Advanced Hybrid™ Technology

Craig Rinschler, W .L. Gore & Associates, Inc., USA,
describes the company's new air pollution control technology.

Introduction

The Advanced Hybrid™ filter is a new air pollution control device that closely integrates electrostatic precipitation (ESP) and GORE TEX® membrane filter bag technologies into a compact, durable, cost effective device. Its configuration promotes a synergy between these two technologies whereby the filter bags are able to operate at high air-to-cloth ratios and be cleaned while eliminating a concern with dust re-entrainement. This results in a strong potential to produce superior filtration.

The predominant air pollution control device for a cement kiln is still the ESP. However, practically all new plants or major plant expansions in North America over the last 20 yrs have installed a fabric filter as the primary air pollution control device. Over the next 10 - 15 yrs, a vast majority of these existing ESPs will need to be replaced due to pending tighter air emissions regulations.

There are approximately 250 cement kilns in the US and Canada. At present, 20% of these kilns utilise pulse jet fabric filters. This figure is likely to continue to grow and may reach as high as 75% by 2010, due to particulate matter (PM) legislation. Currently approximately 20% of these kilns burn alternative fuels. As part of the HWC MACT legislation, mercury emissions limits will likely be in effect for all plants burning alternative fuels in 2005. Even plants not burning alternative fuels may be subjected to some form of mercury standard as the PCA MACT legislation is revisited. A similar trend exists in Europe as a large number of cement plants convert their air pollution control equipment from ESPs to fabric filters.

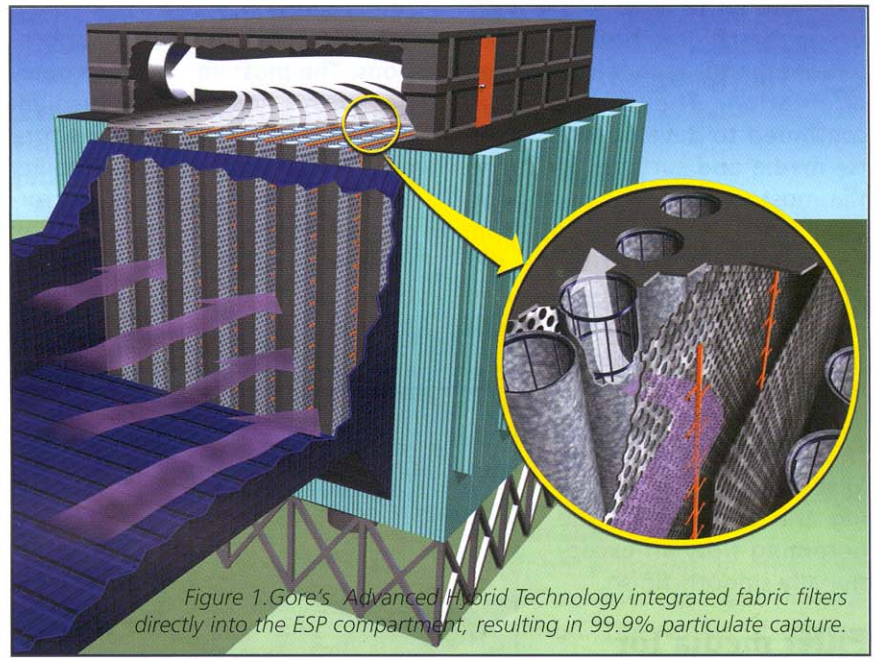

Figure 1. Gore's Advanced Hybrid Technology integrated fabric filters directly into the ESP compartment, resulting in 99.9% particulate capture.

The Advanced Hybrid™ filter technology aims to provide the most cost effective and reliably stable solution for the control of fine particulate and mercury. This technology was patented by the University of North Dakota's Energy & Environmental Research Centre (EERC). W. L. Gore & Associates, Inc. (Gore) has been a technical and financial supporter from the early stages and has been instrumental in developing it to its current commercial form. Today, Gore owns the worldwide rights to practice and sublicense this technology to a select group of original equipment manufacturers (OEMs) around the world. The first OEM to receive a license is ELEX AG, and will provide the first full-scale Advanced Hybrid™ filter application on a cement kiln this spring.

Concept and theory

The filter's configuration promotes a synergy between the ESP and fabric filter technologies, whereby the filter bags are able to operate at high air-to-cloth (A/C) ratios and be cleaned online while

Table 1. Pilot filter PM dust loadings EPA method 17					
Inlet (mg/Nm³)	Outlet (mg/Nm³)	Temperature (°C)	Moisture (%H_2O)	Sample time (hrs)	Removal efficiency (%)
2677	0.21	138	12.2	4	99.993
3112	0.09	138	11.8	17	99.997

eliminating the potential concern with dust re-entrainment.

The geometry consists of alternating rows of ESP components and filter bags within the collector (Figure 1). The inlet dust is directed in to the ESP collection zone. The inlet dust is directed in to this zone, which not only removes most of the dust prior to it reaching the filter bags, but more importantly it also effectively captures the dust when the filter bag is pulsed clean, thereby essentially eliminating the potential for dust re-entry (Figure 2). The perforated collecting plate captures the charged particles as well as serving to protect the filter bags from any potential electrical damage from the discharge electrodes. These are periodically cleaned using typical rapping methods. The GORE-TEX® membrane filter bags remove more fine particulate than conventional filter bags and effectively clean online to maintain a low overall filter drag. This can be achieved because the fine microporous structure of the membrane captures fine particulate on its surface. The filter bags are cleaned using pulse jet cleaning techniques.

Since the Advanced Hybrid™ Filter can be operated at high A/C ratios, less fabric filter components such as filter bags and cages and pulse valves and solenoids are needed. This translates into a more reliable system that requires less overall maintenance because it has fewer components.

The net result is excellent particulate control at costs less than currently used. This technology is easily adapted to new installations as well as reftrofits of existing ESPs.

Performance/application data

A pilot filter unit has been in operation since July 1999, filtering 15 000 am³/hr (9000 acfm) of flue gas from a coal-fired cyclone boiler. The unit consists of four rows of eight filter bags and commercially available rigid discharge electrodes positioned in the ESP zone. It has exhibited stable operating levels of 3.4 – 3.7 m/min (11 - 12 fpm) on fly ash from burning powder river basin (PRB) coal. Typical fabric filter flange-to-flange pressure differentials have been maintained during continuous operation with an average online pulse cleaning cycle of greater than 20 min. Particulate matter capture efficiency levels greater than 99.99% by EPA Method 17 have been demonstrated.

The pilot unit has demonstrated a high level of reliability. The filter was operated with the ESP voltage off for a period of time, and while it required the filter bags to be cleaned more frequently, once the power was restored the pilot unit returned to its normal operating conditions.

The latest milestone to be reached, is obtaining the approval to build a first full size system on a plant in Italy. The system will integrate exhaust gases from the kiln, raw mill, and clinker cooler into one dedusting unit. The performance data is shown in Table 2.

Conclusion

In summary, the Advanced Hybrid™ filter provides many benefits as listed in Table 3, when compared to existing particulate control technologies.

The filter utilises highly efficient and durable GORE-TEX® membrane filter bags, which provide excellent performance over a very long life. This leads to low operating costs since filter bag replacements are a key cost component. The power requirements for the fan, the ESP components and the compressed air are all within the ranges of comparable air pollution control technologies.

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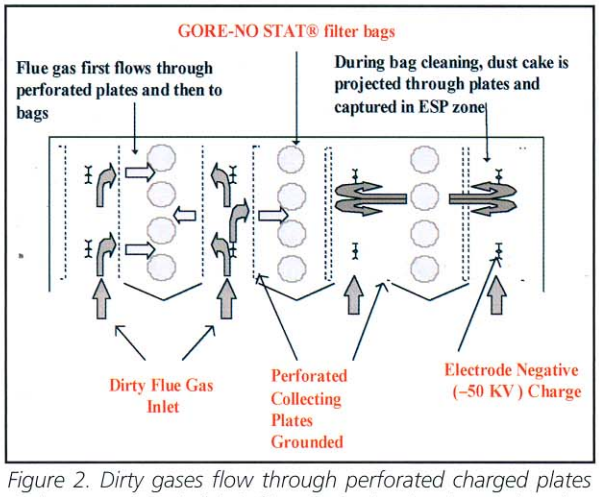

Figure 2. Dirty gases flow through perforated charged plates and on to anti-static fabric filters. Pulse jet cleaning pushes dust back on to ESP plates eliminating reintrainment on the filter.

Table 2. Cement plant operating conditions	
AHPC size	3 compartments, 200 filter bags each
Gas-volume	330 000 am³/h (200 000 acfm)
A/C ratio normal conditions	3.45 m³/m³ min (11.3 fpm)
A/C ratio max. conditions	4.49 m³/m³ min (14.7 fpm)
Temperature	140 °C (284 °F)

Table 3. Benefits of the equipment	
Benefits	Reasons
Lower capital cost	Compact design, high A/C ratio, fewer components
Lower operating cost	Fewer components, durable, long lasting membrane filter bags, comparable energy consumption costs.
Lowest emissions	GORE-TEX® membrane filter bags
Fuel flexibility	The unique ESP and baghouse arrangement allows it to perform well over a wide range of operations