The Resco Line™

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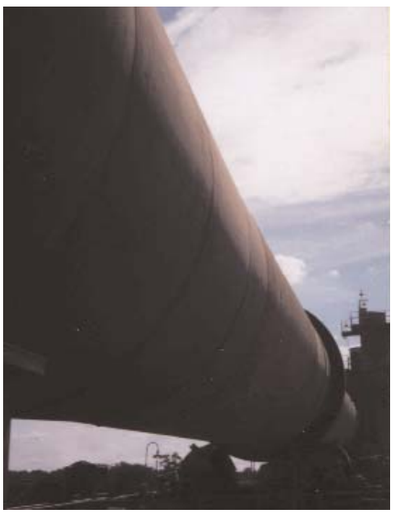
A Newsletter for the Cement and Lime Industry



High Alumina brick Selections for Rotary Kilns

High alumina brick refractories are used in the calcining zones of cement kilns and rotary lime kilns, and in the burning zones of many lime recovery kilns.

Two years ago, Resco began manufacturing high alumina brick for general industrial applications. The product line ranged from 60% to 85% alumina content. Products in this alumina range can have several primary raw materials. Refractory-grade bauxite and mullite (3 Al2O3-2 SiO2) grains are two principal components.

Calcined bauxite has an alumina content of approximately 89%, and a bulk specific gravity (density) of approximately 200 pcf. Mullite calcines have an approximate chemical composition of 60% alumina, 38 % silica, and a density of approximately 170 pcf Either of these primary raw materials is blended with clays and other components to adjust alumina content and create the refractory bond during firing.

Selection of bauxite or mullite grain as the primary raw material depends on the desired alumina content and the environment for which the brick will be exposed. In general, refractoriness increases with alumina content. Using this principle, a higher tapping temperature in a steel mill may require a higher alumina content refractory in the ladles.

In rotary lime and cement kilns, greater resistance to lime generally favors higher alumina and lower silica contents in refractories. Lime can flux high alumina brick refractories at temperatures in the range of 2138ºF (1170ºC). 80% alumina brick made from bauxite may be more resistant to this attack.

Alkali can be present in cement and rotary lime recovery kilns, and brick based on mullite grain may be more resistant to alkali spalling (see Resco Line, April 2001).

Ceramic vs. Phosphate Bonding

The ceramic bond forms in conventional high alumina brick by reaction of the minerals present in the bond clay to form mullite (3 Al_2O_3-2 SiO_2). Mullite is a very refractory mineral (melting point of 3416°F).

Phosphate bonding can be developed in the brick by adding phosphoric acid to the mix components. Aluminum orthophosphate, ($AlPO_4$), is formed during the firing process. Phosphate bonding is used to increase the mechanical strength and abrasion resistance of the refractory composition.

Many refractory brick anchors are made in phosphate-bonded high alumina compositions for increased tensile strength. Often rotary pebble lime kilns have abrasive feed at the kiln entry, and phosphate-bonded high alumina brick are used to resist the sliding abrasion of the stone charge. Because the phosphate ties up free alumina, phosphate bonding can increase the alkali resistance of a high alumina brick composition.

Alkali Attack

High alumina refractories can react with soda (Na_2O) and potash (K_2O) to form alkali alumino-silicates. In cement applications, high alumina linings can react to form potassium alumino-silicates, like kalsilite. Linings in lime recovery kilns of paper mills can react with soda carryover, forming sodium alumino-silicate minerals such as albite.

Alkali reactions are detrimental because they are expansive. After formation, alkali alumino-silicates occupy a greater volume than the original refractory. As alkali reactions progress during the lining campaign, the brickwork exhibits spalling to relieve the stresses of the greater volume.

Generally lower alumina content refractories based on mullite grains can perform better in alkali environments at intermediate temperatures.

Resco's High Alumina Brick Product Line

Four brands constitute Resco's offering for rotary kiln application.

RESCAL™ 70D

The industry standard lining for rotary lime and cement kiln calcining zones is still the burned 70% alumina brick. Based on refractory grade bauxite, this alumina class gives predictable service at an economical cost.RESCAL™ 70D has been used in cement and lime kiln applications for many years. RESCAL™ 70D exhibits surprisingly good alkali resistance.

RESCAL™ B75L

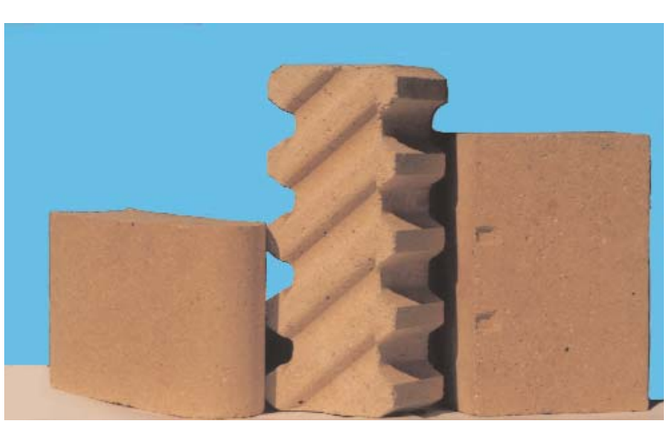
This product features higher alumina content than the 70% class, at 79% alumina. RESCAL™ B75L can be used for increased resistance to reaction with free lime in zones immediately up-kiln from basic brick burning zones.

RESCAL™ 85B

This phosphate-bonded refractory has increased strength and abrasion resistance as well as good alkali resistance. RESCAL™ 85B contains approximately 82% Al2O3.

SENECA™ 60P

For greater alkali resistance in cement kiln calcining zones and rotary lime recovery kiln burning zones, SENECA™ 60P can be selected. Phosphate-bonding gives SENECA™ 60P improved porosity and increased mechanical strength. The high mullite content further enhances resistance to the formation of expansive alkali minerals and the resultant spalling.



Three of RESCO'S high alumina brick brands used in minerals processing. At left is alkali-resistant SENECA™ 60P, high strength RESCAL™ 85B in the center, and a Kiln Arch-2 in RESCAL® 70D on the right.

High Alumina Brick Product Line con't

SENECA™ 60P, and Resco's three other rotary kiln brands, are manufactured at Resco's East Canton, OH plant in metric rotary kiln shapes from 160-mm thick to 220-mm thick, in British sized rectangular shapes (9 x 6 x 3.5" and 9 X 6 X 4" arches and wedges), and in Rotary Kiln Block sizes (9 x 6 x 4" and 9 x 9 x 4" RKB's).

	SENECA™ 60P	RESCAL™ 70D	RESCAL™ B75L	RESCAL™ 85B
Bond	Phosphate	Ceramic	Ceramic	Phosphate
Bulk Density, pcf	160	168	172	174
Apparent Porosity	13%	19%	19%	18%
Modulus of Rupture, psi (ASTM C-201)	1980	1450	1650	2100
Cold Crushing Strength, psi (ASTM C-201)	8400	6500	8500	9500
Reheat Test Permanent Linear Change after Heating to 2912° F	+3.8%	+4.5%	+3.0%	+2.4%
Approximate Chemical Analysis:				
Al_2O_3	62.0%	72.0%	79.0%	82.0%
SiO_2	31.0	22.0	15.0	10.0
Fe_2O_3	1.4	1.5	1.7	1.6
$Na_2O + K_2O$	0.5	0.7	0.5	0.4

Basic Brick Notes - RESCOMAG® 85

In the last issue, we highlighted our five magnesite-spinel basic brick brands. RESCOMAG® 85 is a magnesite-spinel brick containing synthetic sintered magnesia, fused magnesia-alumina spinel and a bonded matrix. RESCOMAG® 85 is designed for general transition zone service in cement kilns and for rotary lime kiln burning zones. Improved shell temperature, in comparison to other spinel refractories, is a key benefit of RESCOMAG® 85. Four examples show this brand's good performance in cement kilns.

- In February, post-campaign measurements were taken on a RESCOMAG® 85 lining in a 3.6-meter (12') diameter long dry-process rotary cement kiln in the Southwest. Installed between 65' and 90' from the discharge, the RESCOMAG® 85 maintained a minimum 86% of the original thickness (220-mm) after 12 months service. The wear rate was 0.26 mm/day in this zone.

- RESCOMAG® 85 performed for a full year campaign in the lower transition zone (22 to 32') of a 16' (4.9-m) diameter kiln with precalciner out west.

- RESCOMAG® 85 in the upper transition zone of a 15' diameter kiln with precalciner showed only 2" of erosion over an 11-month campaign for a Southeast area kiln.

- RESCOMAG® 85 completed a 15-month campaign in the upper transition zone of a precalciner 12.5' diameter kiln in the Southwest.

  Send me an e-mail message if you are interested in further details (christopher.macey@rescoproducts.com).

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Handling Castables in Adverse Weather

Castable refractories are blends of refractory cements and refractory aggregates. Many of the guidelines apply for both Portland Cement concrete and refractory concrete. Some general principles include using clean tools and equipment. Clean water, suitable for drinking, is also required. This is a standard of the American Concrete Institute. Contamination of the water, even on a minute level, can affect set and strength.

An ideal condition for placement of standard cement content and low cement vibratable castables is when the material and ambient temperatures are between 60°F and 85°F. Temperatures outside these ranges can present difficulties for installation.

Cold Weather
Although most parts of North America are past extreme cold weather conditions, the guideline is to keep the material and installation area above 60°F during installation and for the 24-hour cure. Using hot water for tempering the castable may help, but remember that the tempering water has a much smaller mass than the refractory itself. Even hot water may not heat the tempered mix much if the dry castable is very cold.

Low cement castables contain water-soluble admixtures to control flow properties. In cold weather, consider using hot water to activate these admixtures. It may take additional mixing time to get the batch to wet up. (One other note: for the same reasons, low cement gunning mixes may be more difficult to apply in cold weather.)

Some Like it Hot
In hot weather, it is desirable to keep the material and installation area below 85°F during the installation and curing period. Higher temperatures may shorten working time. Higher temperatures also cause the castable to dry out more quickly, leading to surface cracking. Use cold water to temper castable when it is hot. Icing down the water may make the difference between a difficult and a successful installation. You can also shade or apply a water spray to the exterior of the vessel shell to maintain a cooler ambient temperature.

These installation guidelines are available on a CD called our Engineering Manual. Send me an e-mail message if you would like a copy.

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Control of the conditions during mixing affects the quality of a castable installation. It is especially critical to large pours.