ADVANCEMENT IN REFRACTORIES FOR CEMENT INDUSTRY

TATA REFRACTORIES LIMITED

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Challenges for Cement industry in view point of refractories supplier

- Usage of alternative cost effective fuels.
- Adaption to wide range of raw materials characteristic.
- Higher thermal loading in ever increasing kiln capacity.
- Minimum 335-340 days running requirement of kiln.
- Compliance to Strict norms to protect environment.
- Requirement of higher 53 grade rather than 33 or 43 in market.

OPERATING PARAMETERS AND THEIR EFFECT ON REFRACTORIES LINING

1. Silica Modulus (SM) = % of SiO_2 / % of (Al_2O_3 + Fe_2O_3)

Typical range 1.8 to 2.7 . If <1.8 low melting phase is formed which wash away the coating. If>3 no coating is formed and produces off grade cement .

2. Alumina Modulus (AM) = % of Al_2O_3 / % of Fe_2O_3

Typical range 1.0 – 1.5. If < 1.0 state is fluid which promotes the formation of large balls in the kiln which destroys coating. If > 2.5 viscous state is formed. As no solidification takes place it is difficult to form coating.

3. % Liquid Phase (LP)= 1.13 C3A + 1.35 C4AF+ MgO+ Alkalis

This determine the type of coating formation on the surface of refractories.

30% LP - Dense & hard coating
25% LP - Fairly good coating
20% LP - Loose & Porous coating

4. Alkali Equivalent (AE) :

Usually 0.6% or below. Alkalies attack entire brickwork severely when AE is high. If AE index is higher provision of alkali by-pass is required.

5. Alkali / Sulphate ratio :

By using high S coals & pet coke or other blended coals S content goes up which effects the coating & allows material buildup on riser ducts.

•ASM = 1

(Alkali Salts in a balanced ratio)

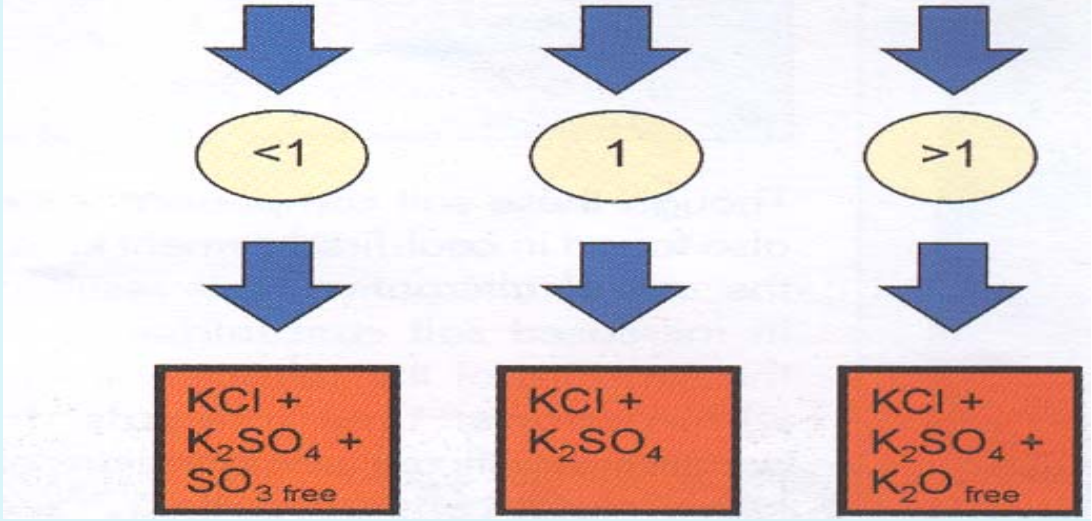
• ASM > 1

(Excess of Alkali)

• ASM <1

(SO2 / SO3 in excess)

$$ASM = \frac{\frac{K_2O}{94} + \frac{Na_2O}{62} - \frac{Cl}{71}}{\frac{SO_3}{80}}$$



A. Balanced ratio of Alkali Salts (ASM ~ 0.8 – 1.2)

- All alkalis , sulphates & chlorides react in the kiln gas atmosphere to form alkali chloride & alkali sulphate salts.
- The salt compounds migrate into the brick structure until they reach the condensation temperature.
- The crystallization of the salts lead to densification of brick structure thus reducing its elasticity & thermal shock resistance.
- However , in this case the changes in the property of refractory lining by chemical influences are rather unlikely.

However , in alternative fuels presence of heavy metal compounds like PbS can cause weakening of brick structure primarily in the upper transition zone.

B. Excessive Alkalis in the Kiln Atmosphere (ASM >1)

- Under oxidizing kiln gas atmosphere , an excess of alkalis leads to oxidation of the chromium ore (From Mag Chrome bricks /alloyed anchors) to form alkali chromates & alkali chromate sulphates.
- Yellowish efflorescence is observed in brick or in the area of metal anchoring in castable linings.
- This leads to spalling of the affected brick surface or dropping of castable sections due to corrosion of metal anchors.
- In case of High Alumina bricks , there is a 30 % increase in volume; – due to formation of β–Alumina ; Feldspathoids (KAS4) and Feldspars (KAS6) – Alkali Spalling takes place.

C. Excessive Sulpur Oxides in the Kiln (ASM <1)

- In case of Mag Chrome Brick - C2S (Bellite) occurring in low concentrations in the brick react with SO2/SO3 to form lower melting silicates like Merwinite (C3MS2) and Monticellite (CMS). By this the Magnesia of the brick is corroded .

- In case of Dolomite Brick – The CaO is reformed into CaSO4 or CaS. Further , the organic impregnation substances in dolomite bricks can release CO under operating conditions which reacts with CaSO4 to form CaS & CO2. CO2 can effect recarbonization of CaO . – These are all accompanied with volume changes weakening the brick structure.

STRESS FACTORS ON REFRACTORIES LINING

STRESSES

1. Thermal stress.

2. Mechanical Stress.

3. Chemical stress.

THERMAL STRESS

- Thermal shocks (Break downs, kiln stoppages, coating fall off).

- Flame- heat load- overheat.

MECHANICAL STRESS

- Erosion due to clinker/coating movement
- Impact due to clinker fall off
- Mechanical tension due to kiln ovality

CHEMICAL STRESS

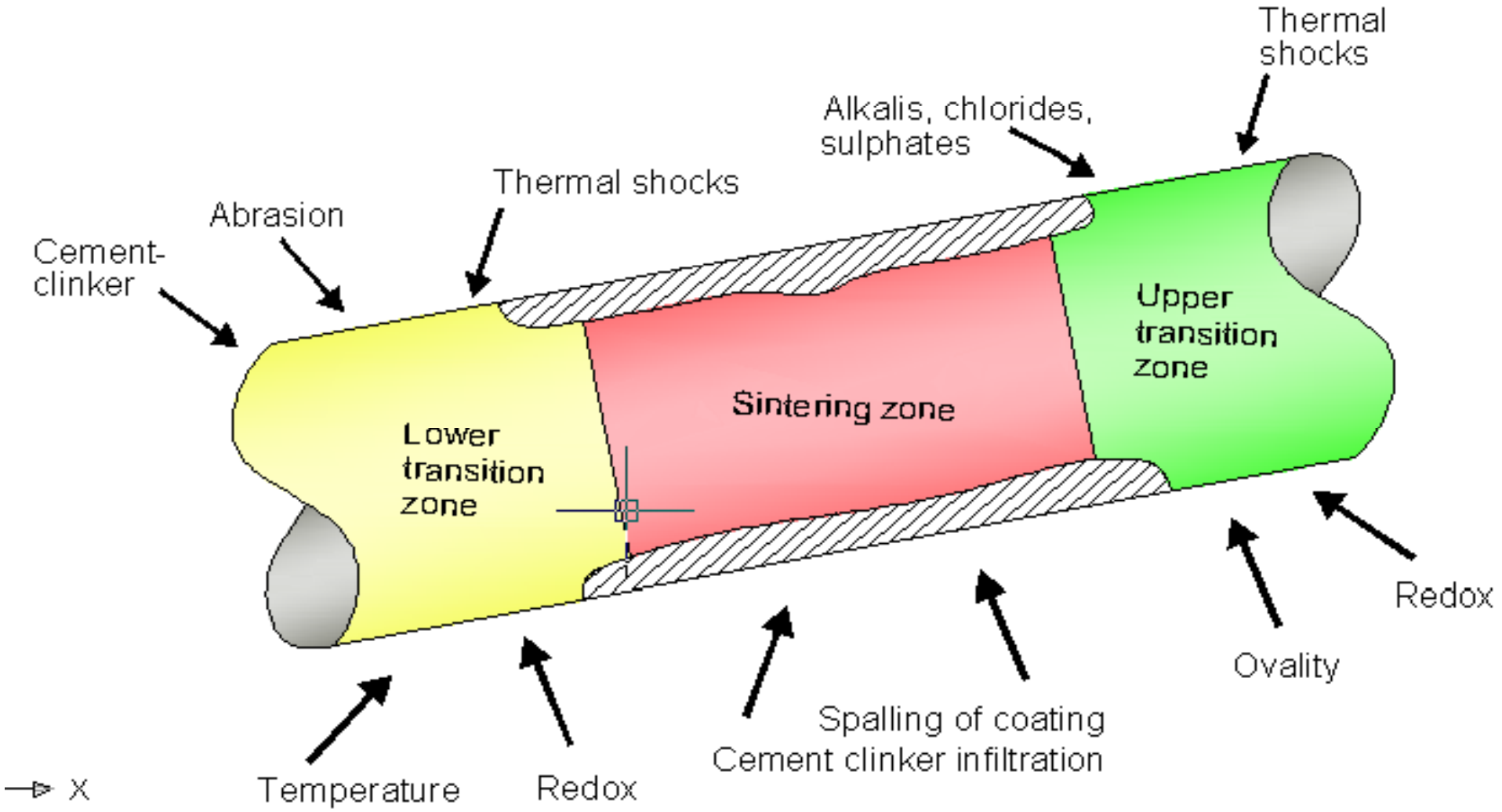
- Redox reaction.

- Corrosion due to volatile alkali salts components which condense and solidify at varying depth.

Stress Factors in Kiln

Main Stress Factors	Wear Effect	Product Counter Measure
Corrosion	Weakening of Microstructure	High Corrosion resistance
Thermal shock & Mechanical Load	Cracking with brick fall off	Micro structural flexibility, Thermal Elasticity
Erosion	Abrasion	High abrasion resistance
Gas / Vapour infiltration (No coating Transition Zone)	Salt Deposition inside brick matrix & Brick fall off	Optimum open pores, Permeability & Chemical bonding
Main requirements : Favorable Coating, Moderate Thermal Conductivity, Environmental Compatibility		

Stress on Hot zones of CRK



NEW GENERATION FACILITIES FOR REFRACTORIES MANUFACTURING FROM HOUSE OF TATA

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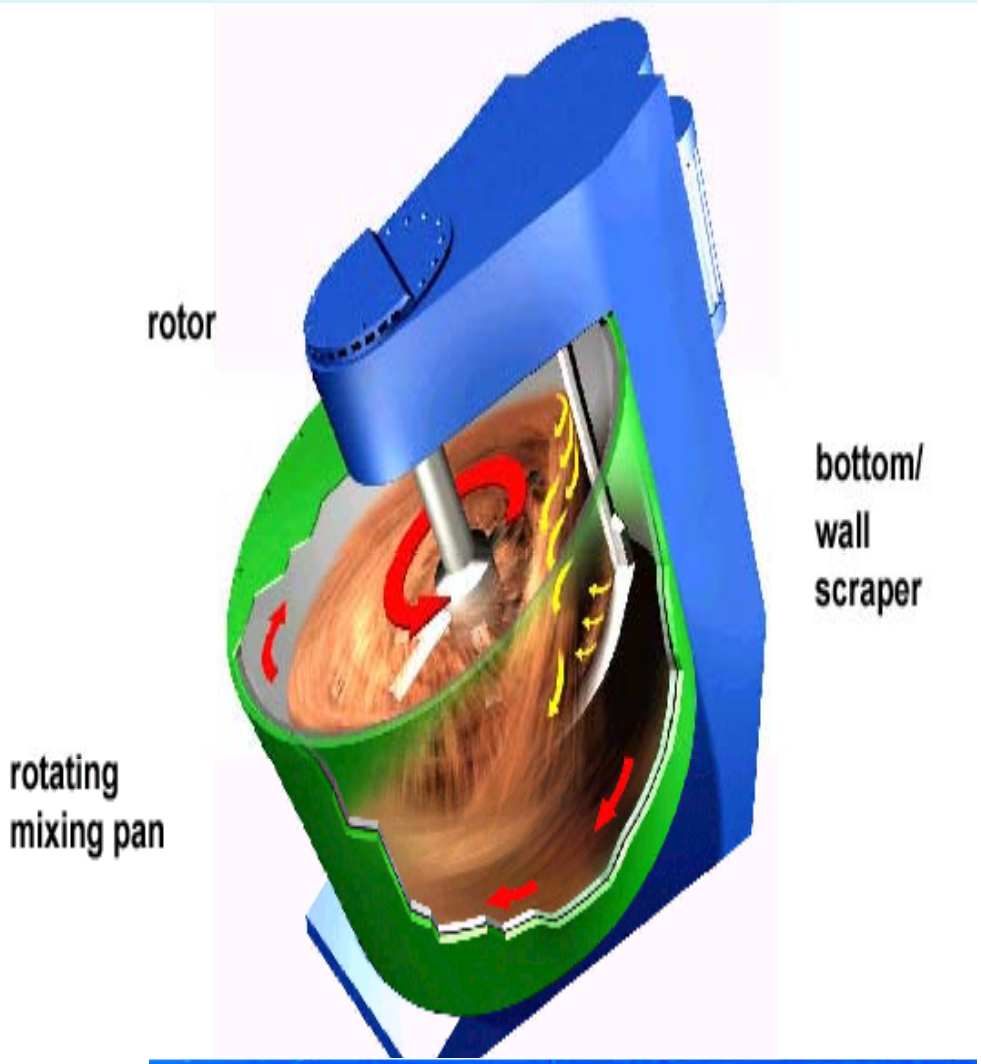
High Quality Raw Materials

- Talochite from own captive mine.
- Imported and low iron Indian bauxite.
- Imported Dolomite.
- Fused Magnesia.
- Andalusite.
- Synthetic raw materials like white tabular alumina and mullite.

Tyco Weighing M/C – For batch preparation

High Intensity inclined mixer
For mixing of batch



1600 MT SACMI PRESS

SACMI PRESS

ATTRIBUTES	SACMI PRESS	OLDER VERSION OF HYDRAULIC PRESS
Green Size Tolerance	+ / - 0.5 mm	+ / - 1.5 mm
B.D. Variation in Bricks	0.02 gm./cc Max.	0.30 gm./cc Max.
Difference in Apparent Porosity from front to back in the same brick	0.2 % Max.	1.5 % max.
Segregation	No segregation	Sporadic segregation problem
Pressing of high taper bricks	Up to 100 mm	Up to 60 mm
Productivity	3.5 to 4.0 MT / hr.	1.0 - 1.2 MT / hr.

Tunnel Drier

Oil Fired Tunnel Kiln

PLC Controlled Monolithic Plant

Automated Packing
For Bricks and Monolithics

Modern Testing Facilities

- X Ray Diffractometer
- X R F
- Creep testing machines
- High Temp furnaces (+ 1850 deg)
- Hot MOR
- Hot stage Microscope
- Thermal conductivity (DIN)
- Climate chamber

SELECTION OF REFRACTORIES FOR DIFFERENT AREAS

Preheater Tower

The different sections of preheater are -

- Cyclone
- Precalciner
- Riser Duct
- Inlet Housing
- Raw Meal Pipes & Feed Chute

Cyclone System

Each cyclone system is absolutely unique, because its operating characteristics and special problems are steered not only by its design and construction but also by factors such as:

- The raw meal it processes,
- Nominal- and peak throughput,
- The combination of fuels burned, particularly alternative fuels burned at the Precalciners and/or smoke chamber.

Strong demands on refractory linings, anchor systems and expansion joints:

- To accept increasingly high temp,
- To withstand the chemical attack of alkalis, chlorine, Sulpur and transition metals,
- To provide the smooth, non-wetting surfaces that support optimal airflow and reduce or eliminate buildups.

Precalciner

• Integrating Precalciners into the cyclone system is one way to improve energy use .

• Utilizing heated air from the cooler, Precalciners dramatically improve the system's thermal efficiency .

• Precalciners also help reduce fuel costs by optimizing the burning of cheaper waste and low-grade fuels.

• Due to higher operating temperature, chemical attack is a more severe problem in the Precalciners than in the cyclones.

Kiln Inlet Housing

Major stress on refractories are

- **Abrasion.**
- **Choking of the materials on surface.**

TRL Offers Talochite Based Products

What is Talochite ?

It is a special grade Alumino silicate refractory aggregate subjected to high temperature calcinations exceeding 1500 Deg C

Features :

- Low in Ferric Oxide, alkalies and Titania
- Particles with good abrasion resistance.
- Angularity of particles provides good packing density & strength.
- Mineralogically it is composed of mullite & amorphous silica glass.
- Virtual absence of crystoballite.

All these ensures :

- High Refractoriness Under Load.
- Low Thermal expansion.
- Good abrasion resistance
- High Volume Stability.

REFRACTORIES FOR PREHEATER TOWER

Cyclone & Precalciner

- Tata HD or Tata 40HG for conical portion & side walls.
- Tata 40HG or Tata 60B and TATACAST AH 50 for roof.

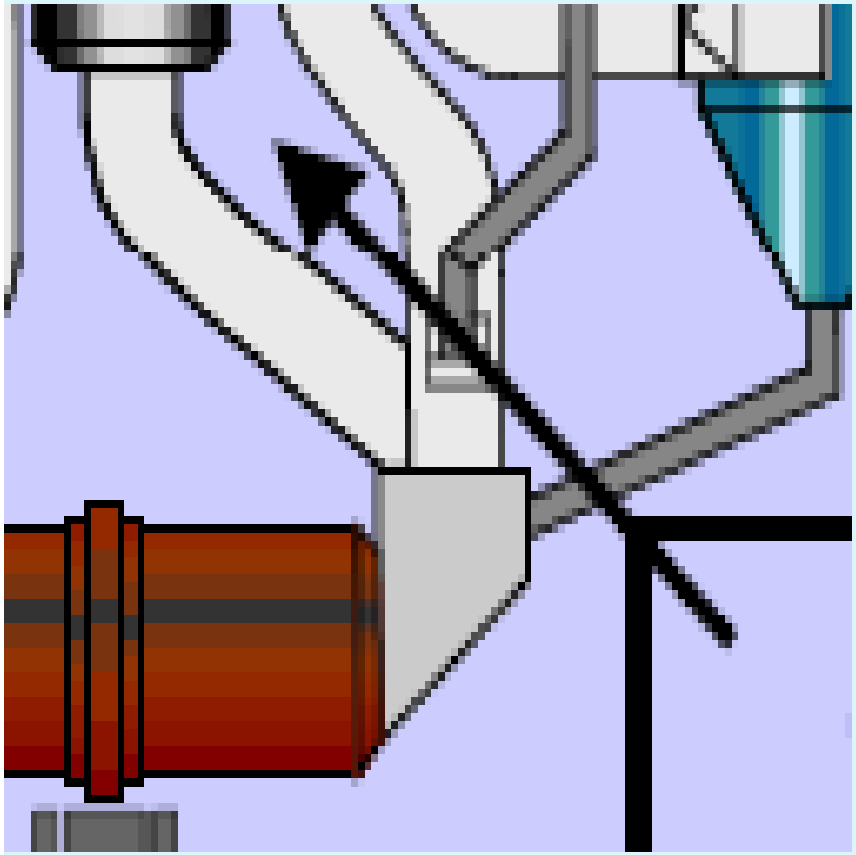
Meal Chute & Feed Pipe

- Tata Cast FH 45 or Tata Cast AH 50 Plus.

Riser Duct

- Tata Cast AH 50plus or Tata Cast 30 SC for roof
- Tata HD or Tata 40HG for rest area.

REFRACTORIES FOR KILN INLET HOUSING



TRL's recommended products

- Tata Cast 30 SC for feed pipe.
- Tata Cast LC 60 for Lip plate.
- Tata Cast LC 60 for inlet cone

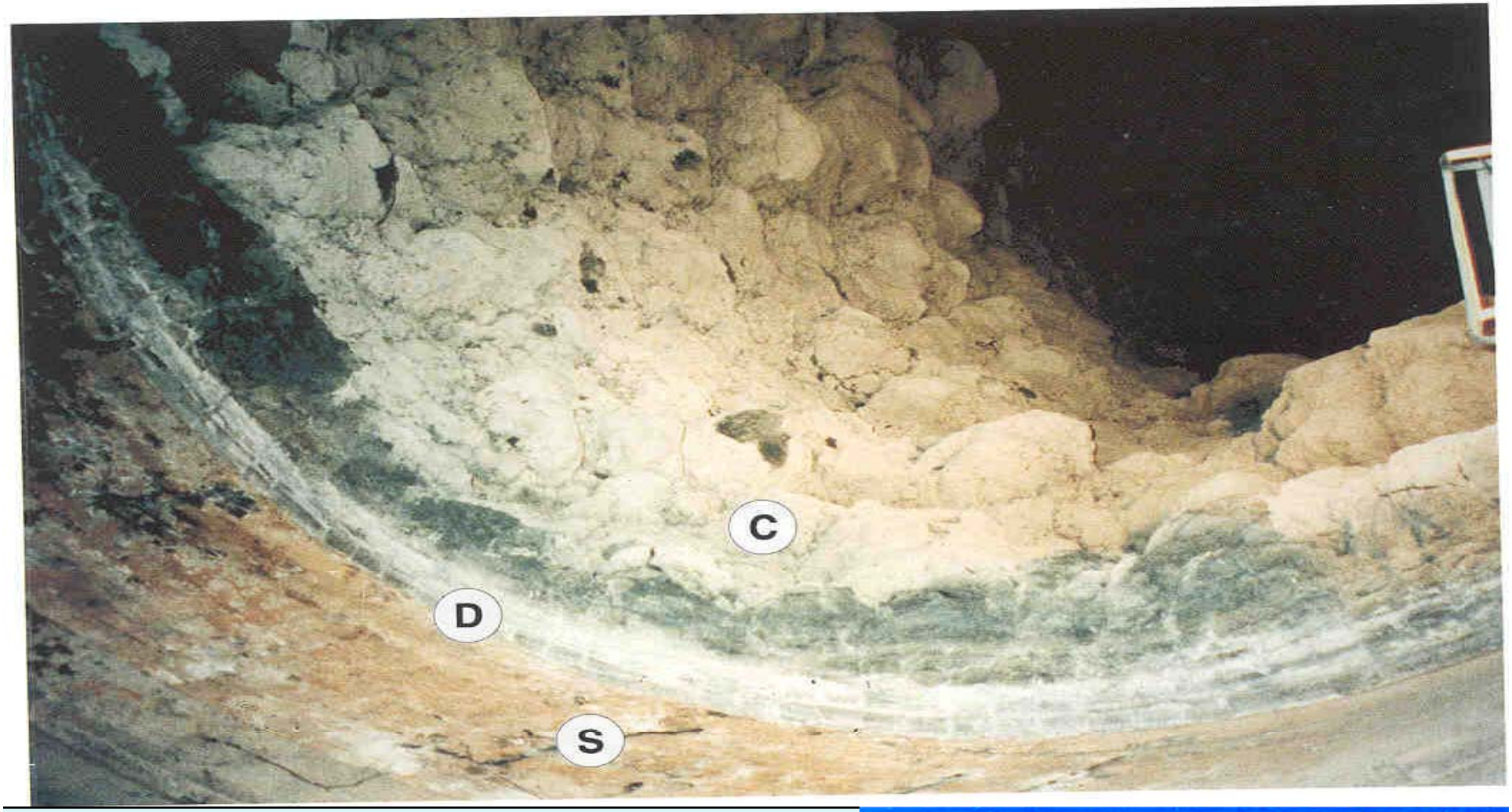
REFRACTORIES LINING IN ROTARY KILN

Dolomite – Best Refractories for BZ

- Coating formation - Faster than any refractories.
- Strong & Stable coating.
- Reduced reactivity of Clinker melt (C_2S, & C_3S).
- Lower brick temperature hence less heat loss.
- Corrosion resistance to alkalies & redox condition.
- Environmental safety.
- Longer campaign life.

Dolo Bricks –Clinker contact zone

Stable Coating Formation on Dolomite bricks



Transition Zone

OPERATION

- Intermittent Coating.
- Increased mechanical stress.
- Increased thermal shock.

Requirement of Refractory Brick

- High strength.
- Thermal elasticity.
- Thermal shock resistance.

Mag-Al Spinel Bricks for TZ

- High purity raw materials mainly Dead burnt Magnesia, Synthetic Mag-Al Spinel (Coarse) with small addition of Al_2O_3.

New Generation Chemical Bonded bricks for TZ & BZ

Products

- Tata PS1 & Tata PS2 for BZ of CRK.
- Tata 60AR of TZ of CRK.

Special Features

- Tata PS1, PS2 & 60AR qualities have better thermo mechanical, thermal shock resistance and alkali resistance properties.

- The lower impurity levels (CaO, K_2O, Na_2O, Fe_2O_3) due to special grade raw materials usage results in higher thermo mechanical property.

- The chemical bonding enhances the thermal shock resistance property.

- Tata PS1, PS2, 60AR qualities have excellent alkali resistance property due to following reasons.

1. The lower porosity reduces the permeability of alkali vapours
2. The chemical boding reacts with alkali vapours and forms a thin layer of alkali phosphate which prevents further penetration of alkali vapours.
3. The matrix of the brick is rich in Silica which is relatively inert to alkali vapours.

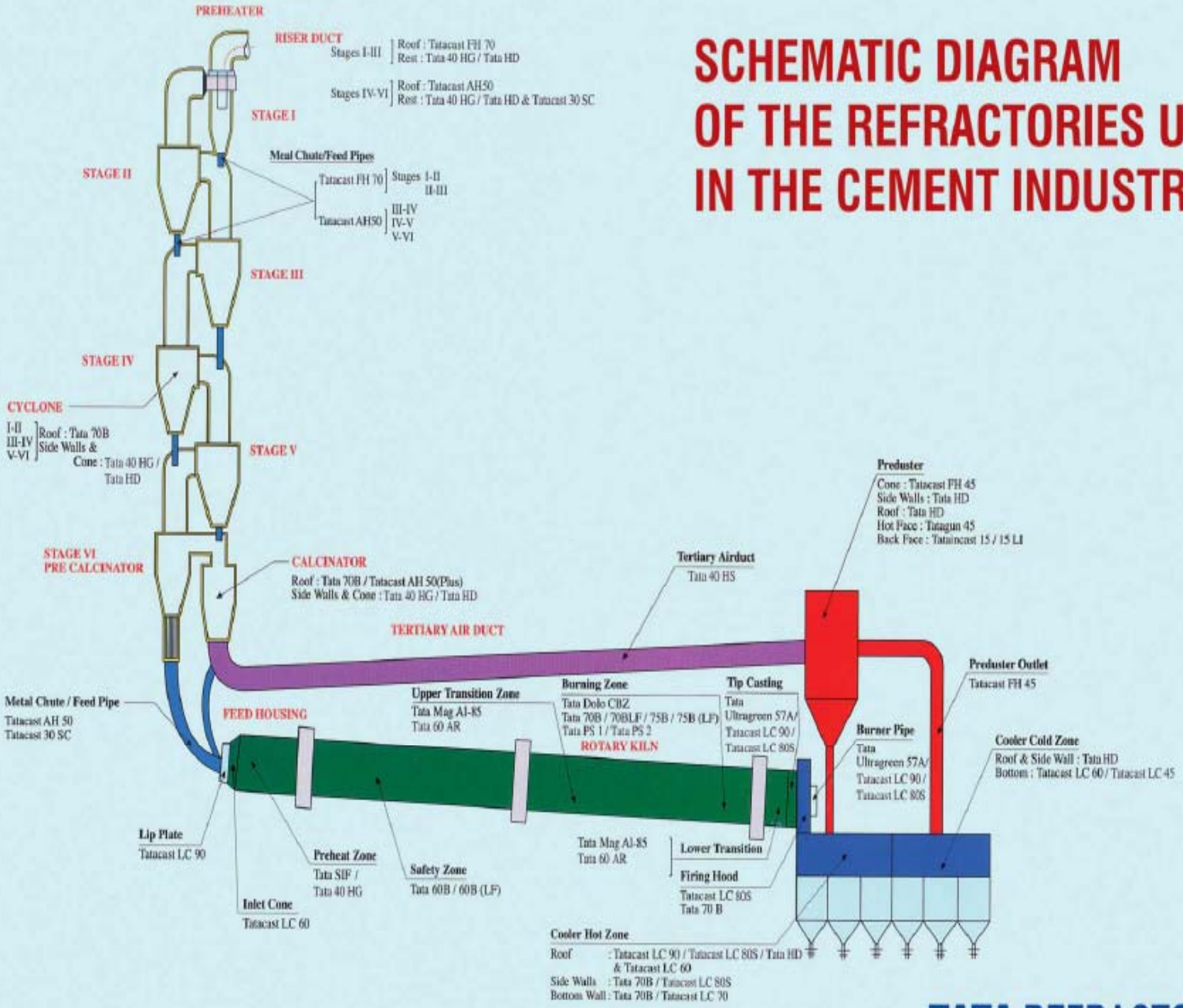
Demand in refractories lining for other important areas

AREA	EFFECT ON REFRACTORIES	PROPERTIES REQUIRE IN REFRACTORIES
Tip Casting	High abrasion at elevated temp.	High abrasion resistance, Thermal shock resistance
Burner Pipe	High abrasion, thermal shock	High abrasion resistance, Thermal shock resistance
Bull Nose	High abrasion, point stress, thermal shock	High thermal shock and abrasion resistance.
TAD	Abrasion	High strength, Low porosity
Cooler Hot Zone	High temp, very high abrasion	High Strength, Abrasion resistance

COMPLETE SOLUTION OF REFRACTORIES FOR CEMENT PLANTS

FROM HOUSE OF TATA

SCHEMATIC DIAGRAM OF THE REFRACTORIES USAGE IN THE CEMENT INDUSTRY



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THANK YOU

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