

Interpreting Refractory Wear in Rotary Kilns

Last May, this newsletter focused on refractory wear in high alumina brick due to alkali attack. Cracking of a brick lining is often associated with wear. Refractories are by their nature rigid, and are prone to crack. Refractories crack in response to external stress or changes in volume. Identifying the cause of cracking requires careful analytical work.

Stress from a Loose Installation

Rotary kiln brickwork is installed with the objective of putting the lining into compression. As the temperature of the brickwork is elevated, the brick expand (reversibly), further increasing the compression. It is absolutely critical to achieve good lining tightness: good brick-to-brick contact and good brick-to-shell contact.



Figure one: Ring of brick adjacent to a fallen lining. Note the propagation of cracking from the cold end out to the hot face.

Figure one (1) shows a basic brick lining that was installed loosely. Brick fell out of this lining within about six weeks of operation. Note the propagation of the cracking from the cold end toward the hot

face. Any movement present within the brick ring causes brick to point load and fracture. Deep spalling can be an indication of a lining that was installed without sufficient tightness.

Stress from the Kiln Shell

Good contact of the brick to the kiln shell is essential for proper tightness of the lining. In situations where the kiln is deforming (ovality) excessively, the brick lining can exhibit shifting, crushing and cracking. Typically this occurs over tires or at stress points along the kiln shell. Common causes of kiln shell ovality include wear on tire filler bars and improper alignment. Measurement of tire creep can indicate whether the problem is simply filler bar wear.

Figure two (2) shows brickwork in a lining that has exhibited crushing in a "trough" pattern. This problem was caused by the misalignment of the kiln at the #2 tire. A thorough ovality and alignment study may be necessary to completely diagnose the problem. *Cont. on backside*



Figure two: Brick loss in a "trough" formation due to a problem with alignment.

What's New in Resco?

- ◆ We've had at least a half-dozen successful installations of QUICKTURN™ products in rotary kilns. QUICKTURN™ 60G (gunning mix) and QUICKTURN™ 60PC (pump castable) were covered in the May 2001 RESCO LINE™. These materials can be heated to operating temperature without a controlled dry-out. (Look for our silicon carbide containing QUICKTURN™ formulation soon.)
- ◆ For applications that cause extreme abrasive wear on refractories, R-MAX™ low cement castables should be considered. R-MAX™ is available in gunning (R-MAX™ G), casting (R-MAX™ C) and multiple purpose (R-MAX™ MP) mixes. Abrasion resistance as good as 3-cc loss (ASTM C-704 test results) is possible with R-MAX™ C. Gunned linings with C-704 results less than 5-cc are possible with R-MAX™ G. Rotary pebble lime kiln feed end linings, tumblers and planetary cooler elbows come to mind.
- ◆ One lining of RESCOMAG™ 92 FMS looks particularly promising in a cement kiln transition zone in a strong alkali salt environment. RESCOMAG™ 92 FMS was featured in the February 2001 RESCO LINE™. RESCOMAG™ 92 FMS is a magnesite-spinel refractory that contains special fused grains for corrosion resistance.
- ◆ If you haven't tried RESCORAM™ 70 BLUE plastic, check it out. It has excellent workability and is useful as a general patching material for preheater repairs as well as nose rings and burner pipe linings. RESCORAM™ 70 BLUE is made at our Greensboro, NC facility.



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Mineralogical Volume Changes

Thermo-chemical alterations cause changes in volume of the refractory. When liquids are present within the refractory, shrinkage can occur. When some new refractory minerals form, or phases change, permanent growth can occur.

Shrinkage: On the microscopic level, liquids in the refractory cause the fine grains within the matrix to sinter together forming larger grains.

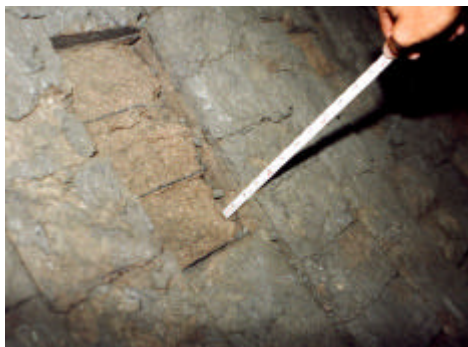


Figure three: Liquid phase attack caused spalling in this magnesite-spinel lining.

One such example is liquid phase attack (see the RESCO LINE™ Volume 2, number 1). Figure three (3) shows the basic brick lining in a cement kiln that

has absorbed liquids from an overheated clinker. Figure four (4) shows the reacted hot face in a cut section. The reacted area exhibits cracking beneath the shrunken hot face zone and "slabs" off. Chemical analysis of the hot face area will confirm attack from a liquid slag or melt. In the case of clinker liquid phase attack, this will be indicated by enrichment of lime and silica in the refractory hot face.



Figure four: Cut section of the brick shows cracking below the hot face portion where the liquid phase has penetrated.

Expansion: The other end of the spectrum from shrinkage is permanent expansion. This type of alteration is characteristic of alkali attack on high alumina refractories. The products of reaction between alkalis and alumina-silica brick have much greater volumes than the original refractory, so the affected brickwork often will crack in order to



Figure five: Expansive alkali cracking in high alumina brick. Note the corners have cracked to relieve the pressure.

relieve the stress caused by the increase in size. Expansive cracking in brickwork can often be observed as diagonal cracking at hot face brick joints (see figure 5). If alkali cracking is suspected, an X-ray diffraction analysis of the used brick is useful in confirming the nature of the expansive alkali phase.

Editor's Corner - On Alites and Belites

In life, make sure you know your Alites from your Belites. (In Portland cement technology, alites are the tricalcium silicate crystals in clinker, and belites are the dicalcium silicate crystals.)



If you know me personally, you probably have heard me talk about my 10 year-old son, Peter. Peter came into the Macey family about 9 years ago by way of Guatemala. If I ever talked to you about him, you would also know Peter has a severe hearing loss. He's verbal but he communicates with a 4-year-old level vocabulary.

That said it was the July 4th fireworks celebration at the local municipal park, about twenty minutes before the show was to start. Peter has a way of becoming very insistent when he wants something. While we are waiting for the fireworks, Peter says: "I want belites." Now, this place was kind of loaded with vendors selling glow in the dark neck rings and other assorted goodies, so I figured Peter was hitting me up for some largely worthless trinket, and I resisted. After a heated four-minute exchange, I realized Peter just wanted to catch lightning bugs. You know, fireflies fly like **bees** and they have **lights** on their tails.

The point of the story is that I was so caught up in the interpretation that was most obvious to me that *I failed to hear the message*.

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A company's message should be what it has done and can do *as second nature* - constancy of purpose. A recent tour of our Marelán, Quebec plant with a customer got me to focus on Resco's message.

Marelán, Quebec still has a distinctive capability to serve the rotary kiln market by maintaining high standards of product quality and customer service. Over the last year, our East Canton plant has brought on our 70% and 80% alumina burned brick product line with excellent consistency. Resco's R&D continues to provide useful, new monolithic products with greater user friendliness. These things the market still needs.

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