

Application of Refractory Castable

Procedure

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 nonmandatory 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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CONTEC

Comissão de Normalização
Técnica

SC - 09

Thermal Insulation and
Refractories

Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard [N-1](#). For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

Foreword

This Standard is the English version (issued in 12/2010) of PETROBRAS N-1617 REV. F 12/2010. 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 establishes the conditions required for storage and application of refractory castable.

1.2 This Standard applies to designs initiated after its date of issuance as well as to existing equipment items when they undergo maintenance or reform.

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 (including any amendments) applies.

PETROBRAS [N-9](#) - Tratamento de Superfícies de Aço com Jato Abrasivo e Hidrojateamento;

PETROBRAS [N-133](#) - Welding;

PETROBRAS [N-1728](#) - Castable Refractory;

PETROBRAS [N-1910](#) - Castable Lining Design;

PETROBRAS [N-2864](#) - Application of Refractory Lining - Personnel Qualification;

ABNT [NBR 13320](#) - Materiais Refratários - Determinação da Fluidez de Concretos Convencionais e de Fluência Livre;

ABNT [NBR 15239](#) - Tratamento de Superfícies de Aço com Ferramentas Manuais e Mecânicas;

ASME [Section IX](#) - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1 curing

chemical reactions that occur at low temperatures after water is added to the castable. The curing time is the time period between the beginning and end of such reactions

3.2**hydraulic curing**

treatment given to the castable after its application to ensure water retention in order to allow for the continuity of the reactions observed during the curing process

3.3**course**

an area in which refractory castable can be applied before the material placed at the beginning of the refractory application begins to set

NOTE In cylindrical vessel applications, a course represents the concrete ring applied horizontally to the shell, with the height being sized in such a manner as to allow it to be closed before the concrete begins to set.

3.4**initial setting**

it is characterized by loss of the consistency needed for application of the material after water is added to the mix

3.5**rebound material**

gunning castable which bounces away from the wall due to factors, such as: excess pressure, lack of pre-wetting, angle of inclination of gun nozzle, insufficient bonding material or inadequate grain size

3.6**workability**

property that allows refractory materials, when wetted, to be molded and worked with greater ease, depending on their consistency and plasticity

4 General Conditions**4.1 Storage**

4.1.1 Concrete shall be stored in a dry, well-ventilated location, not subject to excessive heat and protected from direct sunlight.

4.1.2 The maximum piling of packages per pallet shall be in accordance with the manufacturer's criteria. In the absence thereof, the following criteria shall be followed:

- a) five metallic packages;
- b) ten multi-sheet paper or plastic bags.

4.1.3 Concrete shall be stored in such a manner as to allow for the control of validity periods and consumption on a first-in first-out (FIFO) basis of warehouse material, which shall be properly handled so as to prevent damages.

4.1.4 There shall be no direct contact with the floor, and the material shall be laid on pallets.

4.1.5 In those cases in which the castable is stored for a period of time greater than the validity period for use or whenever it is necessary to prove the quality of the material, the inspection provided for in PETROBRAS [N-1728](#) shall be repeated for revalidation of the material, with a validity of 3 months.

4.2 Homogenization and Mixing

4.2.1 Castable shall be perfectly homogenized in the dry condition before water is added according to the instructions provided by the castable manufacturer. The percentage of added water shall be the same as that used in the test for qualification of the application procedure (see 4.3).

4.2.1.1 Metallic fibers shall be added during the homogenization process by passing them through a 6 mm to 8 mm mesh sieve so that they can be uniformly distributed throughout the entire volume of the castable.

4.2.1.2 The total contents of each castable package shall be homogenized, even when the quantity used is smaller than that of the packaged unit.

4.2.2 No material shall be added to the castable received from the manufacturer, except metallic fibers, where applicable.

4.2.3 Castable from a particular manufacturer shall not be mixed with castable from other manufacturers.

4.2.4 Mix only the sufficient quantity of castable to be applied before the initial setting.

4.2.5 Mixers shall be of sufficient capacity to ensure a continuous supply of castable during application.

4.2.6 Water used for the mixing and wetting process shall be potable, free from sulfates and with a chloride content less than 50 ppm.

NOTE The maximum temperature of water shall be 24 °C.

4.2.7 The temperature of the mixture shall be kept between 19 °C and 24 °C during the application, and the temperature of water or concrete may be changed for that range to be reached.

4.2.8 The mixing recipients shall be metallic and watertight as well as cleaned (at each mixture) and dried.

4.2.9 The castable shall be deemed to have been well mixed when:

- a) no segregation is observed between grains;
- b) no regions wetted differently are observed;
- c) proper consistency is achieved.

4.3 Application Procedure

The following information set out in the qualification shall be included in the application procedure in the indicated sequence:

- a) application method;
- b) application position (vertical or overhead);
- c) method and degree of surface preparation;

- d) lining thickness and type of anchorage;
- e) material, manufacturer and commercial reference;
- f) percentage and type of metallic fiber to be added (when applicable);
- g) water proportioning range;
- h) mixing method, type of mixer and capacity;
- i) workability (when applicable);
- j) safety requirements for handling refractory material;
- k) requirements for handling and disposal of wastes (packaging and leftover materials);
- l) if the castable is applied through the spraying method, the following shall be defined:
 - distance between gun nozzle and plate;
 - operating air pressure of gunning machine;
 - type, model and manufacturer of gunning machine;
 - height of each course;
- m) if the castable is applied through the pouring method, the following shall be defined:
 - type of formwork to be used;
 - height of each course;
 - period of time to complete the course;
 - compaction technique;
 - stripping time;
- n) if the castable is applied through the pouring method with external vibration, in addition to the provisions in m), the following shall be defined:
 - vibrator (manufacturer, type, model, characteristics);
 - quantity, location and sequence of operation of vibrators;
 - maximum/minimum vibration time;
 - vibration variables (frequency and acceleration);
- o) if the castable is applied through the pouring method by pumping, in addition to the provisions in m), the following shall be defined:
 - pumping equipment (manufacturer, type, model, characteristics);
 - layout for installation, piping, and accessories;
 - pumping points, application sequence;
 - pipe cleaning and lubrication method;
 - define the fluidity (ABNT [NBR 13320](#)) required for application (parameters and frequency of verification test);
- p) wetting and curing technique.

NOTE Whenever any of the variables mentioned in a), b), e) and g) is modified, the procedure shall be requalified.

4.4 Refractory Application

4.4.1 For regions to be welded in the assembly phase the lining application shall be interrupted according to the orientations contained in the design.

4.4.2 In the absence of the orientation mentioned in 4.4.1, use the recommendations of Table 1. **[Recommended Practice]**

Table 1 - Minimum Distance From Lining to Weld Bead

Types of lining		Minimum distance (mm)	
		Welding on lining side	Welding on opposite side
Anchored to hexagonal wire mesh or "S" anchor fitting		100	100
Monolithic		100	35
Dual layer	1 st layer	100	50
	2 nd layer	200	100

4.4.3 For dual layer, the weld joining hexagonal wire mesh panels shall be located on a row of threaded or welded anchors.

4.4.4 The castable shall only be applied up to two hexagons before the region of the weld joining hexagonal mesh panels.

4.4.5 Whenever possible, equipment parts shall be previously adjusted before the castable is applied so as to avoid the need for adjustments among parts of the equipment in the assembly phase as this could cause damages to the lining. **[Recommended Practice]**

4.4.6 When the castable is applied before assembly on long parts, care shall be taken in the assembly phase so as to avoid bending of the part.

4.4.7 During the refractory application phase, observe the minimum time periods for moving parts, in accordance with Table 2.

Table 2 - Minimum Time Periods for Moving Parts

Types of castable	Change of position and/or small displacements	Field transportation and assembly
Chemical setting castable up to 1" thick	12 hours	24 hours
Hydraulic setting castable of any thickness or chemical setting castable over 1"	24 hours	48 hours
NOTE 1 The above time periods may be modified according to the manufacturers recommendations, provided due care is taken to prevent structural damages to the castable. [Recommended Practice]		
NOTE 2 Parts on which refractory plastic was applied shall be dried with localized heating before assembly.		

4.4.8 On hot days (ambient temperature above 30 °C), during the hydraulic curing and application phases, care shall be taken to keep the plating temperature below 30 °C (e.g.: water spraying, nighttime application, etc.).

4.4.9 On cold days (ambient temperature below 10 °C), during the application and hydraulic curing phases, care shall be taken to keep the temperature of the plate at a temperature above 10 °C (e.g.: water spraying).

4.4.10 All heat treatments, pressure tests and plate inspections shall be completed before the castable is applied. Pneumatic tests may be done after refractory application, leaving the joints being tested without lining.

NOTE For equipment on which refractory has been applied during the manufacturing and/or assembly phase the pressure test may be performed after refractory application, in specific situations, provided all technical requirements are verified and the recommendations of the manufacturers of refractory material and of the designer are followed. The procedure for application, drying, pressure testing and inspection of the dry refractory material after the pressure test shall be previously approved by PETROBRAS.