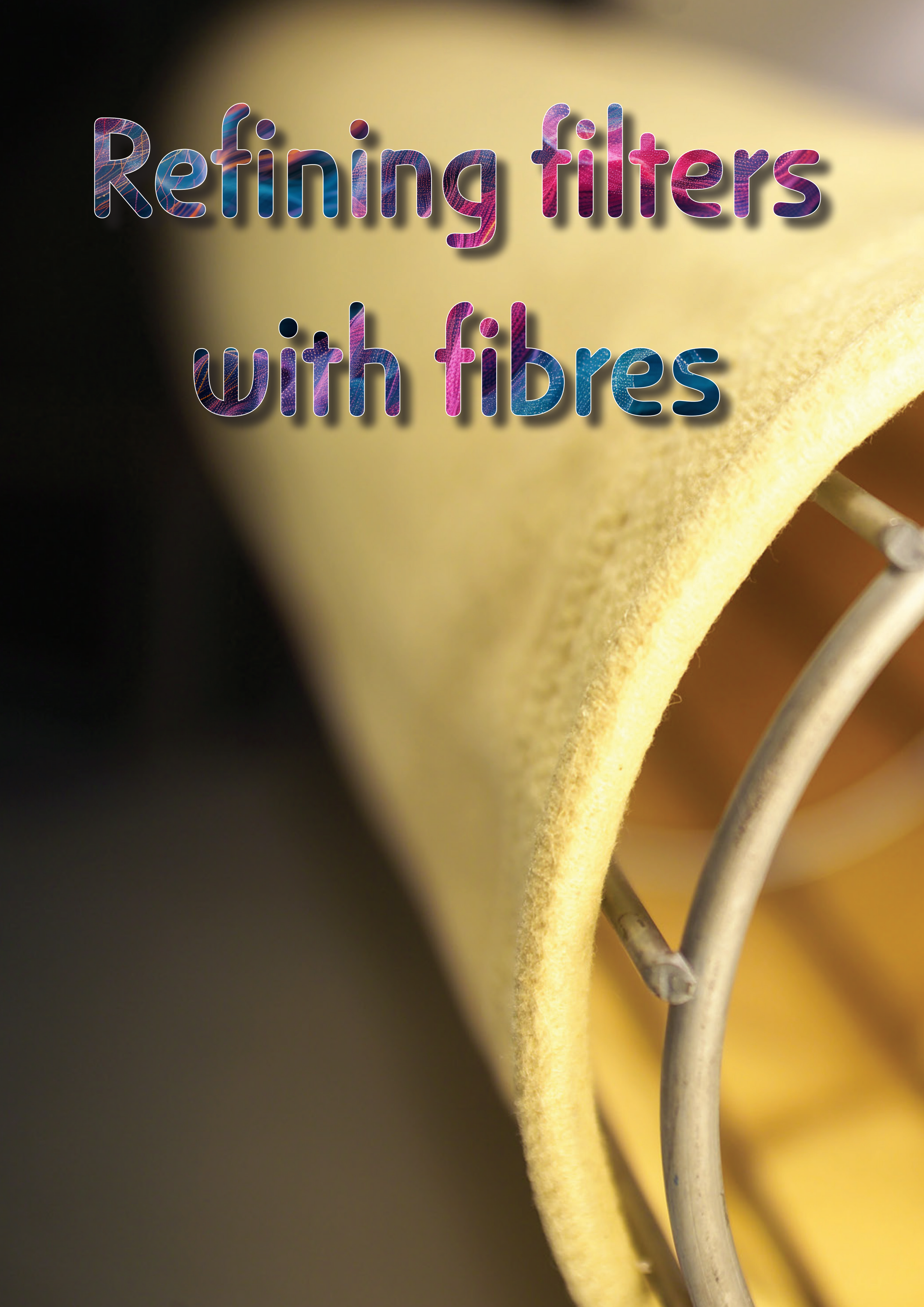
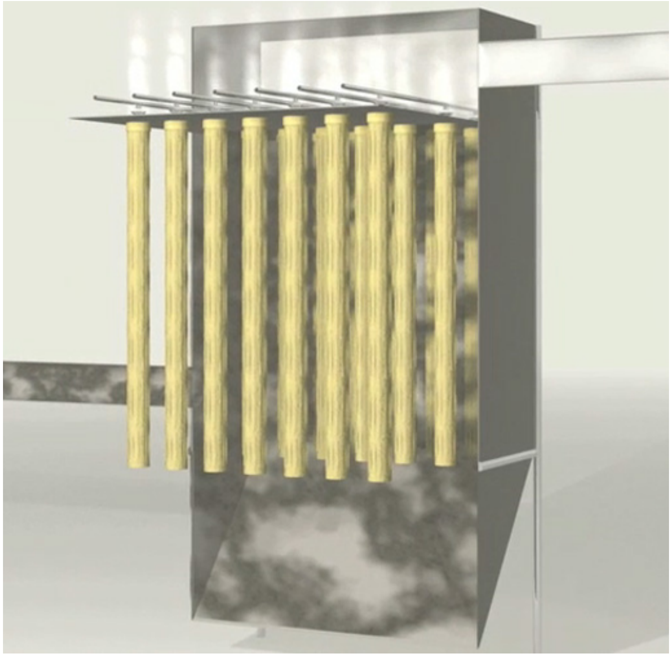
Refining filters with fibres

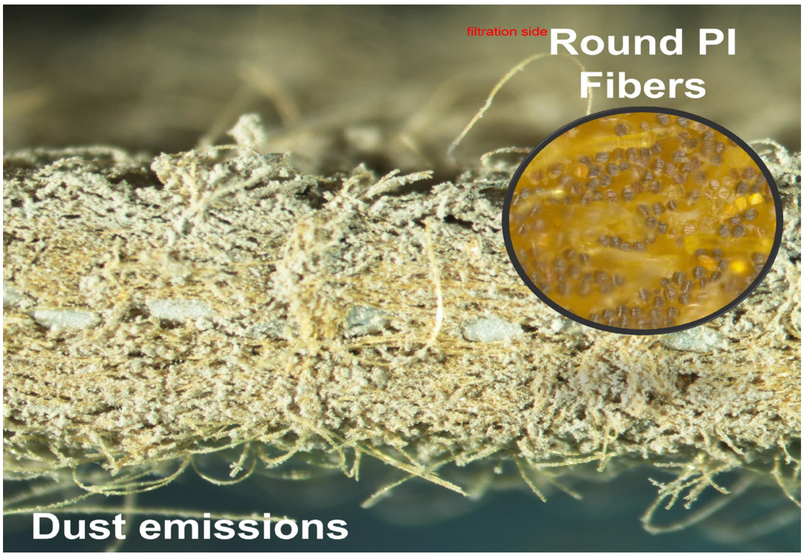


Nathan Schindler, Evonik Corporation, and Robert Wood, Micronics, demonstrate why filters are only as good as their fibres.

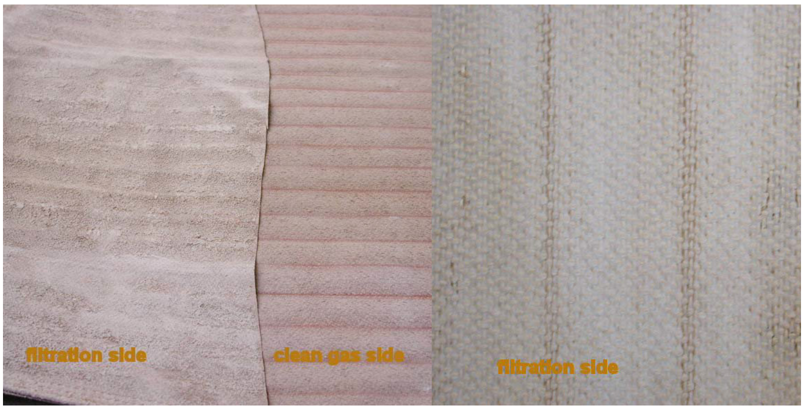
Cement plants are extremely efficient and complex operations requiring optimal system performance to maintain high production rates and competitive clinker costs. In a modern cement plant with a rotary kiln and preheater/pre-calciner, a properly operating kiln/raw mill baghouse is critical to maintaining full production capacity. This article will review the challenges faced by one North American cement plant that has increased production and changed (or adopted) alternative fuels (AF), but not upgraded the kiln/raw mill baghouse by increasing its size. Choosing the right filter media has been critical to maintaining system performance over time. After more than a decade of success with filter bags made by the Micronics Engineered Filtration Group, Inc. and constructed with Evonik's P84® fibre, an alternative vendor supplied filter bags made from round-shaped generic polyimide fibres. The impact on the plant was significant, as the alternative bags could not handle the gas flow, causing the plant to reduce production and increase the total cost of ownership of the baghouse.



A pulse-jet baghouse.



Round PI fibres.



An example of a failed membrane.

The challenge

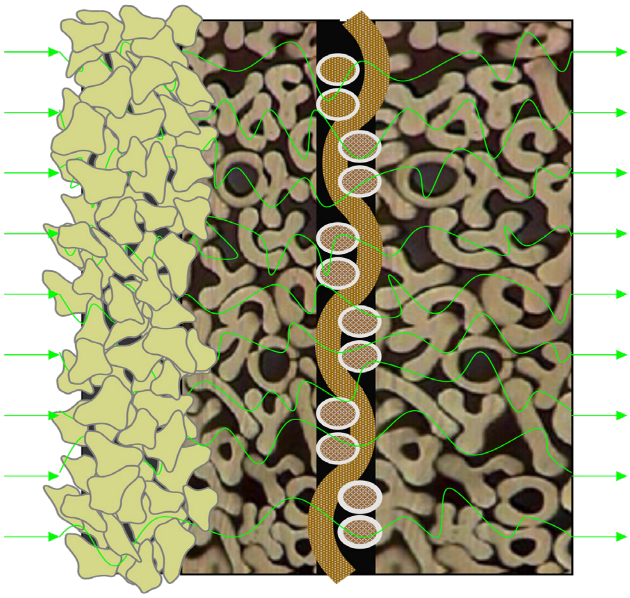
This North American cement plant, like most others in the region, is under pressure to meet multiple requirements: tight supply conditions mean that every ton of clinker counts; strict environmental regulations require consistent, low particulate emissions; and energy reduction goals encourage the use of AF and management of electrical consumption. In this case, the air-to-cloth ratio through the kiln baghouse has historically been high and today it is well in excess of standard design conditions. Air-to-cloth ratio is a key design point for pulse-jet baghouses. Many cement plants utilise woven fiberglass bags laminated with an ePTFE membrane in the kiln baghouse. In such cases, it is critical to maintain an operating air-to-cloth ratio less than 1 m/min (3.3 cfm/ft^2) to avoid excessive pulsing, which causes delamination of the membrane and holes in the filter media, allowing emissions more than the regulatory requirements. At this plant, the average air-to-cloth ratio through the compartments is significantly above the standard design criteria, exceeding 1.4 m/min, with some bags experiencing even higher air-to-cloth ratios closer to 2.0 m/min.

The plant did not reach this point in a single instant, but gradually over time. Changes in fuel mix and a focus on a higher production have increased the volumetric flow rate through the baghouse. Evonik and the Micronics Engineered Filtration Group, Inc. have supported the plant through these changes, going back to approximately 2000. Initially, the glass/membrane bags were replaced with more robust P84 filter bags, capable of handling the high velocities through the bags. By approximately 2010, it became clear that this construction required further optimisation to maximise filter bag life and minimise pressure drop through the baghouse.

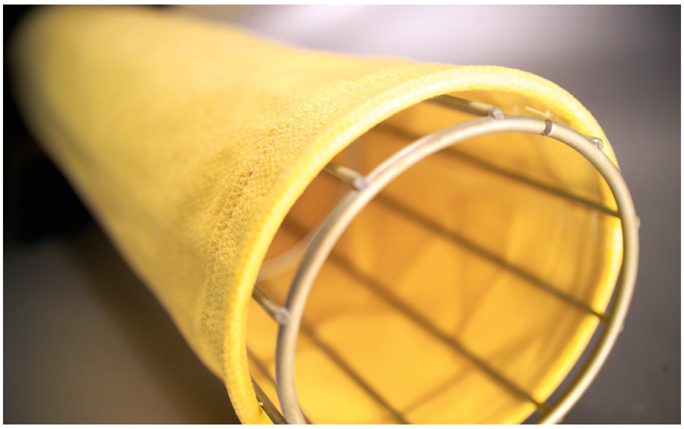
Up to the challenge?

The unique shape of P84 provides significant surface area for the collection of dust. By utilising a mix of fine and standard deniers, Evonik and

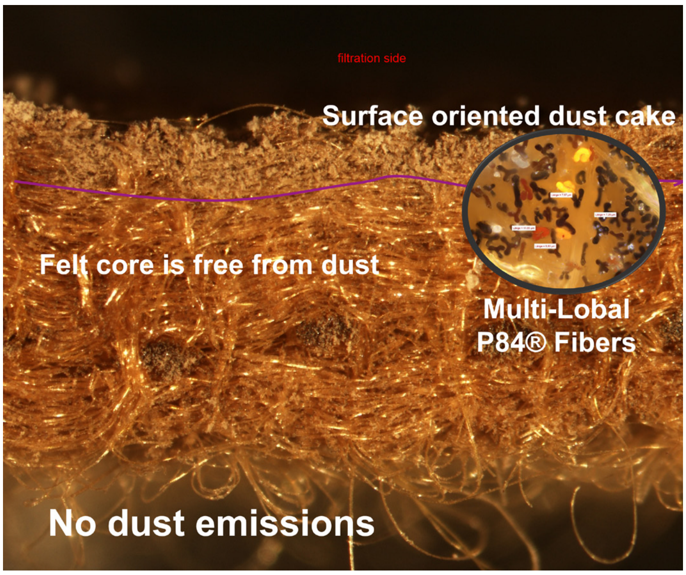
Micronics helped the plant to design a felt optimised for fine particle sizes (75% < 2 μm), high air-to-cloth ratio, and peak temperatures up to 240˚C. This proprietary construction was successful in providing an impressive filter bag life of around four years. The plant experienced a reasonable pressure drop, averaging around 160 mm H_2O WC (6.3 in.) and a manageable pulsing frequency. The plant was able to manage its bag replacement schedule by replacing one or two compartments per year with P84 felt and Micronics bags produced in the region. Even though these bags are of a special design and made-to-order, deliveries in time for the annual outage were manageable, and the plant could maintain a small quantity of spares in case of an upset.



P84 fibres cross section, P84 dust cake structure.



P84 – a high standard in filtration.



P84 felt after four years.

Compared to membrane bags, felt bags made from Evonik's P84 fibre are easy to store and install. Standard carbon steel cages with fewer wires save the plant money on cage costs. The robust, three-dimensional filtration surface is not easily damaged by micro-tears.

Overall, the plant experienced significant benefits using P84 bags designed for their application. These benefits included: reliable production, fuel flexibility, low pressure losses and ID fan electricity consumption, low cage costs, reduced capital expenditures to increase the baghouse size, and manageable bag replacements during outage.

A unique fibre

In 2021, the plant sought to decrease the costs of their filter bags and purchased their replacement bags from an alternative filter bag supplier. These bags were produced in China and took several months to deliver.

Although a trained eye would have immediately recognised the difference in the colour of the bags, most plant personnel would not necessarily notice the difference right away. While round PI has a similar chemistry for temperature resistance, only P84 fibres have the irregular, multi-lobal shape that provides filtration performance benefits.

During the early 2023 outage, more than half of the bags were up for replacement. After starting up, the plant experienced a normal and reasonable pressure drop across the baghouse. The new bags appeared to be working with all compartments averaging below 180 mm H_2O pressure drop. However, after one month of regular operation, the pressure drop across the baghouse escalated. The trend of increasing pressure drop continued over the following months. By June, the pressure drop was already up above 180 mm H_2O and the pulsing system was constantly pulsing.

A bag inspection demonstrated that one of the new bags made of round PI was already blinded after only a few months of operation while one of the P84 bags seemed to be as good as new after 18 months. As the year progressed, the round PI bags continued to blind, shifting flow to other compartments and causing even higher velocities across the remaining good bags, causing premature damage to the good bags. By the end of the year, the plant had difficulty maintaining production levels, with the pressure drop exceeding 200 mm H_2O and with intensive and continuous pulsing.

By that time, the plant incurred significant additional expenses. First, instead of four years of bag life, the plant only obtained one year. All the bags will need to be replaced early with a cost approaching US$500 000.

Labour to remove and install the bags will add another US$100 000. Energy cost related to high DP and constant pulsing will add another US$100 000 in operational expenses. Compounding these unplanned expenditures, the plant's production will continue to suffer this year while compartments are isolated for bag replacement and high pressure drops limit the gas flow rate.

Conclusion

P84 has been used in some of the most challenging high temperature filtration systems in the world. Its unique, irregular multi-lobal shape provides enhanced filtration performance, while its temperature and chemical resistance are ideal for cement and other mineral applications. In the end, a seemingly good purchase price decision yielded a costly result. ■

About the authors

Nathan Schindler is Technical Sales Manager for Evonik Corporation. Nathan has over 20 years of experience in all aspects of the combustion and air pollution emission control technologies. Nathan is responsible for sales and technical support of Evonik's P84 fibres in the US and Canada.

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He is responsible for sales and support in the Quebec province of Canada, as well as the Labrador coast.