OPTIMISING BEREAR BOARS PERFORMANC

Giuliamaria Meriggi, Boldrocchi, discusses the implentation of equipment to improve performance and lower cost in a number of US case studies.

Introduction

Reducing costs and improving plant performance in terms of production, reliability, energy efficiency, and environmental targets are always important goals for cement plants. It is important to note, therefore, that the design of each piece of main equipment plays a key role in achieving those goals.

Boldrocchi has been increasingly active in the US and Canada and opened a branch near Atlanta in 2017 to better serve the North American market, from initial contact through to post-delivery service and maintenance. Using select recent case studies, this article will look at design and integration considerations to help increase overall performance and reduce costs.



Installation completion of a fabric filter on the kiln and raw mill at Buzzi Unicem USA's Cape Girardeau, Missouri.

Integrated design: US Lime Co.

Boldrocchi was awarded a contract for a project which will be commissioned in 2018 by Maerz Ofenbau AG to engineer and manufacture integrated solutions surrounding the new lime kiln at US Lime Co.'s St. Clair plant in Marble City, Oklahoma.

The solution included a fabric filter, fan, interconnecting ductwork, air dilution damper, dust transport system, and a silencer (Boldrocchi has a centre of excellence in noise control).

Hiring one supplier for the entire integrated system offers several benefits, especially for a relatively smaller plant, both in terms of production efficiency and CAPEX. When the supply chain is split, overdesigning occurs, as each supplier overdesigns each piece to ensure performance. This overdesign includes the following consequences:

- CAPEX increases because each supplier takes a margin, and each piece is overdesigned, increasing its cost.
- While some overdesign is good practice, when every supplier adds a 10% margin in pressure or flow capacity to 'be safe', the difference between the actual operating parameters and the designed parameters often becomes too large and the machinery no longer performs correctly – or at least optimally.
- Similarly, one supplier for an integrated system can find ways to save CAPEX and space by balancing the design of each piece so that they work well together, without being overdesigned and by optimising the layout of such aspects as walkways, stairs, and ductwork.

Lower emissions and reduced consumption: Buzzi Unicem USA

The fabric filter on the kiln and raw mill at Buzzi Unicem USA's Cape Girardeau plant was past its useful life and Boldrocchi was awarded a turnkey flange-to-flange contract to replace it, along with the filter's ID fan, emergency/fresh air damper, and dust transport system for commissioning in spring 2018.

Buzzi Unicem USA requested the baghouse exceed all US Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. Boldrocchi therefore designed a baghouse that reduces dust emissions to a mere 0.01 lb per tonne of clinker (2 mg/Nm³). Engineers customised a pulse-jet high-dust model that includes a dust preseparation section to reduce the amount of dust reaching the 8 m (26 ft) long bags.

Design considerations to ensure such stringent emission levels are reached in especially in high-dust environments, include the following:

- The bag fixation system should have a double sealing ring at the top to ensure no dust leakage (Boldrocchi uses an in-house developed snap-ring concept).
- The bag cleaning system should have high efficiency to optimise the compressed air pressure and consumption, mitigating the mechanical stress on the bags (Boldrocchi prioritises online versions).
- Cleaning accessories should be designed to increase the induced airflow in long bags, such as the ones in this project. This ensures proper cleaning throughout the entire bag length and avoids dust cakes.

Improvements under layout constraints: Lhoist North America

Boldrocchi is in the midst of a turnkey contract with Lhoist North America, at its Montevallo, Alabama, lime plant, to replace two gas conditioning towers (GCTs) (one on each kiln) and the plant's entire systems (ducts, dampers, and all mechanical and electrical elements) that had become obsolete.

To contain costs, the GCTs had to be the same size as the underperforming ones. The challenge was to do so while significantly improving performance. Engineers have therefore designed the inlet cone, distribution plates, and injection system to achieve objectives using their knowledge, experience, and computational fluid dynamics (CFD) modelling. Optimally designed inlet cones and distribution plates homogenise the gas flow, so that the injection system can perform properly. An uneven inlet distribution can mean a failure to reach the target temperature consistently.

The customised air atomisation injection systems (water and compressed air) must ensure a homogeneous, misty spray: uneven droplets can cause corrosion and underperformance. The system must also ensure a dry tower bottom, preventing build-up over the full operation range.

One baghouse for multiple benefits: Holcim US

When Holcim US's Hagerstown cement plant in Maryland was undergoing a modernisation, Boldrocchi



A multi-source integrated fabric filter was designed for Holcim US's Hagerstown, Maryland plant.



Boldrocchi provided an integrated approach for the Hagerstown cement plant in Maryland.

was contracted by KHD (US) to provide a multi-source integrated fabric filter designed to remove dust from both the kiln, raw mill, and the clinker cooler.

This solution – using one baghouse to dedust both flue gas streams – offers several benefits including the following:

- The composition of the gas, resulting from the mix of gases from the kiln and clinker cooler, is easier on the fabric filter: it is less sticky (than kiln dust) and less abrasive (than clinker cooler dust). Combining the gas flow in one fabric filter therefore reduces dust cakes and abrasion on the filter bags, increasing reliability, performance, and bag lifetime.
- These integrated fabric filters significantly reduce the footprint of the dust removal solutions, as well as CAPEX, as costs are lower for civil work and steel work related to the baghouse itself. CAPEX savings can reach 30%.

Boldrocchi provided an integrated approach to this project as well, which included an air-to-gas heat exchanger (HE) for the clinker cooler line, a baghouse for the alkali by-pass, and all the main process fans and secondary fans, among other equipment.

Saving CAPEX and improving plant reliability: Buzzi Unicem USA

Boldrocchi completed a turnkey contract with EPC contractor thyssenkrupp Industrial Solutions for Buzzi Unicem USA's Maryneal, Texas, plant last spring.

Boldrocchi engineered baghouses and fans, as well as related systems, for the kiln, raw mill, and coal mill, including ducts, stacks, dampers, dust transport systems, and structures, among other equipment.

The client's plans changed partway through the project, requiring modifications to completed equipment. Modification 1: whereas the kiln and raw mill baghouse first needed the inlet and outlet on opposite sides to connect the baghouse to three old kilns, the change required them on the same side to serve a new kiln on a new line. The fabric filter, having already been completed, Boldrocchi designed internal deflectors that could allow both configurations. Modification 2: the change also required the completed stack to be higher. Engineers conceived a new stack bottom, which was added under the already fabricated one.

Boldrocchi manufactured process fans for this project keeping reliability (low maintenance and long lifetime) its top focus.

A kiln fan must withstand the kiln's high temperature – even in difficult conditions – to allow the kiln's continuous operation, so material selection is crucial. This double inlet fan is designed for a continuous operating temperature of 280°C (536°F) and peaks of 450°C (842°F). Due to these specifications, the shaft is in 16Mo3, a specified pressure vessel grade chrome molybdenum steel alloy, and the impeller is in Dillimax 690, a high-strength quenched and tempered, fine-grained structural steel.



Boldrocchi completed a turnkey contract at Buzzi Unicem USA's Maryneal, Texas plant.



Boldrocchi's heat exchanger at Holcim US's Trident cement plant in Three Forks, Montana.



The heat exchanger at the Trident cement plant was designed to minimise pressure losses and reduce energy.

A raw mill fan must stand-up to high pressure and higher dust content. This one has a double inlet, a fully wear-lined impeller and a double layer of lining (on the blades and shaft) to cope with a dust load of 30.59 grain/acf (70g/Nm³). The wear liner on the casing scroll is made of a high-performance wear and impact resistant steel. The wear plates are carefully positioned, which is also important to protect the equipment, once again improving reliability.

Designing heat exchangers to minimise pressure losses and reduce energy: Holcim US (now CRH)

When the Trident cement plant in Three Forks, Montana had additional APC measures installed to comply with NESHAP, Boldrocchi was given the contract to install a new air-to-gas HE.

The HE was engineered to reduce the clinker cooler exhaust gas from 540°C (1000 °F) to below 150°C (300°F). Boldrocchi engineered and manufactured all elements of the HE in-house, including the four axial fans, designed to minimise noise and power consumption. The bundles of tubes are designed to maximise heat transfer between the ambient air and the process gases, resulting in a more compact layout (saving space and CAPEX) while always maintaining low pressure losses across the bundles, meaning lower energy consumption.

Design is done with the calculation of the number of bundles of tubes, the number of tubes per bundle and tube length, the configuration of the tubes, the number of fans required per module and the number of modules, the design of the inlet and outlet flanges, and the control system (in this case two VFDs, which reduce energy costs by slowing the fans during lower loads).

Conclusion

Several aspects of equipment design can have a significant effect on a plant's performance and there are often innovative ways to find CAPEX savings. The interconnected design of an entire system avoids overdesigning several machines, ensuring the best efficiency point for the system and lower CAPEX for the client. Engineering reliable fans, fabric filters, gas conditioning towers, and heat exchangers, among other machinery, improves plant performance and lowers OPEX in terms of energy consumption, maintenance, and avoided shutdowns. Finally, CAPEX can be saved, due to a flexibility of finding new design solutions when issues arise.

About the author

Giuliamaria Meriggi is the Managing Director at Boldrocchi North America and Executive Director of International Operations at Boldrocchi. She splits her time between Atlanta and Milan. She began working in air pollution control shortly after finishing her engineering degree in 2001 and has since amassed expertise in a wide array of industrial processes and systems within the cement and lime industries. Over the past 17 years, she has held various engineering, commercial, and operational roles.