Effects of Halogens and Flue Gas Conditions on SCR Catalyst Mercury Oxidation and ESP Mercury Capture

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Project Objectives

- **Establish the behavior of commercial SCR catalysts for Hg oxidation with respect to fuel halogen level and other flue gas conditions**
- **Investigate the rate of mercury capture at a pilot-scale ESP**
- **Report catalyst behavior for the SCR fleet as a whole**
- **Guide end-users in terms of optimal operating SCR conditions to maximize Hg oxidation for its removal in downstream existing environmental controls**

Approach

- Utilize the Mercury Research Center (MRC) as a test platform
- Perform the same parametric test sequence on each catalyst type
- Investigate Hg response to variations in flow, temperature, ammonia, and halogen level
- Test four different conventional SCR catalysts

Mercury Research Center

- Host Unit: Crist Unit #5, 75 MW, T-fired boiler
- 5 MW Equivalent (24,000 acfm @ 700 ºF)
- 3-Layer SCR
- 2 m X 2 m RXR size
- 4 m^3 Catalyst per Layer
- Diluted Anhydrous Ammonia w/AIG

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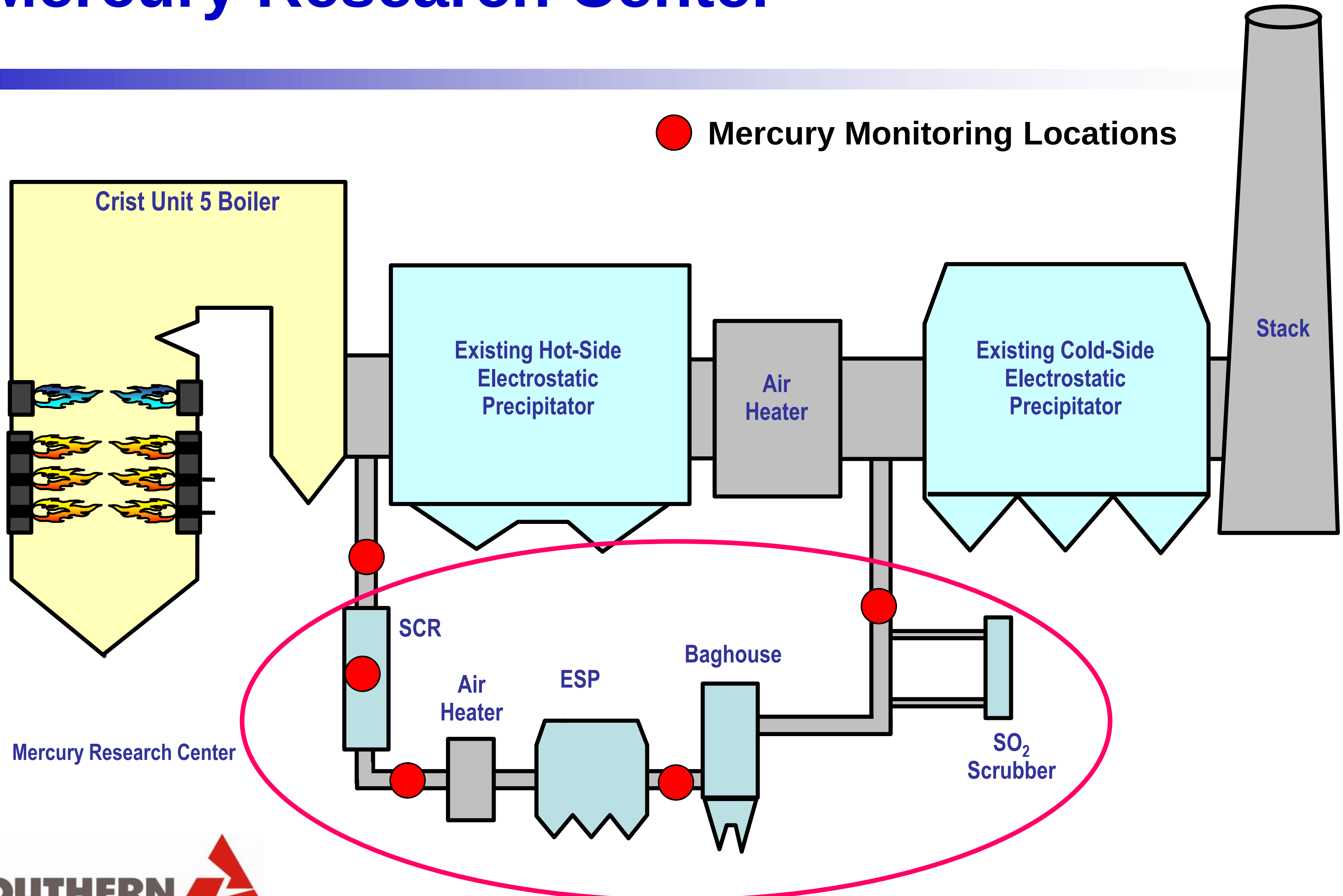
Mercury Research Center



Ammonia Injection Grid

Reactor Internals

Mercury Probe

Mercury and Flue Gas Monitoring

- 3 TECO Continuous Mercury Analyzers
- Additional Tekran Mercury Monitors
- Continuous SO_2, NO_x, CO_2, O_2 (reactor inlet and outlet)
- Chlorine injected as HCl before SCR, measured continuously by FTIR
- Bromine added as $CaBr_2$ solution on coal

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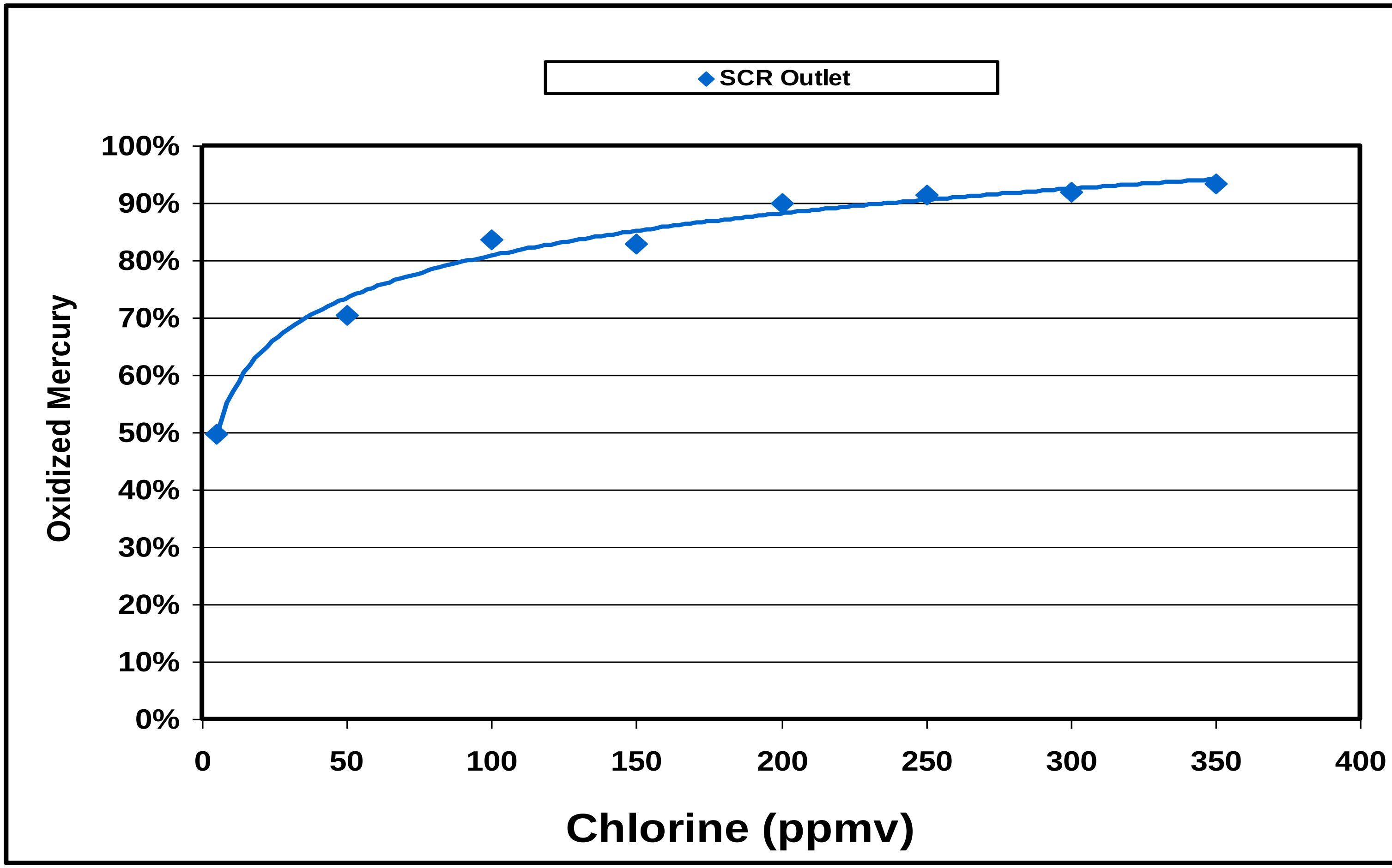
Coal Composition

Coal ID	A	B	C	D	E	F	G
State	Colombia, SA	Colombia, SA	UT	WV	WV	IL	IL
ULTIMATE ANALYSIS (%, dry basis)							
% Total Moisture	12.39	9.77	6.54	5.63	5.75	11.89	11.39
% Ash	7.03	6.92	10.05	16.03	14.46	8.2	7.26
HOC (btu/lb)	13,003	13,366	13,325	12,612	12,785	13,570	13,656
% Total Sulfur	0.65	0.59	1.3	0.66	0.94	1.75	1.18
Cl (ppmw)	40	39	336	624	1173	4047	4011
Ash Material							
SiO_2	59.62	64.72	43.63	63	59.14	52.67	55.26
Al_2O_3	20.94	20.31	18.28	29.4	29.46	19.88	22.42
Fe_2O_3	7.13	7.48	4.37	3.75	4.4	17.13	11.85
CaO	2.49	1.23	10.51	1	0.67	2.07	1.91

SCR Catalysts Tested

Parameter	A	B	C	D
Number of Layers	2	2	3	2
Approx. Total Catalyst Volume (m^3)	6.8	6.7	5.9	8.4
Approx. Exposure Hours	2,000	2,000	8,000	16,000
K (m/h)	40.1	44.7	38.7	29.4
SO_2 Conversion (%)	0.33	0.33	0.12	0.86

Effects of Chlorine on SCR Catalyst Hg Oxidation
Averaged from 4 tests



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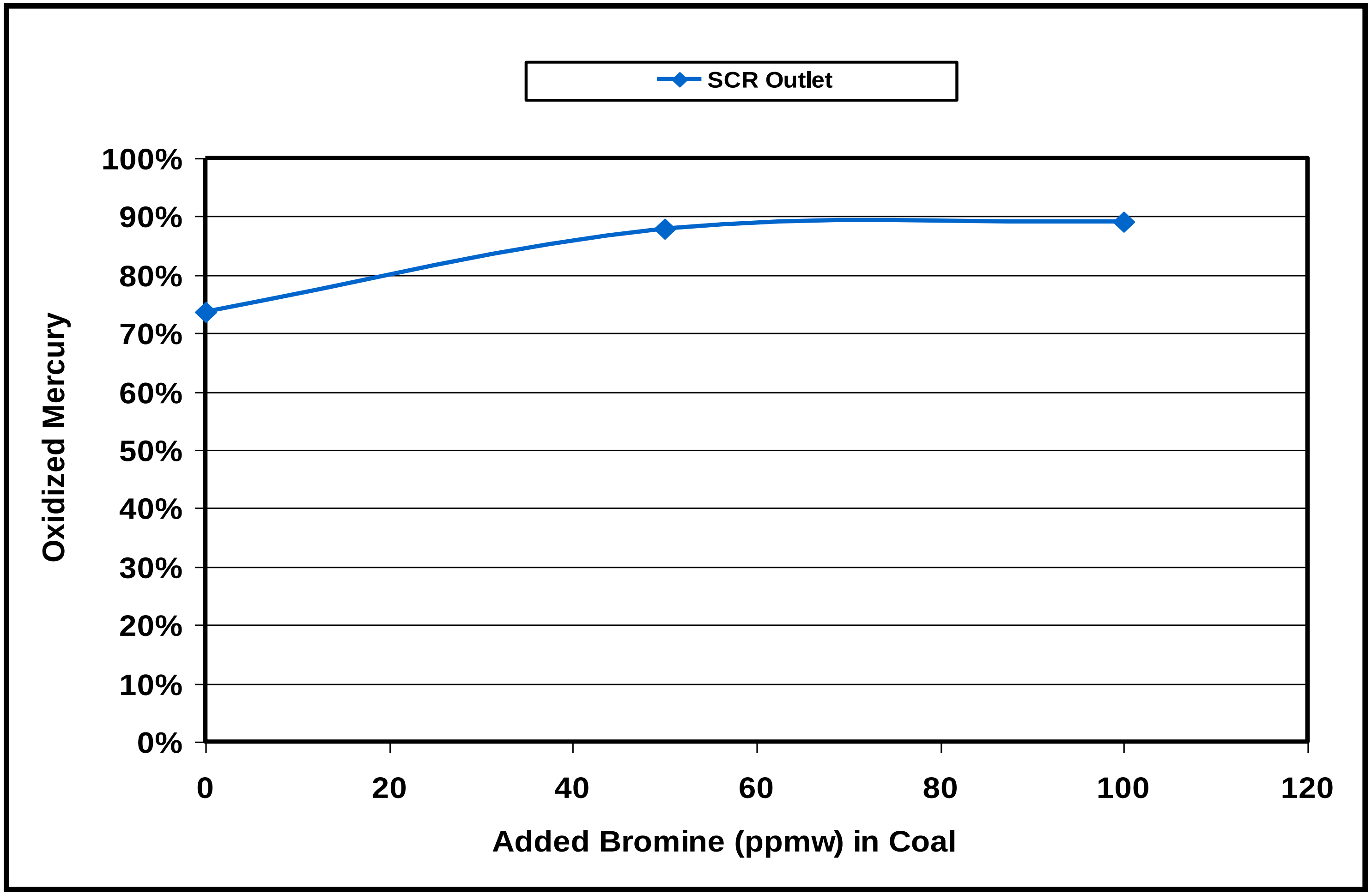
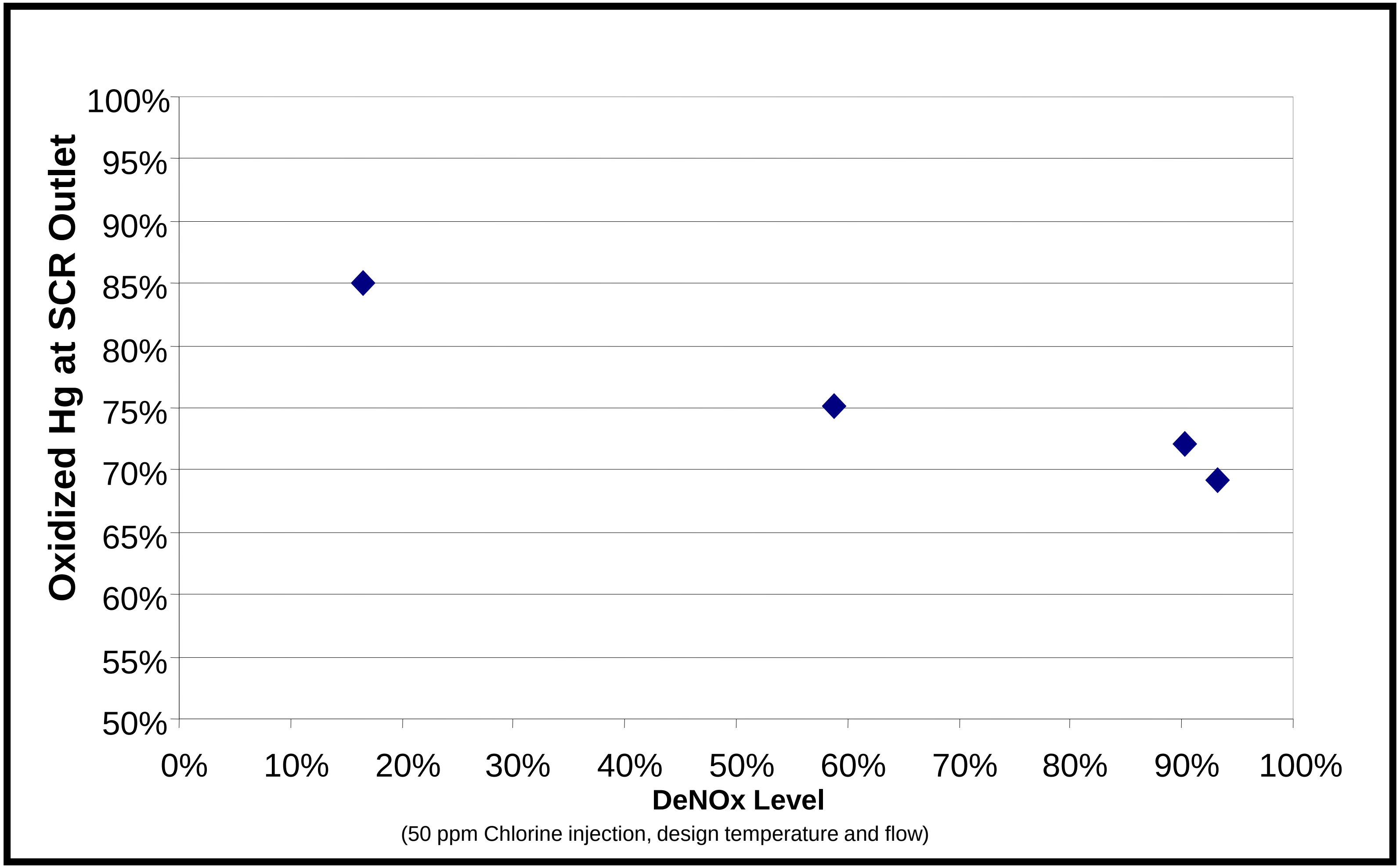
Effects of Bromine on SCR Catalyst Hg Oxidation

Averaged from 4 tests

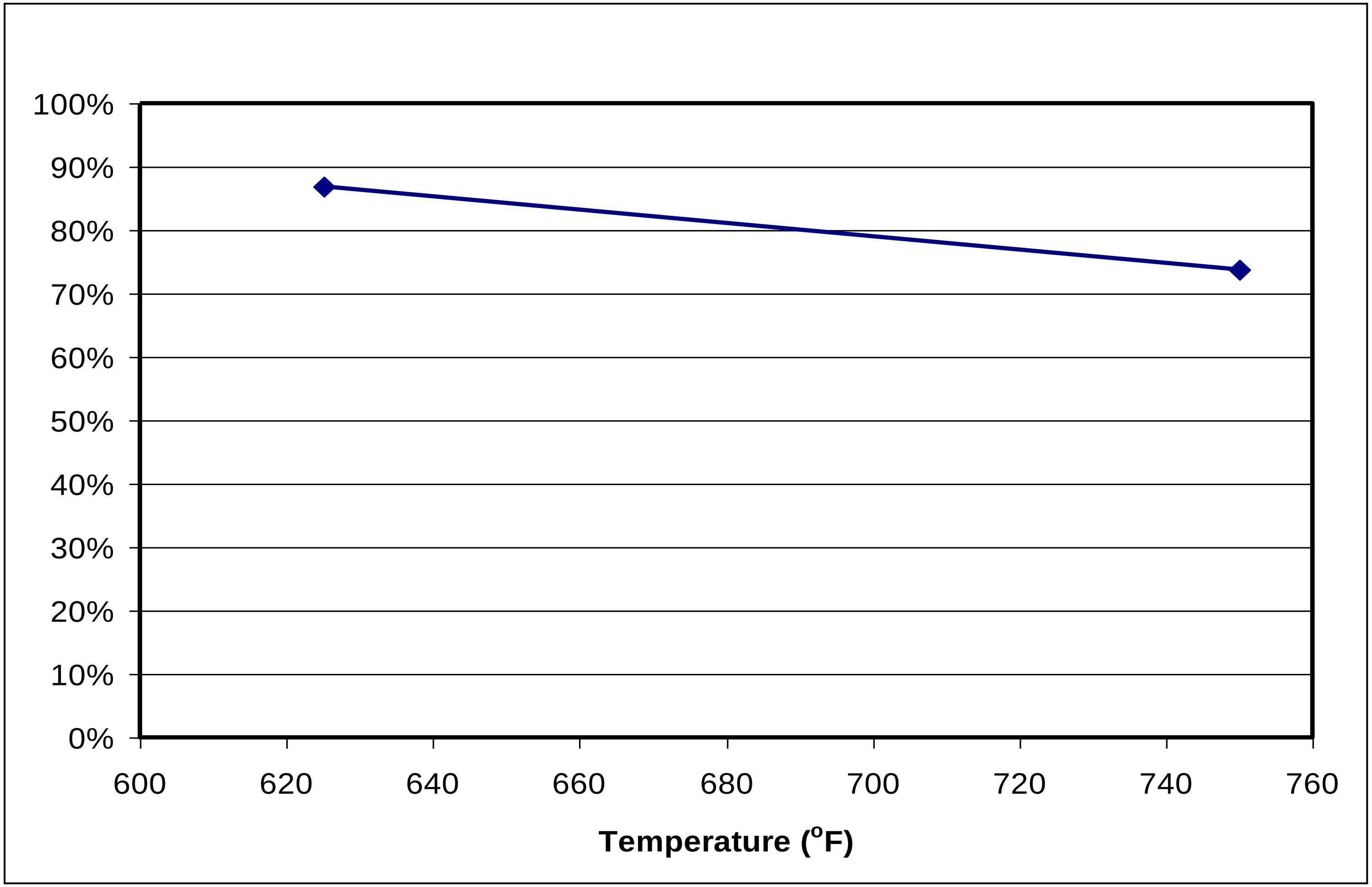


Ammonia and Chlorine Effects



Effects of Temperature on SCR Catalyst Hg Oxidation

Averaged from 4 catalyst types



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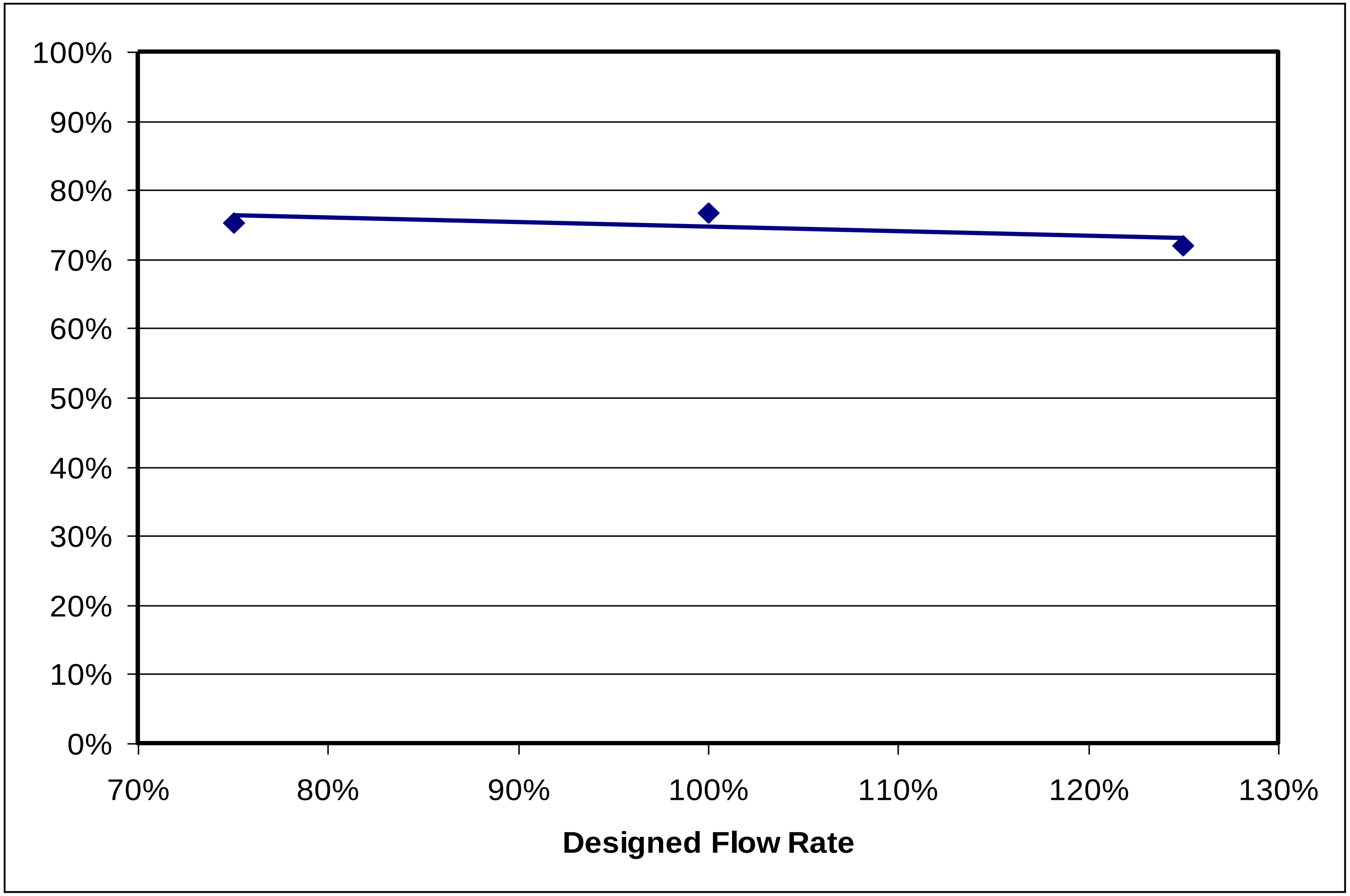
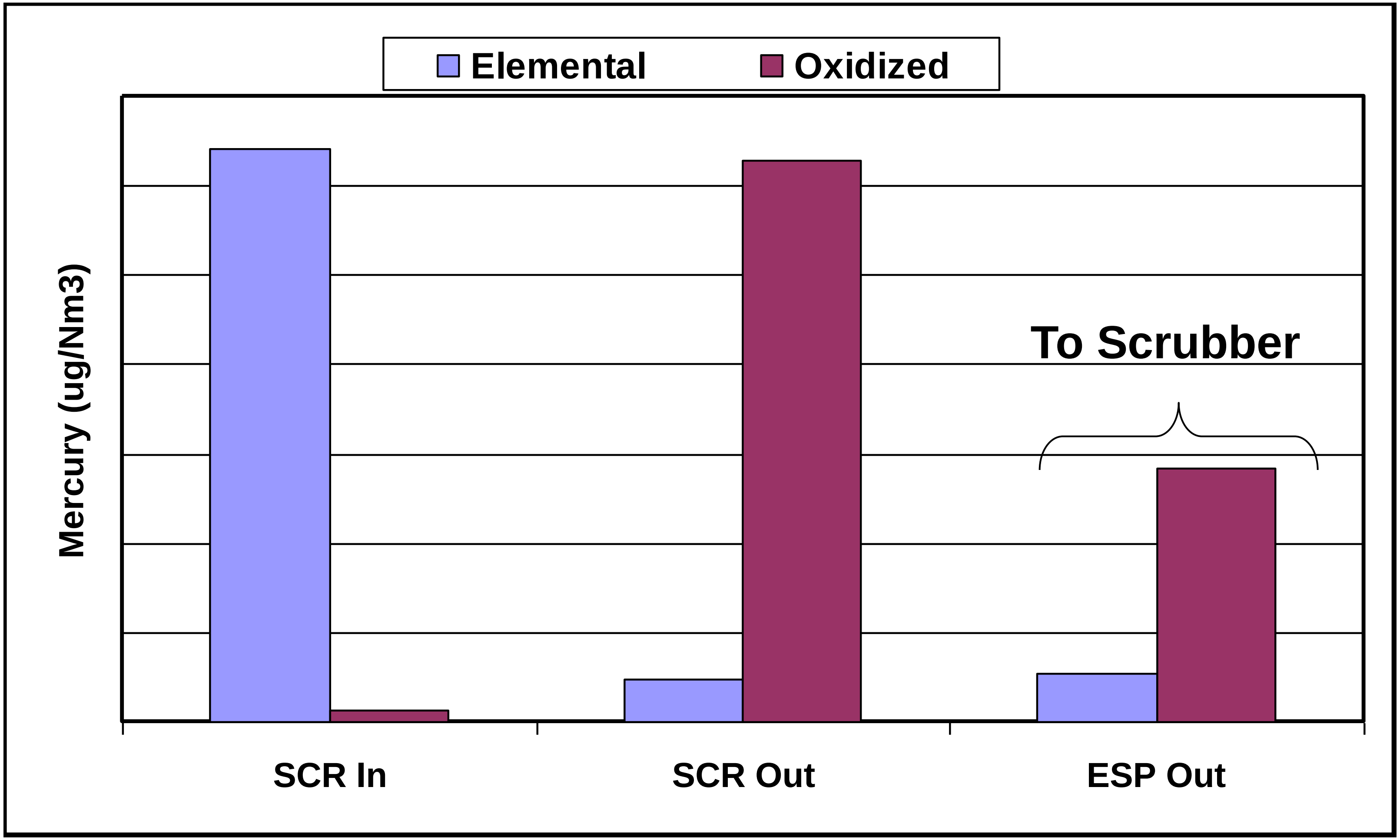
Effects of Flow on SCR Catalyst Hg Oxidation

Averaged from 4 catalyst types



Mercury Partitioning

Results from a single test



Conclusions & Recommendations

- All SCR catalysts tested (Ti-V) showed similar relative mercury oxidation behavior
- Increasing chlorine levels will have beneficial effects on SCR mercury oxidation and ESP capture
- The addition of bromine resulted in a very sharp increase in mercury oxidation
- Ammonia has an inhibiting effect on mercury oxidation across the SCR

Conclusions & Recommendations

- Independent changes in flow rate did not appear to have much effect on mercury oxidation
- To capitalize on this co-benefit effect, facilities may consider the artificial adjustment of halogens, through direct injection of fuel additives such as HCl or $CaBr_2$ or fuel blending
- Lower temperature operation of the SCR will help to maximize SCR mercury oxidation and improve ESP capture. Lower operating temperatures also have potential benefits in terms of SO_2 oxidation.

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