Current Trends in Membrane Fabric Filtration

for Carbon Black Production

By

Mr. V. K. Dubey, Vice President of Manufacturing, Phillips Carbon Black Limited
Mr. Thomas C. Savage, Global Business Leader, GORE-TEX® Filtration Products, W. L. Gore & Associates, Inc.
Mr. Vineet Maindola, Regional Business Manager, W. L. Gore & Associates, Inc.

First Presented at Carbon Black '05
Perspective in Asia Pacific
Suzhou, China
October 16-18, 2005

Current Trends in Membrane Fabric Filtration for Carbon Black Production

By

Mr. V. K. Dubey, Vice President of Manufacturing, Phillips Carbon Black Limited
Mr. Thomas C. Savage, Global Business Leader, GORE-TEX® Filtration Products, W. L. Gore & Associates, Inc.
Mr. Vineet Maindola, Regional Business Manager, W. L. Gore & Associates, Inc.

ABSTRACT

In this paper, the current trends in ePTFE membrane filtration in the carbon black industry will be discussed. Membrane filtration has evolved over the past 30 years. These advancements are helping carbon black producers improve their manufacturing processes. This paper will present a case study of a recent joint initiative by Phillips Carbon Black Limited (PCBL) and W. L. Gore & Associates (Gore). The goal of the initiative was to improve productivity and increase the filter bag life in the vapor bag collector at PCBL's plant in Durgapur, India.

By replacing non-membrane filter bags with ePTFE membrane filter bags manufactured by Gore, PCBL has been able to increase airflow, reduce pressure drop and significantly extend the operational life of the filter bags. As an added benefit, the plant plans to optimize the bag collector performance even further by adding a new fan. The result is expected to be increased production.

CARBON BLACK TODAY

With surging demand, the carbon black industry is in growth mode. A growing number of producers are increasing capacity by building new production lines. Carbon black producers are also undertaking projects to increase capacity on their existing lines. We have seen this trend for the past few years, and indications are that the trend will continue into the 2008-2013 period. The Freedonia Group predicts that carbon black demand will increase 4% annually over the 2003-2008 time period. [(1)] This outlook is similar to the 3.5% annual growth in the carbon black market mentioned by Mr. Paul Ita of the Notch Consulting Group.[(2)] Mr. Ita sees the Asian market growing at a faster 4.4% annual rate in the 2003-2010 time frame.

Carbon black is used in a number of applications including paints and inks. The primary use of carbon black continues to be as an additive for tire rubber. The growth estimates for carbon black appear to be confirmed by looking at expected tire production. In an April 1, 2005 report, The Freedonia Group estimates that the global tire production is expected to grow 44% from 1155 million units in 2003 to 1665 million units in 2013.[(3)] The growth in the Asia Pacific countries is expected to be even higher at close to 50% growth from 2003 to 2013.

The challenge for the carbon black industry is to meet these increased demands while still generating acceptable profits. Rising oil prices have left a very thin profit margin and only the most cost competitive producers will be able to remain in the business. In order to meet this challenge, the industry is increasingly pushing for increased productivity by adopting best practices for manufacturing processes. One of the important manufacturing processes at a carbon black plant is the fabric filtration bag collectors. Fabric filters are the primary dust collection device and they play a very important role in the overall plant performance. When operated efficiently, the bag collector not only contributes to environmental compliance, it can also

contribute to plant profitability and productivity.

FABRIC FILTERS

Attachment 1 [4] illustrates a typical carbon black manufacturing process. In this process there are a number of filtration steps. The most common areas where fabric filters are used include: 1.) Venting of the main process, 2.) Venting of the dryer, and 3.) General ventilation and packaging areas. Each of these bag collectors have unique operating conditions which must be considered when selecting the fabric filter type. Some items to be considered include: 1.) Bag collector style, 2.) Filtration method, and 3.) Filter media type.

BAG COLLECTOR TYPES

At a carbon black plant, the main process, dryer, and ventilation bag collectors will either be a reverse-air style or a pulse-jet style design. Both of these designs are well known within the carbon black industry. In general, older carbon black plants (or processes required to vent large volumes of gases) utilize the reverse-air style bag collector. This design typically requires less maintenance since there are few moving parts. However, because of the need for a low air-to-cloth ratio, a reverse-air style collector requires more area or "footprint." In a reverse-air bag collector, the carbon black particles are captured on the inside of the long, cylindrical filter bag (see Figure 1).

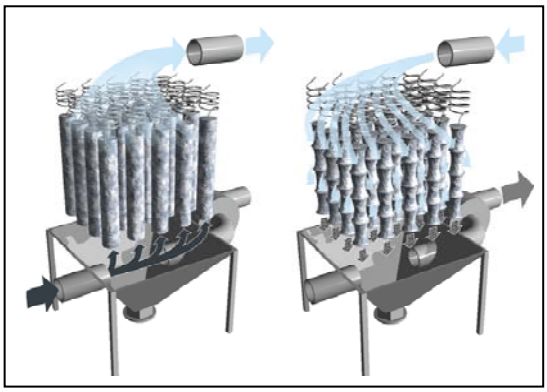

Figure 1: Illustration of a reverse-air style dust collector.

The dust is removed by reversing the direction of the gas flow. This process partially collapses the filter bag and dislodges the dust.

A pulse-jet style collector is the typical bag collector design used in newer plants. This type of bag collector is also used when there are space limitations such as might be found when a new production line is added to an existing plant. In a pulse-jet style bag collector, the dust is collected on the outside of the filter bag (see Figure 2).

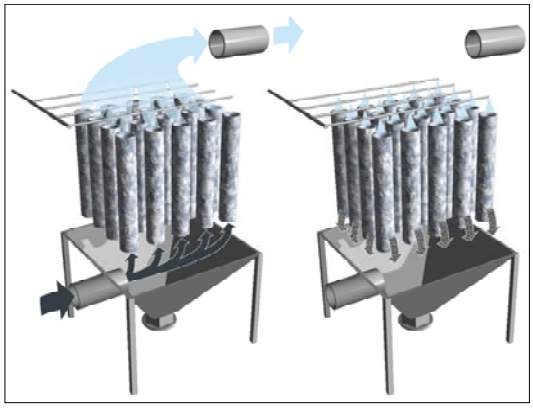

Figure 2: Illustration of a pulse-jet style dust collector.

During a bag cleaning, a shot of compressed gas is directed into the bag. The compressed gas causes the filter to expand and this movement releases the built-up dust. This aggressive, fast cleaning method allows for a thicker filter material to be used. A pulse-jet style collector can typically operate at higher air-to-cloth ratios compared to a reverse-air style bag collector. However, filter bag life may be shorter due to the aggressive mechanical movement imparted to the bag by the compressed gas.

Since each carbon black manufacturing line is unique and presents special filtration challenges, it is suggested that the carbon black manufacturer contact a qualified bag collector manufacturer for more specific information.

FILTRATION METHOD

After the bag collector type has been selected, the next step is to decide which filtration method to use. In the carbon black industry, the filters are either non-membrane or membrane. Both types of filters use similar filtration or backing materials. In the case of a membrane filter, a thin ePTFE membrane is laminated to a backing material. An example of an ePTFE membrane filter is shown in Figure 3.

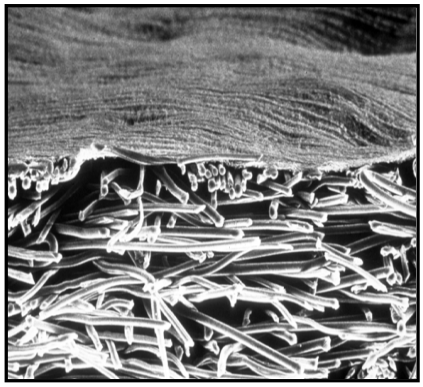

Figure 3: Cross-section of filtration media showing the ePTFE membrane and backing.

The use of ePTFE membrane as a filtration surface was pioneered more than 30 years ago by Gore. As shown in Figure 4, membrane filtration relies on a thin, microporous ePTFE membrane to perform the filtration function.

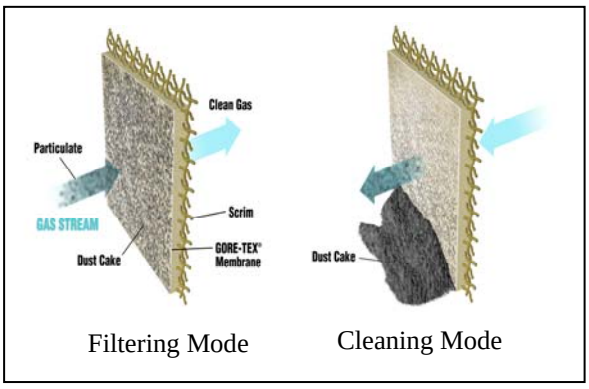

Figure 4: Illustration of a membrane filter in the filtering and cleaning mode.

Membrane filtration relies on "surface filtration" and provides excellent initial filtration efficiency. The membrane provides a smooth surface, resulting in excellent dust cake removal during the cleaning cycle. The benefits of membrane filtration can include consistent airflow, high filtration efficiency and longer useable filtration life compared to non-membrane filters. It is important to remember that membrane filters are limited to applications where the continuous operating temperature is below 260°C.

While membrane filters rely on surface filtration, non-membrane filters rely on a two-stage or "depth filtration" mechanism. During initial start-up, a non-membrane filter must first "season." In the seasoning process, the dust penetrates the surface and builds up in the area between the filter's fibers. This dust is often referred to as the "primary" dust cake. Once the primary dust cake is formed, a "secondary" layer of dust forms on the filter's surface. It is this secondary dust cake which provides much of the filtration efficiency. Figure 5 illustrates non-membrane filtration.

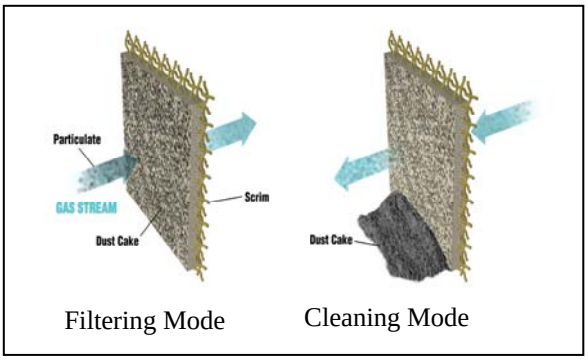

Figure 5: Illustration of a non-membrane filter in the filtering and cleaning mode.

Non-membrane filters offer a low initial cost, however, they can require more frequent replacement depending on the application.

Both ePTFE membrane filters and non-membrane filters are available in a variety of material types. Table 1 shows some typical filter media types and applications where they are used.

Media Type				
	Polyester Felt	**Fiberglass Fabric**	**Aramid Felt**	**PTFE Felt**
Resistance to Mechanical Damage	Good	Fair	Good	Good
Bag collector Type	Pulse-Jet	Reverse Air / Pulse-Jet	Pulse-Jet	Pulse-Jet
Resistance to Alkali	Good	Fair	Fair	Excellent
Resistance to Acids	Good	Fair to Good	Fair to Good	Excellent
Maximum Continuous Temperature	130°C	260°C	204°C	260°C
Typical Application Area	Ventilation Filter	Main Process / Vapor Filter	Vapor Filter	Vapor Filter

Table 1: Comparison of various fiber types used in industrial filtration.

In general, woven fabrics are used in reverse-air style bag collectors because filter bag flexibility and movement is important. Non-woven, or felted, materials are used in the more mechanically demanding pulse-jet style collectors.

Because of the many application specific parameters to consider, your filter supplier should be contacted to help with your filtration selection.

CURRENT TRENDS

Since being introduced more than 30 years ago, ePTFE membrane filtration has continued to evolve to meet the increasingly demanding needs of the industry. The two most significant areas of development have been: 1.) Membrane technology, and 2.) Backing material types.

As mentioned earlier, ePTFE membrane filters rely on the thin, microporous membrane to perform the filtration function. The membrane should be durable, it should possess high filtration efficiency, and it should provide good dust cake release characteristics. Over time and during use, the membrane can become damaged. Filter suppliers have worked to reduce this damage. Gore has developed a new family of membranes aimed at reducing this damage. These new membranes have a unique combination of strength and permeability.

This new family of membranes is represented by the "D Series" line in Figure 6. These more durable membranes are available on a variety of backing material types.

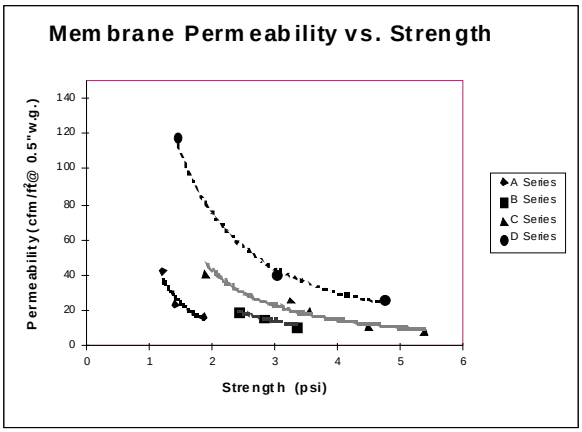

Figure 6: Comparison of permeability vs. strength for ePTFE membranes

Another consideration in filter bag selection is the backing material type. Depending on the application area, a carbon black plant might use filters made with polyester, aramid, fiberglass, or PTFE fibers. The fiber chosen for each application depends on the thermal, mechanical, and chemical requirements of the application.

One trend seen in the carbon black industry has been the use of more chemically resistant filter media types. This trend is driven by at least two things: 1.) The use of feedstocks higher in sulphur content, and 2.) The desire for longer filter bag life. To meet this challenge, some carbon black producers are changing to more acid-resistant fiberglass fabrics. In other cases, the fiberglass may be replaced by the more chemically resistant PTFE fibers. While these more chemically

resistant fibers have a higher initial cost than the ones they replace, this is more than compensated by the longer life and un-interrupted production runs.

CASE HISTORY

Phillips Carbon Black Limited operates three manufacturing plants in India. The largest of these plants is located in the East of India at Durgapur. The Durgapur plant has the capacity to produce 140,000 Mt/year of carbon black. Additionally, this facility is the only carbon black producer in Asia with the ISO-9001 certification.

Recently, the plant personnel initiated a project to optimize the performance of one of their vapor bag collectors.

As shown in Table 2 [(5)], this bag collector is a pulse-jet style bag collector which had previously used non-membrane, fiberglass fabric filter bags. Together with Gore, PCBL decided to replace these non-membrane filters with membrane filters. Since installing GORE-TEX® Filter Bags, the Durgapur plant has been able to increase filter bag life from an average of 9 months to more than 15 months.

Line 3 Vapor Bag Collector	Units	Non-Membrane Filters	GORE-TEX® Membrane Filters
Airflow	Nm^3/hr	12,500	15,000
Production rate (N550 / N660)	Mt/day	125 / 140	125 / 140
Pressure Drop	Mm of H_20	150	80
Bag Life	Months	9	15+

Table 2: Vapor bag collecctor comparison showing advantages of GORE-TEX® filters.

PCBL has seen consistent productivity on both the N550 and N660 grades produced on this line. The pressure drop has been only 80mm H_20, which is almost half compared to the pressure drop when non-membrane filters were installed.

As a result of this successful project, the team at Durgapur has identified a new initiative to further de-bottleneck this line. A new, larger fan is on order. When the fan is installed, the plant expects to see a minimum production increase of 5 Mt/day for both the N550 and N660 grades of carbon black.

CONCLUSION

As the carbon black industry settles into the 21st century, it is clear that demand for the product is increasing. Successful companies are increasingly adopting best practices in their manufacturing processes. The fabric filter bag collector is an important part of the carbon black plant. An optimized filtration system can help a plant meet their profit, productivity, and environmental goals.

As suppliers to the carbon black industry, filter bag manufacturers are responding to the needs of the carbon black plant. Over the past few years, new product development has accelerated. New membranes have been introduced and the use of new filtration materials has become more common place.

The joint initiative between PCBL and Gore shows that there are still many opportunities to optimize the fabric filtration systems. By adopting the use of ePTFE membrane filter bags, the Durgapur plant has seen an increase in airflow and the production rate has remained stable. Filter bag life has been increased from 9 months to more than 15 months compared to when non-membrane filter bags were used. Finally, after further de-bottlenecking efforts, PCBL expects to be able to increase production by 5Mt/day.

AUTHOR'S BIOGRAPHIES

V. K. Dubey is the Manufacturing Head for Phillips Carbon Black Limited (PCBL) Durgapur, Baroda, and Cochin plants. Prior to joining PCBL, he worked as Vice President (Production) at Alexandria Carbon Black for approximately 2 years and identified and executed projects to improve productivity and product quality, and develop new product grades. With these improvements in place, the company is benchmarked internally in the AV BIRLA group for best productivity, yield, and product quality.

Mr. Dubey was associated with Thai Carbon Black right from inception until 2001, and was involved in its rapid expansions, product quality, and productivity improvements. He was personally associated in developing a quality system of Thai Carbon Black and was a key member for preparing the company for successfully winning the prestigious Deming Quality Award from Japan.

The Quench boiler was also developed and commissioned during his tenure. Mr. Dubey was associated in developing cost effective packaging including the Bulk Liner and bulk liner filling machine for product export to Japan.

Mr. Dubey is married and has two sons. He holds a Masters Degree in Chemistry.

Thomas C. Savage is the Global Business Leader for GORE-TEX® Filtration Products at W. L. Gore & Associates. Tom holds both Ceramic Engineering and Master of Business degrees. Over the past 17 years he has served in product development, sales, and marketing roles within both the refractory and filtration industries.

Vineet Maindola is the Regional Business Manager for GORE-TEX® Filtration Products at W. L. Gore & Associates. Vineet holds both Mechanical Engineering and Master of Business degrees. Over the past 16 years he has served in technical support, sales, and marketing roles, primarily in the filtration industry.

REFERENCES

[1] "World Carbon Black to 2008", The Freedonia Group, April 01, 2005, Summary Table, Page 3.

[2] "Carbon Black Faces Energy Cost Pressure", Chemical Market Reporter, John Hoffman, February 14, 2005.

[3] "World Carbon Black to 2008", The Freedonia Group, April 01, 2005, Table 11-7, Page 21.

[4] Phillips Carbon Black Limited

[5] Phillips Carbon Black Limited

Attachment 1