b>Interpolation of tabulated climatic data</b> .....                             | 17          |
| 5.4                            | <b>Boundary heat and moisture flows</b> .....                                     | 18          |
| 5.4.1                          | <b>Heat transfer</b> .....  | 18          |
| 5.4.2                          | <b>Vapour diffusion</b> .....   | 21          |
| 5.4.3                          | <b>Convective latent heat flow</b> .....  | 21          |
| 5.4.4                          | <b>Wind driven rain</b> .....   | 21          |
| 5.5                            | <b>Initial conditions</b> .....   | 22          |
| <b>6</b>                       | <b>Numerical simulation</b> .....   | 22          |
| 6.1                            | <b>Background</b> .....   | 22          |
| 6.2                            | <b>Geometrical modelling</b> .....  | 23          |
| 6.3                            | <b>Grid and time step sensitivity studies</b> .....                               | 23          |
| <b>7</b>                       | <b>Documentation of input data and results</b> .....                              | 24          |
| 7.1                            | <b>General</b> .....  | 24          |
| 7.2                            | <b>Problem description</b> .....  | 24          |
| 7.2.1                          | <b>General</b> .....  | 24          |
| 7.2.2                          | <b>Scope and subject of simulation</b> .....                                      | 24          |
| 7.3                            | <b>Model geometry and input parameters</b> .....                                  | 24          |

|   |  |           |
|---|--|-----------|
| 7.3.1   | Simulated geometry.....  | 24        |
| 7.3.2   | Initial conditions.....  | 24        |
| 7.3.3   | Boundary conditions.....   | 24        |
| 7.3.4   | Material parameters.....   | 25        |
| 7.3.5   | Auxiliary models.....  | 25        |
| 7.3.6   | Output specifications .....  | 25        |
| 7.4   | Simulation method and numerical properties .....                   | 25        |
| 7.4.1   | General .....  | 25        |
| 7.4.2   | Simulation tool .....  | 25        |
| 7.4.3   | Numerical simulation properties .....                              | 25        |
| 7.4.4   | Numerical accuracy control.....                                    | 26        |
| 7.5   | Calculation report .....   | 26        |
| 7.5.1   | General .....  | 26        |
| 7.5.2   | Display of results .....   | 26        |
| 7.5.3   | Interpretation of the results.....                                 | 26        |
| <b>Annex A (informative) Material parameters .....</b>  |  | <b>28</b> |
| A.1   | General .....  | 28        |
| A.2   | Heat storage.....  | 28        |
| A.3   | Heat transport .....   | 28        |
| A.4   | Moisture storage .....   | 30        |
| A.5   | Moisture transport properties .....                                | 31        |
| A.5.1   | General .....  | 31        |
| A.5.2   | Water vapour diffusion resistance.....                             | 31        |
| A.5.3   | Liquid transport properties.....                                   | 33        |
| A.6   | Material-related model limitations.....                            | 34        |
| A.6.1   | General .....  | 34        |
| A.6.2   | Influence of material boundaries on liquid moisture transport..... | 34        |
| A.6.3   | Hysteresis phenomena .....   | 34        |
| A.6.4   | Swelling.....  | 35        |
| A.6.5   | Weathering and ageing.....   | 35        |
| <b>Annex B (normative) Benchmark tests.....</b>   |  | <b>36</b> |
| B.1   | General .....  | 36        |
| B.1.1   | General background .....   | 36        |
| B.1.2   | Reference implementation .....                                     | 36        |
| B.2   | Problem description.....   | 36        |
| B.3   | Results .....  | 38        |
| B.4   | Other benchmark cases and validation suites .....                  | 40        |
| <b>Annex C (informative) Moisture design years.....</b>   |  | <b>41</b> |
| <b>Annex D (normative) Inside boundary conditions for residential and office buildings.....</b>   |  | <b>42</b> |
| <b>Annex E (normative) Auxiliary models for the simplified inclusion of special effects .....</b> |  | <b>43</b> |
| E.1   | General .....  | 43        |

|            |  |           |
|------------|--|-----------|
| <b>E.2</b> | <b>Rear ventilation and venting of building components.....</b>          | <b>43</b> |
| <b>E.3</b> | <b>Condensation caused by air flow through building components .....</b> | <b>44</b> |
| <b>E.4</b> | <b>Wind driven rain penetration .....</b>                                | <b>45</b> |
|            | <b>Bibliography .....</b>  | <b>47</b> |

This document is a preview generated by EVS

## European foreword

This document (EN 15026:2023) has been prepared by Technical Committee CEN/TC 89 “Thermal performance of buildings and building components”, the secretariat of which is held by SIS.

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 January 2024, and conflicting national standards shall be withdrawn at the latest by January 2024.

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

This document supersedes EN 15026:2007.

The significant technical changes compared to the previous edition EN 15026:2007 of the standard are:

- the scope has been shortened;
- all the transport formulae are given for two-dimensional calculations and source terms for auxiliary models accounting for special effects have been added;
- approaches to calculate the sources and sinks in the transport formulae to account for these special effects, i.e. component ventilation, rainwater penetration and air infiltration, are documented in Annex E;
- ice formation and freezing enthalpy have been added to the heat transport formula;
- the section on material properties has been expanded with more detailed information given in Annex A;
- the sections on internal and external boundary conditions and the corresponding annexes have been modified to account for new research results.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## Introduction

This document defines the practical application of hygrothermal simulation software used to predict transient heat and moisture transfer in multi-layer building envelope components subjected to dynamic climate conditions on either side.

In contrast to the steady-state assessment of interstitial condensation by the Glaser method (as described in EN ISO 13788), transient hygrothermal simulation provides more detailed and accurate information on the risk of moisture problems within building components and on the design of remedial treatment. While the Glaser method considers only steady-state conduction of heat and vapour diffusion, the transient hygrothermal simulation models which are composed of the formulae defined in this document also take account of heat and moisture storage, latent heat effects and liquid and convective transport under realistic boundary and initial conditions. The application of such models has become widely used in building practice in recent years, resulting in a significant improvement in the accuracy and reproducibility of hygrothermal simulation.

The following examples of transient heat and moisture phenomena in building components can be simulated by the models covered in this document:

- drying of initial construction moisture;
- moisture accumulation by interstitial condensation due to diffusion in winter;
- moisture penetration due to driving rain exposure;
- summer condensation due to migration of moisture from outside to inside;
- outside surface condensation due to cooling by long-wave radiation exchange;
- moisture-related heat losses by transmission and moisture evaporation.

The factors relevant to hygrothermal simulation of building components are summarized below. The document starts with the description of the physical model on which hygrothermal simulation tools are based. Then the necessary input parameters and their procurement are dealt with. The evaluation, interpretation and documentation of the output form the last part. Benchmark cases for the assessment of numerical simulation tools are discussed in Annex B.

Input parameters include:

- assembly, orientation and inclination of building components;
- hygrothermal material parameters and functions;
- boundary conditions, surface transfer for inside and outside climate;
- initial condition, calculation period, numerical control parameters.

Output parameters include:

- temperature and heat flux distributions and temporal variations;
- water content, relative humidity and moisture flux distributions and temporal variations.

Based on the output parameters, experimentally validated post-processing tools can help to evaluate:

- Moisture dependent thermal performance;
- biological growth, rot and corrosion;
- moisture-related damage and degradation.

Outputs from the calculations are useful for various purposes, but applications are not covered by the standard and are made at the user's own risk.

This document is a preview generated by EVS

## 1 Scope

This document specifies the model components to be used in a numerical hygrothermal simulation model for calculating the transient transfer of heat and moisture through building structures.

This document specifies a method to be used for validating a numeric hygrothermal simulation model claiming conformity with this document.

## 2 Normative references

The following referenced documents are indispensable for the application 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.

EN ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions (ISO 7345:2018)*

EN ISO 9346, *Hygrothermal performance of buildings and building materials — Physical quantities for mass transfer — Vocabulary (ISO 9346:2007)*

## 3 Terms, definitions, symbols and units

For the purposes of this document, the terms and definitions given in EN ISO 9346 and EN ISO 7345 apply. The following symbols and units apply.

| Symbol      | Quantity  | Unit                   |
|-------------|---|------------------------|
| $a_r$       | rain water retention factor of a surface                                      | - (0 ... 1)            |
| $c_l$       | specific heat capacity of liquid water  | J/(kg·K)               |
| $c_v$       | specific heat capacity of water vapour  | J/(kg·K)               |
| $c_{ice}$   | specific heat capacity of ice   | J/(kg·K)               |
| $c_a$       | specific heat capacity of air   | J/(kg·K)               |
| $c_s$       | specific heat capacity of dry material (solid)                                | J/(kg·K)               |
| $D_1$       | liquid conductivity   | m <sup>2</sup> /s      |
| $E_{sol}$   | total flux density of incident solar radiation                                | W/m <sup>2</sup>       |
| $g, g_w$    | density of moisture flow rate   | kg/(m <sup>2</sup> ·s) |
| $g_l$       | density of liquid water flow rate   | kg/(m <sup>2</sup> ·s) |
| $g_{l,max}$ | density of water flow rate which can be absorbed at the surface of a material | kg/(m <sup>2</sup> ·s) |
| $g_p$       | density of moisture flow rate of available water from precipitation           | kg/(m <sup>2</sup> ·s) |
| $g_v$       | density of water vapour flow rate   | kg/(m <sup>2</sup> ·s) |
| $h$         | surface heat transfer coefficient   | W/(m <sup>2</sup> ·K)  |