

# PETRONAS TECHNICAL STANDARDS

## DESIGN AND ENGINEERING PRACTICE

### TECHNICAL SPECIFICATION

## MATERIALS FOR HIGH-TEMPERATURE CONVERSION PROCESS FURNACE PARTS

PTS 31.24.40.31

FEBRUARY 2010



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|------------|---------------------------------------------------------|
| PTS No:    | 31.24.40.31                                             |
| PTS Title: | MATERIALS FOR HIGH-TEMPERATURE CONVERSION FURNACE PARTS |

This revision of PTS **31.24.40.31 – MATERIALS FOR HIGH-TEMPERATURE CONVERSION FURNACE PARTS (February 2010)** has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS **31.24.40.31 (December 2000)** will be removed from PTS binder / e-repository from herein onwards.

The custodian of this PTS is:

Name: Abu Bakar M Arif

Tel. No: 03-27836211

Please direct any questions regarding this PTS to the above-named.

## Document Approval

|                       | Name                             | Designation                        | Date        | Signature |
|-----------------------|----------------------------------|------------------------------------|-------------|-----------|
| Prepared/<br>Reviewed | Aid Farhan Maarof                | Executive, MCI                     | 5/2/10      |           |
|                       | Mohd Shahrizal PKM<br>Seeni Mohd | Executive, MCI                     | 5/2/10      |           |
| Approved              | Tan Yew Min                      | Staff (Materials Engineering)      | 5/2/10      |           |
| Approved              | Abu Bakar M Arif                 | Principal (Materials Engineering)  | 05 FEB 2010 |           |
| Verified              | Che Wan Ibrahim Che<br>Wan Sudin | Head, MCI, GTS                     | 8/2/10      |           |
| Verified              | Pau Kiew Huai                    | General Manager, Engineering, GTS  | 11.2.10     |           |
| Endorsed              | Pau Kiew Huai                    | Acting Senior General Manager, GTS | 11.2.10     |           |

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## TABLE OF CONTENTS

|           |                                                                |           |
|-----------|----------------------------------------------------------------|-----------|
| <b>1.</b> | <b>INTRODUCTION .....</b>                                      | <b>4</b>  |
| 1.1       | SCOPE .....                                                    | 4         |
| 1.2       | DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS ..... | 4         |
| 1.3       | DEFINITIONS .....                                              | 4         |
| 1.4       | CROSS-REFERENCES .....                                         | 4         |
| 1.5       | SUMMARY OF CHANGES SINCE PREVIOUS EDITION .....                | 5         |
| <b>2.</b> | <b>SELECTION OF MATERIALS .....</b>                            | <b>6</b>  |
| 2.1       | GENERAL .....                                                  | 6         |
| 2.2       | SELECTION GUIDELINES. ....                                     | 6         |
| 2.3       | MATERIALS CHARACTERISTICS .....                                | 8         |
| 2.4       | STEAM-NAPHTHA AND STEAM-METHANE REFORMING FURNACES .....       | 9         |
| 2.5       | NAPHTHA, GAS OIL AND GAS CRACKING FURNACES .....               | 10        |
| 2.6       | HIGH TEMPERATURE (PROCESS) STEAM SUPERHEATING FURNACES .....   | 11        |
| 2.7       | STATICALLY CAST COIL SUPPORTS .....                            | 11        |
| <b>3.</b> | <b>ADDITIONAL MATERIAL REQUIREMENTS.....</b>                   | <b>12</b> |
| 3.1       | CHEMICAL COMPOSITIONS .....                                    | 12        |
| 3.2       | MECHANICAL CHARACTERISTICS .....                               | 12        |
| 3.3       | CASTINGS .....                                                 | 12        |
| 3.3.1     | Statically Cast Coil Supports and Fittings .....               | 12        |
| 3.3.2     | Centrifugally Cast Tubes and Coil Assemblies .....             | 12        |
| 3.4       | MICROSTRUCTURAL REQUIREMENTS .....                             | 13        |
| <b>4.</b> | <b>INSPECTION AND TESTING .....</b>                            | <b>14</b> |
| 4.1       | GENERAL .....                                                  | 14        |
| 4.2       | CHEMICAL COMPOSITION .....                                     | 14        |
| 4.3       | MECHANICAL TESTING .....                                       | 14        |
| 4.4       | SURFACE INSPECTION .....                                       | 14        |
| 4.5       | RADIOGRAPHY .....                                              | 15        |
| 4.6       | PRESSURE TESTING .....                                         | 15        |
| <b>5.</b> | <b>WELDING OF TUBES AND COIL ASSEMBLIES .....</b>              | <b>16</b> |
| 5.1       | FABRICATION OF NEW COILS .....                                 | 16        |
| 5.2       | REPAIR OF OLD COILS .....                                      | 16        |
| <b>6.</b> | <b>DEVELOPMENTS IN FURNACE TECHNOLOGY .....</b>                | <b>17</b> |
| 6.1       | MILLISECOND FURNACES .....                                     | 17        |
| 6.2       | INTERNALLY-COATED, OVERLAY-WELDED AND BI-METALLIC TUBES .....  | 17        |
| <b>7.</b> | <b>STORAGE .....</b>                                           | <b>18</b> |
| <b>8.</b> | <b>REFERENCES .....</b>                                        | <b>19</b> |

## 1. INTRODUCTION

### 1.1 SCOPE

This PTS specifies requirements and gives recommendations for selection of materials for furnace parts which under operating conditions will have a metal temperature above 700 °C. For furnace tubes, this metal temperature shall be taken to be the skin temperature.

In addition, some guidelines are given to assist in the fabrication, inspection and testing of new furnace parts and the repair welding of used parts.

The PTS is intended for transfer lines, radiant tubes, fittings and assemblies for:

- steam-naphtha or steam-methane reforming, for the production of synthesis gas or hydrogen;
- naphtha, gas oil or gas cracking, for the production of ethylene or other lower olefins;
- high temperature (process) steam superheating.

For the selection of materials for furnaces having metal temperatures below 700 °C, and for the furnace structure, reference shall be made to PTS 31.24.00.30.

This PTS is a revision of the PTS of the same number dated *December 2000*; a summary of the main changes since the previous edition is given in (1.5).

### 1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this document is confined to companies forming part of PETRONAS group, and to Contractors nominated by them.

This PTS is intended for use in oil refineries, chemical plants and gas plants.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this PTS as closely as possible.

### 1.3 DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

### 1.4 CROSS-REFERENCES

Where cross references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (8).

## 1.5 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

The previous edition of this PTS was dated *December 2000*. Other than editorial changes, the following are the main changes since that edition:

| Section    | Change                                                                                               |
|------------|------------------------------------------------------------------------------------------------------|
| 2.3 to 2.6 | <i>Updated materials designations</i>                                                                |
| 5.2        | <i>Updated welding requirements for repair of coils</i><br><i>Added reference to PTS 30.10.60.18</i> |

## 2. SELECTION OF MATERIALS

### 2.1 GENERAL

The high temperature furnace parts covered by this PTS shall be made of wrought or cast heat-resisting iron-chromium-nickel alloys.

Selection of the most appropriate heat-resistant alloy for each application requires evaluation of the potential degradation of that material due to its exposure to the process environment and of the optimum mechanical properties at high temperatures. The following criteria shall be evaluated when materials are selected for these applications:

- stress-rupture and creep strength;
- resistance to thermal cycling and shock;
- resistance to internal carburisation and metal dusting;
- external oxidation;
- embrittlement behaviour;
- fabrication requirements;
- availability and cost.

To make this possible, several “families” of special heat-resistant alloys have been developed by tube Manufacturers. The materials recommended in this PTS are considered to be the best and most practical materials currently available for the particular application; however, often the final selection is a compromise between materials’ environmental performance and mechanical properties.

Wherever possible, alternative materials are also recommended, and these may be considered as preferable where it is known either during design, or as a result of lessons learned during operation, that the particular furnace components require additional resistance to certain operational conditions.

Some of the latest developed higher temperature alloys do not have standard specifications but are still considered proprietary alloys by Manufacturers. They are known by their generic material type and there can be several variations within each generic type or from different Manufacturers. Determining their acceptability requires a detailed review by the Principal of the proprietary materials’ high temperature properties, including creep rupture values, testing requirements (see section 4), and records of successful applications.

A section has also been included on the repair welding of tubes which have been in operation and may have become embrittled.

The effects of new furnace technology and materials developments are dealt with in (6).

### 2.2 SELECTION GUIDELINES.

The tables in Section 2.4 to 2.7 indicate the recommended materials of construction for the different types of furnaces and furnace components covered by this PTS. Wherever possible the materials referenced are from industry standard specifications. However, in the case of the higher temperature applications, where industry standard specifications do not presently exist, generic materials types, as described in Section 2.3, are listed and often there will be a choice of similar alternatives from different Manufacturers.

For the most critical applications the actual material selection will be dependent upon a number of factors, e.g. operational coking/de-coking practice and its effect on carburisation, furnace design and potential distortion etc.

In the case of new furnaces it is recommended that the initial selection of the generic material type is based upon the design requirements and any known operational characteristics of the furnace. Once the basic generic type of material has been established, a final selection from the available standard and proprietary alloys may be made in consultation with the tube Manufacturers, based on performance and economic considerations.