MASTERFUL CASTABLES

A small but crucial area for any cement plant is the kiln burner pipe, where under-performance can not only significantly reduce plant efficiency, productivity, and quality, but also impact sustainability performance. The refractory lining protecting the burner pipe is crucial for keeping the burner pipe in operation. The lining on the burner pipe is among those parts of a cement plant with the shortest lifetime and hence often requires relining due to the extreme temperatures and high abrasion levels, which are further enhanced by the use of alternative fuels and the associated chemical attacks on the lining. Therefore, even small increases in the lifetime of the refractory lining can hugely improve productivity while the time needed for shutdowns and the potential for breakdowns is minimised.

Aiming for efficient and sustainable production

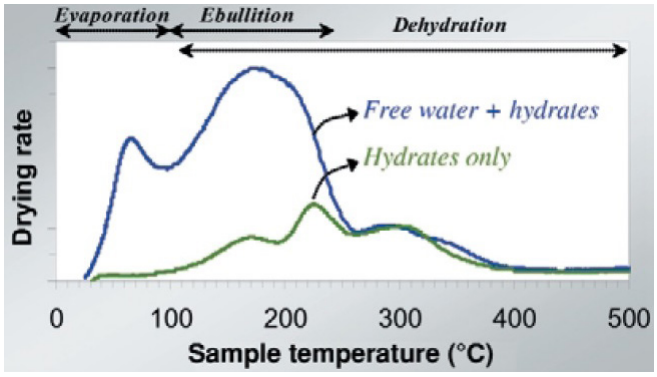
With a legacy spanning over six decades of operations, Ramco Cements is one of the most established cement manufacturers in India. Its production journey started in 1961 with an initial capacity of merely 200 tpd, but by 2022, the company had five integrated cement units providing 21 million tpy of production capacity.

Sustainability and innovation have always been Ramco Cements' core values. For

Pankaj Gupta, HASLE Refractories, reveals how an Indian cement plant achieved a 12-month lifetime for the lining of its burner pipe by using an abrasion- and heat-resistant castable.

HASLE D52A's reduced reactivity with different chemicals can be seen in the crucible test results where D52A is tested with different alkalis and slag. The results showed that there were minimal levels of penetration by these chemicals.

The severe condition of the refractory lining at the burner pipe tip within 2 – 3 months at Ramco's Jayanthipuram Unit, prior to the involvement of HASLE Refractories.



Both free and chemically-bonded water are present in the refractory castable, and which evaporate at different temperatures and can potentially cause issues for the performance of the refractory lining if not heated carefully.

instance, the company set up the first dry process line in southern India, and over the years it has also installed electrostatic and permanent magnetic separators, implemented vertical roller mills, and employed cross belt analysers.

But the initiatives do not end with the equipment and methods employed. The fuels being burnt are also under the spotlight. Across all five of their units located at Jayanthipuram, Ariyalur Alathiur, Virudhu Nagar, and Kurnool District, different grades of alternate fuels are used. Pet coke is used in the kiln burners while 15 – 20% of alternative fuels are charged at the calciner stage, such as agri-waste, carbon black, organic liquids, and sludge, with a long-term vision to increase this percentage in the future to further reduce the carbon footprint.

Burner pipe issues and recommendations

After previously upgrading the burner design at the Jayanthipuram site, the lifetime of the burner pipe castable decreased from 5 months to 3 months.

The castable was failing at the tip area, where cracks quickly formed and chunks of the castable were subsequently coming out. Due to this failure, the plant was forced to frequently undertake unscheduled maintenance breakdowns to replace the burner pipe, which reduced the efficiency and productivity of the plant. So, the plant turned to HASLE Refractories with the aim of achieving a 6-month minimum lifetime of the burner pipe refractory lining.

Choosing the appropriate castable

Depending on the kiln operating conditions and the nature and pattern of the burner pipe refractory failure, such as thermal spalling, high abrasion, chemical attack, alkali spalling, and coating formations at the tip area, HASLE can recommend a range of different unique grade castables, including the D52A, D59A, D65TA, and D1550Sc.

As the nature of the refractory failure for the burner pipe was mainly associated with high alkali attack along with high temperatures and abrasion at the burner tip area, HASLE D52A was recommended.

HASLE D52A is a high-grade mullite and chamotte-based low-cement castable with a service temperature of 155°C. It comes with a medium percentage of Al_2O_3 which makes it very alkali-resistant without compromising its physical properties. Iron oxide and calcium oxide are also kept at

optimum levels to achieve excellent physical properties at elevated temperatures.

The castable has excellent physical strength at different temperatures (ranging from 110˚C to 1500˚C), excellent abrasion resistance, and a very high hot modulus of rupture (HMOR) which makes it particularly suitable for such critical areas in cement plants.

In additon to enhanced chemical, physical, and thermal properties, HASLE D52A also exhibits improved resistance to hazardous gases present in the kiln systems. Thanks to its unique recipe resulting in a very low porosity and its use of high-grade virgin raw materials, this makes the material resistant to different gases such as alkalis, sulfates, and chlorides, which are introduced in the kiln system due to the use of a higher percentage of different alternative fuels such as pet coke, municipal solid waste, agricultural waste, plastics, and tyres.

Installation practice is crucial to achieving long lifetimes

The installation practice is a very important factor when it comes to castable laying. A good quality castable underperforms if standard installation procedures are not followed. Many factors contribute to getting the most out of the castable on the burner pipe or any other critical area of application. First, a proper anchor design is key, including the spacing, distribution, and fixing pattern of the anchors, while the casting design should also take into consideration the thermal expansion of the materials through, for instance, expansion joints. But also, the casting method itself can impact the performance of the lining, where factors such as the castable panel length, formwork, mould design (to allow for optimal vibration), casting position (vertical or horizontal), and using suitable vibrators and mixer machines, along with the curing period, all play vital roles.

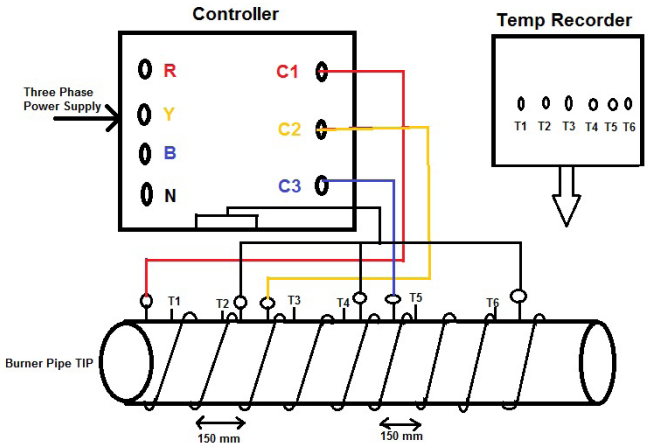
A burner pipe during installation, many factors impact the performance of the burner pipe lining, including the spacing, distribution, and fixing pattern of the anchors. HASLE can assist with the design of the installation.

Preheating doubled the lining lifetime

After the first installation of HASLE D52A in the burner pipe at Ramco Cement's Jayanthipuram site, the plant improved the lifetime of the refractory lining to 6 – 7 months. However, to further improve the refractory life of the burner pipe, it was decided that the burner pipe castable should be preheated.

Preheating is the process of drying out the castable lining after it is installed and, in this case, doing so before taking the burner pipe into operation. By preheating the pipe at a controlled rate, both free and chemically-combined water from the refractory lining is removed, whereby the lining achieves its ultimate strength and permeability. Before casting, the dry castable is mixed with 4 – 5% water to make it workable. This castable mix contains water physically retained in capillary pores as well as chemically bonded as cement hydrates. If the burner pipe is taken directly into operation, the castable is exposed to a high rate of heating, and as soon as the castable temperature reaches above 100˚C, steam begins to form which generates high stress within the castable. Furthermore if the temperature is not controlled, as operation continues water vapour is not able to escape through the capillary, extreme steam pressure builds up inside the castable and will break its hydraulic bonds, resulting in the formation of cracks. Over time, during operation, these cracks will propagate, and due to the high temperatures and dust load in the kiln hood area, the castable is at high risk of failing prematurely. This initial crack generation in the castable can be avoided if the water vapour is removed in a controlled manner through adjusting the temperature. The slow heating will allow the water vapours sufficient time to evaporate slowly through the capillaries without breaking the hydraulic bonds of the castable.

The preheating process can be started after the natural curing (normally 24 hours) of the



Preheating equipment assembly: to control and monitor the burner pipe preheating process, the system uses sensors to manage the temperature precisely via the heating coils.

In the process of setting up a burner pipe for controlled preheating, attaching the heating coils.

Preheating a burner pipe at Ramco Cements Jayanthipuram Unit, aided by a team of HASLE supervisors.

castable layer. In this process, rolls of heating coils are used to heat the castable, which are wrapped around the burner pipe, and the temperature is set through a controller unit.

Suitable thermocouples are used to check the ongoing temperature of the castable. This temperature can be seen on the digital temperature display unit and the running temperature is recorded using a temperature plotter.

The whole burner pipe is wrapped with a ceramic blanket to retain the temperature inside. The temperature of the burner pipe castable is initially increased from ambient temperatures to the required temperature at a very slow rate, and the temperature is then held at the desired level for several hours in a process called soaking. After the soaking period has elapsed, the temperature is further increased at a slow pace to the new desired level and then again held for several hours. After the soaking period is completed at the highest desired temperature, the burner pipe is cooled down to an ambient temperature at a slow cooling rate.

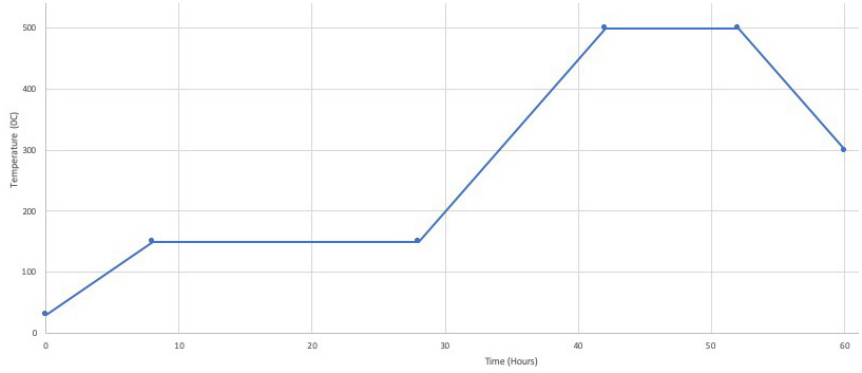
A step forward towards sustainable production

By using the HASLE D52A castable and preheating the burner pipe, Ramco Cement is able to continue production for a full campaign without any breakdowns due to the underperformance of the burner pipe refractory lining.

Intermittent breakdowns cause losses in production, fuel, and material, which detracts from the plant's overall sustainability objective. HASLE Refractories can help cement plants to be more sustainable by increasing the overall lifetimes of refractories for different areas of cement

The burner pipe after around 12 months of operation at Ramco Cement's Jayanthipuram plant.

Ramco Cement's Jayanthipuram plant, Andhra Pradesh, India.



Burner pipe castable preheating curve followed by Ramco.

plants by using its high-grade, low-cement castable products.

"We are proud that the joint effort undertaken by HASLE and the Ramco plant team has resulted in a working life of 12 months of the burner pipe refractory as well as in kiln tip casting (nose ring) and cooler bull nose area. We always follow the standard practice for preheating the burner pipe in all of our units. We thank the HASLE team for providing their technical support during the installation of the HASLE D52A castable in all of our plants", M. Srinivasan, Executive Director – Operations at Ramco Cement concludes.

Experiences from around the world

The HASLE castable solutions for the burner pipe have shown good performance, and not only in the Ramco Group plants but in cement plants worldwide. Under a wide range of operating conditions, the tailor-made burner pipe refractory solutions have consistently achieved lifetimes of around 12 months.

For instance, a Malaysian 1000 tpd white cement plant using pet coke achieved a 12-month lifetime with HASLE D1550SC-HT and a changed mould design for optimal casting, compared to 3 months with another castable. After upgrading their production capacity from 4500 tpd to 6000 tpd, Indian cement plant Shree Jayajothi Cement – running on coal and 20% pet coke – was unable to achieve a 6-month lining lifetime in the burner pipe area; with HASLE D52A they achieved a 12-month lifetime. Several cement plants in Europe using high levels of alternative fuels and RDF achieve successful lifetimes of their burner pipe linings using HASLE D52A. ■

About the author

Pankaj Gupta is Business Head at HASLE Refractories and services the Indian, Middle Eastern, and African cement markets. He holds a Bachelor's degree in Ceramic Technology and a Master's degree in Business Management. Having rich industrial exposure of more than 17 years, he has extensive theoretical and practical experience from onsite installations and an in-depth understanding of refractory challenges and solutions.