Fabric filtration comes of age

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In recent years cement producers have become increasingly aware of the significant performance differences between the newest fabric filtration technology and electrostatic precipitators (ESPs). ESPs were the preferred choice of the cement industry for many years, but as environmental regulations have become tighter, their capabilities were increasingly challenged.

Many of these challenges came to light in the late 1990s, when environmental regulations influenced the choice of equipment for kiln filters. For example, cement producers with ESPs faced major start-up difficulties caused by excessive carbon monoxide (CO) levels. Full or partial de-energisation was needed to prevent explosions and reduce potential equipment damage. This became an even bigger issue with the increasing use of alternative fuels. Safety mechanisms would often shut down the voltage when CO levels approached their explosion limit value – perhaps several times per day – meaning the technology could never be properly deployed, ultimately increasing the potential for dust emissions. It became clear that a better technology was needed to ensure cement producers could meet their environmental obligations. Now, fabric filtration is increasingly seen as the best-available technology to help producers meet their goals and with good reason.

The prevalent concept of filtration changed in the late 1990s. Until then, the predominant concept had involved using bags of a maximum 4.5m in length. At the time, the cell plate was positioned at the top of the filter and the bags hung supported internally by a steel cage to prevent collapse. Gas and dust would enter from below and find their way up between the bags, leaving a filter cake on the outside of the bags. When the bags required cleaning, the dust would work its way down between the bags. Skilled as they were, filter designers needed to design the filters to maintain full control over the can velocity and interstitial velocity. The risk was well-known: the high value of these parameters could easily lead to a performance loss (mainly the differential pressure). The system seemed to have found a technical limit to bag length.

A cement producer in Norway at the time saw the powerful benefits of fabric filtration technology development. After discussing its emissions challenges with FLSmidth Airtech, a solution was chosen based on the latest innovations in fabric filtration. At its research centre in Dania, Denmark, FLSmidth is constantly testing and refining technology through computational fluid dynamics (CFD), validated through field research and R&D pilot-scale modelling. This has proven to be highly advantageous when it comes to identifying future trends.

**Side inlet innovation**

At the Norwegian cement plant, two main kiln filters were required. To solve the plant’s specific challenges, FLSmidth introduced two important innovations. The first of these was installing extra-long filter bags, which at 6m were the longest filter bags in the industry at the time. With 33 per cent extra length, it was a big step forward.

But perhaps more significant was the novel approach of a side inlet for gas and dust, instead of the conventional bottom entry. This innovation prevents the formation of a filter cake on the outside of the bags and extends the bag’s life time and reduces the need for maintenance, process control and troubleshooting.

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inlet. FLSmidth was the first to introduce a side inlet on fabric filters, which effectively helped the cleaning of the filter cake formed on the outside of the bags. This extended the filter bag lifetime to eight years and significantly reduced the need for maintenance, process control and troubleshooting, allowing more focus and resources on the main goal: operating the plant and producing cement.

**Longer bags**

Since 1998 FLSmidth has implemented more than 500 filter systems with long (>6m) filter bags. These bags are used within all cement applications: raw and cement mills, coal mills, bypass, cooler and kiln. FLSmidth Airtech has a long track record of supplying ESPs and the company has always invested significant resources in research within gas and dust distribution. When introducing a new long bag standard, careful attention is paid to parameters such as gas distribution and bag cleanability to ensure stable performance.

Today, many cement producers choose 10m or 12m bags due to their cost effectiveness. Several important cost drivers for capital expenditure and operating expenditure are reduced when implementing side inlet and long filter bags.

Due to the increased bag length, the amount of steel required to enclose the filter bags is significantly reduced. Similarly, as the bag size is increased, the footprint is decreased, resulting in lower civil construction costs.

**Velocity control**

Some suppliers still believe that gas and dust distribution is not important in a fabric filter, but this often leads to shorter bag life as well as higher emissions and differential pressure. FLSmidth’s research and product development has resulted in several fabric filtration design benefits.

Among these is the introduction of a TD-screen distribution system, which enables filters to be kept compact and provides full control of velocity below 2m/s (up to 15m/s without distribution). The arrangement of the filters allows low velocities, distributed as evenly as possible inside the baghouse.

High velocities would cause negative effects such as high pressure drop, mechanical wear and dust entrainment in the system, making it impossible to efficiently control the flow distribution. This would increase the volume required and unnecessarily push up capex.

Furthermore, the resulting velocity of the gas between bags is directed downwards, assisting the cleaning of the bags by allowing filters to be cleaned while online, instead of recollecting on the bag as a standard vertical upwards can velocity would do.

This is a significant benefit, as most other comparable designs rely on offline cleaning, involving dampers being opened and closed, and a generally more unstable operation mode.

**Reducing operating costs**

With today’s high energy prices, controlling operating costs is vital to cement producers’ commercial performance. Inevitably, the focus is on reducing power consumption and optimising the pulse-jet cleaning system can help achieve this.

While compressed air is needed as part of the fabric filter’s normal operations, the aim is to reduce the amount consumed, specifically by reducing the pressure loss across the bags.

FLSmidth Airtech’s technology includes a venturi installed in the bag opening. This approach ensures that the cleaning pulse can easily enter the bag, while preventing it from escaping as the internal cleaning pressure builds.

The venturis reduce pressure loss during filtration, generally to below 15Pa. Without the use of venturis, the cleaning pressure inside the bags can be as much as 30-34 per cent lower, which increases compressed air consumption – and therefore operating costs.

**Total concept**

It is of course vital to factor in all aspects of a fabric filter when considering its contribution to plant productivity. With its attention to detail, FLSmidth has developed several innovative technologies. One of these is the star cage concept, which minimises the contact between cage and bag, significantly increasing the lifetime of a woven-glass bag.

Another involves how the filter can reduce not just dust emissions but also harmful gaseous emissions. This has been successfully achieved with the FLSmidth CataFlex bags, which effectively filter emissions of NOx, NH3, volatile organic compounds, dioxins/furans, CO, and of course, particulate matter.

**Ensuring integration**

As a one source provider, FLSmidth Airtech not only sells fabric filters but delivers a full service to cement plant operators together with its sister company FLSmidth Inc – AFT Operations (Advanced Filter Technologies), ensuring integration with other cement units and full cement plant optimisation.

Our FLSmidth – AFT operation is a direct manufacturer of filter bags with operations in the USA and India. Combining industry expertise with a long track record of supplying ESPs, FLSmidth Airtech has always focussed on research within gas and dust distribution, with innovation high on the agenda. With the ever-increasing focus on climate change and environmental legislation, fabric filtration is a crucial step towards reducing the costs of operating cement plants as well as minimising the environmental impact.
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