

# Thermal Insulation Material

## Standardization

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

**Technical Requirement:** A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

**Recommended Practice:** A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a non mandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

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## Introduction

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**CONTEC**  
Comissão de Normalização  
Técnica

**SC - 09**  
Thermal Insulation and  
Refractories

## Summary

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## Foreword

This Standard is the English version (issued in 01/2014) of PETROBRAS N-1618 REV. G 03/2013, and incorporate the Erratum of 05/2013 and the Amendment of 01/2014. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

## 1 Scope

1.1 This Standard standardizes high and low temperature thermal insulation materials, complementary materials, and accessories used for installing thermal insulation for external use in equipment and piping.

1.2 This Standard applies to designs started as of its issuance date as well as to maintenance or refurbishing work on existing facilities/equipment.

1.3 This Standard contains Technical Requirements and Recommended Practices.

## 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 applies.

PETROBRAS [N-1358](#) - Sólidos por Volume - Determinação pelo Disco de Aço;

PETROBRAS [N-1367](#) - Determination of Solids Content by Mass on Paints and Related Products;

ABNT [NBR 5007](#) - Tiras Relaminadas de Aço de Baixo Teor de Carbono para Estampagem - Especificação;

ABNT [NBR 5589](#) - Arame de aço de baixo teor de carbono — Requisitos;

ABNT [NBR 6323](#) - Galvanização de Produtos de Aço ou Ferro Fundido- Especificação;

ABNT [NBR 6331](#) - Arame de Aço de Baixo Teor de Carbono, Zincado, para Uso Geral- Especificação;

ABNT [NBR 7000](#) - Alumínio e suas Ligas - Produtos Extrudados com ou sem Trefilação - Propriedades Mecânicas;

ABNT [NBR 7008-2](#) - Chapas e bobinas de aço revestidas com zinco ou liga zinco-ferro pelo processo contínuo de imersão a quente Parte 2: Aços de qualidade comercial e para estampagem;

ABNT [NBR 7556](#) - Alumínio e suas ligas - Chapas - Requisitos;

ABNT [NBR 8094](#) - Material Metálico Revestido e Não Revestido - Corrosão por Exposição à Névoa Salina - Método de ensaio;

ABNT [NBR 8096](#) – Material Metálico Revestido e Não-Revestido – Corrosão por Exposição ao Dióxido de Enxofre- Método de ensaio;

ABNT [NBR 8635](#) - Arames de Aço Inoxidável para Forjamento a Frio de Parafusos e Porcas - Especificação;

ABNT [NBR 9228](#) - Feltros Asfálticos para Impermeabilização - Especificação;

ABNT [NBR 9688](#) - Isolantes Térmicos de Lã Cerâmica Mantas - Especificação;

ABNT [NBR 9909](#) - Isolantes Térmicos de Lã Cerâmica - Painéis - Especificação;

ABNT [NBR 10404](#) - Isolantes Térmicos de Lã Cerâmica - Flocos - Especificação;

ABNT [NBR 10412](#) - Isolantes Térmicos de Lã de Vidro - Feltros de Lamelas - Especificação;

ABNT [NBR 10662](#) - Isolantes Térmicos Pré-Moldados de Silicato de Cálcio - Especificação;

ABNT [NBR 11357](#) - Tubos Termoisolantes à Base de Lã de Vidro;

ABNT [NBR 11358](#) - Painéis Termoisolantes à Base de Lã de Vidro;

ABNT [NBR 11360](#) - Isolantes Térmicos de Lã de Vidro - Flocos - Especificação;

ABNT [NBR 11361](#) - Mantas Termoisolantes à Base de Lã de Vidro;

ABNT [NBR 11363](#) - Tubos Termoisolantes à Base de Lã de Rocha - Especificação;

ABNT [NBR 11364](#) - Painéis Termoisolantes à Base de Lã de Rocha - Especificação;

ABNT [NBR 11722](#) - Feltros Termoisolantes à Base de Lã de Rocha - Especificação;

ABNT [NBR 11726](#) - Espuma Rígida de Poliuretano para Fins de Isolação Térmica - Especificação;

ABNT [NBR 11777](#) - Cimento Isolante à Base de Silicato de Cálcio para Rejuntamento - Especificação;

ABNT [NBR 13047](#) - Isolante Térmico de Lã de Rocha - Mantas Flexíveis com Suporte de Tela Metálica;

ABNT [NBR ISO 18553](#) - Método para Avaliação do Grau de Dispersão de Pigmentos ou Negro-de-fumo em Tubos, Conexões e Compostos Poliolefinicos;

ISO [1522](#) - Paints and Varnishes - Pendulum Damping Test;

ASTM [A36/A36M](#) - Standard Specification for Carbon Structural Steel;

ASTM [A109/A109M](#) - Standard Specification for Steel, Strip, Carbon, Cold-Rolled;

ASTM [A167](#) - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip;

ASTM [A390](#) - Standard Specification for Zinc-Coated (Galvanized) Steel Poultry Fence Fabric (Hexagonal and Straight Line);

ASTM [A480/A480M](#) - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip;

ASTM [A492](#) - Standard Specification for Stainless Steel Rope Wire;

ASTM [A879/A879M](#) - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface;

ASTM [B209](#) - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate;

ASTM [B633](#) - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel;

ASTM [B841](#) - Standard Specification for Electrodeposited Coatings of Zinc Nickel Alloy Deposits;

ASTM [B849](#) - Standard Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement;

ASTM [B850](#) - Standard Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement;

ASTM [C177](#) - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus;

ASTM [C461](#) - Standard Test Methods for Mastics and Coatings Used with Thermal Insulation;

ASTM [C518](#) - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus;

ASTM [C534/C534M](#) - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form;

ASTM [C552](#) - Standard Specification for Cellular Glass Thermal Insulation;

ASTM [C591](#) - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation;

ASTM [C610](#) - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation;

ASTM [C795](#) - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel;

ASTM [C892](#) - Standard Specification for High-Temperature Fiber Blanket Thermal Insulation;

ASTM [C1029](#) - Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation;

ASTM [C1728](#) - Standard Specification for Flexible Aerogel Insulation;

ASTM [D5/D5M](#) - Standard Test Method for Penetration of Bituminous Materials;

ASTM [D36/D36M](#) - Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus);

ASTM [D70](#) - Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method);

ASTM [D71](#) - Standard Test Method for Relative Density of Solid Pitch and Asphalt (Displacement Method);

ASTM [D92](#) - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester IP Designation: 36/84 (89); AASHTO no T48; DIN 51 376;

ASTM [D113](#) - Standard Test Method for Ductility of Bituminous Materials AASHTO no T51;

ASTM [D146/D146M](#) - Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing;

ASTM [D471](#) - Standard Test Method for Rubber Property Effect of Liquids;

ASTM [D522](#) - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings;

ASTM [D523](#) - Standard Test Method for Specular Gloss;

ASTM [D543](#) - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents;

ASTM [D570](#) - Standard Test Method for Water Absorption of Plastics;

ASTM [D635](#) - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position;

ASTM [D638](#) - Standard Test Method for Tensile Properties of Plastics;

ASTM [D790](#) - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;

ASTM [D1238](#) - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer;

ASTM [D1505](#) - Standard Test Method for Density of Plastics by the Density-Gradient Technique;

ASTM [D1525](#) - Standard Test Method for Vicat Softening Temperature of Plastics;

ASTM [D1621](#) - Standard Test Method for Compressive Properties of Rigid Cellular Plastics;

ASTM [D1622](#) - Standard Test Method for Apparent Density of Rigid Cellular Plastics;

ASTM [D1623](#) - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics;

ASTM [D1754/D1754M](#) - Standard Test Method for Effect of Heat and Air on Asphaltic Materials (Thin-Film Oven Test);

ASTM [D2042](#) - Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene;

ASTM [D2126](#) - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging;

ASTM [D2240](#) - Standard Test Method for Rubber Property-Durometer Hardness;

ASTM [D2244](#) - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates;

ASTM [D2247](#) - Standard Practice for Testing Water Resistance of Coating in 100 % Relative Humidity;

ASTM [D2794](#) - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact);

ASTM [D2842](#) - Standard Test Method for Water Absorption of Rigid Cellular Plastics;

ASTM [D3349](#) - Test Method for Absorption Coefficient of Ethylene Polymer Material Pigmented with Carbon Black;

ASTM [D3359](#) - Standard Test Methods for Measuring Adhesion by Tape Test;

ASTM [D4141](#) - Standard Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings;

ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique;

ASTM D6226 - Standard Test Method for Open Cell Content of Rigid Cellular Plastics;

ASTM E313 - Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates;

ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

### 3 Terms and Definitions

For the purposes of this document the following terms and definitions are applied.

#### 3.1

##### **rigid thermal insulation**

pre-molded pieces supplied in the form of segments, half sections, boards, and special parts and made of the following insulating materials:

- a) calcium silicate;
- b) rigid polyurethane and polyisocyanurate foam;
- c) expanded perlite;
- d) cellular glass.

#### 3.2

##### **flexible thermal insulation**

flexible pieces supplied in the form of felts, panels, flexible pipes, blankets, flakes, cords, and modules and made of the following insulating materials:

- a) glass wool;
- b) rock wool;
- c) ceramic wool or fiber;
- d) aerogel;
- e) elastomeric foam.

#### 3.3

##### **complementary material**

material used to protect the thermal insulation and/or to install the vapor barrier, such as: cements mastics, sealants, protective coatings.

#### 3.4

##### **accessory**

material used to facilitate the installation and to fix the insulating and complementary materials, such as: wires, bands, clips, seals, screws.

#### 3.5

##### **high temperature**

all operating temperature above the mean of the maximum ambient temperatures during the two hottest months of the year.

#### 3.6

##### **low temperature**

all operating temperature equal or below the mean of the maximum ambient temperatures during the two hottest months of the year.

## 4 Rigid Thermal Insulation

When the thermal insulation were applied on equipment or piping made of stainless steel, series 300 and 400, the maximum chloride and fluoride content in the insulation shall be in accordance with the criteria set out in ASTM [C795](#).

### 4.1 Calcium Silicate

The required characteristics are those specified in ABNT [NBR 10662](#).

### 4.2 Rigid Polyurethane (PUR) and Polyisocyanurate (PIR) Foam

#### 4.2.1 Pre-Molded (in Half Sections, Segment and Plate) and Injected Polyurethane

The required characteristics are those specified in ABNT [NBR 11726](#), with the following additional requirements:

- a) with flame retarding agents;
- b) expanding agent free of CFC gas (chlorofluorocarbon);
- c) thermal conductivity according to ASTM [C591](#), considering for:
  - ABNT [NBR 11726](#), Type 1, in accordance with ASTM [C591](#), Grade 2, Type I;
  - ABNT [NBR 11726](#), Type 2, in accordance with ASTM [C591](#), Grade 2, Type II;
  - ABNT [NBR 11726](#), Type 3, in accordance with ASTM [C591](#), Grade 2, Type V.

#### 4.2.2 Sprayed Polyurethane

The required characteristics are those specified in ASTM [C1029](#), with the following additional requirements:

- a) with flame retarding agents;
- b) expanding agent free of CFC gas;
- c) characteristics according to Table 1.

**Table 1 - Characteristics of Sprayed Polyurethane**

| Properties                            | Conditions | Units             | Values |       |        | Test method                                                  |
|---------------------------------------|------------|-------------------|--------|-------|--------|--------------------------------------------------------------|
| Apparent density                      | -          | kg/m <sup>3</sup> | 35/45  | 48/60 | 90/120 | ASTM <a href="#">D1622</a>                                   |
| Maximum thermal conductivity at 24 °C | up to 24 h | W/m.K             | 0,014  | 0,015 | 0,018  | ASTM <a href="#">C518</a><br>or<br>ASTM <a href="#">C177</a> |
|                                       | after 30 d | W/m.K             | 0,015  | 0,016 | 0,020  |                                                              |
| Water absorption                      | maximum    | g/cm <sup>2</sup> | 0,024  | 0,021 | 0,018  | ASTM <a href="#">D2842</a>                                   |
| Number of closed cells                | minimum    | %                 | 90     | 92    | 95     | ASTM <a href="#">D6226</a>                                   |
| Maximum linear variation              | 7 d/70 °C  | %                 | 2      | 3     | 3      | ASTM <a href="#">D2126</a>                                   |
| Compressive strength                  | minimum    | kPa               | 200    | 250   | 700    | ASTM <a href="#">D1621</a>                                   |
| Tensile strength                      | minimum    | kPa               | 280    | 300   | 800    | ASTM <a href="#">D1623</a>                                   |
| Bending resistance                    | minimum    | kPa               | 280    | 300   | 800    | ASTM <a href="#">D790</a>                                    |

#### **4.2.3 Pre-molded Polyisocyanurate (in Half Sections, Segment and Plate)**

The required characteristics are those listed in ASTM [C591](#).

#### **4.3 Expanded Perlite (in Half Sections, Segment and Plate)**

The required characteristics are those listed in ASTM [C610](#).

#### **4.4 Cellular Glass(in Half Sections, Segment and Plate)**

The required characteristics are those contained in ASTM [C552](#).

### **5 Flexible Thermal Insulation**

When the thermal insulation were applied on equipment or piping made of stainless steel, series 300 and 400, the maximum chloride and fluoride content in the insulation shall be in accordance with the criteria set out in ASTM [C795](#).

#### **5.1 Glass Wool**

##### **5.1.1 In Thin Felt Sheets**

The required characteristics are those specified in ABNT [NBR 10412](#).

##### **5.1.2 In Panel**

The required characteristics are those specified in ABNT [NBR 11358](#), with the following additional requirements:

- a) utilize just density of 40 kg/m<sup>3</sup> ou 60 kg/m<sup>3</sup>;
- b) continuous use temperature:
  - density of 40 kg/m<sup>3</sup>: 350 °C;
  - density of 60 kg/m<sup>3</sup>: 450 °C.

##### **5.1.3 In Tubular Form**

The required characteristics are those specified in ABNT [NBR 11357](#), with the following additional requirements:

- a) density from 60 kg/m<sup>3</sup> to 100 kg/m<sup>3</sup>;
- b) continuous use temperature of 450 °C.

##### **5.1.4 In Blanket**

The required characteristics are those specified in ABNT [NBR 11361](#), with the following additional requirement:

- a) utilize just density of 40 kg/m<sup>3</sup> ou 60 kg/m<sup>3</sup>;
- b) continuous use temperature:
  - density of 40 kg/m<sup>3</sup>: 350 °C;
  - density of 60 kg/m<sup>3</sup>: 450 °C.