Fabric Selection for Hot Gas Applications

The McIlvaine Company
Panel Discussion

January 8, 2015

Presented By: John D. McKenna, Ph.D.

ETS, Inc.
1401 Municipal Road, NW
Roanoke, VA 24012

What Will Be Covered?

- Cleaning Methods & Filter Media Options (CFB)
- Emission Goals and Design & Selection
- Time v. Temperature Study
- Emission Performance in Lab (Membrane vs. Felts)
- Relative Bag Performance
- Cost Considerations
- ETS, Inc. Study – "Acid Resistance of Woven Fiberglass Fabrics with & without a Membrane"
- Evonik Fibers 11th Conference on High Temperature Filtration

Cleaning Methods & Filter Media Options (CFB)

Pulse Jet

1) PPS Felt
2) P-84® Felt
3) Teflon® Felt
4) PPS Felt/ePTFE membrane
5) PPS Felt/PTFE Resin
6) Woven Fiberglass
7) Woven Fiberglass/ePTFE membrane
8) PPS Felt/P-84® Blends
9) Aramid (Nomex®) Felt

Reverse Air

1) Woven Fiberglass
2) Woven Fiberglass/ ePTFE membrane

Design:
Fabric Selection Considerations

Gas Stream

- Temperature
- Moisture
- Chemistry
- Dust Loading

Dust Characterization

- Abrasiveness
- Stickiness
- Explosiveness
- Flammability

Fabric

- Filtration Performance
- Temperature Max
- Release Properties
- Pressure Drop
- Life/Durability
- Costs

Other

- ePTFE Membrane
- Coatings/Treatment
- Blends
- Scrim
- Hardware

Fabric Selection Chart

Fabric	Max Continuous Temp	Surge Temp.	Acid Resistance	Fluoride Resistance	Alkali Resistance	Flex Abrasion Resistance	Relative Cost*
Cotton	180 °F	200 °F	Poor	Poor	Good	Very Good	0.3
Wool	200 °F	230 °F	Good	--	Poor	Fair	--
Polypropylene	200 °F	200 °F	Excellent	Poor	Excellent	Very Good	0.4
Acrylic	265 °F	284 °F	--	--	Fair	Good	0.4
Polyester	275 °F	300 °F	Fair	Poor to Fair	Fair	Very Good	0.4
Basofil®/ Melamine	375 °F	-- °F	Good	--	Excellent	--	--
PPS	375 °F	425 °F	Good	Good	Very Good	Very Good	1.0
Nomex®/ Aramid	400 °F	425 °F	Poor to Fair	Good	Good	Excellent	0.9
P-84®/ Polyimide	400 °F	500 °F	Fair	Fair to Good	Fair	Good	1.7
Teflon®/PTFE	450 °F	500 °F	Excellent	Excellent	Excellent	Fair	4.7
Glass Felt	500 °F	550 °F	Good	Poor	Fair	Fair	1.6
Woven Fiberglass	500 °F	-- °F	Fair to Good	Poor	Fair to Good	Fair	0.8

*Relative Cost – PPS Pulse Jet Bag 5”∅ x 10’ Long

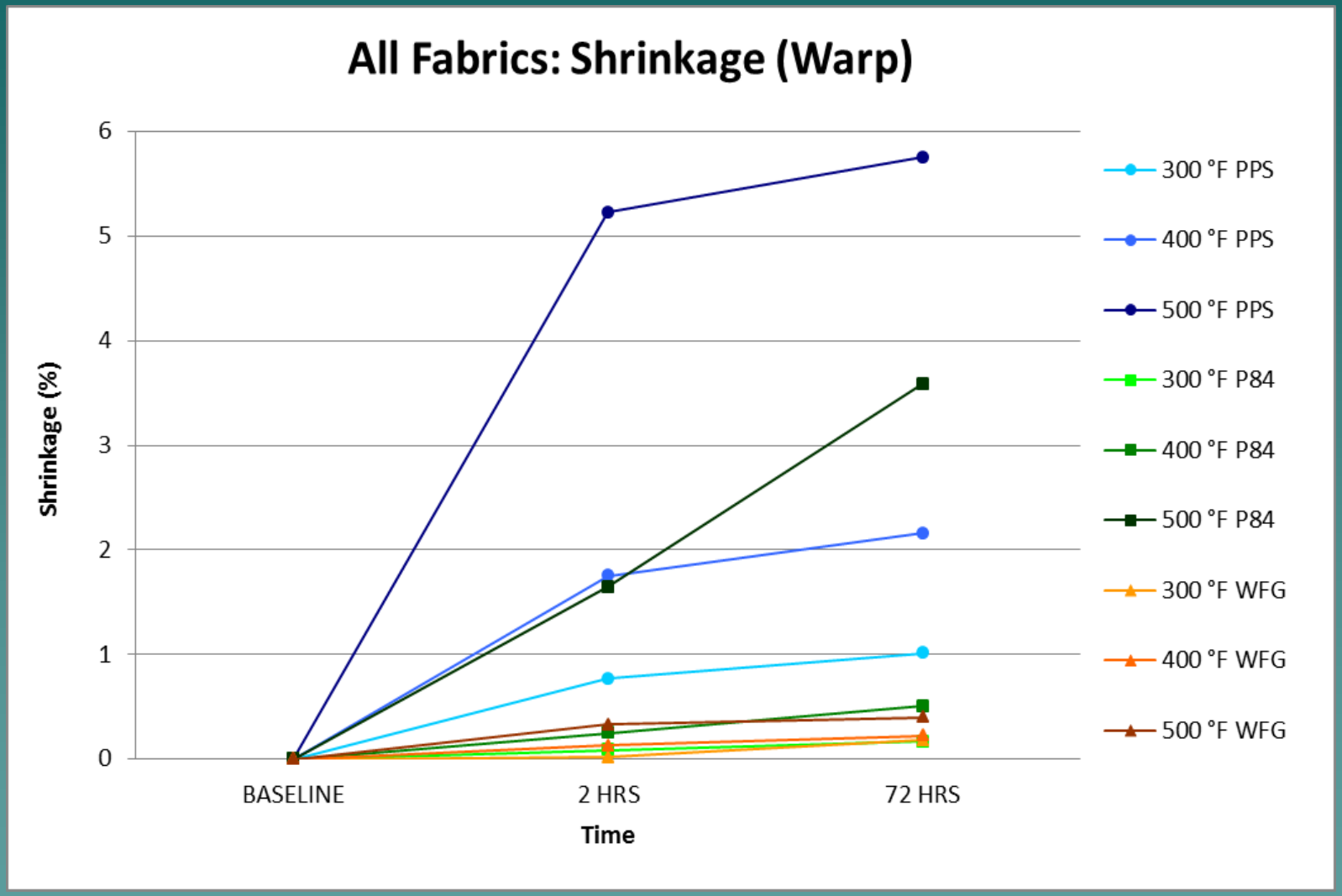
Time v. Temperature Study Summary of Results

SUMMARY OF TEST RESULTS

ALL FABRICS (PPS, P-84, & WFG w/ePTFE Membrane)

TEST PERFORMED		BASELINE	300 °F AFTER 2 HRS	300 °F AFTER 72 HRS	400 °F AFTER 2 HRS	400 °F AFTER 72 HRS	500 °F AFTER 2 HRS	500 °F AFTER 72 HRS
WEIGHT, oz/yd²								
PPS		15.13	15.06	15.11	14.87	14.83	14.97	14.96
P84		18.66	17.92	16.68	18.11	16.91	16.90	18.71
WFG		23.28	23.18	23.10	23.52	23.50	23.40	23.42
PERMEABILITY, fpm								
PPS		34.9	36.2	37.4	38.6	39.0	31.3	30.8
P84		20.8	21.7	30.7	21.8	27.8	23.9	20.8
WFG		4.6	5.4	5.9	5.5	5.8	5.5	5.8
SHRINKAGE-%								
PPS	WARP	-	0.77	1.01	1.75	2.16	8.79	8.91
	FILL	-	-0.01	0.25	0.49	0.66	5.23	5.75
P84	WARP	-	0.08	0.17	0.25	0.51	1.65	3.58
	FILL	-	0.16	0.37	0.27	0.52	1.52	3.71
WFG	WARP	-	0.02	0.18	0.13	0.23	0.33	0.40
	FILL	-	-0.02	0.01	-0.17	-0.08	0.14	0.21
MULLEN BURST, psi								
PPS		410	423	438	440	430	433	370
P84		715	590	558	633	565	590	655
WFG		1500	1500	1285	1290	1355	1210	920
TENSILE STRENGTH, lbs/in								
PPS	WARP	87	83	87	90	87	81	63
	FILL	144	147	142	140	141	126	99
P84	WARP	86	94	79	92	94	111	105
	FILL	170	166	161	174	190	180	181
WFG	WARP	500	500	500	500	500	475	329
	FILL	500	500	500	500	500	500	475
MIT FLEX, # flexes								
PPS	WARP	190220	233252	121986	241888	159490	75224	56949
	FILL	137731	121278	88662	131724	81249	87791	25023
P84	WARP	102267	198072	54316	17948	35810	95863	35148
	FILL	314043	59618	50048	34308	35639	80773	28664
WFG	WARP	32566	19802	41749	27550	21896	26778	19556
	FILL	28282	23177	18545	15429	16943	12839	9915

Time v. Temp. Summary Graph



Emission Performance in Lab

(Membrane v. Felts)

	Fabric Type		
Parameter:	PPS Felt	P-84 Felt	Woven Fiberglass w/ ePTFE Membrane
Outlet PM 2.5 Particle Concentration, gr/dscf	0.0000669	0.0000482	0.0000007
Number of Pulses	179	168	108
Residual Pressure Drop, Performance Test Period, inches w.g.	1.04	0.94	1.05
Removal Efficiency % (PM 2.5)*	99.99879	99.99911	99.99999

$$* \frac{(\text{Dust Concentration} * 0.5287) - \text{PM 2.5 Outlet Concentration}}{\text{Dust Concentration} * 0.5287} * 100$$

Relative Bag Performance Conclusions

- Filtration performance of P-84 and PPS felt similar and very good.
- Filtration performance of WFG/Membrane excellent.
- Other study* shows membrane out-performs traditional felts.
- Bag Life
  - PPS Felt, can exceed 5 years
  - P-84 Felt, can exceed 2½ years
  - WFG/Membrane, dependent on multiple factors
- Cost of Bags
  - P-84, commands a premium (1.7)
  - WFG/Membrane, (.8)
- Ultimate decision is a function of site specific inlet definition and cage design.

Cost Considerations

- Current pricing per bag, 33’ long by 5” diameter:
  - PPS Felt ~ $81-90
  - P-84 Felt ~ $143-158
  - WFG/Membrane ~ $73-81

“Acid Resistance of Woven Fiberglass with & without a Membrane”

ETS, Inc. study conducted Summer of 2014 with the following objectives:

- Gauge the effectiveness of membrane coated woven fiberglass fabrics to resist acid
- Differences in fabric finishes
  - Acid resistant
  - PTFE coated
- Do production methods of woven fiberglass influence performance or longevity?
- Comparable data of woven fiberglass fabric response to sulfuric acid

Managing Bag Life – An Action Plan

- SELECTION - Select media for the inlet gas constituents & process operation.
- SPECIFICATION - Specify filter media, thread, bag and hardware.
- QUALITY ASSURANCE - QA/QC program to insure what is delivered meets the spec.
- INSTALLATION - Oversee the installation of the bags and perform leak tests.
- BAG MONITORING - Test periodically. Increase frequency if strength or permeability decline steeply.
- IDENTIFY & CORRECT – Immediately fix any leaks or high ΔP.

Preventing the dust from entering the "clean side" of the baghouse and bags is a must.

Evonik Fibers 11th Conference on High Temperature Filtration

- Conference held September 9-11th, 2014 in Leogang, Austria
- "New Filtermedia Concepts to Optimize Baghouse Performance"
- Presentations available on Evonik website

THANK YOU FOR LISTENING

- LAB CONTACTS (540) 265-0004

John D. McKenna Ph.D. (Principal) jmck@etsi-inc.com
Ext. 293

Terry G. Williamson (VP-Laboratory Operations) terryw@etsi-inc.com
Ext. 295

Christina C. Clark (Engineering Manager) christinac@etsi-inc.com
Ext. 216

Questions?