The TGT Baghouse at Lafarge Paulding: An Update

Andrew Haberl, Procedair Industries, Canada, and Peter Finnis, Procedair Industries, US, provide details of the installation of pulse-jet baghouses on two wet kilns in Paulding.

Introduction

It has been 5 yrs since Lafarge started up the new pulse-jet baghouses on its two wet kilns in Paulding, Ohio, USA. Yet despite extended periods of operation at significantly above the design flow rate, the plant still operates on the original set of bags, and the kilns have experienced virtually no baghouse-related downtime. Furthermore, the baghouse pressure drop and dust emissions remain well within targets. It is obvious that the combination of a TGT low-pressure baghouse and SUPERFLEX® filter bags is continuing to chart new territory in the ongoing debate about options for kiln gas dedusting.

Project history

The cement plant at Paulding, Ohio, was originally started in 1956. It operated two wet kilns to produce 1400 tpd of Portland cement using coal and petcoke. In 1994, the decision was taken to convert the plant to burning more liquid waste fuels under BIF regulations, and then to increase production to approximately 1520 tpd. In conjunction with this effort, the electrostatic precipitator (ESP) on each line was to be decommissioned in favour of a baghouse to ensure compliance with BIF regulations. After an extensive study, Lafarge elected the offer from Procedair Industries: a TGT low-pressure pulse-jet design, using an ePTFE membrane bag supplied by W. L. Gore & Associates. This was to be the first application of a low-pressure pulse-jet baghouse on a cement kiln in North America, but based on its experience with the TGT in other industries, Procedair felt confident to offer a 6 year bag life guarantee and low emission levels.

Figure 1. The TGT baghouse at Lafarge Paulding.

Table 1. Key application data	
Number of systems	2
Kiln type	Short wet kiln
Fuel source	Liquid waste
Design gas flow rate	135 000 ACFM
Design gas temperature	410 °F
Inlet dust loading	13.2 gr/ACF
Stack emissions target	.01 gr/DSCF @ 7% O_2

Table 2. Baghouse design data	
Type of baghouse	TGT low-pressure pulse-jet
Filtering velocity	3.6 cfm/ft^2
Type of bags	Gore SUPERFLEX®
Bag life guarantee	6 yrs
Bag length	21 ft
Flange-to-flange pressure drop	8 in. WG
Compressed air pressure	20 - 35 psig
Number of modules	5 per system
Cleaning method	Online

Procedair supplied the baghouse, ductwork, and compressed air system for both kilns on a turnkey basis. The key parameters of the application and the baghouse are listed in Tables 1 and 2, respectively. Design, fabrication, and installation proceeded over an 18 month period in 1995 and 1996, and the system on kiln 2 was started up in October 1996. Kiln 1 began operation a few months later, in February 1997. The installation is depicted in Figure 1.

Shortly after start-up, the plant found it necessary to add a mid-kiln bypass system to ensure compliance with environmental regulations. At the same time a production increase was planned. Due to the increased gas flow to the baghouses that this created, the plant actually had to decide between a reduction (rather than an increase) in plant production, or to begin operating the baghouses at substantially above the design filtering velocity. Given the demand for cement at the time, it was not a difficult decision: the increased production was expected to be worth much more than the cost of changing the bags more frequently.

The TGT filter

The big question that remained was how much the increased filtering velocity would reduce the bag life. This, of course, depended on the sensitivity of the filter to the changing conditions.

Fortunately, the TGT incorporates a number of key design features that make it extremely flexible in this regard. For example, it benefits from an extremely low interstitial velocity[1], which is achieved by an inlet distribution baffle that splits the dust and gas (Figure 2). It also incorporates a wider bag-to-bag spacing in the direction of the reservoir (compared to that along the blow pipe) to permit easier gas flow between the bags.

Another major part of the flexibility of the TGT is from the patented Independent Action Piston (IAP) valve. The ideal long-bag pulse-jet filter requires a pulse valve with two important criteria, as follows:

- To be fast acting with high flow rate but low pressure drop to provide the high acceleration force to the fabric during the bag inflation sequence.
- To allow the bag to deflate in a controlled fashion after cleaning, known as 'soft landing' or 'progressive return to filtration'. This is required to ensure low emissions despite fine particles with on-line cleaning and long bags.

The IAP valve meets both these criteria. Its high flow rate characteristic derives from venting the pressure rapidly behind the piston and using the compressed air pressure in the manifold to move and open the piston very rapidly (Figure 3). The slow closure of the IAP valve is achieved by simply closing the vent behind the piston. By balancing this closure force with the decaying pressure in the manifold, the pressure in the bag is gradually reduced. The bag is progressively returned to its filtration position and high return acceleration forces are eliminated.

By contrast, standard diaphragm valves have an inherent 90 ° abrupt bend that can limit acceleration during inflation. They also snap closed as quickly as they open, which gives rise to the rapid fabric return on a conventional high pressure pulse jet filter.

Table 3. Typical operating parameters	
Inlet temperature	~350 °F
Actual inlet gas flow	25% over design
Actual filtering velocity	4.25 ft/min
Actual stack dust emissions	Excellent
Pressure drop	7 in. WG
Pulse air pressure	25 psig average
Number of bags changed	81 out of 2850
Number of compartment-wide bag changes	None
Kiln downtime due to baghouses	None

Performance since start-up

Many people have been pleasantly surprised by the performance of the system over the years. Table 3 shows typical operating parameters. Despite the high filtering velocity (4.25 fpm), both pressure drop and the number of bag failures have remained low.

The original set of bags has not yet been changed on either system, and there are no signs that a bag change will be required in the near future. By collecting and analysing sample bags every 6 months, a curve of strength-versus-time has been generated. As shown in Figure 4, the residual mullen burst strength of the bags had stayed at around 850 psi for the first 4 yrs[2]. It dropped slightly about a year ago, but then stabilised at approximately 600 psi, which is significantly above what is typical for SUPERFLEX® bags on over 50 installations worldwide. This superior bag strength is attributed to the soft landing that is characteristic of the TGT and its IAP valve. It is anybody's guess as to how long the SUPERFLEX® bags at Paulding will last.

Despite the fine overall performance, a few minor optimisations have been required. One of the primary challenges in the design of large kiln baghouses is to ensure an equal distribution of both the gases and the dust among the modules, as well as equal distribution among all the bags within a given module. This is achieved through a combination of experience, computer modeling, and physical scale modeling.

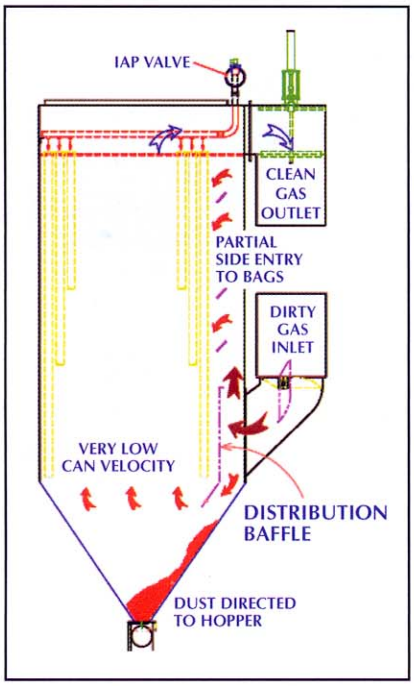

Figure 2. Schematic of the TGT with side inlet baffle.

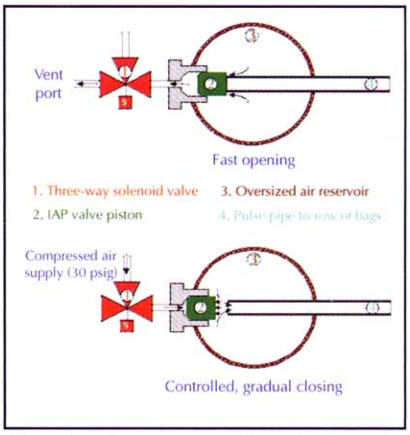

Figure 3. The patented IAP valve provides a 'soft landing' for the bags.

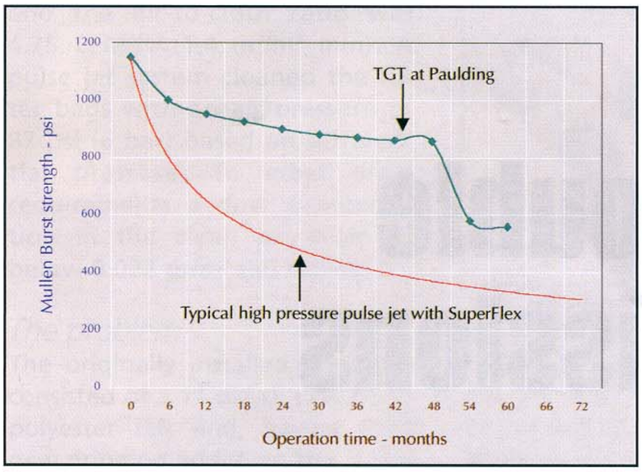

Figure 4. Performance of SUPERFLEX® bags on the TGT at Paulding.

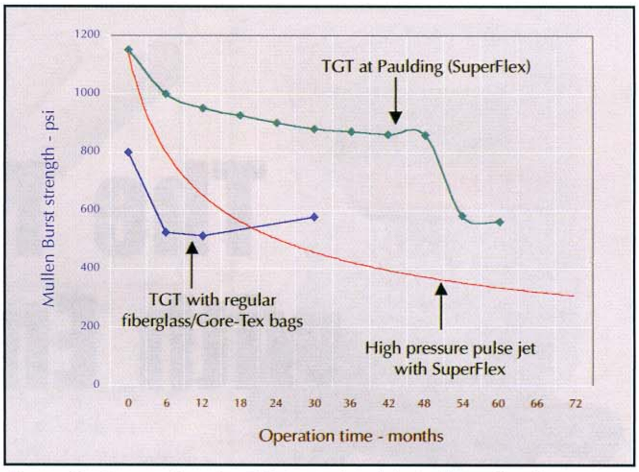

Figure 5. Comparing the TGT to other kiln/mill applications.

At Paulding, physical modeling was carried out and deflector plates were included to ensure good distribution at the inlet flange to the baghouse, even though it was right after a sharp compound elbow. Nevertheless, there were a few bags in the back corner of the first modules that experienced premature velocity abrasion failure, and hence certain tube sheet holes had to be plugged. Also, some abrasive wear around the chutes from the inlet plenum to certain modules was discovered and repaired in 2000/2001[3]. Finally, there was a period where IAP valves were failing due to improper insulation and overheating in the penthouse. But all three issues appear to be resolved, and total maintenance costs over 5 yrs of operation have been more than satisfactory.

Implications for the cement industry

Paulding is not the only cement kiln application using the TGT low pressure baghouse, and certainly not the only one using a pulse-jet baghouse. W. L. Gore has generated a similar strength-versus-time curve for a TGT kiln application using GORE-TEX on regular fibreglass, which is compared to Paulding and a typical high-pressure pulse-jet in Figure 5. With a little bit more data, one could conclude that the TGT can make a bag with GORE-TEX membrane on regular fibreglass perform as well as a SUPERFLEX® bag on a high-pressure pulse-jet.

In considering the options for any capital investment, total life cycle cost is the overriding factor for most industrial companies. This must take into account total capital cost (supply and installation) as well as total running cost (energy consumption and maintenance). For kiln dedusting, this boils down to the decision between an ESP, a reverse-air baghouse, and a pulse-jet baghouse. In recent years, several analyses have been carried out to assess the life-cycle costs for different kiln sizes. However, they did not take into consideration the performance advantages of the TGT low pressure pulse-jet as demonstrated at Paulding. Because it works well at higher air-to-cloth ratio than a high-pressure pulse-jet, it combines the low maintenance cost of a reverse air unit and the competitive capital cost of a pulse-jet filter.

It seems that the industry is becoming aware of the TGT advantage. Since Paulding, Procedair has been awarded four additional contracts by Lafarge for the TGT on kiln/mill applications worldwide. The TGT baghouse was selected for Heidelberger's massive Lehigh Cement kiln currently under commissioning in Union Bridge, Maryland, and has also been selected for a number of plants in Europe, including two ESP rebuild applications. For the Richmond, Canada, plant upgrade, Lafarge selected the TGT with GORE-TEX on regular fibreglass, and the system has been in operation since May 1999. Performance results there continue to demonstrate the benefits that can be achieved with a low-pressure, soft-landing system.

Conclusion

If one looks at recent projects, the industry debate on reverse-air-versus-pulse-jet for the kiln/mill application seems to be swinging towards the latter. But the TGT with SUPERFLEX® at Paulding continues to perform well beyond expectations. As time goes on, more and more evidence builds up that suggests the best solution is not just a pulse-jet, but a low-pressure, soft-landing pulse-jet equipped with high-quality membrane bags.

Footnotes

1. Interstitial velocity is the speed at which the gas and dust ascend between the bags. It is also known as 'can velocity', and is a critical factor in the design of a baghouse. If it is too high, the dust coming off the bags during cleaning does not have a chance to fall to the hopper, and cleaning efficiency is greatly compromised.
2. The initial drop from 1150 psi over the first 6 - 12 months is a perfectly normal characteristic of all membrane-on-fibreglass bags. However, as the curve shows, in most cases it drops much lower.
3. It is interesting to note that both of these phenomena could have been aggravated by the increased velocity caused by the higher volume flow rate.

References

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