

2050 Using Part 2 — Refractory

Abstract

This section tells what you will find in Part 2—Refractory, of the *Insulation and Refractory Manual*.

Scope and Application

Part 2 provides engineering guidelines and specifications for the purchase, installation, and repair of refractory lining systems in the Company's refineries and petrochemical plants. These guidelines describe refractory materials and installation methods, give design and calculation procedures, and recommend lining systems for various applications. Inspection guidelines, including an inspection checklist, are also included.

Safe handling procedures for materials containing ceramic fiber, crystalline silica, and asbestos are discussed in Part 1; see Section 500 and Model Specifications IRM-MS-4775 and IRM-MS-4776.

Part 2 has been written for design and project engineers and inspectors throughout the Company who are responsible for selecting, installing, or inspecting refractory lining systems.

The intent is to provide practical, useful information based on Company experience. Therefore, forms have been included in the front of the manual for your convenience in suggesting changes. Your input and experience are important for improving subsequent printings and keeping this manual up-to-date.

Organization

The colored tabs in the manual will help you find information quickly. In summary:

- **White** tabs are for table of contents, introduction, appendices, PC disks, index, and general purpose topics.
- **Blue** tabs denote Engineering Guidelines.
- **Gray** tabs are used for Specifications and related drawings and forms.
- **Red** tab marks a place to keep any documents on insulation and refractories developed at your facility.

Engineering Guidelines

The following are abstracts of each section of the manual.

Section 2100 Material Selection Considerations

This section introduces you to refractory lining materials and gives guidelines for choosing the type of refractory material to use. These guidelines include preliminary considerations (heat loss, the amount of time allowed for installation, economic factors, and previous history of this and similar linings) and refractory property considerations (thermal conductivity, erosion resistance, temperature limits/shrinkage, strength, thermal expansion, resistance to thermal shock and chemical attack). The use of additives to improve performance is also discussed. Typical failure mechanisms are listed, and factors used to develop a list of recommended brands are also named.

Section 2200 Lining Systems for Vessels and Lines

Refractory lining systems for vessels and lines consist of a refractory concrete material anchored to the inside wall. The systems differ from each other in anchoring method, in their material content and in how the material is applied. This section discusses types of anchorage and lining systems used for vessels and lines: their properties, advantages and limitations, and their recommended applications.

Section 2300 Lining Systems for Fired Heaters and Boilers

Due to its excellent insulating properties and its light weight, refractory ceramic fiber (RCF) is used as the main refractory lining in about 75% of all process furnaces. There are, however, instances where other types of refractories are more suitable. Insulating firebrick (IFB) is sometimes used as the lining on the bottom 6 feet of a furnace wall and in other areas where increased durability is needed. Castable refractories provide increased erosion resistance in convection sections, breechings and stacks, around door frames, and in areas where soot blowers are used. Plastic refractories and special refractory shapes are also used to a small extent in fired heater linings. These systems and their characteristics, advantages, limitations, and recommended use are discussed in this section.

Section 2400 Recommended Types of Linings

This section consists of two figures. One of them gives recommended lining system(s) for equipment used in process plants. Equipment includes various parts of FCC regenerators and reactors, including vessel linings, odd shapes like u-bends, y-sections, standpipes, etc.; cyclones, flue gas lines, steam generators, slide valves, seal pots, and CO boilers. Also included are hydrogen plants, NH_3 plants, sulfur plants, ethylene furnaces, fired heaters and boilers, and stacks.

The second figure shows the refractory locations in a typical FCC unit.

Section 2500 Refractory Installation in Vessels, Lines

This section tells the engineer what to consider when planning the installation of refractory material in vessels and lines. Preparation before installation (storage and handling, surface preparation, and installation of anchorage) is discussed. The four

main methods of installation are described—gunned, cast or handpacked, installation of chemically setting materials, and vibration cast.

Section 2600 Installation of Lining Systems for Heaters, Boilers

This section is helpful for engineers planning the installation of refractory linings in fired heaters and boilers. All four classes of refractory materials are used to some extent in fired heaters and boilers, but refractory ceramic fiber (RCF) and castables are dominant.

Section 2700 Curing and Dryout

This section tells what must be done to a lining after placement and before firing. The terms “curing” and “dryout” are defined, and curing methods are given for various refractory materials. Then dryout theories and procedures are discussed, including advice on modifying startup procedures after water washing. Typical dryout schedules are given for five typical refractory lining systems.

Section 2800 Repairs

This section identifies refractory linings that need repair and also help you choose a successful repair method. A list is given of items to consider before beginning a major repair; causes of lining failures are given; and typical refractory repairs done on refinery and petrochemical equipment are outlined.

Safe handling of RCF and crystalline silica materials is discussed in Section 500. This is critical during refractory tear-outs.

Section 2900 Refractory Inspection

This section discusses inspection of new refractory work, including repair work. The discussion includes: the use of third party inspectors and testing services; the prequalification testing of materials, including the kinds of tests that are usually performed on various refractory material; and prequalification of contractors' procedures and work crews. Specific guidelines are given for inspecting the application of monolithic lining systems, refractory ceramic fiber systems, and brick and special shapes.

Specifications, Standard Drawings and Forms

This part of the manual contains: 1) the Company's specifications in commented form; 2) the Company's standard drawings and forms that pertain to refractory lining systems.

Section 4000 Introduction to Specifications

This section lists the refractory specifications in Part 2 and discusses the difference between an MS and an EG specification.

Section 4100 Contracting Plans

Because refractory jobs are large and costly, particular attention should be paid to developing the most cost-effective contract for the Company. This section discusses

contract strategies for refractory work. The type of work to be done—new installations versus repair work, field work versus shop work—will govern the strategy chosen. Three types of contracts are discussed: materials purchase, installation, and inspection. Time-and-material contracts and lump sum contracts are compared for use in repair work, and refractory installations in new plants and new shop-lined equipment. Contracts for third-party inspection companies are also discussed.

Other Company Manuals

The text sometimes refers to documents in other Company manuals. These documents carry the prefix of that manual. The prefixes and their referents are:

Prefix	Company Manual
CIV	Civil and Structural
CMP	Compressor
COM	Coatings
CPM	Corrosion Prevention
DRI	Driver
ELC	Electrical
EXH	Exchanger and Cooling Tower
FFM	Fluid Flow
FPM	Fire Protection
HTR	Fired Heater and Waste Heat Recovery
ICM	Instrumentation and Control
IRM	Insulation and Refractory
MAC	Machinery Support Systems
NCM	Noise Control
PIM	Piping
PMP	Pump
PPL	Pipeline
PVM	Pressure Vessel
TAM	Tank
UTL	Utilities
WEM	Welding

To Get Help:

Call CRTC Materials and Equipment Engineering at CTN 242-3247.

Suggestions For Use

New Installations

Choosing the Lining System. See Section 2400 for recommendations. If you are unfamiliar with the terms in Section 2400 (anchor types, material types, installation methods) see the following section(s):

- Vessels and Lines:
 - Anchors, Section 2200
 - Materials, Section 2200, IRM-EF-881, and GB-N1268
 - Installation methods, Section 2500
- Fired Heaters, Boilers:
 - Anchors and materials, Section 2300
 - Installation methods, Section 2600

Choosing Lining Thickness. See Section 2122 for heat loss calculations. For recommended thickness of RCF, see also Section 2316. Contractors are never responsible for specifying thickness. If you will use the same material type as that recommended in Section 2400 for this application, and if thickness is specified there, you may not need to calculate thickness.

Expansion Joint Calculations. These calculations are needed if the lining system will include insulating and/or regular firebrick. Use the calculation method shown in Section 2320.

Assemble a Contract Package. See Section 4100 for a sample package. For new construction, or for major revamping or replacement, include design drawings.

1. For specifying the purchase of monolithic refractory materials, use IRM-EG-4785. For the purchase of other refractory materials, such as refractory ceramic fiber (RCF), use the Lotus® spreadsheet BIDBASIS.WK1 on the PC disc in the manual to prepare a document similar to Attachment 1 of Figure 4100-2.
2. For specifying the installation of lining systems, see IRM-MS-4786, -4787, -4788, and -4789. Sections 2500, 2600, 2700, and 2800 give background information about refractory installation.
3. Before hiring a third-party testing service, you may wish to read Section 2900 as well as the inspection provisions of each of the specifications.
4. If you are considering use of a third party to perform dryout, see Section 2730.

Repair Work

See the photos in Section 2800 to help you identify linings for tear-out. If you must repair an existing lining system, has the old lining served well? If so, you may want to replace it with the same type of system. If the lining has failed prematurely, analyze why. See “Typical Failure Mechanisms” in Section 2100 and also

Section 2800. Also compare the old lining to those currently recommended for this application in Section 2400. If you are considering a new product, consult first with a Materials and Equipment Engineering refractory specialist.