
Kamol Tanchotikul, Nichapat Patchararungruang, Thanapa Wongwichakorn and Suchaya Amornkittimatee, Siam Refractory Industry Co., Ltd, Thailand, introduce a new technology for hydration prevention in MgO-based bricks.

PREVENTING BRICK HYDRATION

Introduction

Magnesia-based refractory bricks (MgO-based bricks) are used in a wide range of industries, particularly in all burning zones of cement rotary kilns, with an average service life of around one year.

As a result of long production lead time, cement manufacturers always save a percentage of MgO-based bricks (around 20% of the burning zone brick lining) for unplanned shutdowns. For a medium sized rotary kiln, MgO-based brick annual consumptions (per kiln) are

approximately 300 t for all burning zones, including the upper transition zone, coating zone and lower transition zone. For this reason, cement manufacturers save the remaining 60 t for emergency shutdowns. Typically, the spare linings are either partly used or unused; therefore, these bricks remain in storage for a longer period than their shelf life and may eventually hydrate.

Refractory manufacturers occasionally receive complaints from customers regarding hydration problems in MgO-based bricks. This is particularly the

Table 1. Steam test results

Sample	No. of cycles
MS80AF without anti-hydration treatment	12 cycles (cracked)
MS80AF with anti-hydration treatment	>40 cycles (still not cracked)

Cement rotary kiln showing the brick linings.



MgO-based bricks hydrate when stored in inappropriate conditions or kept for more than six months.



Hydrated MgO-based bricks after unpacking.



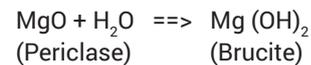
case for spare lining that is kept in store for more than six months or for new cement project sites that do not have a well-prepared warehouse to store bricks during the plant construction period. This problem results in the waste of all hydrated bricks, and also leads to short service life of the lining or the red spot of the rotary kiln shell when the bricks are installed.

Two methods help prevent this from occurring: manufacturers can ensure good packaging design and provide guidelines to customers for optimum storage for MgO-based bricks (dry area with good ventilation; suggested temperature range of around 10 – 30 °C). Siam Refractory has taken a step further, using anti-hydration technology to prolong the shelf life of MgO-based refractory bricks with minimal additional costs.

Hydration is an inevitable problem for MgO-based refractory bricks (basic bricks). In general, all types of magnesia-based bricks deteriorate as a result of the reaction between magnesia (MgO) and water-yielding magnesium hydroxide (MgOH). Magnesium hydroxide causes increased volume inside the brick structure, which leads to serious cracks and a decrease in brick strength.

Hydration reaction

Hydration reaction is a chemical reaction during which water is added to an unsaturated substance. When brick is exposed to water in any form (humidity or moisture) at approximately 40 – 120 °C, it produces magnesium hydroxide (brucite) and grows epitaxial on periclase according to the following endothermic reaction:



This affects the expansion and bursting of the periclase lattice. Consequently, the brick starts to crack and disintegrate in connection with the volume increase of approximately 110%. The volume expansion leads to brickwork movement, which can affect the furnace shell.¹

Lotus effects lead to anti-hydration solution

The lotus effect refers to the highly water repellent (superhydrophobicity)² coating on a leaf's surface, which results in water droplets minimising their surface and trying to achieve a spherical shape. Using this concept, Siam Refractory's research and development team developed a solution to increase the surface tension and hydration resistance of its MgO-based bricks.

Anti-hydration products are designed to extend the shelf life of MgO-based bricks and reduce the risk of using cracked and hydrated bricks in cement rotary kilns. Siam Refractory's final treatment can be applied to the original MgO-based bricks without any modification of the bricks' recipe. Aside from

Table 2. Comparison between MgO-based bricks with and without anti-hydration properties

	Without anti-hydration	With anti-hydration
Product shelf life	Typically, MgO-based brick has a guaranteed storage life of only six months in a well-prepared warehouse. However, depending on the weather and storage conditions, the shelf life of bricks can be either shorter or longer than six months.	Anti-hydration bricks can extend the guaranteed shelf life of MgO-based refractory brick from six months to 24 months with minimal additional costs when bricks are stored in dry and ventilated conditions.
Wasted bricks means wasted money	Generally, cement manufacturers save approximately 20% of their annual MgO-based brick consumption for unplanned shutdowns. If the bricks installed in the rotary kiln have a service life according to plan, these spare linings may hydrate and will be scrapped as waste.	With anti-hydration technology, the spared lining bricks will have longer shelf life when stored in well-prepared conditions. Therefore, the cost of hydrated bricks can be reduced.
Risk of not enough qualified MgO-based bricks for use	When hydration occurs, maintenance plans delay brick selection as skilled technicians must separate the hydrated bricks from the qualified bricks. Depending on the area of relining, after 100% brick selection, cement producers may not have enough MgO-based bricks for maintenance purposes.	With a longer shelf life, anti-hydration bricks can reduce maintenance time and cement plants can be confident of having enough MgO-based bricks for use.
Storage of MgO-based brick	Storage of MgO-based brick should be well-maintained to prevent hydration. The storage area must have a good covered store to protect the bricks from rain and sunlight. In addition, good air ventilation is required to maintain a dry and stable temperature.	Anti-hydration bricks result in less concerns regarding transportation and warehouse conditions. Nevertheless, a well-prepared warehouse for the storage of MgO-based bricks is recommended.

hydration resistance, there are no differences in the brick properties with or without the treatment. Without any treatment, any form of water can easily seep in due to the porosity of the brick; however, after using the company's special treatment, water remains on the brick's surface.

Steaming test

Test procedures:

- The bricks (both with and without the anti-hydration treatment) are placed in the steam tank and steamed at a temperature of 100 °C for 15 minutes.
- After 15 minutes, the bricks are removed and checked for hydration cracks.
- The above steps are repeated until all the bricks are cracked (hydrated). Table 1 shows the results.

Packing and storage test with water inside package

Test procedures:

- 195 MS80AF bricks (with and without the anti-hydration treatment) are placed on a standard pallet. Two hundred bricks without the anti-hydration are placed on the pallet but five pieces in the centre are removed to insert a bottle of water.
- A bottle of water (5 litre) is placed at the centre and holes are made in the cap to release moisture.
- The pallet is then packed and wrapped with plastic shrink film (completely closed and tight).

Brick without lotus effect (water easily seeps through due to the porosity of the brick).



Brick with lotus effect (water remains on the surface of the brick).



Extreme field test using MS80AF (high burnt magnesia-spinel brick)

Test procedures:

- The following bricks are placed outside in natural conditions:
 - Anti-hydration MS80AF brick.
 - MS80AF treated with a moisture absorbent compound.
 - Normal MS80AF brick.
- The bricks are then monitored for cracks every 2 – 3 days.

Siam Refractory does not recommend storing MgO-based bricks according to the field test. It is strongly recommended that customers store MgO-based bricks in well-prepared, dry conditions with good ventilation to prolong the shelf life.

Conclusion

Generally, MgO-based brick will have a guaranteed shelf life of just six months if it is kept in well-prepared storage. Siam Refractory has introduced anti-hydration technology for MgO-based bricks in a number of countries, particularly those with tropical and/or wet conditions such as Thailand, Indonesia, the Philippines, Pakistan and the UAE.

It is advised that customers purchase MgO-based bricks without hydration resistance for annual planned

shutdowns and to spare 20% of MgO-based bricks with hydration resistant properties for unplanned shutdowns in order to ensure that they have reliable MgO-based bricks for use.

For new projects, cement manufacturers are recommended to procure MgO-based bricks with anti-hydration technology, as the installation of refractory bricks may delay construction plans (these bricks may hydrate before installation).

Moreover, cement producers located in tropical areas with long transportation times, or with no well-prepared warehouse to store MgO-based bricks, should procure MgO-based bricks with anti-hydration technology to make certain that the bricks are in a good condition for installation. The technology is an effective solution to extend the shelf life of MgO-based bricks from 6 – 24 months with minimal costs. 🌐

References

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