Curbing downtime

As part of the cooler conversion at its Ste Genevieve cement plant, USA, LafargeHolcim opted for a modular precast cooler curb system to help reduce downtime during the project. This enabled the cement producer to light up only 48 days after shutdown.

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LafargeHolcim's Ste Genevieve plant in Missouri, USA, was commissioned in 2009 as the largest single-kiln line cement plant in the world with a cement capacity of 4Mta. In 2016 LafargeHolcim made the decision to replace its clinker cooler to an IKN Pendulum Cooler to improve the reliability of its clinker cooling (see Figure 1).

The decision was made to perform the entire cooler modification over a kiln outage of 50 days flame-to-flame. To reach this ambitious target, all factors that would contribute to a quick installation had to be foreseen during the engineering and execution of the project.

Figure 1: in 2016 LafargeHolcim decided to replace the clinker cooler at its Ste Genevieve plant, USA

The modular option

As part of these measures LafargeHolcim chose to use the proprietary modular precast cooler curb system from Wahl Refractory Solutions.

Comprised of precast refractory blocks that are prefired to optimise physical properties and performance, the cooler curb system does not require any additional heat treatment or lengthy dry-out schedule prior to kiln start-up. The modular construction is easily installed with the use of lifting straps and placed with the assistance of lifting cranes or chain blocks. Each module is ~200kg in weight and is dimensioned to 700mm in height and 425mm in length. Allowance for thermal expansion is provided through the use of ceramic paper to maintain a 3mm expansion gap between each cooler curb module. The 36m-long section of cooler curbs required 168 precast cooler modules to line both sides of the cooler.

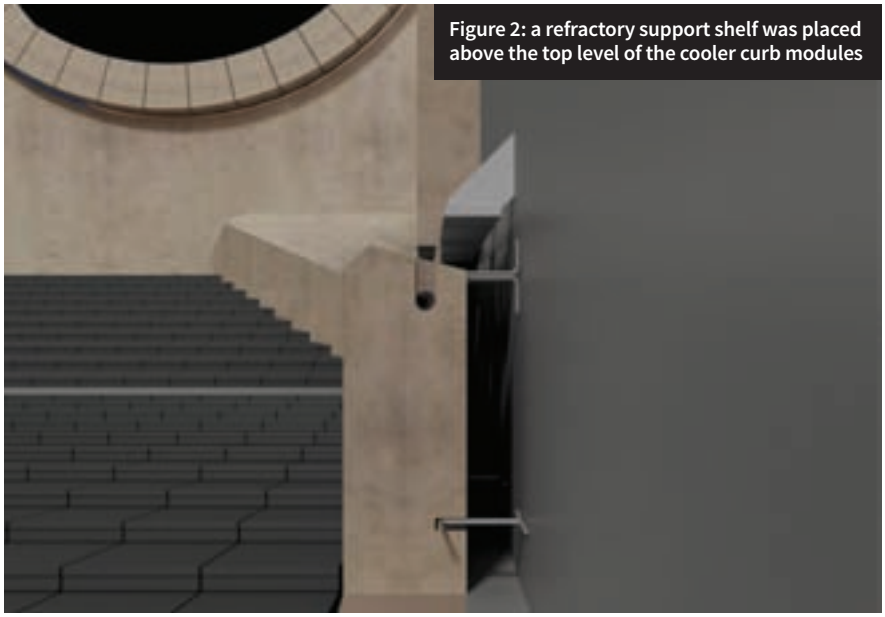

Figure 2: a refractory support shelf was placed above the top level of the cooler curb modules

Wahl offers two options for anchoring to the cooler steel shell:

1. fixation through the use of nuts and bolts
2. using a tie-back design welded to the cooler walls to anchor the installation, as selected by LafargeHolcim.

To assist with future repairs to the refractory walls and cooler curbs, Wahl suggested the placement of a refractory support shelf above the top level of the cooler curb modules (see Figure 2) to support the refractory walls above and allow rapid replacement of worn-out cooler curb modules at a later date without affecting the refractory walls above.

For the Ste Genevieve project, the existing cooler housing has been reused. This means that just the cooler internals were replaced by IKN with only small modifications of the existing cooler housing

Minimal block wear

Wahl Refractory Solutions recently inspected a set of its precast modular cooler curb blocks after nearly seven years in service at Ash Grove Cement's Foreman works, USA. Commissioned in February 2010, the design specification of this 1.7Mta five-stage preheater kiln with inline calciner included Wahl's precast cooler curb blocks for installation in the new cooler.

In December 2016 Wahl's technicians performed a routine inspection to assess the condition of the cooler curbs and evaluate remnant refractory thickness. Their inspection revealed that the blocks had retained 50 per cent of their original thickness in the most severe wear. The chosen installation method was a bolt-through construction. In Figure A, the curb blocks are clearly worn to the point where the bolts are visible, indicating an approximate remnant refractory thickness of 125mm. The total remnant refractory thickness including the backup lining is approximately 235mm. Average wear of the cooler curb blocks after 75 months in service was 125mm.

Figure A

Figure 3: the installation of the cooler curb modules

(see Figure 3). The distance between the grate and the existing cooler housing was designed to be 360mm. The refractory thickness of each cooler curb module is 250mm and the length of the tie-back steel anchor is designed in accordance with the distance between the cooler walls and location of the cooler grates.

After placement of the precast cooler curb modules, the space between the back side of the cooler curb modules and the cooler steel walls is back-filled with a refractory castable by pumps to save on installation time. With the cooler curb modules and backfill material being in place, the installation of the refractory lining of the walls above the cooler curb system can continue using common high-speed refractory placement such as shotcrete or gunnite.

Improved bed depth measurement

To facilitate the determination of clinker bed depth through inspection ports in the sides of the cooler, Wahl designed a depth gauge block positioned across from inspection ports intermittently along the length of the cooler. The depth gauge modules are designed with three rectangular protrusions at different heights and offset from each other laterally to help estimate clinker bed depth (Figure 4).

As the new IKN cooler can operate on a wide range of bed depths, three different indications of bed depth were foreseen. The lowest depth pad gives a depth reading of ~150mm, the middle gauge is ~350mm and the top depth pad 550mm.

Since there are three offset depth gauges that are easily identified from a distance, the clinker depth is estimated by identifying how many of the depth pads are visible above the top of the clinker bed.

Benefits of modular design

Unlike other refractory options for lining cooler curbs, such as brick and cast-in-place refractory monolithics, Wahl's precast cooler curb system is modular and allows for rapid replacement of a section of curb without having an impact on the

Figure 4: depth gauge modules were installed to help measure the depth of the clinker bed

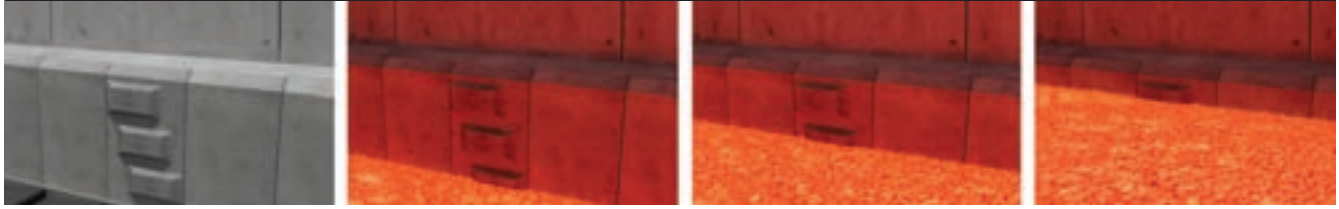

Table 1: refractory zoning and material section

Zone	Fixed inlet to tertiary air duct off-take	Intermediate zone	Cool zone
Distance from static cooler grates inlet (m)	0-6	6-16	16-36
Temperature			
Alkali salt infiltration and attack			
Erosion from abrasive clinker			
Mechanical stresses and thermal shock			
Material selection	WireMax® RSR	WireMax® KLN60	Command® 50
Material description	Ultra-low cement fused mullite-zirconia base	Ultra-low cement mullite base	Low cement kaolin base
Al_2O_3 (%)	50	61	51
SiO_2 (%)	31	35	44
ZrO_2 (%)	11		
CaO (%)	<1	<1	<2
Cold crushing strength (MPa)	116	114	94
Hot modulus of rupture at 1100˚C (MPa)	48	44	22
Abrasion resistance ASTM C-704 (cc loss)	3.9	4.3	5.6
Stainless steel wire reinforcement	Medium wire content	Medium wire content	Low wire content

surrounding refractory.

The modular design also permits the optimisation of the performance of the entire length of the cooler walls by selecting (or zoning) different qualities of refractory materials along the length of the cooler. To comply with LafargeHolcim specifications for cooler modifications, Wahl took into consideration thermal loading along with mechanical stresses and abrasion/erosion concerns of this high-capacity 13,500tpd cooler and opted for zoning the cooler curbs as indicated in Table 1.

Figure 5: the installation of the new precast refractory blocks is complete

Installation

Flame-off for this cooler retrofit project took place on 4 December 2016. The structure of the existing cooler and the cooler housing were mainly being reused. The upper walls and roof itself remained untouched. The refractory and steel casing in the lower walls were removed to help with tear down of the existing cooler internals, such as grates and mechanical components. After five weeks, the retrofit cooler mechanicals and sidewalls were in place and ready for installation of the refractory lining. The first cooler curb module was placed at 14.45h on 9 January 2017. A crew of four men, including a skid-steer loader operator, two masons and one welder, was dedicated to positioning the precast cooler curb modules and welding the tie-back anchors. At 18.45h on 10 January 2017, 160 blocks had been installed in 28h, totalling 68 linear metres of cooler curb length. At this point, the refractory installation could transition to placement of remaining castable using the shotcrete installation method (see Figure 5).

One week later and two days ahead of schedule, the cooler retrofit was completed and went back into operation after only 48 days of downtime. ■