# THE RIGHT TOOL FOR THE JOB

ELIANE TAVEIRA, TE&M DO BRASIL/ BRICKING SOLUTIONS, BRASIL, EXPLAINS HOW TO ACHIEVE IMPROVED EFFICIENCY IN RELINING LARGE ROTARY KILNS IN THE CEMENT INDUSTRY.

## Introduction

One of the key aspects of the cement manufacturing process is that maintaining output at optimum levels is dependent on continuos production. When operating a rotary kiln, achieving a satisfactory runfactor is vital to maintaining good overall kiln economy. Among the factors that affect kiln economy, the inevitable failure of the refractory lining, and the

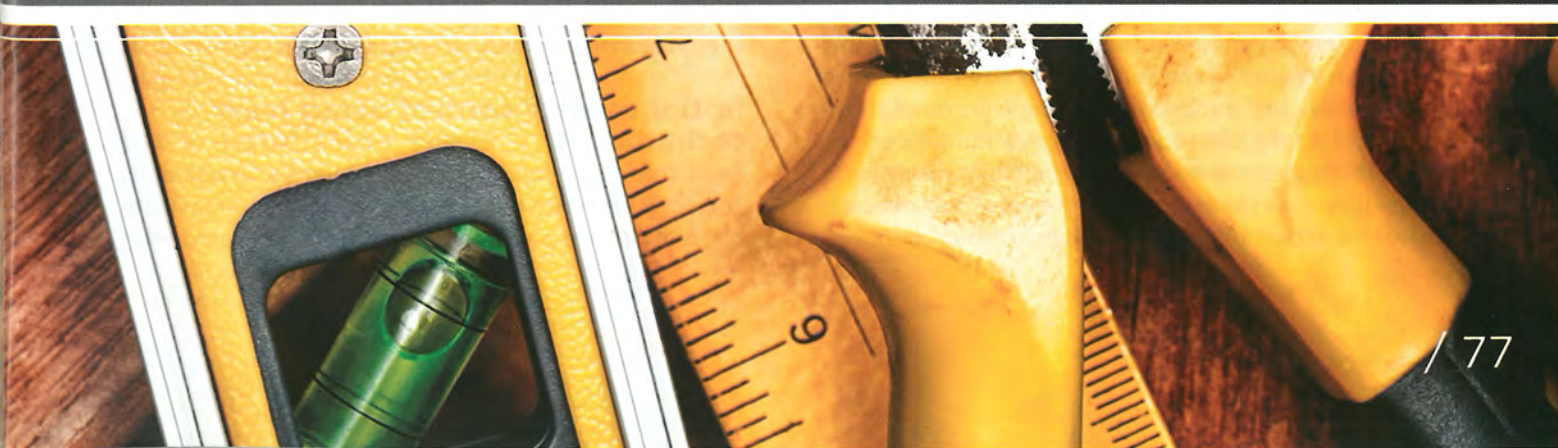

Figure 1. Inaccurate measurement using the welds of the shell as guidelines.

Figure 2. Distortion in brick alignment at the cut row.

subsequent time required to repair it, has always been one of the major causes of regular downtime.

As refractory materials have advanced to meet the requirements of the industry, so have the methods used to undertake repairs. The completion of a satisfactory kiln repair involves a number of different stages, which represent a comprehensive procedure that far exceeds the scope of this article. Once the extent of lining replacement has been decided and the length of the kiln made ready to receive the new brickwork, the utilisation of a pneumatically operated bricking platform, in conjunction with a laser light, can greatly increase the quality of the work and speed of the operation, enabling production to recommence within the shortest possible time.

## The importance of refractories

The refractory in a cement plant can make a difference in its successful operation. It has been estimated that up to 50% of unscheduled kiln outages in the cement industry are caused by refractory issues. For this reason, refractory selection is a serious topic of discussion for the overall operation of a plant.

The increase in use of alternative fuels, with chlorides, some fluorides, high $NO_x$ contents, and high sulfur concentrations, have forced refractory manufacturers to evolve their technologies to find much more resistant materials to meet the requirements of the cement industry. This led to bricks with lower permeability and higher chemical resistance.

Despite the fact that the consumption of refractories represents less than 1% of the total cost of a cement plant, refractory manufacturers have been striving to meet cement industry expectations to raise the total amount of clinker produced per quantity of refractory spent. Consumption depends on refractory performance, which is influenced by several factors, such as raw material quality, the technology used to produce it, and the type of process to which the refractory will be subjected, among others, as well as the quality of installation.

Taking this premise one step further, there are four critical factors that impact the effectiveness of a refractory programme in a cement plant:

- Proper selection of refractory.
- Quality of the installation material.
- Operation of the plant.
- Proper installation of the refractory.

The selection of the refractory, its quality, and the operation of the plant, are all subjects that are often discussed, but the details of proper installation are often lost or assumed to be taken care of by the refractory contractor chosen for each maintenance outage.

New methods for refractory maintenance, based on advanced technology and mechanisation, allow the most efficient and safe repair to be performed.

## Initial quality control using laser technology

For a refractory lining to last, it must be installed correctly and with precision, ensuring the concentricity of each brick ring.

A commonly used method is to measure from the welds of the shell (Figure 1). However, this procedure can be inaccurate, particularly in long kilns with large diameters. Problems with concentricity can lead to spiralling, resulting in damage to the lining.

The placement of each brick ring is vital to the longevity of the refractory lifespan: precise brick placement reduces brick wear and allows the refractory mason to study a strategy for the cut row (Figure 2).

It is a lot more precise and accurate, in terms of brick alignment, to use a laser alignment device. In this method a laser beam can be emitted along the longitudinal axis of the kiln, parallel with its centre line, and deflected at any point along its path by the rotating penta-prism at exactly 90°. This produces a continuous perpendicular light line running down the circumference of the kiln shell. This guideline can be marked on the kiln and reproduced at several points along the length of the kiln (Figure 3). These marks can then be used as exact references, against which the brick ring must be laid, and enable the operator to check the quality of the work in progress.

The prism has been specially designed to enable it to be presented to the main laser beam within an angle of +5° tolerance. In other words, the prism can be presented within an 85° – 90° angle to the main laser beam without affecting the perpendicularity of the projection. Also, once the laser beam is travelling parallel to the centre line of the kiln, the penta-prism can be moved to any position, providing it intercepts the beam. Being rotated by a variable speed motor, the penta-prism enables individual areas on each ring of installed brickwork to be checked.

Although simple to operate, this development produces exacting quality control reference points that assist the use of the pneumatic bricking machine.

Furthermore, by foreseeing the best method to enclose the last brick ring, it is possible to preserve brick length at the cut row (avoiding bricks with less than half their length) and still avoid failure due to the fall of a single brick, up to an entire row, caused by thermal expansion and mechanical demands. This leads to more time between refractory tear out, less downtime, and more cost savings.

There are documented cases of the laser being used for the first time inside a kiln and the laser's accuracy discovering improperly installed retaining rings; these retaining rings are the foundation for properly installed brick.

## Brick installation starts

Once the kiln shell has been marked out, ready to receive new brickwork, the method of installation is be crucial to the speed with which the repair can be completed. Throughout the industry, a variety of methods have been adopted for different reasons according to the requirements and characteristics of each cement plant. Using a pneumatic bricking machine, with a lightweight aluminium double arch, surpasses the use of any other method in terms of achieving the best:

Figure 3. Radialign laser ensures the bricks are properly aligned; guidelines can be marked and reproduced at several points along the kiln.

Figure 4. Pneumatic bricking machine with a lightweight aluminium double arch.

- Ease of operation.
- Speed of operation.
- Safety.
- Quality of work.

## Double arch pneumatic bricking machine

The pneumatic bricking machine essentially consists of a mobile working platform carrying a half-circle aluminium centre (based on the principle of the conventional wood centre), which supports the bricks. The aluminium centre arch is supported by a cart and rail system, which allows the aluminium centre arch to traverse along the length of the platform scaffold (Figure 4). Compressed air powers the pneumatic cylinder lifters, which are used to raise the bricks to the shell and hold them in place.

Figure 5. Hydraulic jack in use, used to tighten the ring radially.

A hydraulic jack assembly then tightens the ring radially (Figure 5). A main control valve releases all the cylinders simultaneously, allowing the centre to be advanced to the next course. After raising all the cylinders of the second arch back in place to hold the brick against the kiln shell, the hydraulic jack can be removed and the keying process can be initiated. As the front arch has an open section, the mason has total access to the keying section and can work ergonomically on this task. The wing masons can simultaneously work on lifting bricks up to the keying section, while the key mason closes the ring.

Once the ring is keyed, shims are inserted using a pneumatic shim driver tool, when, and if, necessary. The use of a hydraulic jack and a pneumatic shim driver allows the masons to control pressure through the gauges installed on those accessories. Turning the manual keying system into a mechanically controlled tool system avoids the cracks and disruptions in the bricks that are commonly responsible for premature failures.

These pneumatic platforms are built in lightweight aluminium 6061 T6 and can handle up to two or three pallets of bricks, plus workers and tools. They are mounted on heavy-duty casters that can be manually moved along the length of the kiln as work progresses. Being lightweight, the entire unit can be moved at a rate of 2 – 3 m/min. The casters are also designed to operate in any of four positions. Should the kiln need to be rotated for any reason after the bricking machine is assembled inside the kiln, the casters can be turned, allowing the kiln to be rotated with the platform remaining in position, after tools, brick, and personnel have been unloaded.

## Attention to detail

Productivity and profits can be greatly improved with relatively low capital costs by paying attention to the smallest details of refractory installation and maintenance. Choosing the right refractory is only one small detail in operating a plant. Proper installation has a significant impact on refractory life; however, the modern refractory installation method is actually the last step of a larger circle. The Circle of Refractory Maintenance is a systemic approach to these smaller details, which involves more than just laying brick. This approach begins with proper access to the kiln, safe inspection equipment and techniques, modern tear-out equipment and methods, proper installation techniques, including radial alignment, efficient material handling and modern installation equipment, and ends with good records and benchmarking.

## Using the best tools

There is more to a cement plant than just a kiln. In like manner, there should be more to refractory than just refractory installation equipment. Proper tools result in proper maintenance. Granted, there are many different types of tools made by different manufacturers, each with their own reasons for using theirs above others. If needs be, even a butter knife can pass for a flat head screwdriver; however, it often cannot handle the torque needed for the job. Securing the best tools to provide the safest, most efficient maintenance approach, as well as the need for speed during outages of any kind, eliminates much of the competition. Those manufacturers that can supply a full range of tools, all wrapped up in a matching toolbox, have a better grasp on the entire process.

With refractory only costing 1% of the capital cost and yet being the main reason for up to 50% of emergency shutdowns, quality and proper installation of the refractory again supports the need to utilise the best tools for the job.

## Conclusion

It is not enough to use the highest quality tool, if it is not the proper tool. This is a good rule of thumb for any job, but particularly important with regards to refractory installation. Refractory materials have enjoyed an enormous development over the years, as has installation technology. But while no cement plant would consider using yesterday's refractory brick, 90% of plants still choose to stick with outdated installation methods. The main reason for making such a decision is often: if it is working, why make a change?

In this same respect, jack and timber, pogo sticks, timber and bolt, etc. are all methods for installing refractory brick, but they do not reduce fatigue, injury, and downtime, and do not add much to the quality of installation. Even though there are many tools that could maintain a rotary kiln, choosing the best tools to provide the safest and most efficient approach in the least amount of time is just good business.