How to get the Most out of Your Baghouse With Gore™ ePTFE Filter media

McIlvaine Hot Topics

October 28, 2010

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W. L. Gore & Associates, Inc.

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Agenda

- Overview of W. L. Gore & Associates
- What is ePTFE membrane filtration
- MACT Legislation (simplified version)
- EPTFE Membrane vs. Other Filter Media
- Getting the most out of ePTFE membrane media
- Conclusions

Overview of W. L. Gore & Associates

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Company Overview

- Founded in 1958
- Inventors of ePTFE membrane (patented in 1963)
- Associate-owned
- 8,500 associates
- 45 plants and sales locations globally
- Manufacturing in U.S., Germany, Scotland, Japan, and China
- Sales of over $3 billion in fiscal 2009
- Ranked in the U.S. and Europe by Fortune Magazine as one of the top 100 company's to work for

Gore's Four Divisions

- Electronic products
- Industrial products
- Medical products
- Fabrics

What is e-PTFE membrane filtration

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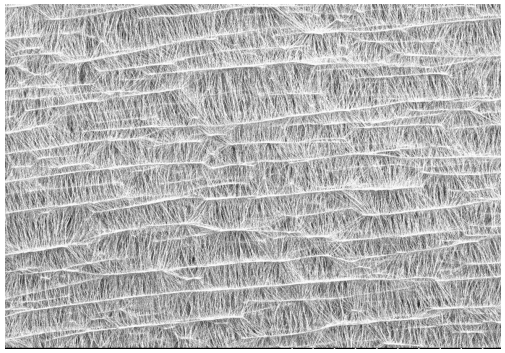
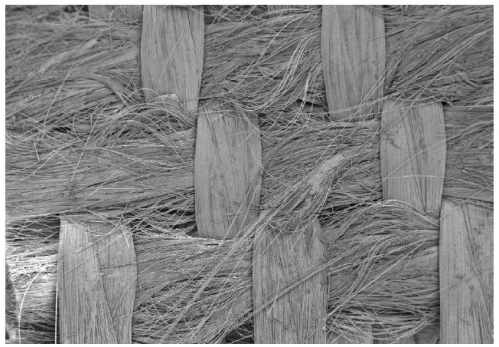
What is Membrane Filter Media?



ePTFE Membrane

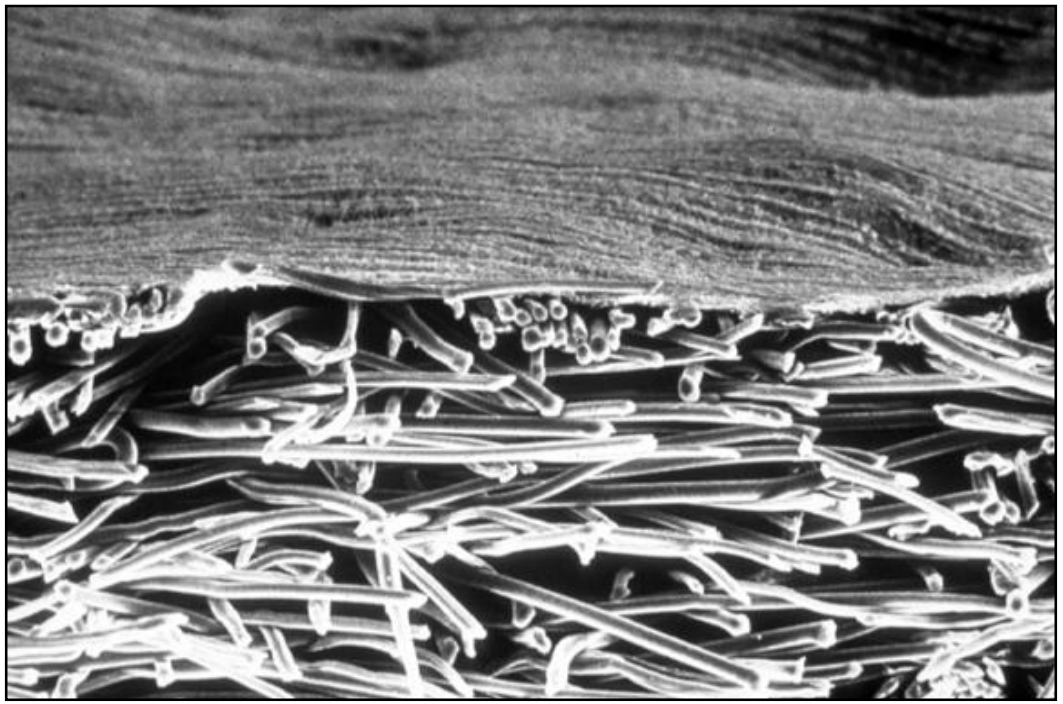
Fabric (Fiberglass or felt)



Proprietary
Lamination Process

ePTFE Membrane
Laminate

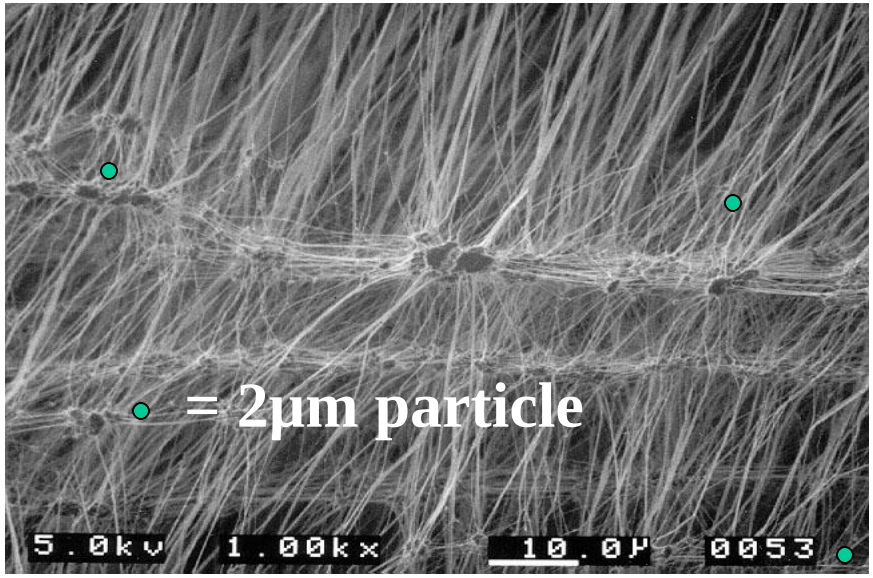
GORE® Filter Laminate



Surface Filtration vs. Depth Filtration

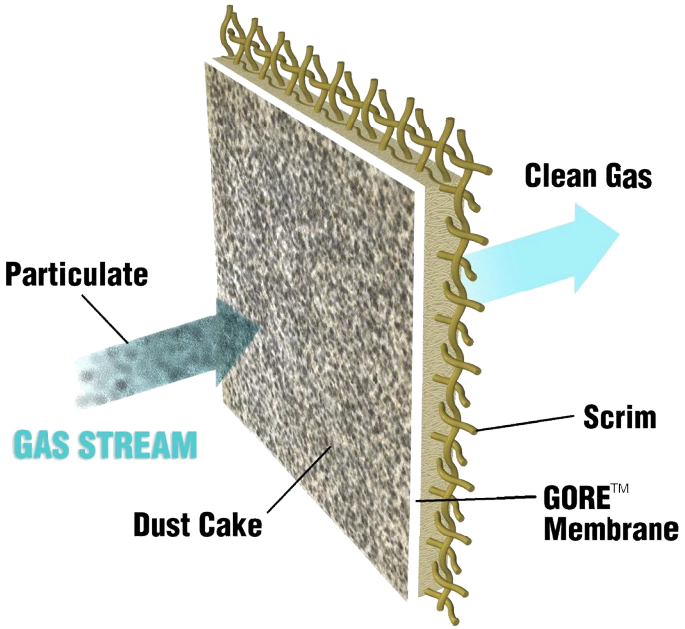
Sieving is one of the mechanisms in Filtration

– Micro-pores collect fine particles on the “Surface” of the membrane

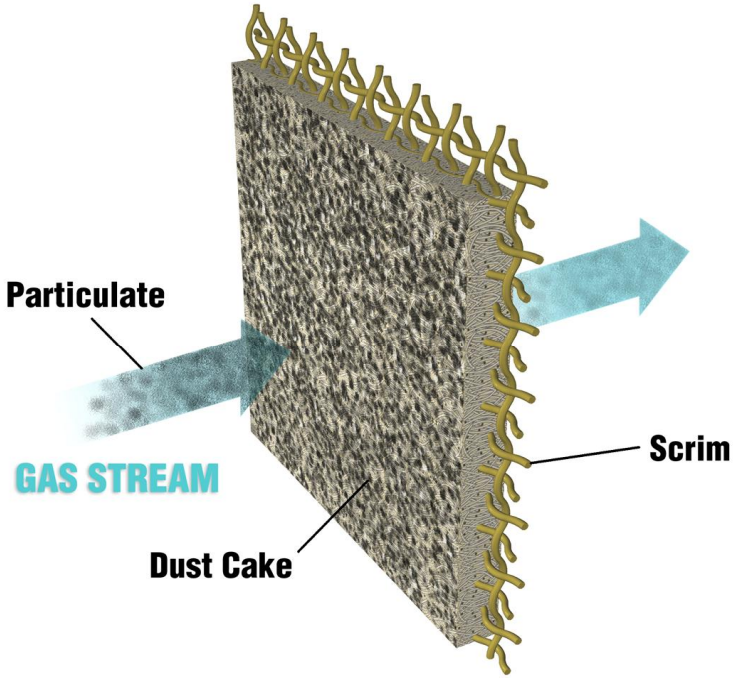


Filtering Mode (Surface vs. Depth)

Membrane Filtering Mode

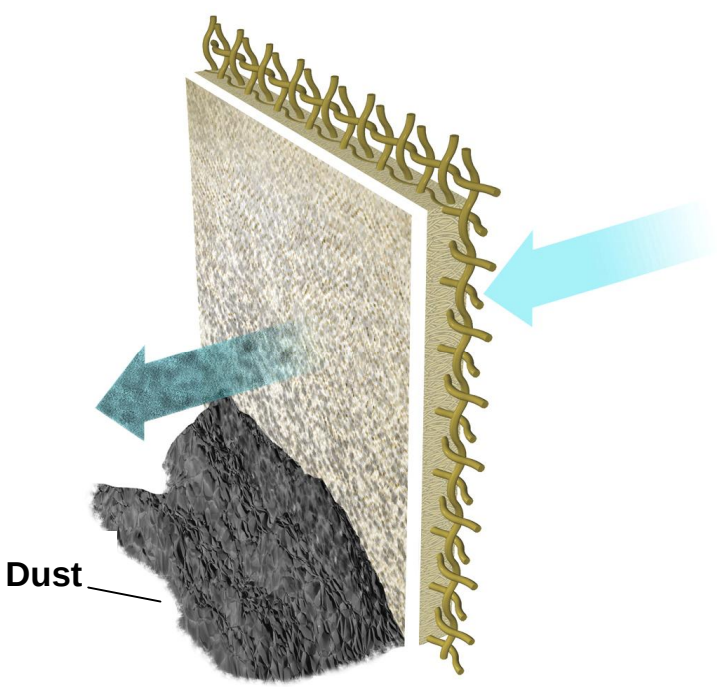


Conventional Filtering Mode



Cleaning Mode (Surface vs. Depth)

Membrane Cleaning Mode



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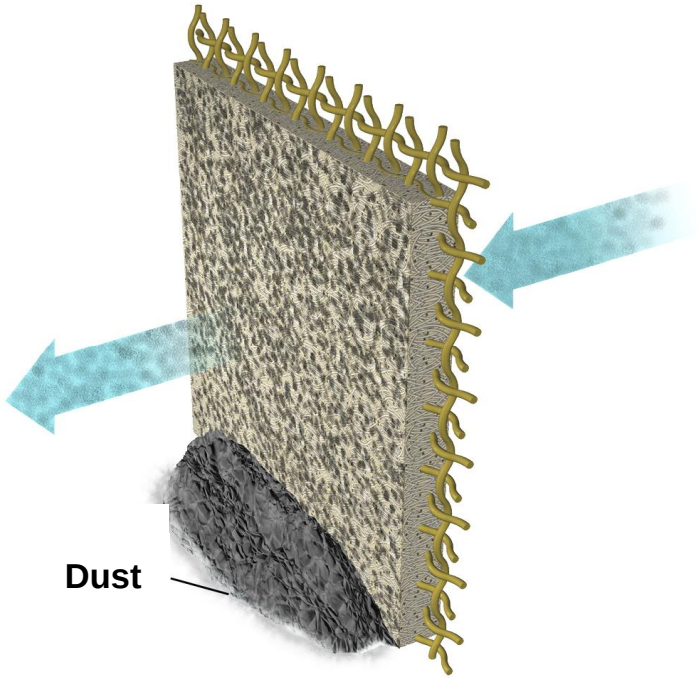

Summary of ePTFE Membrane Filtration

- Particles captured on the surface
  - Extremely fine pores (microporous)
  - Smooth, non-stick , chemically inert surface
- Improved release of dust cake
  - Lower residual (after cleaning) pressure drop
  - Higher airflow/Lower fan energy
- Longer bag life
  - Longer Filtration/Fewer cleaning cycles
  - No abrasive dust in backing material
- Near zero emissions

MACT – NESHAP Summary

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MACT - Simplified

- MACT stands for Maximum Achievable Control Technology
- Effects facilities with Potential to Emit (PTE)
  - > 10 tons/yr of any one HAP (major source)
  - > 25 tons/year of all HAPs (major source)
- In a MACT analysis, the EPA gathers emissions data from plants for a given pollutant
- The data is analyzed and the average of the best performing 12% sets the limit for all existing sources
- The data from the single best source sets the limit for all New Sources

Industrial Boiler MACT

- Proposed rule out in April 2010
  - Effects all existing industrial, commercial, or industrial boilers or process heaters located at a major source
  - Excludes facilities that combust solid waste
  - 9 Categories for existing and new boilers and process heaters
  - Includes Electric Generating Units < 25 Mw
- As many as 57,000 existing units (42,000 boilers/15,000 process heaters) and 4,500 new boilers will be effected
  - Estimated 2,500 existing coal fired and 700 wood fired boilers
  - Approximately 250 new coal and 100 wood fired boilers
- The new limits will reduce air emissions of PM, hydrochloric acid, mercury, carbon monoxide, and dioxin/furnan
- Final rule due December 2010

Partial Proposed Boiler MACT Limits (for PC Boilers – one of the 9 categories)

Pollutant	Existing Source	New Source
PM	0.02 pounds per million BTU (roughly 0.01 gr/dscf; 25 mg/dscm)	0.001 pounds per million BTU (roughly 0.0005 gr/dscf; 1.2 mg/dscm)
Hydrochloric acid	0.02 pounds per million BTU	0.0006 pounds per million BTU
Mercury	0.000003 pounds per million BTU	0.000002 pounds per million BTU
Dioxins/Furans (TEQ)	0.004 ng/dscm	0.002 ng/dscm

Electric Generating Unit (EGU) MACT

- Information Collection Request sent to approximately 500 plants (due July – September 2010) to gather data on HAPs
- Some units asked for additional testing for emissions including
  - Acid gases (SO_2, HCl, HF, HCN)
  - Organics (CO, VOC, THC plus POM, NOx, Formaldehyde, Methane, O_2 CO_2
  - D/F
  - Non Hg Metals (Sb, As, Be, Cd, Cr, Co, Pb, Mn, Ni, Se)
- CO/VOC/THC may be surrogates for non- dioxin/furans organics; $PM_{2.5}$ may be a surrogate for non-Hg metals
- Implications are new APC equipment or upgrades may be requires at many units (e.g. PM control, FGD, Carbon Injection)
- Proposed rule by March 2011
- Final rule due November 2011

Can ePTFE membrane bags help with MACT?

- EPTFE Membrane filter media is gaining acceptance in Power Generation (even before MACT)
- 35 EGU plants currently using ePTFE membrane bags
- Approximately 16,000 Mw of capacity
- Partial list of users
  - Otter tail Power
  - MidAmerican Energy
  - Xcel Energy
  - Kansas City Power & Light
  - Basin Electric
- Membrane bags currently under consideration at several more plants

Gore Filter Media Choices for Boilers

- PTFE Laminates (felt or woven fabrics)
  - Temperatures up to 500°F (260°C) continuous
  - Chemically inert
- Fiberglass Laminates (woven fabric only)
- Temperature up to 500°F (260°C) continuous
  - Available with acid resistant finish
- PPS & Polyimide Laminates (subject to limitations; temperature, moisture, O_2, NO_2, strong oxidizing agents)

EPTFE Membrane vs. Other Filter Media

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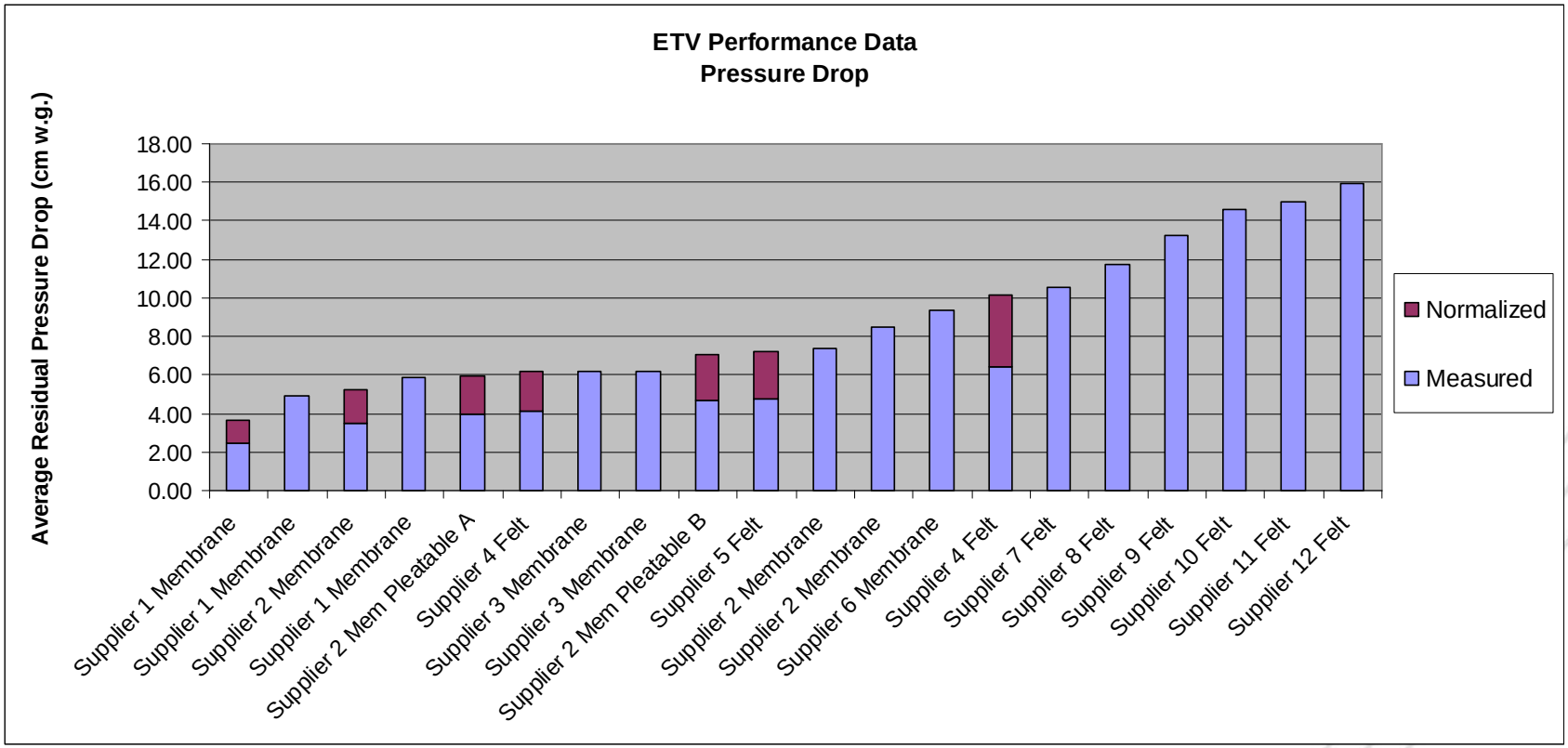
Lowest Pressure Drop - membrane media (EPA ETV expired verifications)



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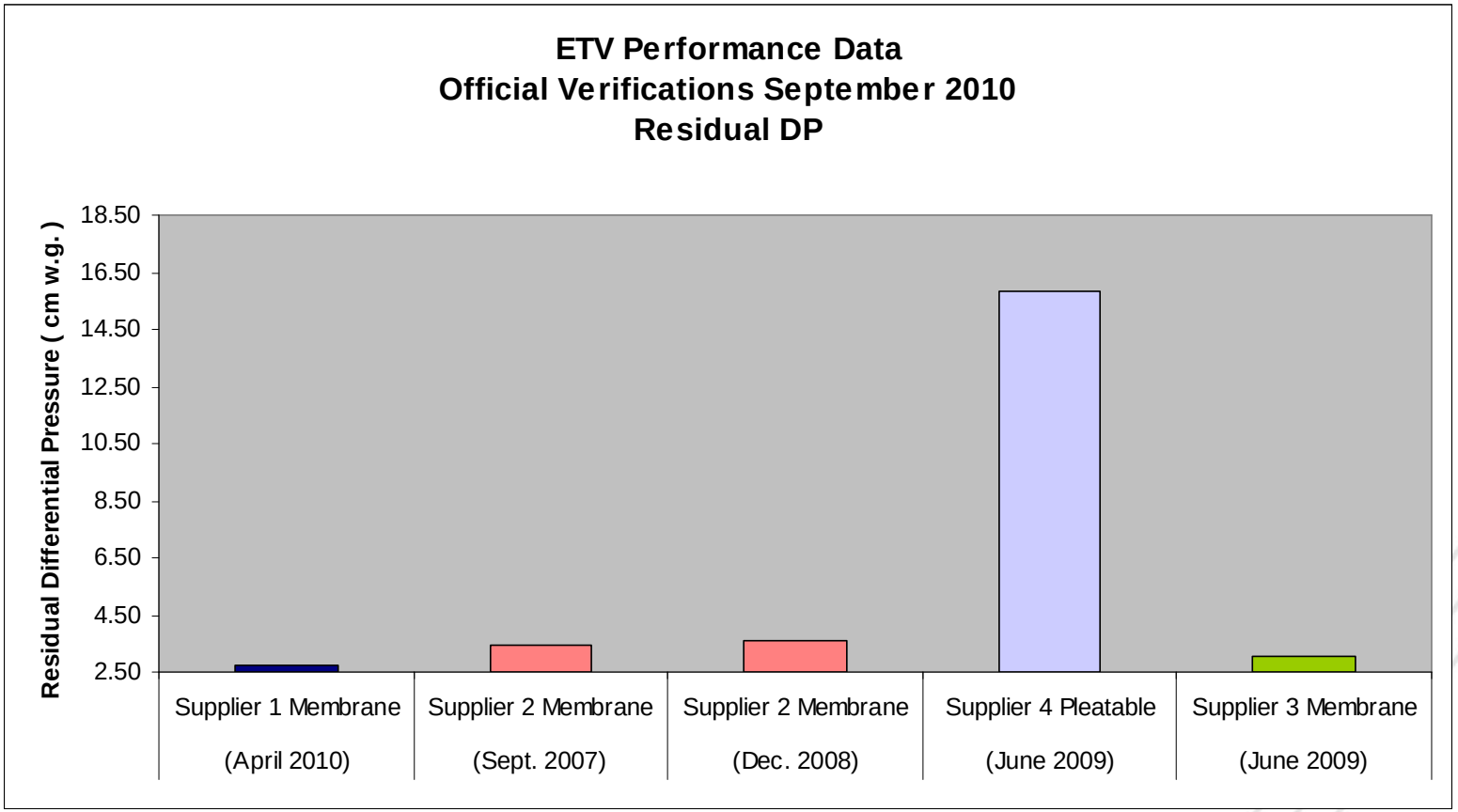
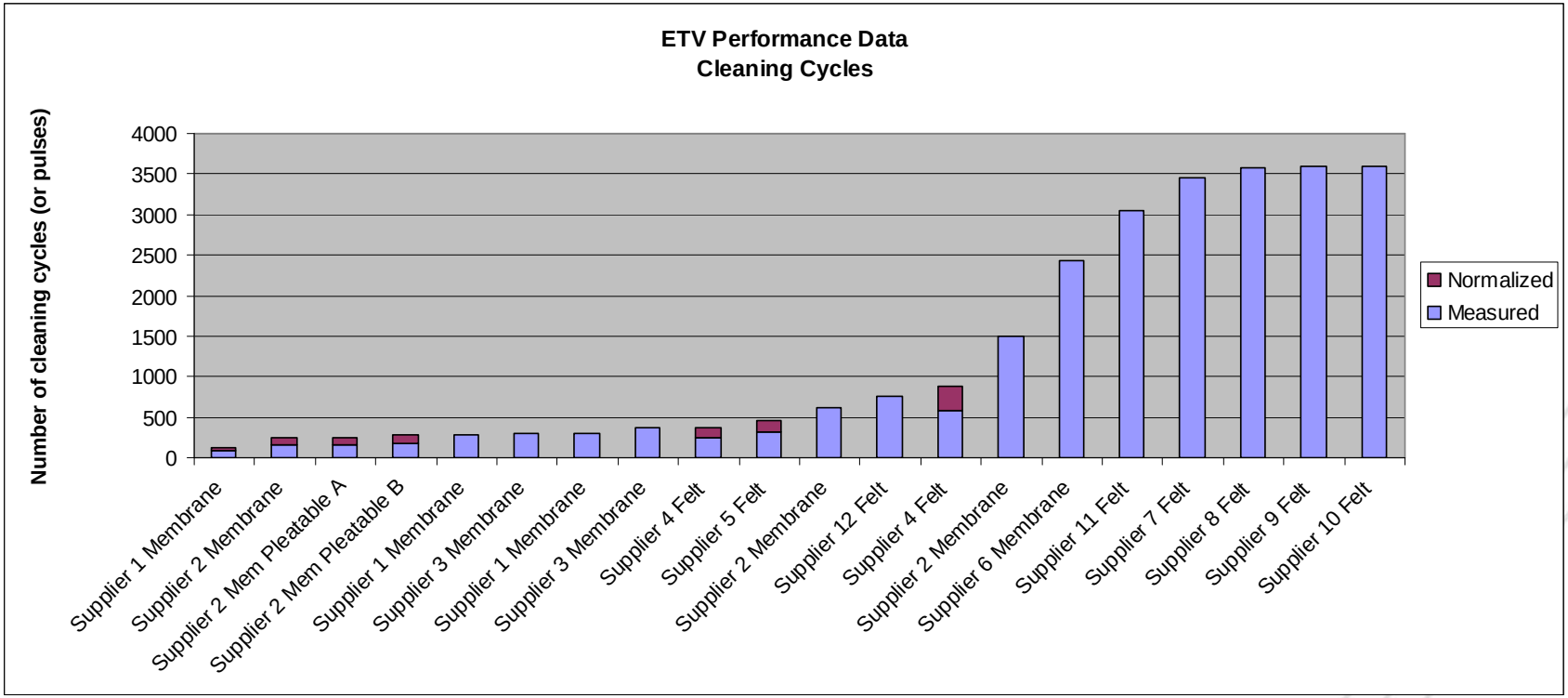


Fewest Cleaning Cycles – membrane media (from EPA ETV expired verifications)



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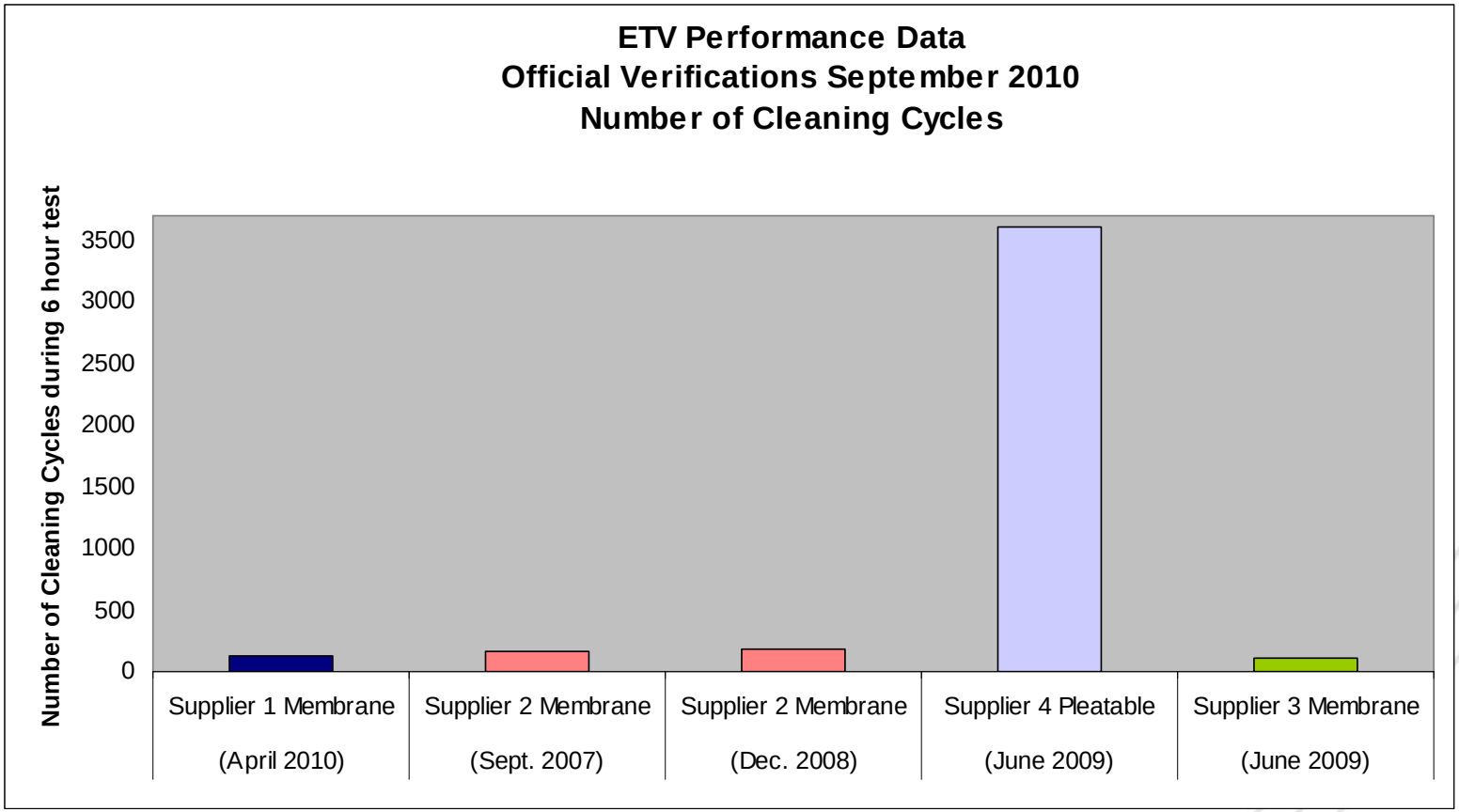
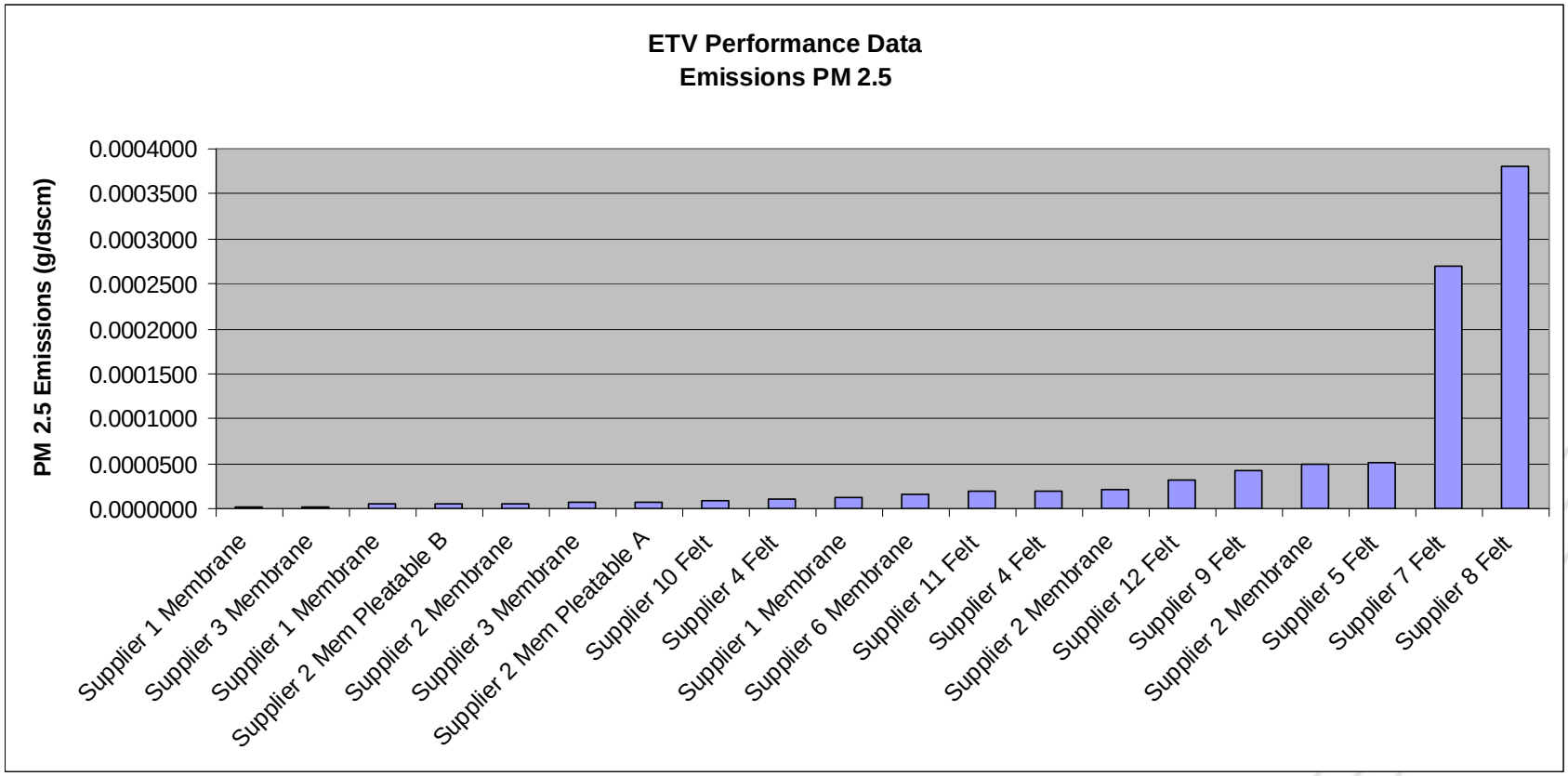


Lowest $PM_{2.5}$ Emissions – membrane media (EPA ETV expired verifications)



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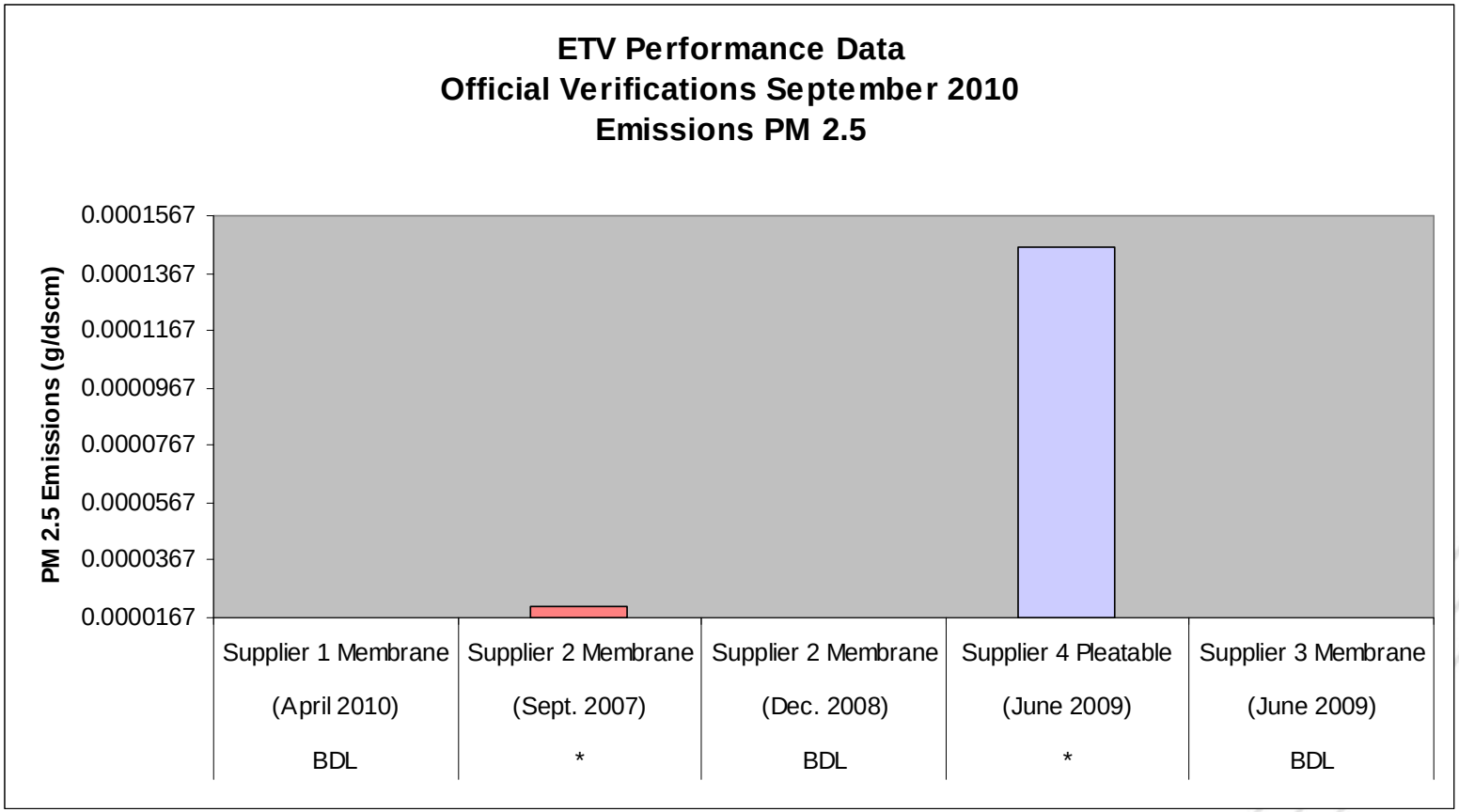

Membrane advantages in Coal Fired Boilers

- Expanded PTFE membrane is chemically inert
- EPTFE membrane captures of fine aerosol PM on the surface
  - Protects the backing material from acidic PM (solid or liquid)
  - (Note: Membrane will not collect acid gas/vapor)
- Smooth, micro-porous surface provides superior release of sticky ash ⟶ lower DP, less frequent cleaning
- EPTFE membrane is less sensitive to changes in ash (size or chemistry) and dust loading ⟶ lower PM and $PM_{2.5}$ emissions

Getting the Most from Your High Performance ePTFE Membrane Filter Media

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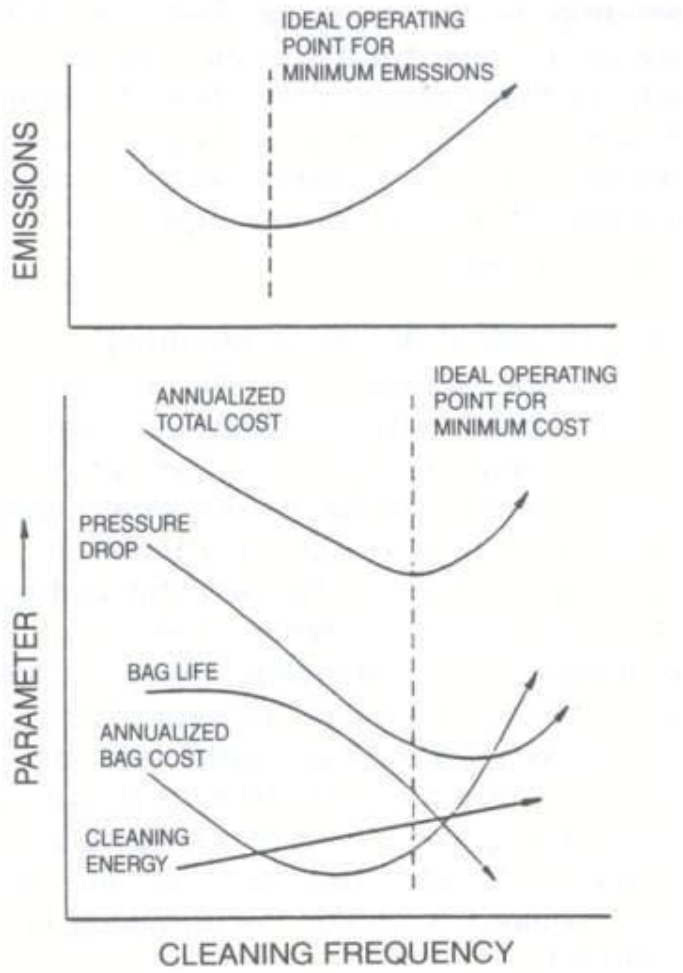
What is high performance?

- Lower Normalized DP (lower filter drag = DP/ACR)
  - Can handle higher dust loading at same relative DP
  - Can handle finer particles at same relative DP
  - Able to release more cohesive ash/dry scrubber products
- Lower PM emissions
  - Can capture fine, submicron particles
  - Eliminates/reduces opacity spikes after cleaning
  - Capable of achieving emissions at or near the detection limit of the test method (front half catch)

What is high performance? (cont'd)

- Longer bag life
  - Less frequent cleaning
  - Less cleaning energy (lower cleaning pressure)
  - Less fabric wear; dust captured on the filtration surface, not in the depth of the media

Objective – Getting the Lowest Annualized Cost w/o Emissions Problems



System Optimization:

- Bag Life
- Emissions
- Pressure Drop
- Gas Flow/Throughput

Should you consider high performance ePTFE membrane filter media in your boiler?

- Have you changed fuel? (Different coal or blend; Biomass or alternative fuel)
- Is your baghouse limiting production?
  - Have you increased production capability?
  - Have you increased the dust loading to the baghouse? (fuel change, dry sorbent injection, etc)
  - Can you perform on-line maintenance without reducing load?
- Do filter bags need to be replaced frequently between planned outages?
- Do you have changing operating conditions (load changes) or periodic upsets (tube leaks)?
- Do you ever have to decrease load due to opacity or emissions related to PM?
- Do you have to meet new environmental regulations?
- Is you baghouse performance below expectations?
  - Differential pressure (DP)
  - Bag life
  - Emissions

If “yes” to any of the above, you may want to consider it

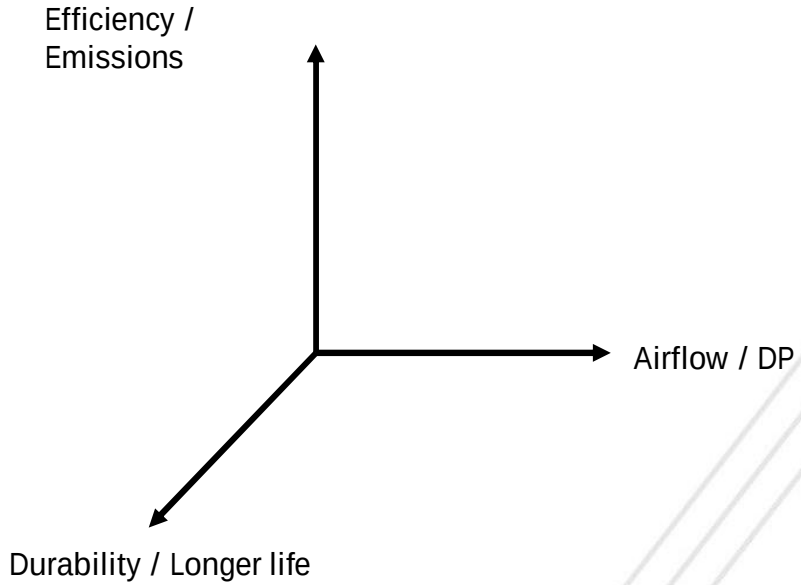
Why consider ePTFE membrane?

- EPTFE Membrane bags can deliver higher performance
  - Lower DP/ Higher gas flow
  - Reduced PM emissions
  - Longer bag life

(There is a higher price for this performance so make sure it is a proper application for ePTFE membrane media)

GORE™ ePTFE Membrane– Optimized performance

- It is relatively easy to optimize for one of these attributes. (window screen has high airflow but poor life and efficiency)
- It is more difficult to optimize for two of these three attributes (steel tubes are highly efficient and could last a long time but with an infinite DP)
- It is even more difficult to optimize for all three simultaneously. Gore innovates to do exactly this.



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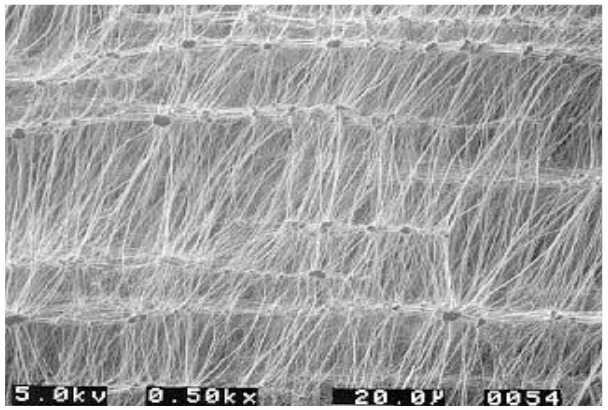
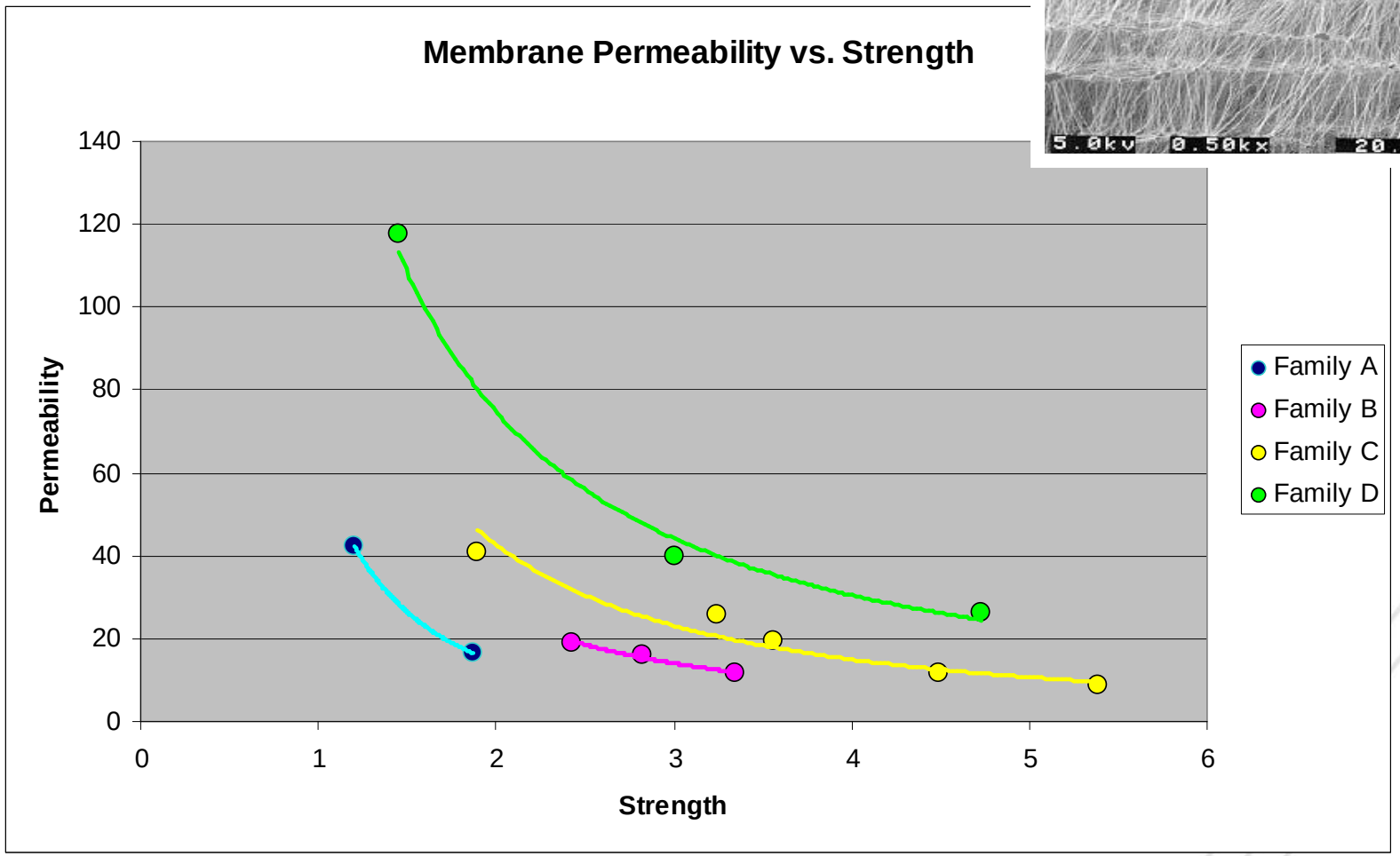
GORE® Filtration Products
Continuous Innovation





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Recommendations: Before Selecting ePTFE Membrane Filter Bags

- Step 1 – Customer Needs Assessment
  - Is the baghouse performing to expectations?
  - Can performance be enhanced with ePTFE membrane media?
- Step 2 - System Design Review
  - Is ePTFE membrane a viable option?
- Step 3 – System Survey
  - Verify current baghouse operating conditions (gas flow, DP, bag life, etc)
  - Check for hardware problems that effect baghouse performance
- Step 4 - System Analysis
  - Project expected performance with ePTFE membrane media
  - Economic Evaluation (Benefits/Costs Analysis)

Recommendations: After installing ePTFE Membrane Filter Bags

- System optimization
  - Minimize Operating Cost
  - Meeting PM Regulations

(usually requires modifications to the cleaning system parameters)

- Check current performance against original projections
- Re-check performance periodically and re-optimize as necessary
- Conduct periodic bag analyses to project bag life

Conclusions

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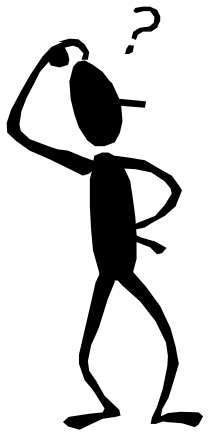
Conclusions

- EPTFE membrane bags are well suited for coal-fired boiler applications
  - Capture corrosive ash/aerosols on a chemically inert surface
  - Superior release of sticky ash
  - PTFE membrane surface is less sensitive to PM size, shape, chemistry, and dust loading
- Can handle process upsets/tube leaks
- Allow maximum fuel flexibility (different coals and alternative fuels)
- Membrane bags can be a cost effective way to improve baghouse performance

(Membrane bags do not collect condensable acid gases or vapors, however, they are compatible with additive systems for SO_3 control)

Questions?



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