TECHNICAL FILTERS INC.
3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5 CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: aturkson@technicalfilters.com

APPLICATIONS OF APEX® PTFE MEMBRANE FILTER MEDIA IN CEMENT KILN DUST COLLECTORS

A: WOVEN FILTER MEDIA

Woven filter media (Figure 1) are two dimensional and so resistance to particle penetration is minimal beyond the contact medium. They were employed typically in dust collectors using shaking as cleaning mechanism.

Disadvantages presented by the woven structure include:

1. Higher particle emission rates
2. Higher pressure drops
3. Reduced service life
4. Lower filtration velocity
5. Higher capital costs

B: NEEDLE PUNCHED FILTER MEDIA

A needle punched fabric is made from webs or batts of fibers in which some of the fibers have been driven upward or downward by barbed needles (Figure 2). This needling action interlocks fibers and holds the structure together by friction forces. The phases of needle punching process are shown in figure 3.

Invention of needle punching technology offered three-dimensional filter media with pore sizes in the range of 10 – 20 microns. Particle emissions are therefore lower in comparison to woven filter media.

The following advantages of needle punched filter media are therefore realized over woven filter media:

Advantages of Needle Punched Filter Media Over Woven Filter Media:

1. Lower Particle Emission Rates
2. Lower Pressure Drops
3. Improved Service Life
4. Higher Filtration Velocities
5. Lower Capital Costs

However, the advent of fluidized bed boilers and graded ball mill unit operations produced relatively finer particles that penetrated standard needle punched filter media, leading to higher emissions and pressure drops and reduced service life for these and other related applications.

The development of expanded Polytetrafluoroethylene (PTFE) membranes and their lamination to both woven and needle punched filter media led to significant improvements in filtration efficiencies.

C: EXPANDED PTFE MEMBRANE-LAMINATED FILTER MEDIA

The process for the manufacture of expanded PTFE membranes starts with pure PTFE fine powder resin. A lubricating agent is added to form a paste which is stretched to form a sheet. Heating and expanding the sheet results in a microporous structure. The lubricating agent is then expelled resulting in pure PTFE membrane (Figure 4).

Advantages of ePTFE membrane laminated filter media over woven and needle punched filter media, especially in relation to submicron particles, are:

1. Much lower emission rates
2. Significantly less pressure drops
3. Much longer service life
4. Higher filtration velocities
5. Lower capital costs

Figures 5 and 6 illuminate the advantages of surface filtration of ePTFE membrane laminated filter media over the depth filtration of woven and needle punched filter media.

The emission efficiency of ePTFE membrane laminated filter media (Figure 5) starts at a very high level and stabilizes in the region of 99.99%, while that of say plain woven glass starts relatively low and builds up to a relatively lower level as particles accumulate within the interstices and then on the surface.

The pressure drop of woven and needle punched filter media begins initially at a lower level due to the much larger initial pore size, and therefore lower resistance (Figure 6). However, the pressure drop increases sharply as particles accumulate within the interstices and stabilizes at a much higher level in comparison to ePTFE membrane laminated filter media whose interstices remain largely devoid of particle penetration.

The ability of ePTFE membrane laminated filter media to generate lower emission rates while maintaining lower pressure drops is why such media have become predominant in process dust collectors attached to kilns and separators in the cement industry.

D: TECHNICAL FILTERS INC.

Technical Filters Inc. is part of a global consortium that has developed its own global brand of PTFE membrane technology known as APEX®. The consortium is the only group that manufactures PTFE fibers, PTFE sewing thread, woven glass substrates, needle felts, laminates PTFE membrane and fabricates filter bag. This unique vertical integration allows top to bottom quality control at the most affordable prices.

E: APEX® GLASS MEMBRANE

APEX® Glass Membrane is the Technical Filters Glass ePTFE membrane laminated filter media brand used for fabrication of filter bags for kiln dust collectors.

APEX® Glass Membrane was tested by ETS Inc., which is an EPA approved independent laboratory.

The test conditions were as follows:

1/ Filtration velocity: 2.0 m/min (normal industrial filtration velocity is 1.0 m/min)
2/ Dust loading: 18.4 g/m3 (average industrial amount)
3/ Particle size: 1.5 +/- 1.0 micron (Cement dust particle size is 5 – 10 microns)
4/ Number of pulses: 10,226 (equivalent to about 100 days in operation)

The emission rate achieved was 0.0031 mg/m3.

To put the results in perspective: The dust was much finer than that encountered in cement plants. The filtration velocity was double that normally encountered in kiln baghouses.

Despite these very aggressive conditions, the emission rate was only 0.0031 mg/m3. The harshest plant requirement is currently < 10 mg/m3.

The full test conditions and results can be found under "Test Data" at our website.

F: CASE HISTORIES

Technical Filters has accumulated an extensive list of APEX® Glass Membrane case histories in cement kiln dust collectors. Roll goods are sometimes supplied to our local partners for filter bag fabrication. Other times, we supply fabricated filter bags directly or through our local partners.

The supply process begins with a thorough evaluation of a completed questionnaire, followed by a round of meetings with the original equipment manufacturer and/or the end user. The terms of supply including prices, delivery, performance warranty, and sanctioning a sample bag are concluded.

We have tabled six case histories out of our extensive library for reference. With Siam Cement, we worked with our local partner to replace 4000 existing bags which had a history of premature failure. The total filter bag surface area was 11455 m^2 and the volumetric flow rate was 11,200 Nm^3/min, resulting in filtration velocity of 0.98 m/min.

With an acceptable filtration velocity value, attention shifted to air flow analysis. Extensive evaluation showed non-uniform inflow was shearing the lower sections of the filter bags, causing wear and tear of the bags. Finite element computational fluid dynamics was used to model the inflow, providing 3D imagery of existing flow profiles and subsequent rectification analysis and inlet profiles.

Implementation of the solution model removed the identified non-uniformity. Then together with on-demand cleaning and a comprehensive preventative maintenance program, the filter bag service life was increased from 18 months to 60 months, well above the service life guarantee of 48 months. The emission level achieved was less than 14 mg/Nm^3, well below the guaranteed level of less than 25 mg/Nm^3.

Over at Union Cement Company in Ras Al-Khaimah, filter bag analysis showed moisture ingress and condensation, resulting in caking of solids and blinding of the filter bags. The system was properly insulated and condensation was prevented by blowing hot air through the system on shut downs. Replacement of 2400 bags in the right half section of the two-unit system resulted in an increase in bag service life from 22 months to 54 months.

The other case histories cited were all in collaboration with local partners. For example, we supplied over 40,000 m^2 of APEX® Glass membrane to our Indian partner in 2011 for bag fabrication to the cement industry. This translated to over 16000 bags for cement kiln dust collectors. One of the keys to success is specification of conservative filtration velocity of about 1.0 m/min, which yields pressure drop of about 100 mm water gauge in stress-free operations.

G: OPTIMAL OPERATIONS OF DUST COLLECTORS

The following operating conditions are indispensable to achieving satisfactory filter bag performance and long service life:

1/ Precoating

Firing up a cement kiln causes an initial system instability. The gases during this period contain insolvent hydrocarbons which will instantly blind the filter bags upon direct contact. The ideal solution would be to bypass the dust collector during this phase. However, this is not permissible in most jurisdictions. To mitigate, cement dust should be injected into fan inlet before start up and allowed to build until pressure drop reaches about 100 mm of water gauge. This precoating step means the insoluble hydrocarbons would not make direct contact with the surface of the filter bags, thus preventing blinding and premature failure of the filter bags.

2/ Cleaning on demand

It is strongly recommended that cleaning of filter bags should be activated based on pressure drop across the filter bags. This ensures sufficient cake build up and cleaning only when necessary. Available enhanced cleaning boards allow on-demand sequences, configurable pre-coating settings, blow-down cycles on automatic basis, tube cleaning abilities, power out memory retention, hour and cycle count recordings. The new boards send alarms for specific solenoid failure, insufficient power, excessed temperature, high pressure drop, and low tank pressure for compressed air manifolds.

3/ Broken bag detectors

This technology uses AC coupled tribo-electricity to continuously monitor baghouse systems for filter media leakage. Dust concentrations of 0.01 mg/m^3 can be detected, regardless of composition because of the AC coupled technology at a wide range of particle density.

4/ Condensation prevention

Condensation is one of the leading causes of filter bag failure in cement kiln dust collectors. As is known to all, mixing water with cement dust results in formation of a paste. Subsequent drying causes a solid, nearly impermeable cake to attach to the filter bag. Attempts to remove this cake, and reduce the resultant high pressure drop, involve continuous pulsing, which causes excessive stress on the filter bags, and leads to premature failure.

To avoid condensation, it is recommended that dry hot air should be circulated continuously through the dust collector on shutdown to ensure temperature does not fall below the dew point.

H: PREVENTATIVE MAINTENANCE

Preventative maintenance is crucial to achieving long filter bag service life. The following steps are recommended:

1/ Daily Steps: • Walk through the baghouse area to check for normal or abnormal visual and audible conditions. • Check the differential pressure. • Monitor the gas flow rate. • Check the cleaning cycle. • Check compressed air and water traps on pulse jet baghouses. • Monitor the discharge system by making sure dust is removed as needed. • Observe the stack plume opacity.

2/ Weekly Steps: • Spot check bag seating conditions. • Spot check for bag leaks and holes. • Check fans for corrosion and blade wear. • Check all hoses and clamps. • Inspect the baghouse housing for corrosion.

3/ Monthly Steps: • Blow out (clear) the manometer • Verify the working order of temperature-indicating equipment. • Check the compressed-air lines. • Check the bag cleaning sequence to see that all valves are seated properly. • Check all moving parts on the discharge system and the screw conveyor bearings. • Check the drive components on all fans.

4/ Quarterly Steps: • Thoroughly inspect all bags. • Calibrate the opacity monitor. • Check gaskets on all doors and ducts. • Inspect the paint on the baghouse and note corrosion. • Inspect the baffle plate for wear. • Observe the dampers for proper seating. • Check the ducts for dust buildup.

5/ Yearly Steps • Check all welds and bolts. • Check the hoppers for wear. • Replace high-wear parts. In addition, test used filter bags to determine residual air permeability and physical characteristics. The report will help identify potential filter bag problems before any catastrophe emerges.

6/ Matrix of Filter Bags

Whether done digitally or manually, a matrix of filter bag arrangement in the dust collector should be kept handy at all times in order to record incidental replacement of filter bags. Sometimes it becomes evident that filter bags in certain sectors are being replaced prematurely on a consistent basis. For example, frequent replacement of filter bags at the entrance could be due to shearing by non-uniform gas flow into the dust collector. Condenser leakage could lead to moisture ingress, leading to blinding of the filter bags in that area.

I: TESTING OF FILTER BAGS

Technical Filters will test your used kiln dust collector filter bags at no charge. Parameters measured include:

1/ Visual inspection as to whether dust is powdery or damp
2/ Air permeability of the top, middle and bottom sections of the used filter bag
3/ Air permeability of the top, middle and bottom sections of cleaned filter bag
4/ Tensile strengths and elongations of the top, middle and bottom sections of the cleaned filter bag
5/ Microscopic photos of the cross sections of the filter bag

These parameters are then compared to those normally generated for new unused filter bags to determine residual service life of the filter bags. The report helps plant operators to replace filter bags on a technical basis or whether problems in dust collector operations are traceable to the filter bags.

So send us your used kiln dust collector filter bag as soon as possible for a free comprehensive evaluation.

J: CONCLUSION

Technical Filters is part of a vertically integrated group weaving fiberglass, manufacturing ePTFE membranes, laminating to substrates and fabricating filter bags. The group is backed by an experienced engineering team with over 38 years of experience in applications of filter bags in cement kiln dust collectors. Partnering with local teams, our APEX® Glass Membrane filter bags have been installed successfully in global cement kiln dust collectors achieving service life of 5 years and pressure drops of 100 mm water gauge in several of these applications.

We look forward to working closely with you and your teams to deliver cost effective APEX® Glass Membrane filter bags, backed by incomparable technical service, to enhance productivity of your cement plants.

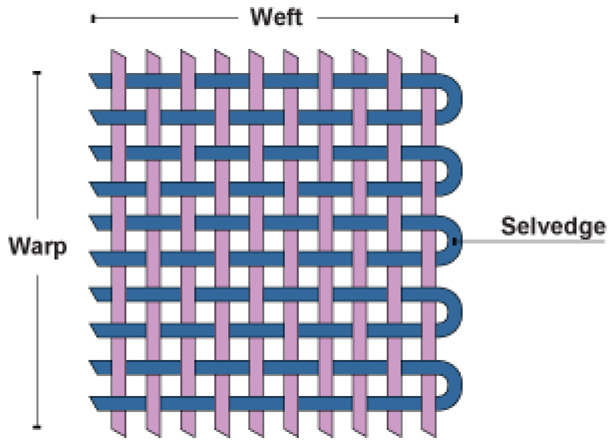

FIGURE 1: STRUCTURE OF WOVEN FABRIC

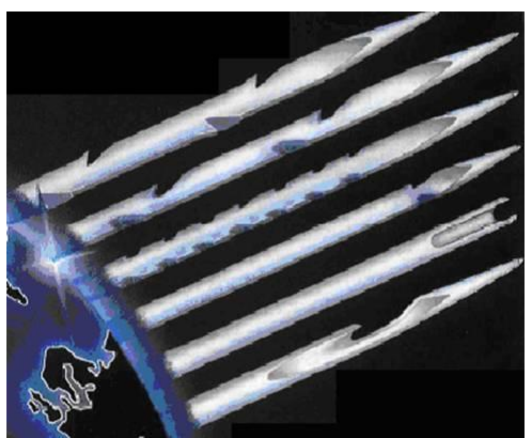

FIGURE 2: BARBED NEEDLES

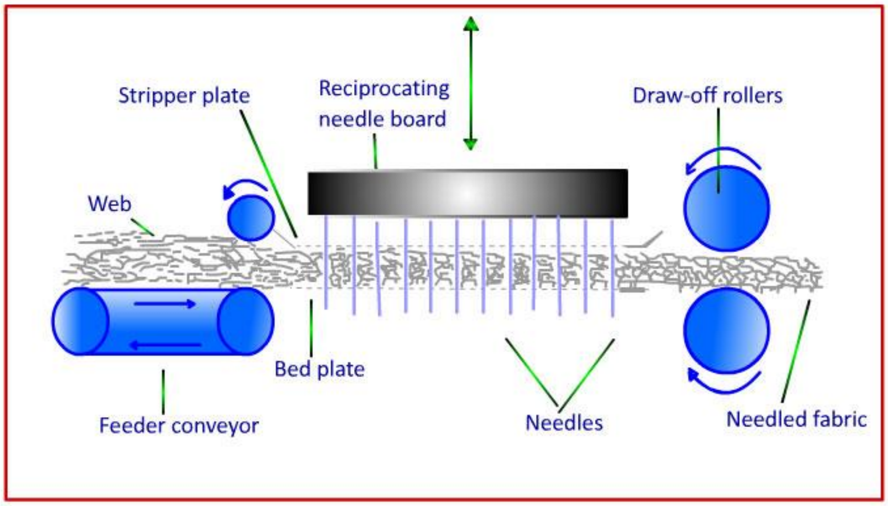

FIGURE 3: NEEDLE PUNCHING PROCESS

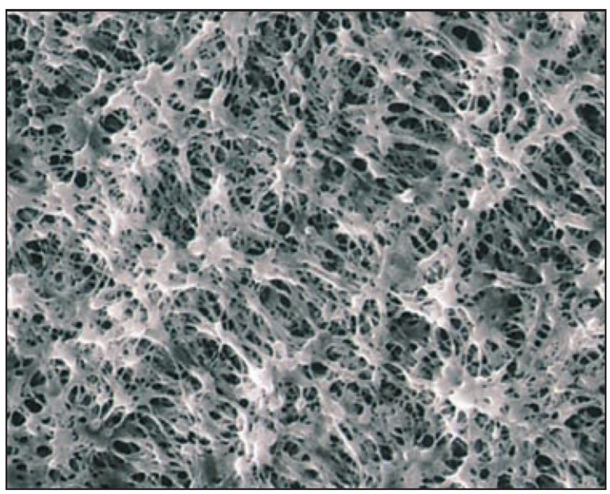

FIGURE 4: ePTFE MEMBRANE

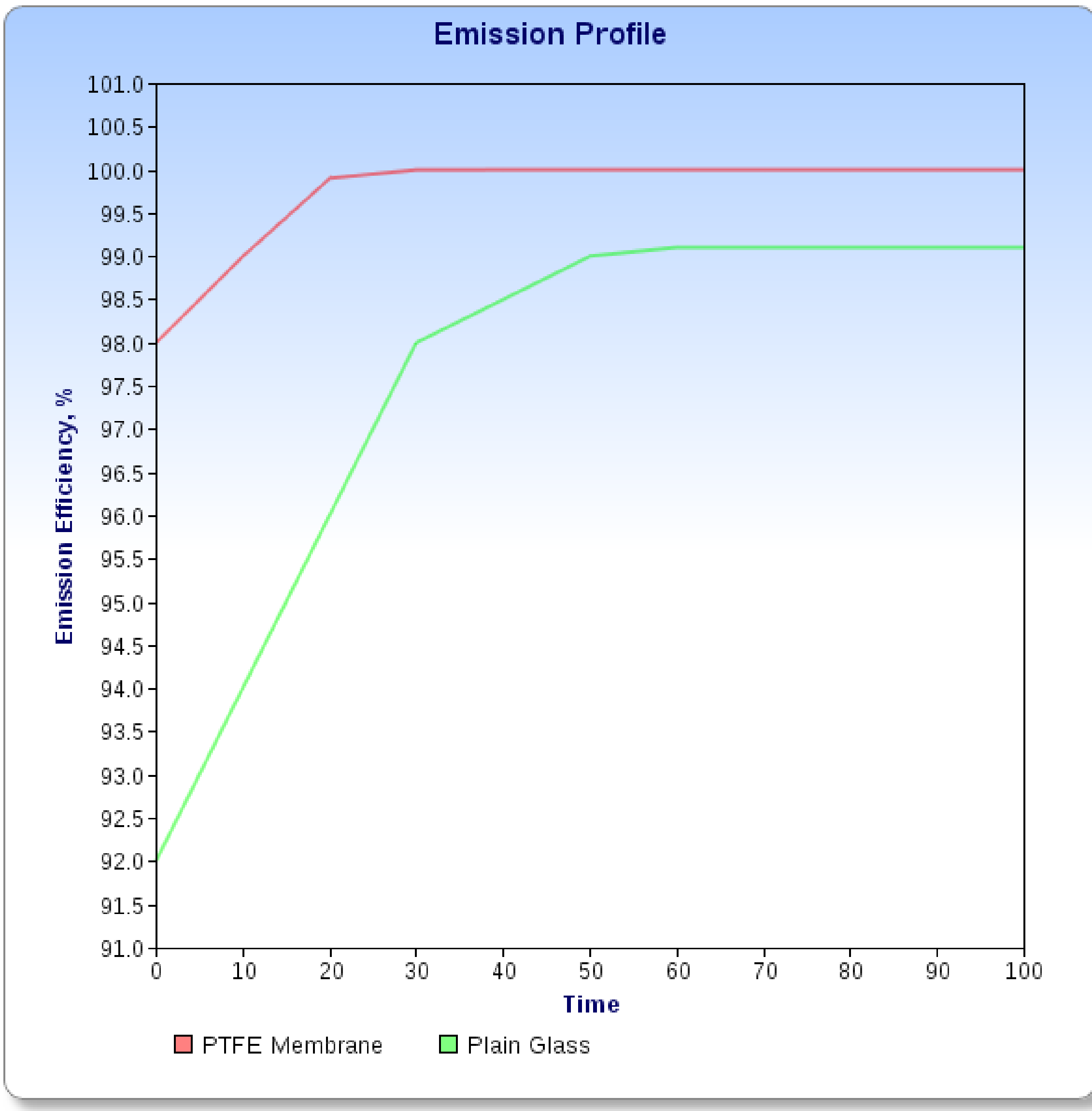

FIGURE 5: EMISSION PROFILES FOR ePTFE MEMBRANE AND PLAIN FILTERS

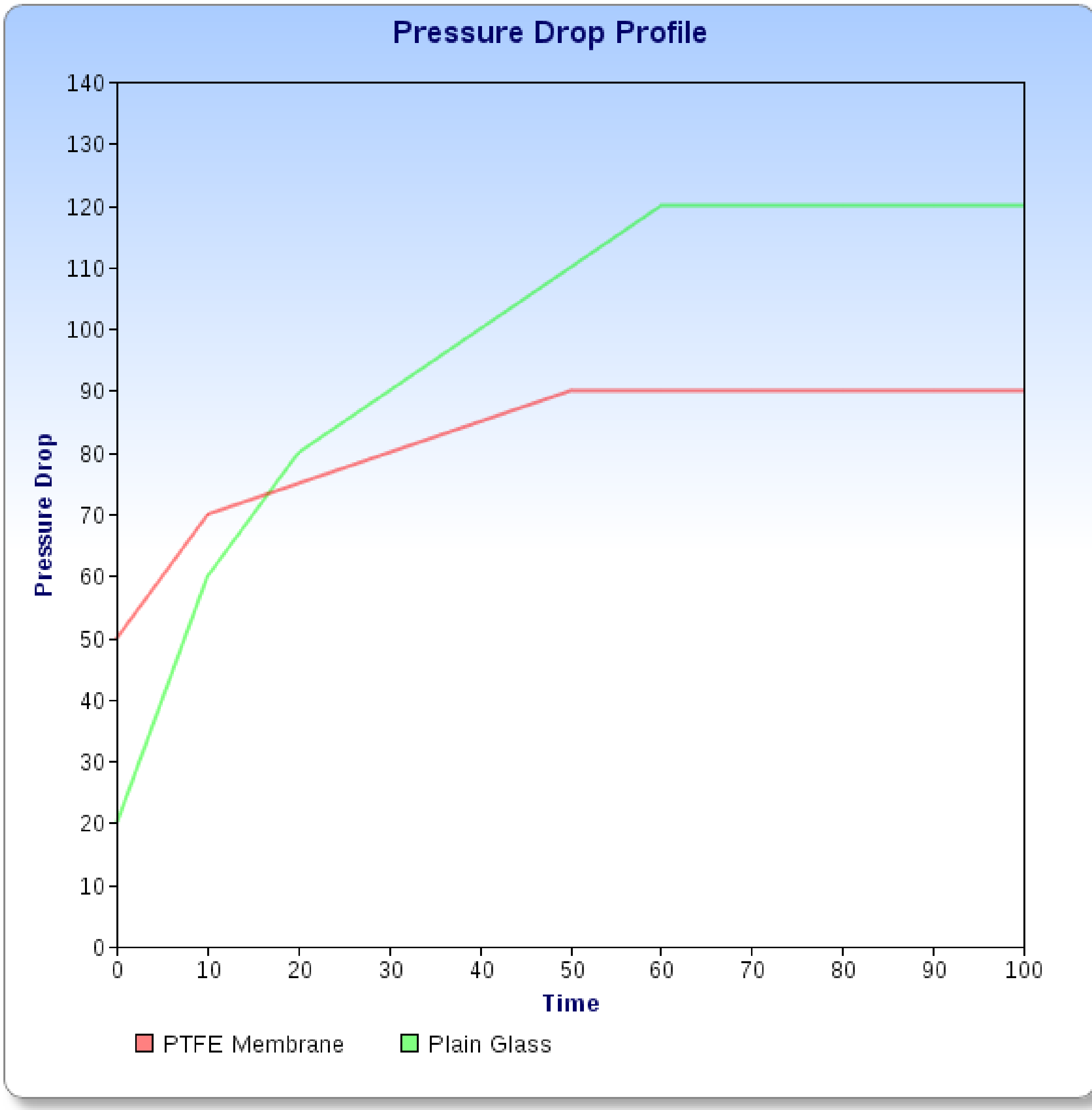

FIGURE 6: PRESSURE DROP PROFILES FOR ePTFE MEMBRANE AND PLAIN FILTERS

TECHNICAL FILTERS INC.

3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Siam Cement, Thailand)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln + Raw Mill
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	152 mm Ø x 6000 mm long
Hardware (Snap band, reinforcement)	SS Snap Band with 150 mm bottom reinforcement
Number of compartments	10
Bags per compartment	400
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	11,200
Filtration velocity, m/min	0.98
Continuous operating temperature, deg. C	145
Surge temperature, deg. C	230
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	25
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	5 - 50
Dust loading, g/m^3	90
Start Up Date	April 8, 2008
Emission rate, mg/Nm^3	< 14
Service life, years	5
Other information	Existing bag service life was 18 months

TECHNICAL FILTERS INC.
3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Union Cement, RAK, UAE)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	160 mm Ø x 5500 mm long
Hardware (Snap band, reinforcement)	SS Snap Band with 100 mm bottom reinforcement
Number of compartments	6
Bags per compartment	400
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	6900
Filtration velocity, m/min	1.04
Continuous operating temperature, deg. C	145
Surge temperature, deg. C	250
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	18
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	Not available
Dust loading, g/m^3	120
Start Up Date	August 15, 2009
Emission rate, mg/Nm^3	< 20
Service life, years	4.5
Other information	Application in one of two streams. Existing bag service life was 22 months

TECHNICAL FILTERS INC.

3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Fars Cement Iran)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	150 mm Ø x 7000 mm long
Hardware (Snap band, reinforcement)	SS Snap Band with 100 mm bottom reinforcement
Number of compartments	4
Bags per compartment	400
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	5600
Filtration velocity, m/min	1.06
Continuous operating temperature, deg. C	140
Surge temperature, deg. C	220
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	30
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	Not available
Dust loading, g/m^3	200
Start Up Date	December 28, 2009
Emission rate, mg/Nm^3	< 10
Service life, years	5.0
Other information	One of four streams

TECHNICAL FILTERS INC.

3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Atbara Cement Sudan)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	150 mm Ø x 3000 mm long
Hardware (Snap band, reinforcement)	100 mm bottom reinforcement
Number of compartments	1
Bags per compartment	1800
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	2800
Filtration velocity, m/min	1.1
Continuous operating temperature, deg. C	140
Surge temperature, deg. C	245
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	18
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	Not available
Dust loading, g/m^3	55
Start Up Date	November 15, 2007
Emission rate, mg/Nm^3	< 20
Service life, years	4 years (Converted to natural gas)
Other information	

TECHNICAL FILTERS INC.

3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Holcim India)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln + Raw Mill
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	152 mm Ø x 6000 mm long
Hardware (Snap band, reinforcement)	SS Snap Band with 150 mm bottom reinforcement
Number of compartments	5
Bags per compartment	450
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	6200
Filtration velocity, m/min	0.96
Continuous operating temperature, deg. C	150
Surge temperature, deg. C	240
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	22
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	5 - 40
Dust loading, g/m^3	175
Start Up Date	May 10, 2012
Emission rate, mg/Nm^3	< 15
Service life, years	Still running
Other information	One of three streams

TECHNICAL FILTERS INC.

3-35 STONE CHURCH ROAD, UNIT 328
ANCASTER, ON L9K1S5, CANADA
TEL: 647 400 2659
Web: www.technicalfilters.com
E-mail: info@technicalfilters.com

Industry (Cement, Coal Boiler, Incineration, etc.)	Cement (Spain)
Application (Kiln, Clinker Cooler, Raw Mill, etc.)	Kiln
Baghouse (Pulse, Reverse Air)	Pulse
Fabric (Glass/PTFE Membrane, etc.)	Glass with ePTFE Membrane
Weight of fabric (g/sqm)	750
Bag Dimensions	127 mm Ø x 4015 mm long
Hardware (Snap band, reinforcement)	SS Snap Band with 100 mm bottom reinforcement
Number of compartments	8
Bags per compartment	350
Off-line or On-Line	Online
Volumetric flow rate, m^3/min	4660
Filtration velocity, m/min	1.04
Continuous operating temperature, deg. C	140
Surge temperature, deg. C	245
Mode of operation (24/7, 12 hrs/day, etc.)	24/7
Moisture in gas, %	27
Acid in gas, ppm	N/A
Alkali in gas, ppm	ND
Average particle size, microns	5 - 50
Dust loading, g/m^3	90
Start Up Date	November 05, 2013
Emission rate, mg/Nm^3	< 10
Service life, years	Still running
Other information	One of two streams