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INDUSTRY GUIDE 9 min read Updated May 2026

Cement Rotary Kiln Refractory Lining: Zone-by-Zone Material Selection Guide

Operating temperatures, material specifications, and failure modes for each zone of a cement rotary kiln — from inlet to burning zone.

A **cement rotary kiln refractory lining** is the heat-resistant inner shell installed along the full length of steel shell from thermal and chemical attack during clinker production. A typical dry-process cement temperatures of 150–350 °C and peak flame temperatures exceeding 1,450 °C in the burning zone. Th resist abrasion from rotating clinker, thermal shock from flame fluctuations, chemical attack from alka and mechanical stress from kiln flexion. Refractory selection is zone-specific: no single material satisf the inlet, burning, transition, and outlet zones. International practice references ISO 10081 (classificati products) and ASTM C401 for castable classification, while GB/T 2992 governs shaped refractory dim production. This guide defines each kiln zone, specifies the material families used in each, and identif drive premature lining replacement.

This guide is intended for kiln engineers, procurement managers, and refractory contractors specifyir materials for new installations or relining campaigns. It covers dry-process cement kilns in the 1,500–(which represent the majority of operating capacity in mid-to-large cement-producing regions globally

Cement Rotary Kiln Zone Overview

A cement rotary kiln is divided into five functional zones, each defined by its operating temperature ra and mechanical load — all of which determine the refractory specification.

ZONE	POSITION (FROM INLET)	GAS TEMP. (°C)	SHELL TEMP. (°C)	PRIMARY REFRAC
Inlet / Preheating	0–15% of kiln length	800–1,000	150–250	Alkali resistance, a
Upper Transition	15–35%	1,000–1,250	200–300	Thermal shock res resistance
Burning Zone	35–65%	1,350–1,500+	250–350	High refractorines resistance
Lower Transition	65–80%	1,100–1,350	200–300	Thermal shock res resistance
Outlet / Cooling	80–100%	700–1,100	150–250	Abrasion resistanc

Refractory Material Selection by Zone

Each kiln zone requires a distinct refractory family; using a single material across all zones is the mos lining failure in cement kilns.

ZONE	MATERIAL FAMILY	TYPICAL AL_2O_3 CONTENT	FORM
Inlet	High-alumina castable or alkali-resistant brick	60–70%	Castable or sha brick
Upper Transition	Spinel brick or high-alumina brick (Grade 65–75)	65–75%	Shaped brick
Burning Zone	Magnesia-spinel brick or dolomite brick	—	Shaped brick
Lower Transition	Spinel brick or high-alumina brick (Grade 70–80)	70–80%	Shaped brick
Outlet	LCC castable or high-alumina brick (Grade 60)	60–70%	Castable or sha brick

Burning Zone Lining: Material Properties and Coating Behaviour

The burning zone is the most demanding section of the kiln; its lining must support clinker coating adl
secondary thermal barrier and extends brick service life.

Magnesia-spinel brick (MgO ≥ 90%, spinel 5–15%) is the dominant burning zone material in modern c

— **Refractoriness under load (RUL $T_{0.5}$):** ≥ 1,650 °C (ISO 1893)

— **Cold crushing strength (CCS):** ≥ 50 MPa

— **Thermal shock resistance:** ≥ 30 cycles at 950 °C water quench (ISO 8894)

— **Porosity:** ≤ 18% apparent porosity

Dolomite brick (CaO·MgO) is used where clinker coating is difficult to establish; its high CaO content p
requires strict moisture control during storage and installation. Chrome-free magnesia-spinel has repl
most markets due to hexavalent chromium disposal regulations.

> **Coating dependency:** A stable 20–40 mm clinker coating on the burning zone brick reduces brick surfac
> °C. Kilns with unstable coating cycles (frequent fuel changes, raw mix variation) require brick with highe
> not higher refractoriness.

Transition and Cooling Zone Lining

Transition zones experience the highest thermal cycling frequency in the kiln; spinel brick and high-al
Al_2O_3 range are the standard specification for these zones.

The upper and lower transition zones are subject to:

— Rapid temperature swings (±200 °C) during kiln stops and restarts

— Alkali vapour condensation (K_2SO_4, $KHSO_4$) at 900–1,100 °C, which causes brick expansion and spa

— Clinker abrasion from the tumbling charge

Spinel-forming high-alumina brick (Al_2O_3 70–75%, with MgO addition to form in-situ spinel) provides t
shock resistance and alkali resistance for transition zones. LCC (Low Cement Castable) is used in trar
kiln geometry (tyre zones, riding rings) makes brick installation impractical.

The outlet zone uses abrasion-resistant castable or 60% Al_2O_3 brick. Ceramic fibre modules are some
insulation behind the outlet brick to reduce shell temperature, but are not suitable as primary lining in

Common Failure Modes and Root Causes

The majority of unplanned kiln shutdowns caused by refractory failure fall into four categories: spallin
wear, and shell overheating from coating loss.

FAILURE MODE	AFFECTED ZONE	ROOT CAUSE	PREVENTIVE M
Thermal spalling	Transition zones	Rapid temperature cycling; brick with insufficient thermal shock resistance	Specify spinel schedule (≤ 5
Alkali attack	Inlet, upper transition	K_2O/Na_2O vapour condensation in brick pores; brick expansion and cracking	Use alkali-resi porosity ≤ 16%
Coating loss + shell overheating	Burning zone	Unstable flame; raw mix variation; brick surface too smooth for coating adhesion	Maintain stabl spinel brick w

FAILURE MODE	AFFECTED ZONE	ROOT CAUSE	PREVENTIVE M
Mechanical wear (abrasion)	Outlet, lower transition	Clinker tumbling; insufficient cold crushing strength	Specify CCS ≥ abrasion-resis are impractica
Castable cracking during dry-out	Inlet, outlet (castable zones)	Excessive heat-up rate; steam pressure build-up in castable matrix	Follow dry-ou 8 h, then 300

Content produced from Zibo's refractory manufacturing cluster — China's largest concentration of ca insulation material production facilities, with over 40 years of continuous kiln lining export history.

IN THIS ARTICLE

FREQUENTLY ASKED QUESTIONS

Cement Rotary Kiln Refractory Lining — FAQ

What is the typical service life of a cement kiln burning zone lining? +

Can LCC castable replace shaped brick in the burning zone? +

How thick should the refractory lining be in a cement rotary kiln? +

What causes red spots on the kiln shell?

+

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