Extending refractory lining lifetimes

The vertical bull nose in lower stage cyclones at cement plants is a potentially fragile area for the refractory lining as it is prone to cracking due to the sharp angles and a high level of abrasion, often needing frequent repair or relining. A precast, curved modular lining from HASLE Refractories has achieved a long lifetime of up to 5.5 years in this area.

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A cement plant in Thailand with a capacity of 5500tpd, running on 85 per cent coal and 15 per cent refuse-derived fuel (RDF), was experiencing issues with short lifetime of the refractory lining at the vertical bull nose zones in the lower stage cyclones (see Figure 1).

The vertical bull nose area is exposed to extremely high abrasion from strong air flow and dust, especially in the lowest stage cyclone with high temperatures, further enhanced by alkali and other chemical attacks as a result of the increased use of alternative fuels.

The previous castable material used in the bull nose area in the lowest cyclone quickly cracked at the leading edge of the bull nose, leading to frequent repairs and a very short lifetime of just 12-18 months. This meant that the Thai cement plant had to repair the lining at each shutdown, which not only resulted in many manhours spent along with materials costs but also took up valuable production time.

Furthermore, the vertical bull nose area is located at an elevated height (more than 20m above the manhole), requiring scaffolding to reach it, adding both time and cost to the maintenance plan (see Figure 2). Therefore, the cement plant was looking for a longer-lasting refractory solution to extend the lifetime and hence minimise downtime and maintenance costs.

Figure 1: bull nose area ('A') of the lowest stage cyclone of the cement plant in Thailand

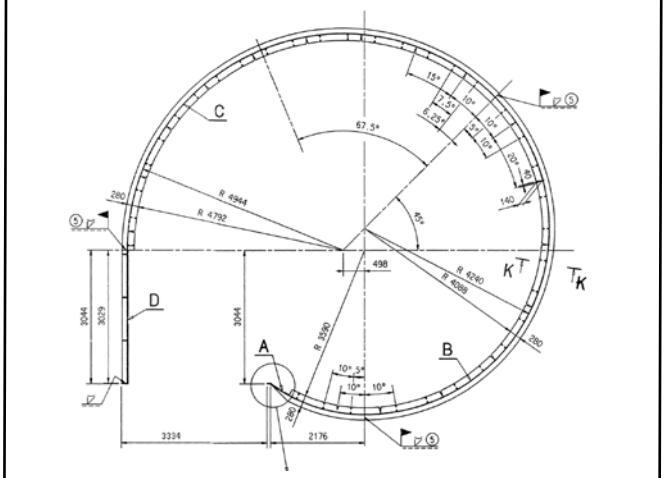

Figure 2: as the vertical bull nose area is located high above the manhole in the cyclone at the Thai cement plant, scaffolding is needed to reach the area

Custom-made solution

The cement producer turned to HASLE Refractories for assistance having previously had positive experiences with the use of the company's refractory materials in other areas of the process, including the riser duct, smoke chamber and calciner. After analysing the operating conditions along with the design of cyclones, a precast solution based on the HASLE Modular Lining concept was proposed.

HASLE's precast Modular Lining was originally designed 30 years ago as a hot-face refractory lining for the critical areas of high-temperature industries. It has continuously been optimised to have a low open porosity and a smooth impact surface which makes the precast elements durable and highly resistant to abrasion, chemical attacks and coating.

Figure 3: HASLE modular lining in the lowest stage cyclone 2.5 years after installation at the Thai cement plant

To secure the highest quality of the modular lining elements, all elements are made exclusively from virgin materials, and manufactured under strictly controlled conditions in HASLE's plant in Denmark. Here, specialised casting equipment is used, such as vibration tables, tailor-made moulds, and dry-out ovens.

The green precast bodies are subsequently prefired for five days up to a peak temperature of 500˚C. All free and bound water is removed (making faster heat-up possible) and a very low open porosity of just 8-10 per cent is achieved. The result is a significantly longer lifetime than traditional in-situ cast linings, which typically have an open porosity of 18-20 per cent or more.

HASLE's Modular Lining has shown excellent results when used in cement plants throughout the world, where typical areas of installation include feed pipes, smoke chamber, cooler bull nose and roof.

The vertical bull nose has a curved section, meaning a precast solution with HASLE's standard Modular Lining elements would not work. Therefore, HASLE's team of experienced engineers started designing a custom-made solution to accommodate the specific designs of the bull nose areas. More specifically, precast elements with different angles were developed to be able to fit the individual curvature of bull nose areas.

Due to a smart element design combining steel anchors with a tongue-and-groove system embedded in the precast elements, a high level of installation flexibility is achieved. Hereby, it was possible to design a tailor-made solution that can fit with the inner angle of 60˚ of the vertical bull nose areas faced at the Thai cement plant.

"By choosing this lining solution, the Thai cement plant ended up saving both manhours and materials. No relining or repairs were needed to keep the vertical bull nose operating for more than five years, resulting in increased production stability at a lower operational cost."

Fast installation with supervision

Installation of the curved modular lining at the bull nose area in the two lowest cyclone stages took place during the annual shutdown in 2015. Installing the precast modular lining is fast and easy.

First, a steel retainer plate is welded in place at the bottom to support the precast elements. Steel anchors are then welded to the wall and easily attached to the modular, precast elements (approximately 250 x 250mm). The precast elements weigh only about 15-16kg each, so no special lifting equipment is required.

Finally, an insulation castable is poured behind the precast elements to minimise heat losses and protect the structure behind the precast elements. Moreover, no controlled dry-out process of the lining is needed.

Whenever a precast Modular Lining installation takes place, a team of HASLE supervisors is on-site coordinating with the relevant local installation company. This ensures that the installation is carried out in accordance with best practices allowing for the best possible lining performance.

Lifetime up to 5.5 years

The cyclone vertical bull nose area is a harsh environment for any refractory lining. Therefore it was encouraging to see that the HASLE Modular Lining could achieve 5.5 years of lifetime in the lowest cyclone, where the hottest temperatures are found in the preheater.

Figure 4: HASLE modular lining in the middle stage cyclone five years after installation at the Thai cement plant

Figure 5: HASLE Modular Lining in the middle stage cyclone in 2022, more than six years after installation at the Thai cement plant. It is still in good operating condition

By choosing this lining solution, the Thai cement plant ended up saving both manhours and materials. No relining or repairs were needed to keep the vertical bull nose operating for more than five years, resulting in increased production stability at a lower operational cost. Furthermore, a similar HASLE precast bull nose installation in the middle stage cyclone reached a lifetime of seven years.

HASLE Refractories Thailand is now in discussions with the plant to replace the entire lining in the lowest stage cyclone with new HASLE Modular Lining. The project is scheduled to be carried out during the upcoming shutdown in spring 2023.

Experiences around the world

Australia

The HASLE precast solution for the vertical bull nose has shown excellent performance, not only in Thailand but also in other cement plants around the world. For instance, in Australia, where a 5500tpd cement plant running on 10 per cent alternative fuels was dealing with heavy abrasion leading to cracking of the existing lining at the bull nose, a short lifetime of less than 12 months was achieved with the used gunning material.

Installed in 2012 the HASLE Modular Lining ended up having a lifetime of 5.5 years. The vertical bull nose area was relined in 2018, again utilising the HASLE modular lining, and it is still in good operating condition.

Austria

More recently, W&P Group's cement plant in Wietersdorf, Austria, was also experiencing issues with low lifetime of the refractory lining in the vertical bull nose in the lowest cyclone. The 2200tpd cement plant, which uses 80-90 per cent alternative fuels, was looking for a refractory solution that withstands the abrasion and chemical challenges experienced in this area. Repairs used to take place every year, being both costly and time-consuming for the plant during its shutdowns.

A HASLE modular lining solution was installed in January 2021 (see Figure 6 and 7) and looked in excellent condition when inspected at the next revision in January 2022.

"We were so satisfied with the HASLE modular lining that we decided also to install it in the next two cyclone stages," said Thomas Neuwirth, production manager at the Wietersdorf plant. ■

Figure 6: installing the individual HASLE Modular Lining precast elements at W&P Group's Wietersdorf plant in Austria. For maximum flexibility during installation, the elements interlock with a tongue and grove system while the anchors are easily mounted to the wall via a steel rail

Figure 7: finished installation of the HASLE Modular Lining in the lowest stage cyclone at the Wietersdorf plant