

Thermal insulation — Determination of steady-state thermal transmission properties of thermal insulation for circular pipes

The European Standard EN ISO 8497:1996 has the status of a British Standard

ICS 27.220

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee RHE/9, Thermal insulating materials, upon which the following bodies were represented:

- Autoclaved Aerated Concrete Products Association
- Chartered Institution of Building Services Engineers
- Concrete Block Association
- Cork Industry Federation
- Cranfield University
- Department of Health
- Department of the Environment (Building Research Establishment)
- Department of Trade and Industry (National Physical Laboratory)
- Electricity Association
- Eurisol (UK Mineral Wool Association)
- European Phenolic Foam Association
- Gypsum Products Development Association
- Power Generation Contractors Association [PGCA (BEAMA Ltd.)]
- Royal Institute of British Architects
- Thermal Insulation Manufacturers' and Suppliers' Association (TIMSA)
- Thermal Insulations Contractors' Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Aggregate Concrete Block Association
- Association of Lightweight Aggregate Manufacturers
- British Ceramic Research Ltd.
- British Precast Concrete Federation Ltd.
- Department of the Environment (British Board of Agrément)
- Flat Glass Manufacturers' Association
- Institute of Refrigeration
- Institution of Chemical Engineers
- Insulation Jacket Manufacturers Federation
- Polyethylene Foam Insulation Association
- University of Salford

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 January 1997

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The following BSI references relate to the work on this standard:
Committee reference RHE/9
Draft for comment 88/73462 DC

ISBN 0 580 26907 8

Amendments issued since publication

Amd. No.	Date	Comments

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National foreword

This British Standard has been prepared by Technical Committee RHE/9 and is the English language version of EN ISO 8497:1996 *Thermal insulation — Determination of steady-state thermal transmission properties of thermal insulation for circular pipes* published by the European Committee for Standardization (CEN). It is identical with ISO 8497:1994 published by the International Organization for Standardization.

ISO 8497 was produced as a result of international discussions in which the United Kingdom took an active part.

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Summary of pages

This document comprises a front cover, an inside front cover, page i and ii, the EN ISO title page, pages 2 to 18 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

ICS 27.220

Descriptors: Thermal insulation, pipes (tubes), tests, determination, thermal properties, thermal conductivity, thermal resistance, thermal measurement.

English version

Thermal insulation — Determination of steady-state thermal transmission properties of thermal insulation for circular pipes

(ISO 8497:1994)

Isolation thermique — Détermination des propriétés relatives au transfert de chaleur en régime stationnaire dans les isolants thermiques pour conduites
(ISO 8497:1994)

Wärmeschutz — Bestimmung der Wärmetransporteigenschaften im stationären Zustand von Wärmedämmungen für Rohrleitungen
(ISO 8497:1994)

This European Standard was approved by CEN on 1995-11-11. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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CEN

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

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Foreword

The text of the International Standard from Technical Committee ISO/TC 163, Thermal insulation, of the International Organization for Standardization (ISO) has been taken over as a European Standard by Technical Committee CEN/TC 89, Thermal performance of buildings 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 February 1997, and conflicting national standards shall be withdrawn at the latest by February 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE Normative references to International Standards are listed in annex ZA (normative).

Introduction

The thermal transmission properties of pipe insulation generally have to be determined using pipe test apparatus rather than flat specimen apparatus such as the guarded hot plate or the heat flow meter apparatus, if results are to be representative of end-use performance. Insulation material formed into flat sheets often has different internal geometry from that of the same material formed into cylindrical shapes. Furthermore, properties often depend significantly upon the direction of heat flow in relation to inherent characteristics such as fibre planes or elongated cells: thus flat specimen one-dimensional heat flow measurements may not necessarily be representative of the two-dimensional radial heat flow encountered in pipe insulation.

Another consideration is that commercial insulations for pipes are often made with the inside diameter slightly larger than the outside diameter of the pipe, otherwise manufacturing tolerances may result in an imperfect fit on the pipe, thus creating an air gap of variable thickness. In those cases where end-use performance data rather than material properties are to be determined, the insulation is mounted on the test pipe in the same loose manner so that the effect of the air gap will be included in the measurements. This would not be the case if properties were determined in a flat plate apparatus where good plate contact is required.

Still another consideration is that natural convection currents around insulation installed on a pipe will cause non-uniform surface temperatures. Such conditions will not be duplicated in a flat plate apparatus with uniform plate temperatures.

NOTE 1 Comparison tests on apparently similar material using both pipe apparatus and flat plate apparatus have shown varying degrees of agreement of measured thermal transmission properties. It appears that better agreement is often obtained for heavier density products which tend to be more uniform, homogeneous and sometimes more isotropic. For those materials which have repeatedly shown acceptable agreement in such comparisons, the use of data from flat plate apparatus to characterize pipe insulation may be justified. As a general rule, when such agreement has not been shown, the pipe test apparatus shall be used to obtain thermal transmission data for pipe insulations.

1 Scope

This International Standard specifies a method for the determination of steady-state thermal transmission properties of thermal insulations for circular pipes generally operating at temperatures above ambient. It specifies apparatus performance requirements, but it does not specify apparatus design.

The type of specimen, temperatures and test conditions to which this International Standard applies are specified in clauses 5 and 6.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7345:1987, *Thermal insulation — Physical quantities and definitions*.

ISO 8301:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*.

ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*.

3 Definitions

NOTE 2 The geometry of pipe insulation requires special terms not applicable to flat specimens. The word “linear” is used to denote properties based upon a unit length (in the pipe axis direction) of a specified insulation size. These linear properties, identified by the subscript “l”, are convenient since the total heat loss can then be calculated knowing the pipe length and the applicable temperature.

“Linear” does not denote heat flow in the axial direction. In this International Standard, the direction of heat flow is predominantly radial.

For the purposes of this International Standard, the following definitions apply. The definitions and symbols given in the following clauses are based upon those in ISO 7345 except for the linear thermal transference (3.1).

3.1**linear thermal transference, K_l**

linear density of heat flow rate divided by the temperature difference between the pipe surface and the ambient air in the steady-state condition. It relates to a specific insulation size and is a measure of the heat transferred through the insulation to the ambient atmosphere

$$K_l = \frac{\Phi/L}{T_0 - T_a} \quad \dots (1)$$

3.2**linear thermal resistance, R_l**

temperature difference between the pipe surface and the insulation outer surface divided by the linear density of heat flow rate in the steady-state condition. It relates to a specific insulation size and is the reciprocal of the pipe linear thermal conductance, Λ_l

$$R_l = \frac{T_0 - T_2}{\Phi/L} = \frac{1}{\Lambda_l} \quad \dots (2)$$

3.3**linear thermal conductance, Λ_l**

reciprocal of the linear thermal resistance, R_l , from the pipe surface to the insulation outer surface. It relates to a specific insulation size

$$\Lambda_l = \frac{1}{R_l} = \frac{\Phi/L}{T_0 - T_2} \quad \dots (3)$$

3.4**surface coefficient of heat transfer, h_2**

areal density of heat flow rate at the surface in the steady-state condition divided by the temperature difference between the surface and the surrounding ambient air. For pipe insulation geometry the following relation applies

$$h_2 = \frac{\Phi}{\pi D_2 L (T_2 - T_a)} \quad \dots (4)$$

3.5 thermal conductivity, λ

defined by the following relation specifically applicable to the pipe insulation geometry. It applies to homogeneous material in the steady-state condition and is the reciprocal of the thermal resistivity, r

$$\lambda = \frac{\Phi \ln(D_2/D_0)}{2\pi L (T_0 - T_2)} = \frac{1}{r} \quad \dots (5)$$

NOTE 3 In ISO 7345, the thermal conductivity is also defined by the more general relation $q = -\lambda \text{ grad } T$.

NOTE 4 Since the pipe surface temperature, T_0 , is used, the thermal conductivity will include the effect of any gap that exists between the insulation and the pipe (see 6.1).

3.6**thermal resistivity, r**

reciprocal of the thermal conductivity, λ , for a homogeneous material in the steady-state condition

$$r = \frac{2\pi L (T_0 - T_2)}{\Phi \ln(D_2/D_0)} = \frac{1}{\lambda} \quad \dots (6)$$

3.7**areal thermal resistance, R**

temperature difference between the pipe surface and the insulation outer surface divided by the areal density of heat flow rate in the steady-state condition. It is the reciprocal of the areal thermal conductance, Λ

$$R = \frac{T_0 - T_2}{\Phi/A} = \frac{1}{\Lambda} \quad \dots (7)$$

where the surface of area A must be specified (usually the pipe surface, sometimes the insulation outer surface, or other as chosen; see note 6 in 3.8)

NOTE 5 The more common "areal" properties, based upon unit area, are often confusing when applied to pipe insulation since the area must be chosen arbitrarily and may range from that of the pipe surface to that of the insulation outer surface. If these areal properties are computed, the area and its location used in the computation must be reported.

3.8**areal thermal conductance, Λ**

reciprocal of the areal thermal resistance, R

$$\Lambda = \frac{1}{R} = \frac{\Phi/A}{T_0 - T_2} \quad \dots (8)$$

where the location of the surface of area A must be specified (usually the pipe surface, sometimes the insulation outer surface, or other as chosen)

NOTE 6 The value of Λ , the areal thermal conductance, is arbitrary since it depends upon an arbitrary choice of the area, A . For a homogeneous material for which the thermal conductivity is defined as in 3.5, the areal conductance, Λ , is given by