BANISHING BUILDUP

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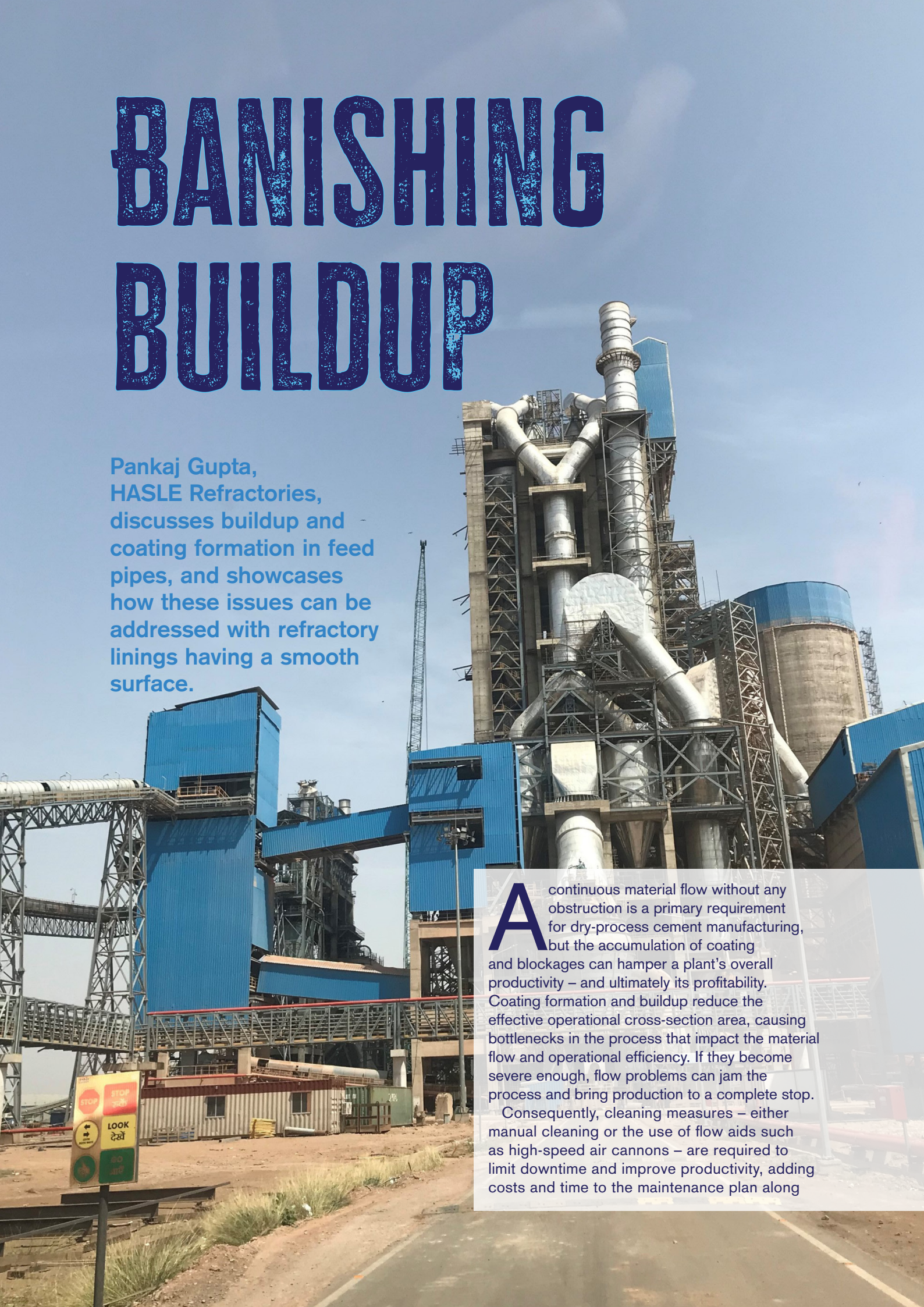
discusses buildup and coating formation in feed pipes, and showcases how these issues can be addressed with refractory linings having a smooth surface.



A continuous material flow without any obstruction is a primary requirement for dry-process cement manufacturing, but the accumulation of coating and blockages can hamper a plant's overall productivity – and ultimately its profitability. Coating formation and buildup reduce the effective operational cross-section area, causing bottlenecks in the process that impact the material flow and operational efficiency. If they become severe enough, flow problems can jam the process and bring production to a complete stop.

Consequently, cleaning measures – either manual cleaning or the use of flow aids such as high-speed air cannons – are required to limit downtime and improve productivity, adding costs and time to the maintenance plan along

with potentially increasing complexity in the production process. Additionally, refractory walls can be worn or damaged by tools or cleaning techniques, necessitating more frequent repairs or relining.

Feed pipes pose a particular challenge

The feed pipes play a vital role in delivering a controlled and consistent flow of raw meal mix into the preheater tower and between its cyclones. But they also pose a special challenge by having a narrow cross-sectional area with a relatively low airspeed of the passing raw meal, catering to a higher risk of deposits sticking to the pipe walls, especially in lower cyclone stages with higher temperatures.

Feed pipes pose a special challenge when coating formation and buildup is present in the preheater process. This is due to their inherited small cross-sectional area combined with a relatively low airspeed of the passing raw meal mix.

An example of severe coating issues in a lower-stage feed pipe section at a cement plant in India, significantly lowering the throughput and posing a high risk of jamming.

The coating formation and buildup in this area seems to depend heavily on the particular chemical composition of the raw meal mix in the clinker manufacturing process. Some plants have negligible coating issues, while others fight a tough battle to minimise and reduce the buildup. For instance, chlorides may be present in the mined chalk or an elevated percentage of MgO in the limestone, which subsequently can react with other components in the process, resulting in a stickier material mix. Furthermore, the burning of alternative fuels – and hence the introduction of additional corrosives like alkalis, sulfates, and chlorides into the preheating process – can in many cases worsen the coating formation on the refractory surfaces.

Counteracting the sticky material

Manually removing the buildup from the feed pipes requires frequent cleaning. In severe cases, cement plants may face the need to shut down operations to clean the coating and buildup, resulting in significant costs in terms of process time, maintenance hours, and wasted energy during the restart.

To avoid the need for manual cleaning and to minimise the associated downtime, several measures can be employed in the process to counteract the potentially sticky raw meal mix in the feed pipes. Flow aids, such as air cannons and blasters, can dislodge accumulated material and facilitate a smoother flow of materials through the pipes. While these flow aids can be beneficial, they may also add complexity to the overall system.

The quality of the refractory lining inside the feed pipes is another crucial factor influencing the deposition of raw meal mix. If the surface of the refractory lining is rough and susceptible to chemical reactions with the passing material, it can promote buildup issues. By creating a smoother surface and utilising high-quality refractory materials, the passing material becomes less likely to stick to the feed pipe walls.

Optimising the refractory surface

Focusing on optimising the refractory lining and its surface can be a cost-effective tool to minimise build up, as no extra complexity is added to the production process.

For instance, a 3000 tpd cement plant in Vietnam, operating solely on coal, encountered

severe coating issues in the feed pipe at the lowest stage cyclone. These issues resulted in reduced efficiency and material flow, necessitating frequent cleaning, and posing the risk of blockages. Moreover, the existing local castable used for the lining of the feed pipes had a lifespan of only 18 months.

The cement plant sought a longer-lasting refractory solution that could effectively address the build-up. Following an onsite inspection, an engineer from HASLE Refractories recommended lining the feed pipe with HASLE D59A, a strong and very dense low-cement castable. Through the use of high-quality virgin materials and an optimised grain size distribution, the lining provides a smooth surface with low open porosity.

Dismantling feed pipe: heavy coating after one year of operation since last relining.

Installation of HASLE cylindrical Modular Lining precast elements in feed pipe sections at a cement plant in India.

Consequently, the lining surface becomes significantly less prone to coating formation.

Hence, In 2018 the feed pipes for the lowest-stage cyclone were lined with HASLE D59A. A recent inspection in the spring of 2023 confirmed that the lining remains in excellent condition without any coating problems. Over the past five years, the plant has not encountered any coating issues or jamming in the feed pipes, which is a significant improvement compared to the frequent cleaning of buildup required previously.

Meticulous manufacturing for a smooth surface

As an alternative to traditional in-situ castings, the HASLE precast Modular Lining system is available to achieve even smoother surfaces. The lining system is based on standardised precast shapes, including specialised cylindrical versions for feed pipes.

To achieve the highest quality, all precast elements are made exclusively from virgin materials and manufactured under strict controls at HASLE's facility in Denmark. Here, specialised casting equipment, such as vibration tables and tailor-made moulds, is used. The green precast bodies subsequently undergo a five-day prefiring process, reaching a peak temperature of 500°C.

This carefully controlled procedure effectively eliminates all free and chemically-bound water, resulting in an impressively low open porosity of just 8 – 10%, a marked improvement compared to the 15 – 20% typically found in in-situ cast linings.

The outcome is an exceptionally smooth surface of the precast elements, boasting heightened resistance to coating. Further, leveraging the refractory material's exceptional resistance to chemical attacks from alkali, sulfates, and chlorides, the precast solution effectively minimises build up and corrosion issues.

The precast feed pipe lining is based on curved 25 cm x 25 cm elements, designed for easy handling and installation. With the integrated tongue and groove joints on all four sides, the precast elements securely interlock to form a stable cylinder, eliminating the need for additional anchoring. During installation, the joints are filled with a 2 – 3 mm mortar, effectively reducing the infiltration of hot and corrosive gases into the layers and casing behind the hot face lining.

The lining offers enhanced flexibility, allowing customisation to meet different diameters, heat-transfer requirements, and lining designs. While the standard precast elements have

a thickness of 70 mm, thinner variants down to 50 mm are available, making them ideal for incorporating an insulation layer behind the precast elements, if desired.

Case study: India

The cylindrical HASLE precast Modular Lining solution for feed pipes was introduced in the mid-2000s, and among the early adopters was an Indian cement group covering numerous plants. It is not uncommon to achieve 6 – 7 years of lifetime with hassle-free operation through this solution.

A recent case is from one of their plants in the Northern part of India. The 10 000 tpd plant has one line with two strings and is mainly running on pet coke, with 5 – 10% alternative fuels. Despite using a silicon carbide (SiC) based low-cement castable, the plant faced heavy coating issues in their lower-stage feed pipes and the lifetime of the lining never surpassed 3 – 4 years. The coating formation significantly hampered the flow of material and subsequently triggered unscheduled stops to remove the buildup.

Following an inspection at site, a tailored HASLE precast Modular Lining was implemented in feed pipes for the stage 5 and 6 cyclones, located in the lowest part of the preheater. The first 20 sections were installed in 2015. Quickly seeing that the coating formation almost vanished and that no jamming issues appeared in that part, the plant opted soon after to fully implement the HASLE precast solution for their feed pipes. So from 2016 onwards, 10 – 20 m of the feed pipes for cyclones 5 and 6 have been relined with the HASLE Precast Modular Lining each year in a rotational scheme. The lining in the pipes now consistently achieves at least six years before relining is needed. Moreover, the standardised, modular precast elements facilitate easy repairs, as worn or damaged parts can be replaced with new precast elements, extending the lining's life well beyond 6 years.

A feed pipe section lined with HASLE precast elements at the cement plant in India after 5 years of operation, with no visible coating.

The implementation of the precast lining has notably minimised buildup in the feed pipe and eliminated the need for unscheduled stoppages to address coating issues. As a result, the Indian cement plant has experienced improved heat and material flow efficiency, significantly boosting overall production performance.

In Northern Europe, a 4300 tpd cement plant – operating on coal and 40% RDF – faced similar challenges of coating and jamming in the feed pipes at the lowest-stage cyclone. After learning about the successful precast installations in India, the maintenance team approached HASLE to explore the viability of this solution for their plant. In January 2023, 10 individual feed pipe sections were lined with the HASLE precast Modular Lining. A follow-up inspection after six months revealed a significant reduction in buildup compared to previous occurrences, with minimal to no coating sticking to the walls of the feed pipe.

Optimising refractory performance can smoothen operations

Cement plants facing severe coating challenges due to sticky raw meal mix or high percentages of alternative fuels can benefit from HASLE's precast and castable lining solution for their lowest-stage feed pipes. The operational cross-sectional area inside the feed pipes can be maximised, and a smooth surface facilitates a consistent material flow, reducing the need for frequent manual cleaning or high-pressure air cannons. Additionally, tailored precast lining designs can incorporate backup insulation to minimise thermal losses.

With a longer refractory lifespan as well as enhanced operational and thermal efficiency, cement plants can conserve natural resources and reduce maintenance costs, fostering a more sustainable and efficient operation.

Moreover, the location of the feed pipes at elevated heights makes the process of dismantling and repairing the refractory lining a cumbersome and hazardous task. So by extending the lining lifespan and hence avoiding yearly repairs, the plant safety index can be significantly improved. ■

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 & a Master's Degree in Business Management. Having a 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.