Mercury Issues for ESP/FF Technology

WPCA/Dominion Seminar

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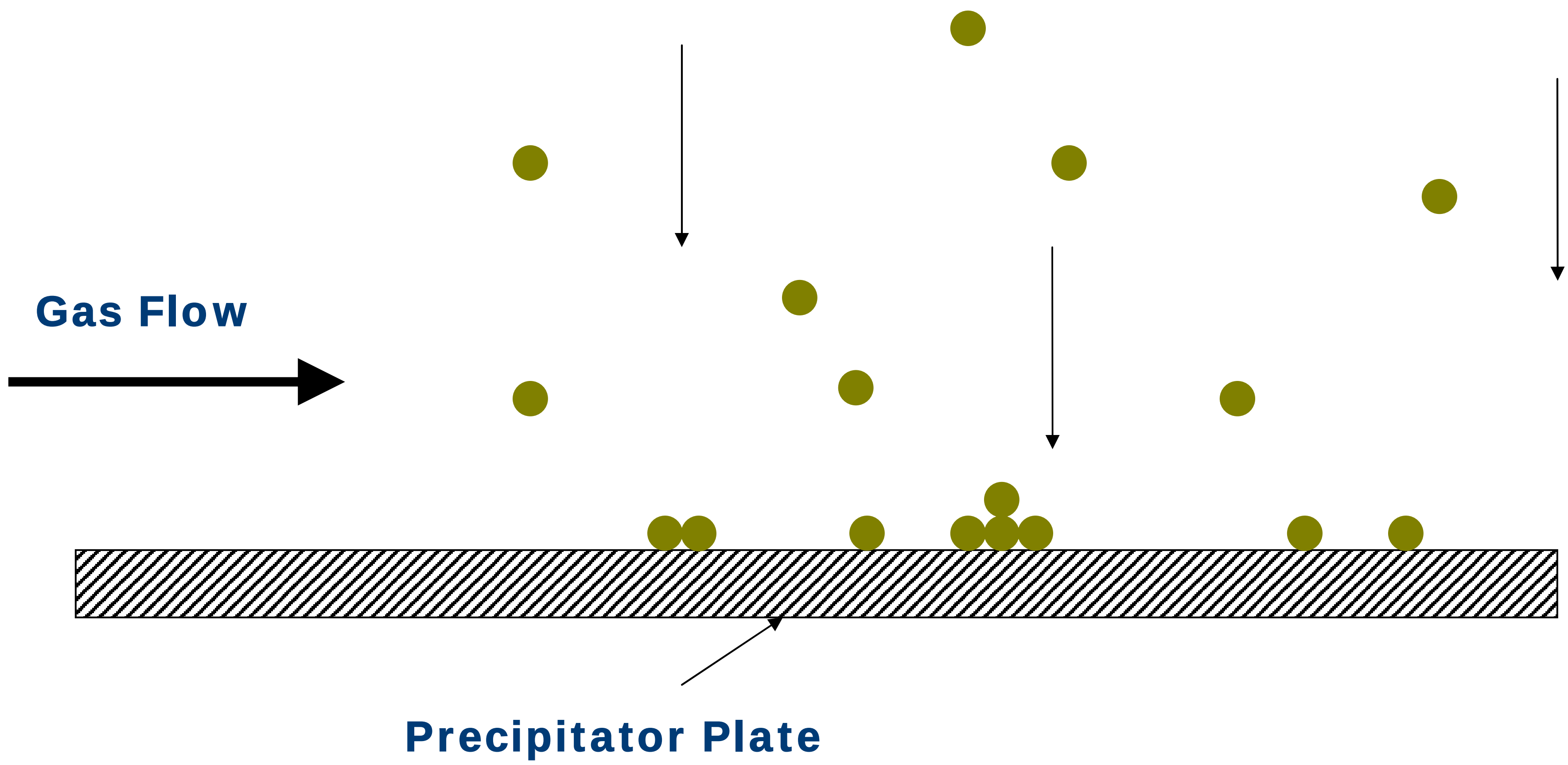
Some Basics…

ESPs

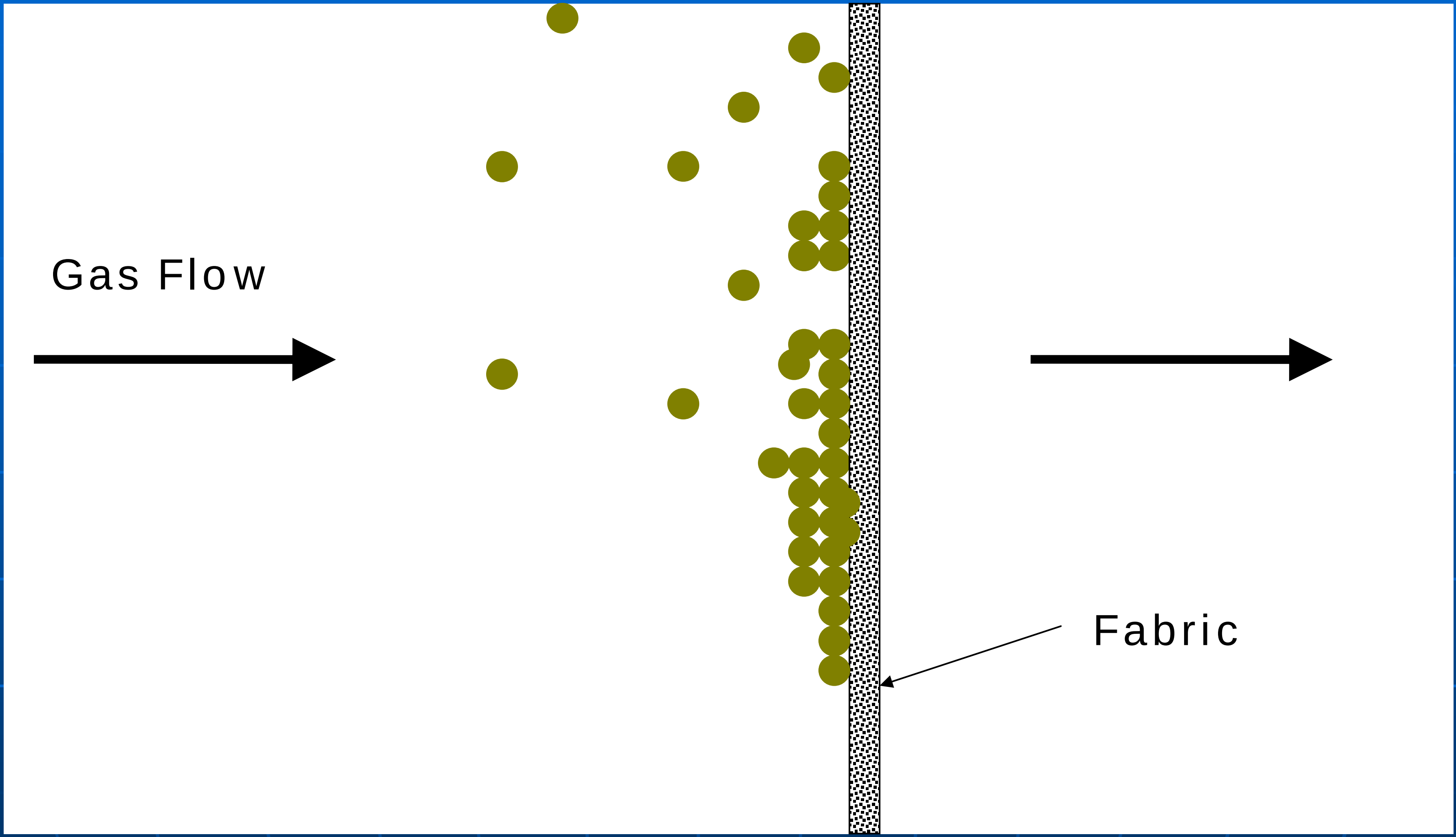
- Creates Residence Time
- Exposure of Hg to gas constituents
- Small Temp. change
- Some ash / gas contacting

Fabric Filters

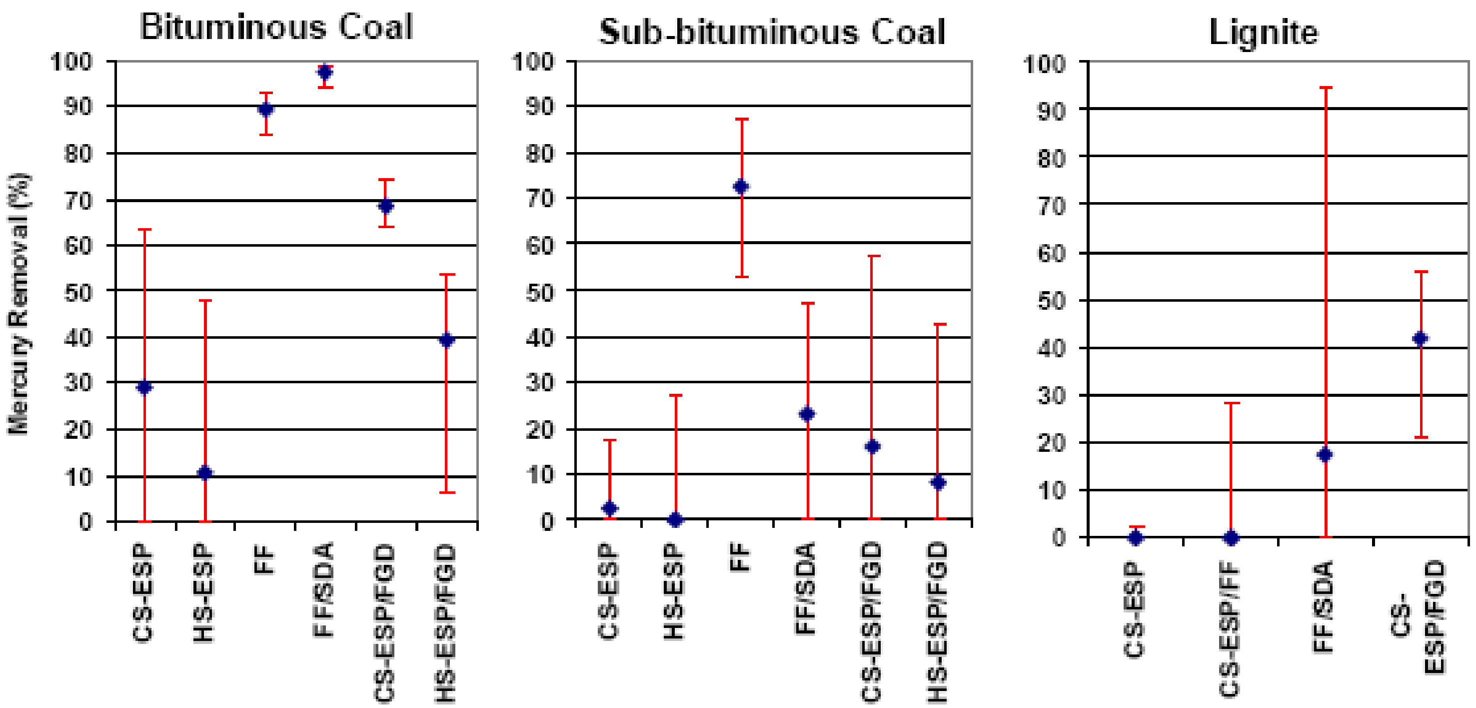
- Creates Residence Time
- Exposure of Hg to gas constituents
- Small Temp. change
- Intimate ash / gas contacting



ESP PHYSICS

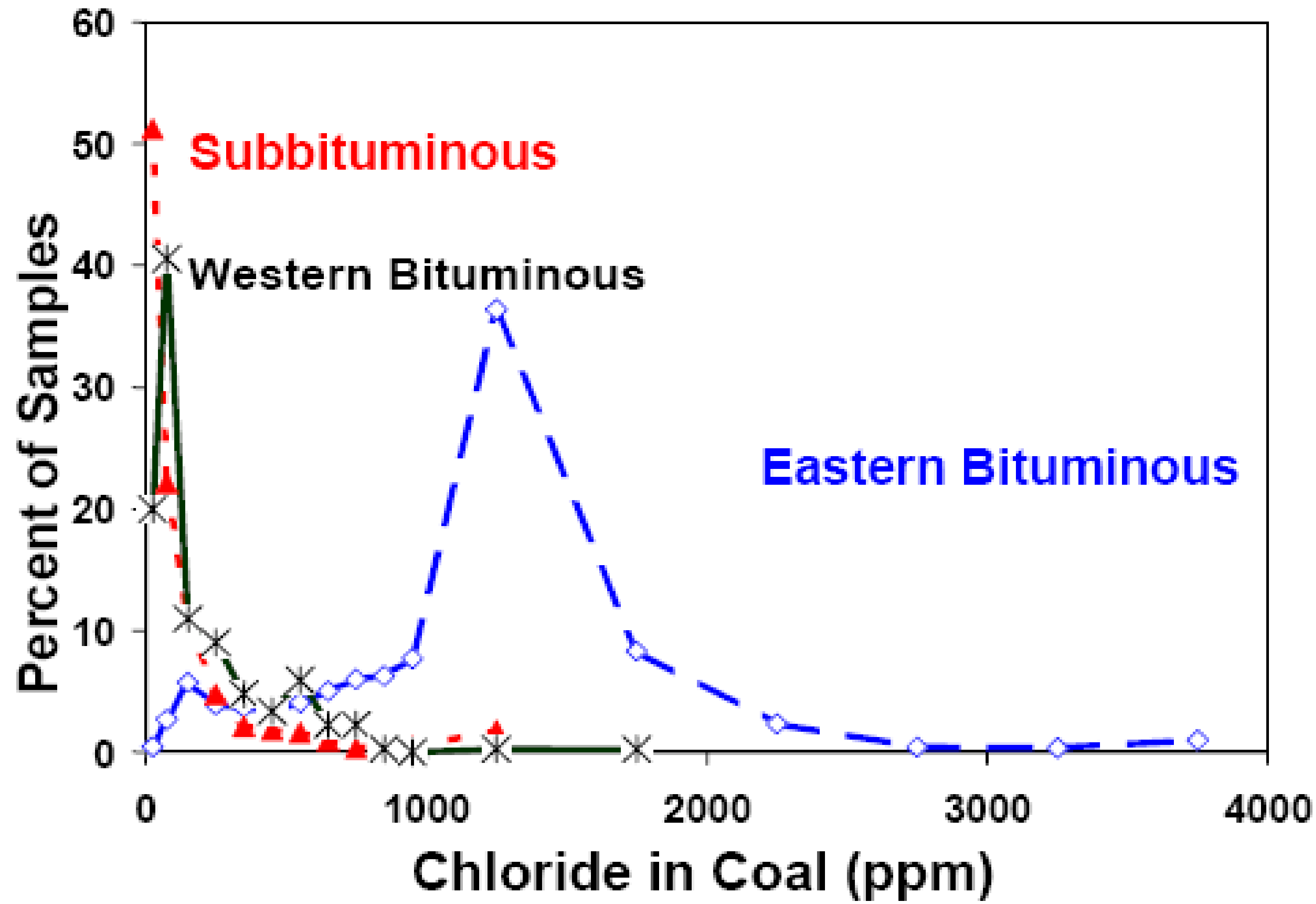


FF PHYSICS



Native Control Effectiveness

-For Illustrative Purposes Only – All Individual Devices Vary ! -



Distribution of Chloride in Coal by Type

Speciated Mercury Measured by Ontario Hydro Method, Baseline Conditions (Without Sorbent Injection). Average of Three Runs, Brayton Point Unit 1, June 2002.

	Particulate (µg/dncm)	Elemental (µg/dncm)	Oxidized (µg/dncm)	Total (µg/dncm)
ESP Inlet	4.6	ND <0.21	0.26	5.1
ESP Outlet	<0.007	ND <0.29	0.18	0.48
Removal Efficiency (%)	99.8	N/A	30.8	**90.6%**

Note: all mercury numbers are µg/dscm at 32°F, 3% O_2.

Example of High Native Hg Removal - ESP

Speciated Mercury Measured by Ontario Hydro Method, Baseline Conditions.

Location	Particulate (µg/dncm)[1]	Elemental (µg/dncm)[1]	Oxidized (µg/dncm)[1]	Total (µg/dncm)[1]	Total (lbs/TBtu)
ESP Inlet	1.97	12.22	2.51	16.7	12.2
ESP Outlet	0.01	9.80	6.01	15.8	11.5
Average RE %	**99.5**	**19.8**	**-139.3**	**5.3**	
% of Total at Inlet	11.8	73.1	15.0		
% of Total at Outlet	0	61.9	38.0		

Note 1: Normal: T = 32 °F, Values corrected to 3% O_2

Example of Low Native Hg Removal - ESP

Pre-Baseline Mercury Measurement Results (S-CEM).

Location	Total Mercury $\mu g/dNm^3$ @ 3% O_2	Oxidized Mercury %
ESP Inlet	7–10	5–33
ESP Outlet/COHPAC® Inlet	7–10	29–51
COHPAC® Outlet	7–10	52–76
Mercury Removal Across ESP	0%	
Mercury Removal Across COHPAC®	0%	

Example of No Native Hg Removal – ESP & FF

Table 1. Non-Scrubbed Units with Cold-Side ESPs

ID*	NOx Control	FGC	SCA	ESP Inlet Temp	Coal Chloride	Ash LOI	% Hg on Filter	% Hg Removal
B-1	LNB		290	289	882		0	8
B-2	LNB		550	310	575	5-10	36	26
B-3	LNB		550	245	966	3-7	30	23
B-4	LNB		252	322	2100	5-10	29	24
B-5	LNB		346	321	800	5-10	75	30
B-6	LNB&S NCR		475	262	264	25	84	88
B-7			323	320	333	3-6	60	46
L-1	LNB		599	368	18		0	7
L-2			267	395	115	1.4	17	-2
L-3				368	29		5	-1
L-4	LNB		470	329	74	1-5	1	-4
S-1		SO_3	468	291	100	<.5	2	-35
S-2	OFA	SO_3	686	306	57	0.09-0.18	1	-3
S-3	CC		213	317	133	1-2	16	10
S-4	LNB		279	322	76	1-2	0	8
S-5		SO_3	279					28
Mix-1	LNB		440	338	3620	<1	82	74
Mix-2			220	342	180	10-20	84	67
Mix-3			220	308	187	10-20	77	54

*B = bituminous, S = subbituminous, L = lignite, mix = blend

Summary Data - ESPs

Table 2. Non-Scrubbed Units with Fabric Filters as Primary Particulate Collector

ID*	NOx Control	FF Inlet Temp	Coal Chloride	Ash LOI	% Hg on Filter	% Hg Removal
B-1	LNB	340	167	10-20	76	51
B-2	LNB	299	55		80	87
B-3	LNB	307	1233		100	100
B-4	LNB	290				99
L-1		358	167	2-4	14	-21
S-1	LNB	348	100	2-4	36	82
S-2	OFA	293	<10	1-2	16	57
S-3	LNB, OFA	342		<1		72
Mix-1	LNB	314	127	20-25	2	-4

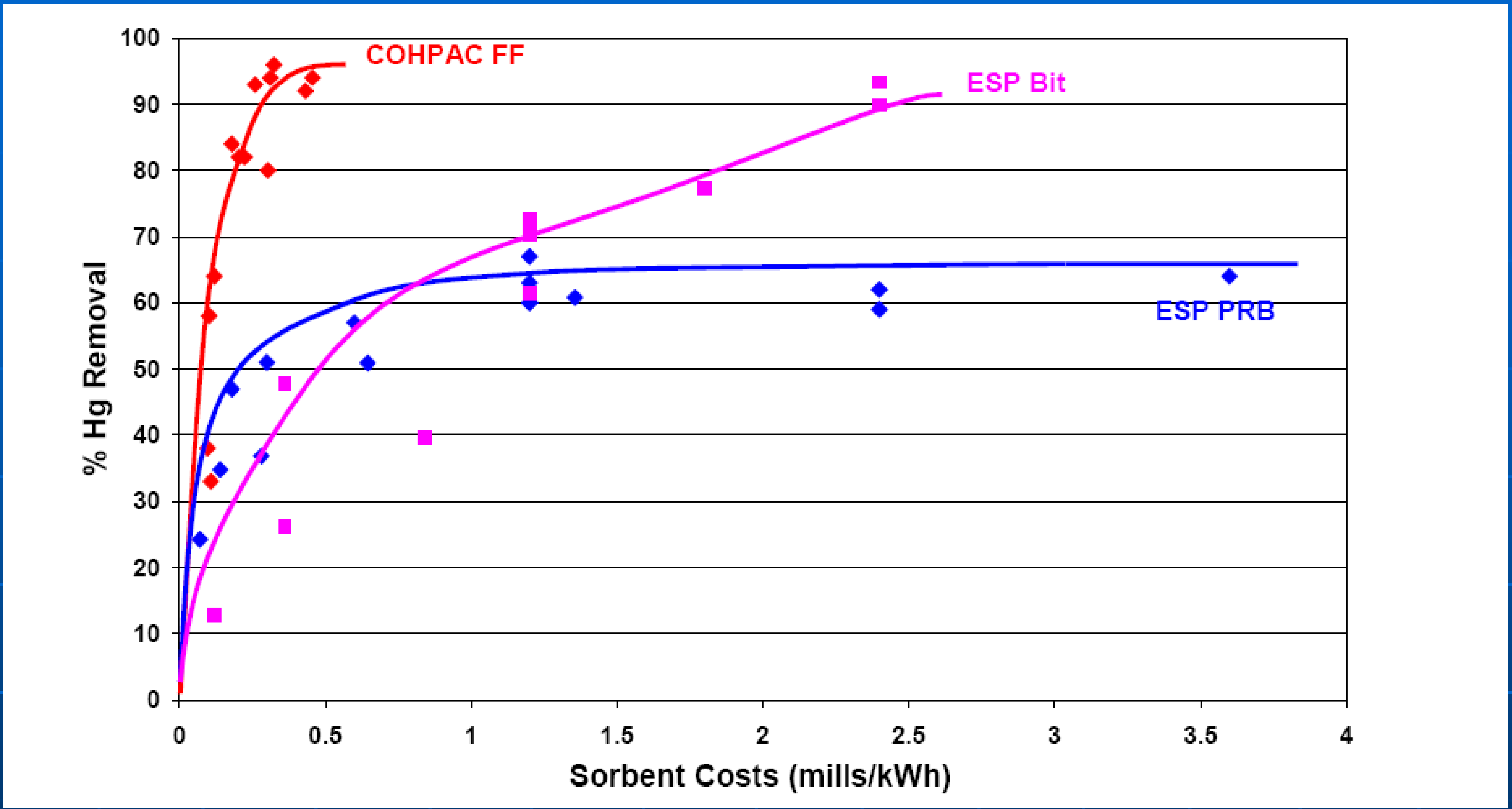
*B = bituminous, S = subbituminous, L = lignite, mix = blend

Summary Data –Fabric Filters

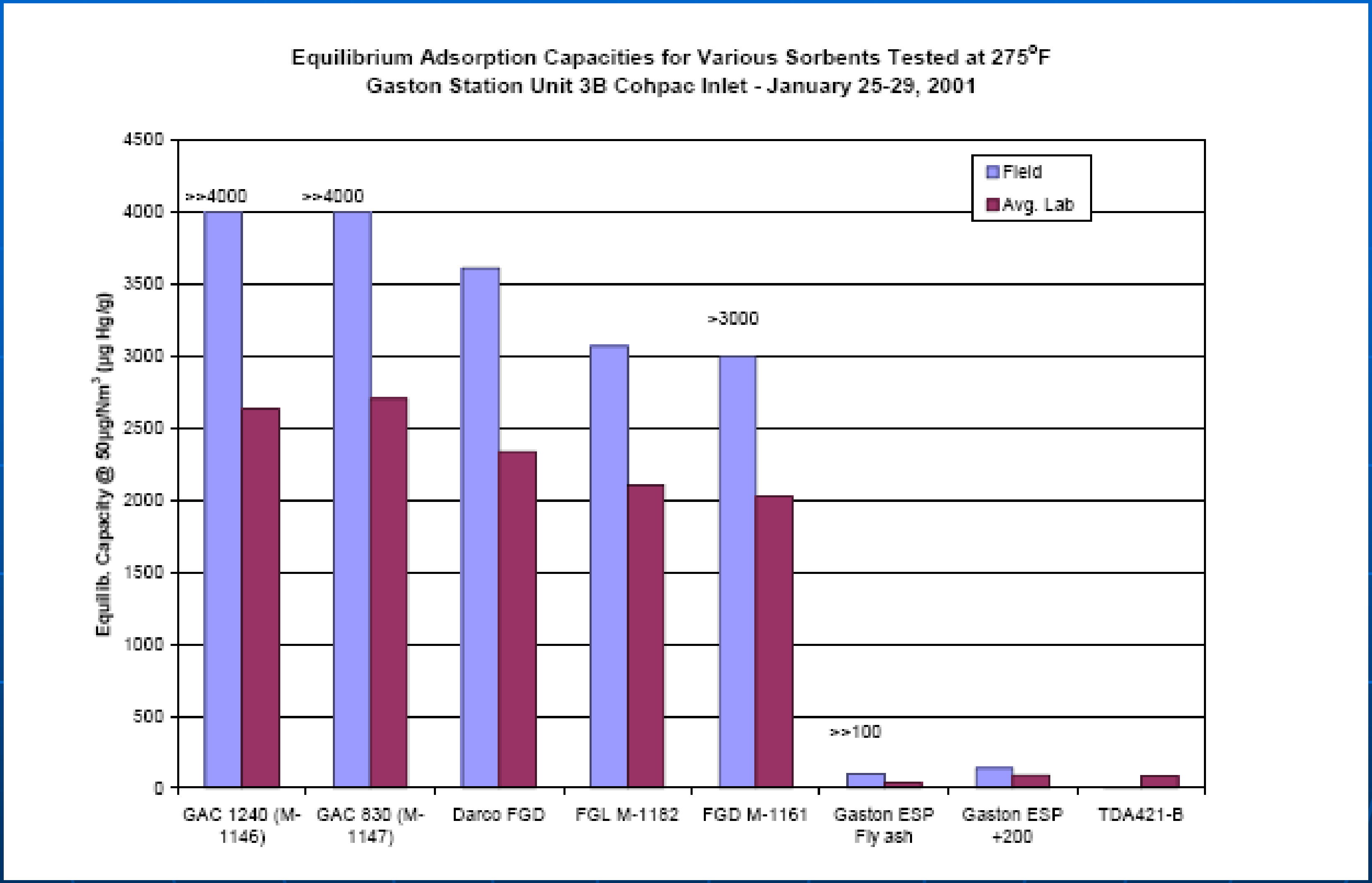
Table 3. Summary of Average Mercury Removal in ESPs and Fabric Filters

Coal	ESPs (% Hg Removal)	Fabric Filters (% Hg Removal)
Bituminous	35	84
Subbituminous	9	70
Lignite	2	0
Bit/Sub/Pet Coke Mix	66	NA

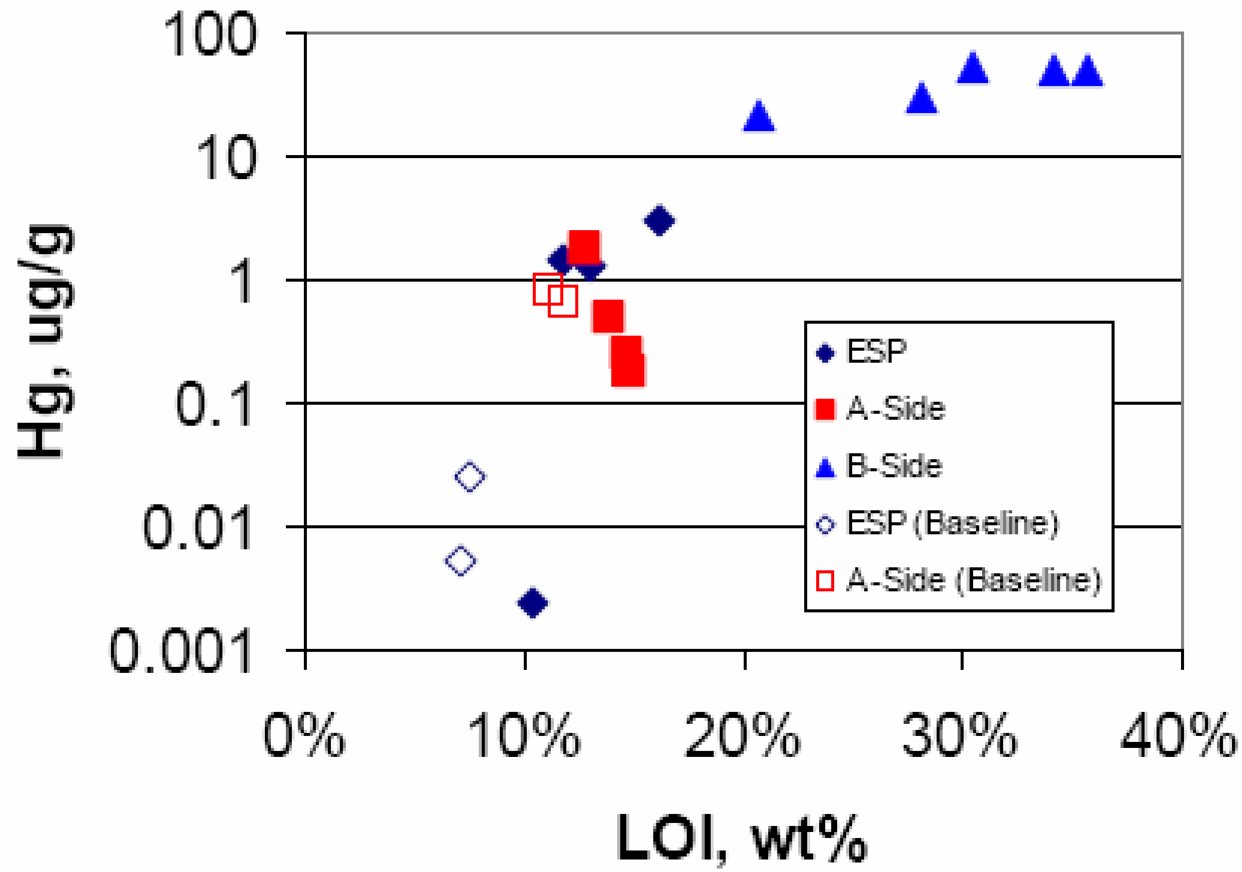
Average Hg Removal Efficiencies



Dramatic Effect of Sorbent Use on Hg Removal

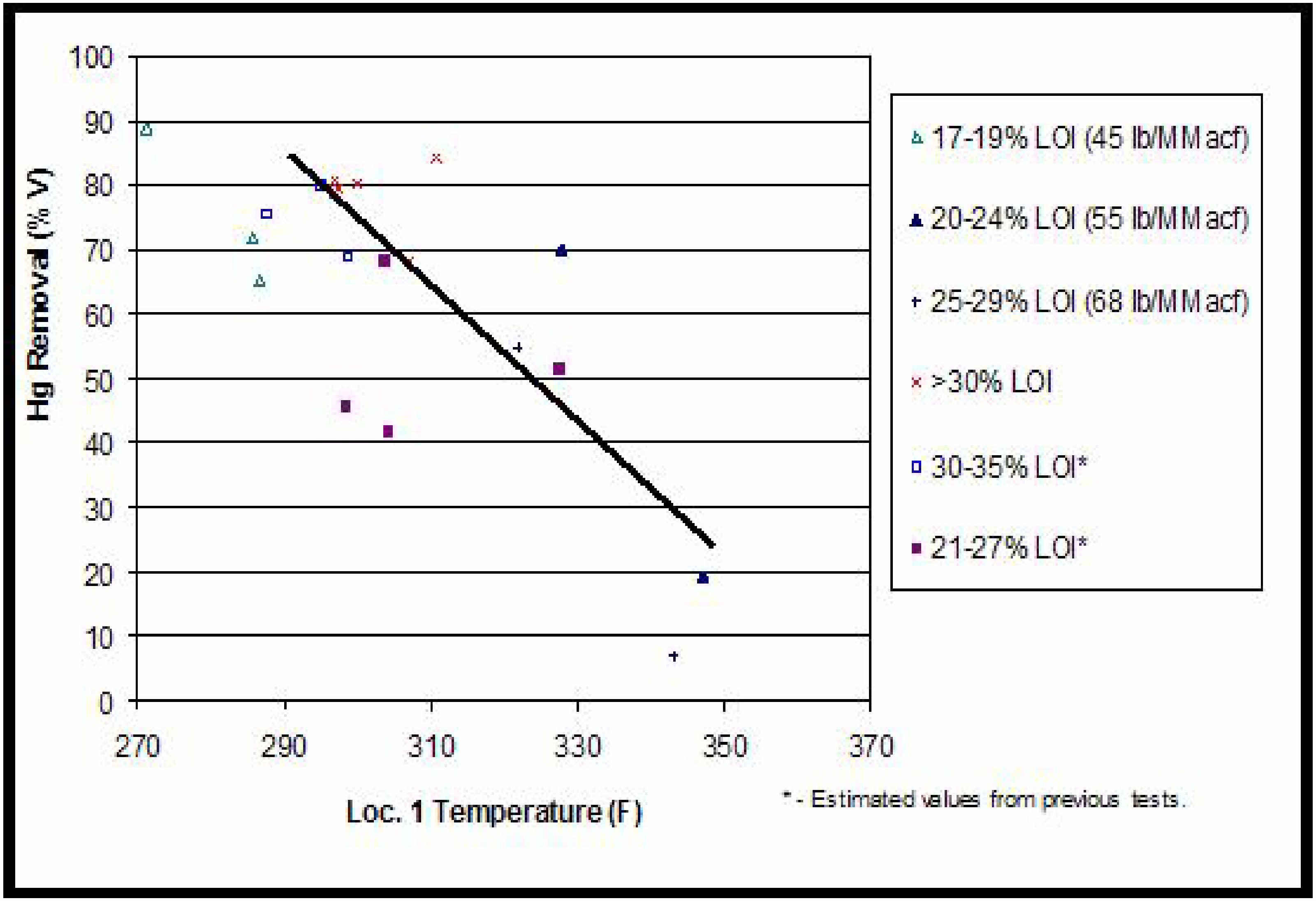


Sorbent Compared to Fly Ash for Hg Removal



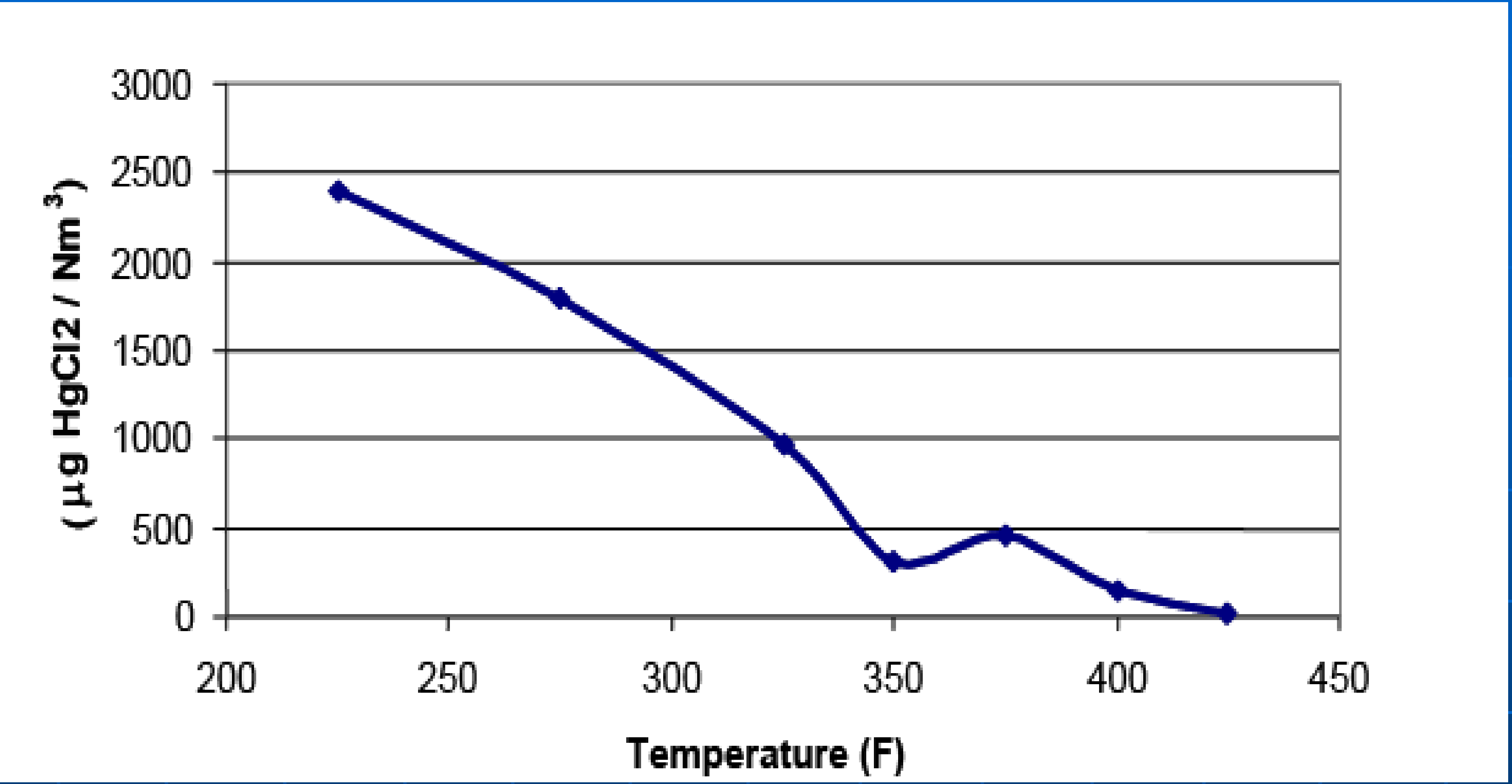
Effect of LOI in Ash on Hg Uptake

Hot-Side ESP Example



Effect of LOI and Temperature on Hg Removal

Cold-Side ESP Example



Sorption Capacity vs. Temperature

Results from Sorbent Screening Tests Conducted by URS Corporation (February 2002)

Sample Name	Base	Ads. Capacity SO_3 Off @ 50 mg/Nm^3	Ads. Capacity SO_3 On @ 50 mg/Nm^3
Norit FGD	Lignite	4314	1380
Norit FGL	Lignite	4281	694
Donau GAL	Lignite	-	1745
Donau HOK300	Lignite	4786	-
Advanced Fuel Research – 2	Tire Derived	-	538
CarboChem	Bituminous	1948	-
SAI-B	Bituminous	1799	-
SorbTech-I	?	62	-
SorbTech-L	Lignite	2091	-
STI 020115-2	BP ash, 80% carbon	>109	0
STI 020121-3	SH ash, 80% carbon	245	0
AANP Zeolite	-	-	7

Detrimental Effect of SO3 on Sorbent Capacity

CONCLUSIONS

- Both ESPs and Fabric Filters can remove Hg.
- Hg Removal Efficiencies are extremely variable and site specific.
- Many factors affect Hg removal including boiler, fuel, operations, residence time, and equipment design.
- Both ESPs and FFs can be integrated into sorbent-based Hg control strategies.
- All other factors being equal – Fabric Filters generally provide better gas/particulate contacting than ESPs.

Data presented acquired from DOE, ADA, URS.