Ten Years of Optimised Baghouse Performance

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Introduction

In 1999, Lafarge Richmond commissioned a new plant in British Columbia, Canada. At that time, the use of pulse-jet style kiln baghouses was still relatively new in the cement industry. Ten years later, the plant is on its third set of kiln baghouse filter bags, and particulate emissions and overall operation of the baghouse is still exceeding expectations. This was achieved by combining sound maintenance practices, proactive inspections to ensure all parts of the baghouse are optimised and in good working order, and the use of a new generation of membrane filter bag technology. This article discusses the process and technology used to achieve these performance levels.

Background

The Richmond plant started up a wet-process cement kiln in 1958 and added a second kiln line in 1967, bringing total production capacity up to 450 000 tpa. In the late 1990s, a new plant was built. The new plant leveraged the positive baghouse experience of Lafarge's existing facility in Paulding, Ohio, USA. The Paulding plant had commissioned two TGT low-pressure pulse-jet baghouses from Solios Environmental a few years earlier (1996, 1997). These were the first two of their kind in the North American cement industry and used GORE® membrane filters. Based on the success at Paulding, Solios was selected for the new Richmond kiln baghouse, which would also use GORE® filters.

Table 1. Original design application data	
Original commission date	**May 1999**
Kiln type	5-stage precalciner kiln
Original kiln rating	3000 tpd
Baghouse	Solios TGT
Fuel source	Coal
Gas flow rate	428 027 am^3/hr (raw mill on)
	434 013 am^3/hr (raw mill off)
Gas temperature	80 °C (raw mill on)
	220 °C acfm (raw mill off)
Inlet dust loading	Up to 68.7 g/am^3

Table 2. Proposed application data	
Kiln type	5-stage precalciner kiln
Current kiln rating (max)	3650 tpd
Baghouse	Solios TGT
Fuel source	Coal
Gas flow rate	532 881 am^3/hr (raw mill on)
	536 900 am^3/hr (raw mill off)
Gas temperature	103 °C (raw mill on)
	225 °C acfm (raw mill off)
Inlet dust loading	Up to 87 g/am^3

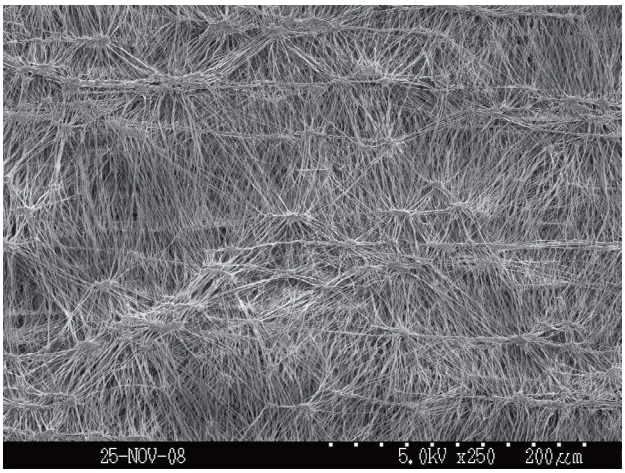

Figure 1. Magnification of membrane structure 500x.

Table 3. Current baghouse data	
Type of baghouse	**TGT low-pressure pulse-jet**
Filtering velocity	1.16:1 m^3 per min/m^2
Type of bags	GORE® High Durability SUPERFLEX® filter bags
Bag length	6.4 m
Pressure drop (average flange-to-flange)	Less than 150 mm w.g.
Compressed pulse air pressure	1.4 - 2 bar
Number of compartments	12
Number of bags/compartment	252
Total number of bags	3024
Cleaning mode	Online

The plant, the baghouse and the filter bags

When commissioned in 1999, the Richmond plant incorporated state-of-the-art design and equipment. The 5-stage precalciner tower was built in conjunction with a two-pier kiln. The kiln was originally rated at 3000 tpd. The design included an in-line, 230 tph vertical roller mill and a three fan system. Both the kiln ID fan and the raw mill ID fans were fixed speed and the exhaust fan was a variable speed fan. The plant was designed with an emphasis on productivity along with environmental stewardship. The main kiln/mill baghouse was designed with many advantages. The Solios TGT baghouse utilises a baffle and side inlet arrangement that minimises lift velocity in the baghouse, therefore reducing the possibility of re-entrainment. A second key feature of the baghouse design is the Integral Action Piston (IAP) valve, which operates by opening quickly to provide the needed cleaning energy of the bags, but closes slowly to minimise filter bag wear against the support cages.

The original filters selected and installed in the Richmond kiln baghouse were GORE® high durability membrane fibreglass filters. Membrane filters, first developed by Gore in 1975, utilise an expanded polytetrafluoroethylene (ePTFE) membrane, which is laminated to a specific backing material chosen to be compatible with the mechanical, thermal, and chemical requirements of the system. Membrane fibreglass filters have become the accepted standard due to the need to meet production requirements and also stay environmentally compliant with increasingly strict global legislation. Since membranes are microporous structures made up of nodes and fibrils in various orientations, different manufacturer's membrane structures result in different performance in terms of differential pressure, particulate matter emissions, and life. Over the years, Gore has continually developed many PTFE membrane structures to optimise the performance of these key attributes for cement users.

In the Richmond plant, the first set of filters was started up in May 1999 and removed in April 2004, lasting nearly five years. The second set of filters was installed in April 2004 and lasted through February 2009. This second set of filters was not supplied by Gore. They offered similar life, but had excessive failures during the last 1.5 years of the bag life. The unexpected failures added both cost and maintenance, and the plant ultimately returned to Gore for the third filter set. For this set of filters, still currently in use, the Lafarge Richmond plant wanted to install filters identical to the original set, which had met the plant's performance expectations. After considering all options, the plant selected GORE® SUPERFLEX® filters, a new high durability fibreglass and PTFE filter from W. L. Gore & Associates. The new filters were engineered to achieve extremely low particulate emissions, low and stable differential pressure, and the longest life compared to more traditional membrane fibreglass filters. These filters were installed in March 2009 and have been operating for just over one year to date.

Comprehensive maintenance plan drives success

Crucial to the long-term success of the system performance was a rigid maintenance programme and regular optimisation of operating settings. This began with a

thorough preparation for the installation of the new set of GORE® membrane filters. To minimise cost, many of the existing cages were refurbished and re-used. Extensive training was given regarding what an acceptable cage looked and felt like; cages with broken wires could not be used and welds had to be smooth to the touch. Cages with broken welds or that were bent were immediately discarded. Cages with sound construction were "staged" for hand sanding with an abrasive pad. A cage took two men approximately 5 minutes to clean and was deemed acceptable for installation once it was smooth to the touch. Special cross-braces were made to allow the cages to be supported, spun and sanded without damage. Ultimately, 50% of the old cages could be salvaged for re-use, significantly reducing cage costs. Installation took about two weeks and all refurbished cages were returned to their original compartments so their performance could be compared to the new cages.

Next, training of the entire maintenance team was implemented so that they understood the unique performance characteristics of Gore's membrane filtration technology and how to properly handle the filters. The objective was to ensure a very thorough installation in order to minimise future maintenance costs.

After all the old bags and cages were removed from the compartment, great care was taken to "clean" each compartment before new bags and cages were installed and to inspect them to ensure there were no tubesheet leaks or weld cracks. Pulse pipes were wiped down and inspected, and blacklight powder injected to detect any bags that were not properly installed. Gore had on-site supervision working with Lafarge maintenance during this entire process.

After startup, Gore and Lafarge Maintenance met to determine the proper cleaning cycle for the baghouse. Cleaning cycle optimisation entailed careful attention to the balance between the draft of the kiln versus compartment differential pressure. New baghouse differential pressure monitoring equipment was installed with a feedback loop to the kiln control. The goal was to pulse the bags as little as possible without negatively affecting kiln draft. This required many trials and optimisation was not realised until two weeks after startup.

Summary

The long-term performance obtained at the Lafarge Richmond site evolved from a methodical approach to deploying membrane technology. With an understanding that membrane filters vary substantially by supplier, the Richmond maintenance staff used data from the past performance of multiple membrane suppliers to reach their filter selection. They then adhered to a thorough maintenance programme, which included pre-installation training, as well as ongoing optimisation of operating parameters. This has facilitated the development of a highly efficient plant filtration system and one of the lowest PM emission plants in Canada. In addition, filter life has been extended and maintenance operating costs have been significantly reduced.