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Hitachi Power Systems America, Inc.

Mercury Co-Benefits with Hitachi TRAC® Catalyst

Hot Topic Hour
November 29, 2012

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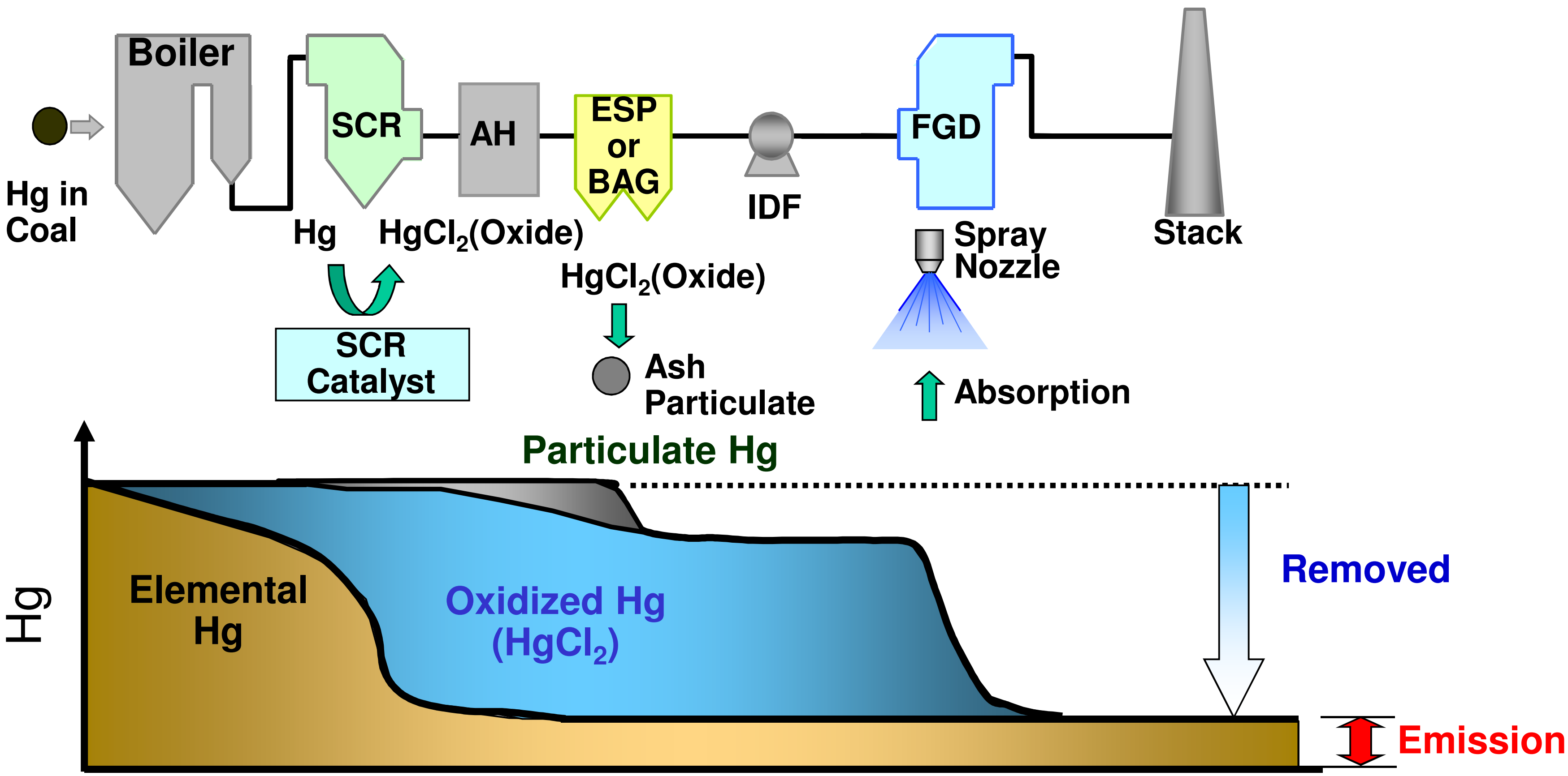
Importance of Catalyst Selection on MATS Compliance

- MATS Sets New Hg Emission Limit of 1.2 lb/TBtu (for most existing units)
- Utilities must meet this Hg emission limit starting in 2015-2016
- Catalyst installed today will still be in service during the MATS compliance time frame.
- Hitachi Advanced TRAC® Catalyst Improves Hg Oxidation Across the SCR
- Utilizing Co-Benefits of an SCR + FGD system and increasing Hg Oxidation across the SCR results in reduced or even eliminated need for sorbent injection (such as ACI) to control Hg emissions.

Decisions made on catalyst today will impact future MATS compliance costs.
Utilizing TRAC® Hg Co-Benefits is a Cost-Effective MATS Compliance Strategy.

Process of Hg Removal by SCR + FGD



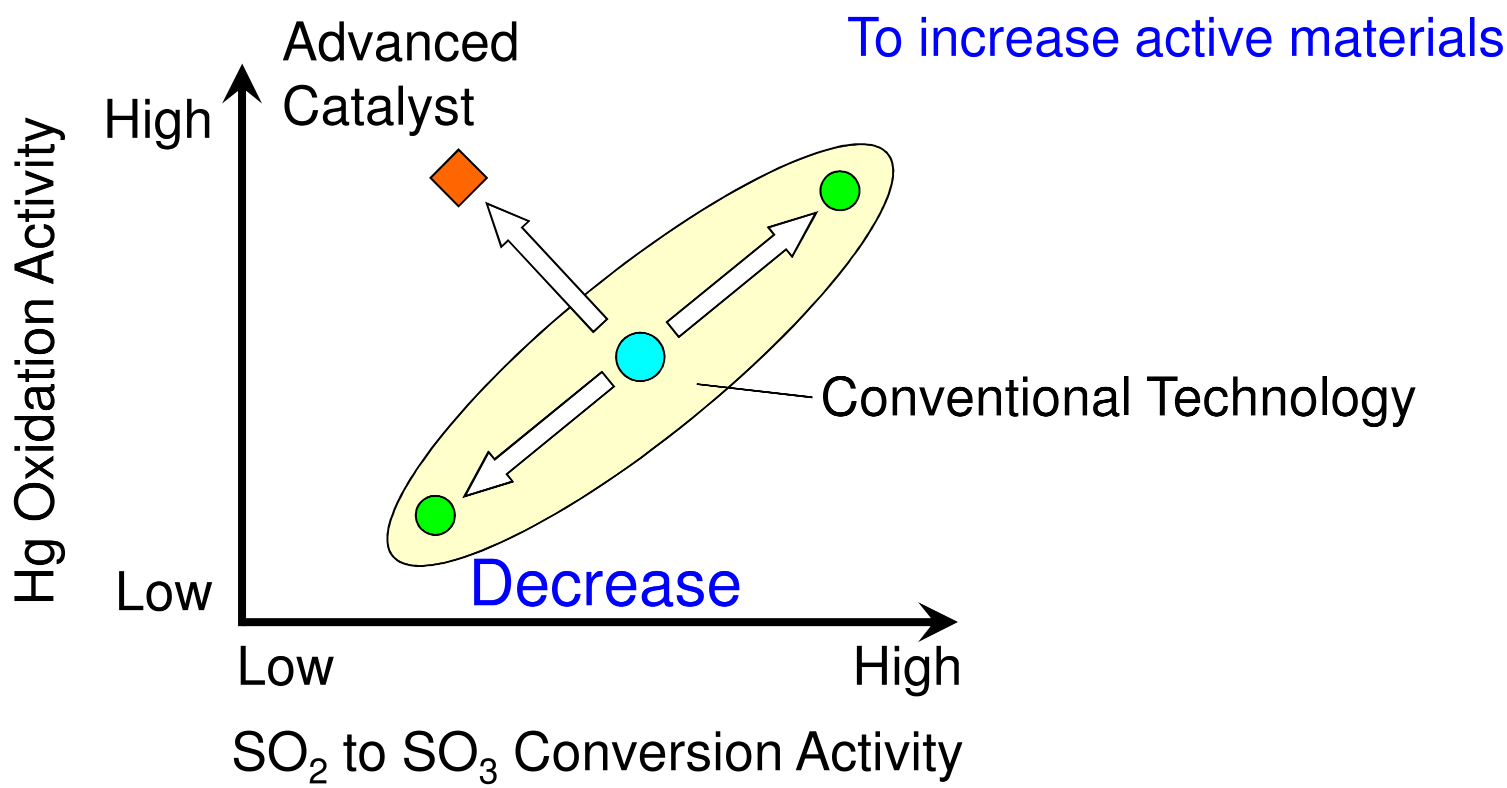
SCR Catalyst is a key component for mercury oxidation

Hitachi Hg Oxidizing Catalyst

TRAC®

The Challenge in Catalyst Design

In order to increase Hg Oxidation in traditional catalyst SO_2 conversion inherently increases as well.



We have developed a new SCR catalyst with Higher Mercury (Hg) Oxidation while maintaining Low SO_2 Conversion

TRAC® – TRiple Action Catalyst

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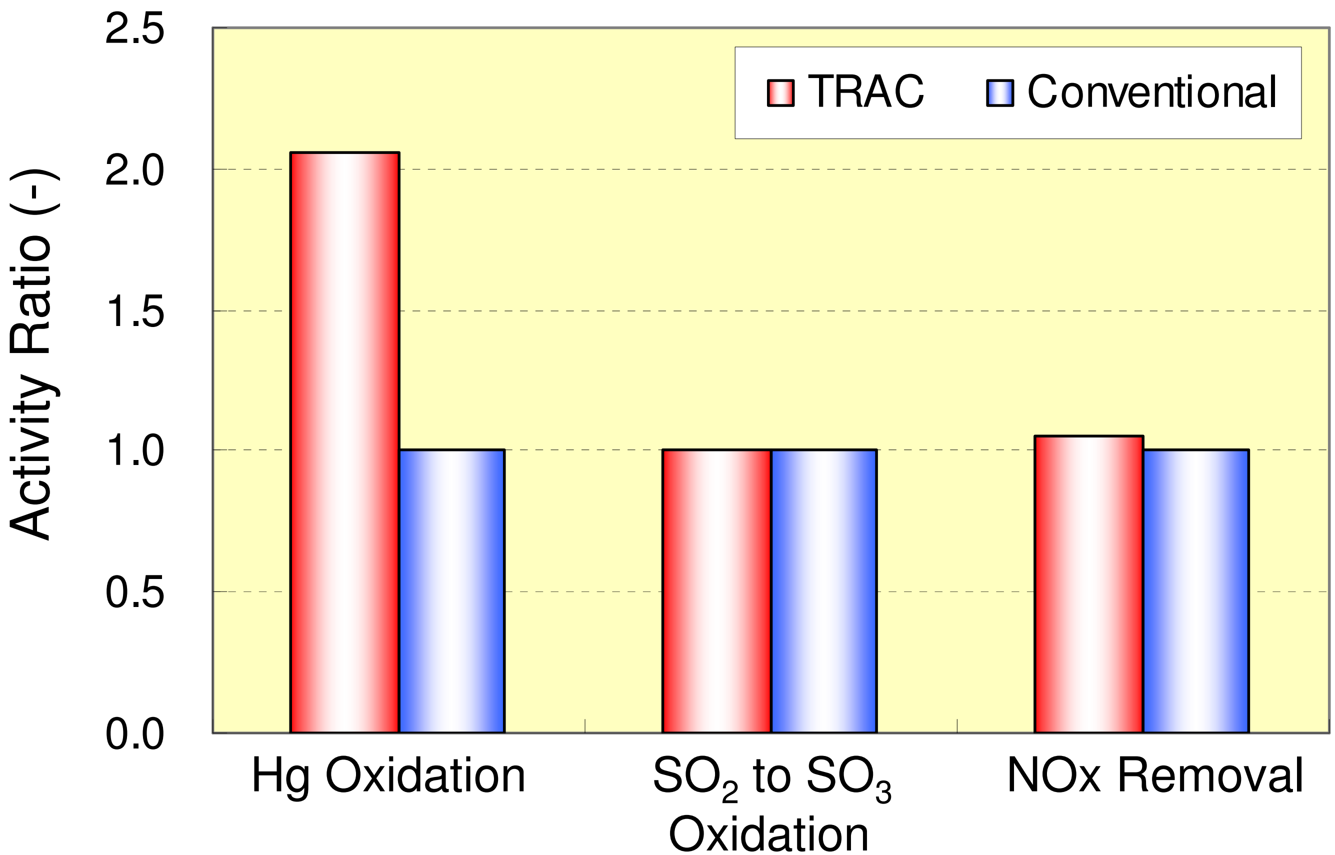
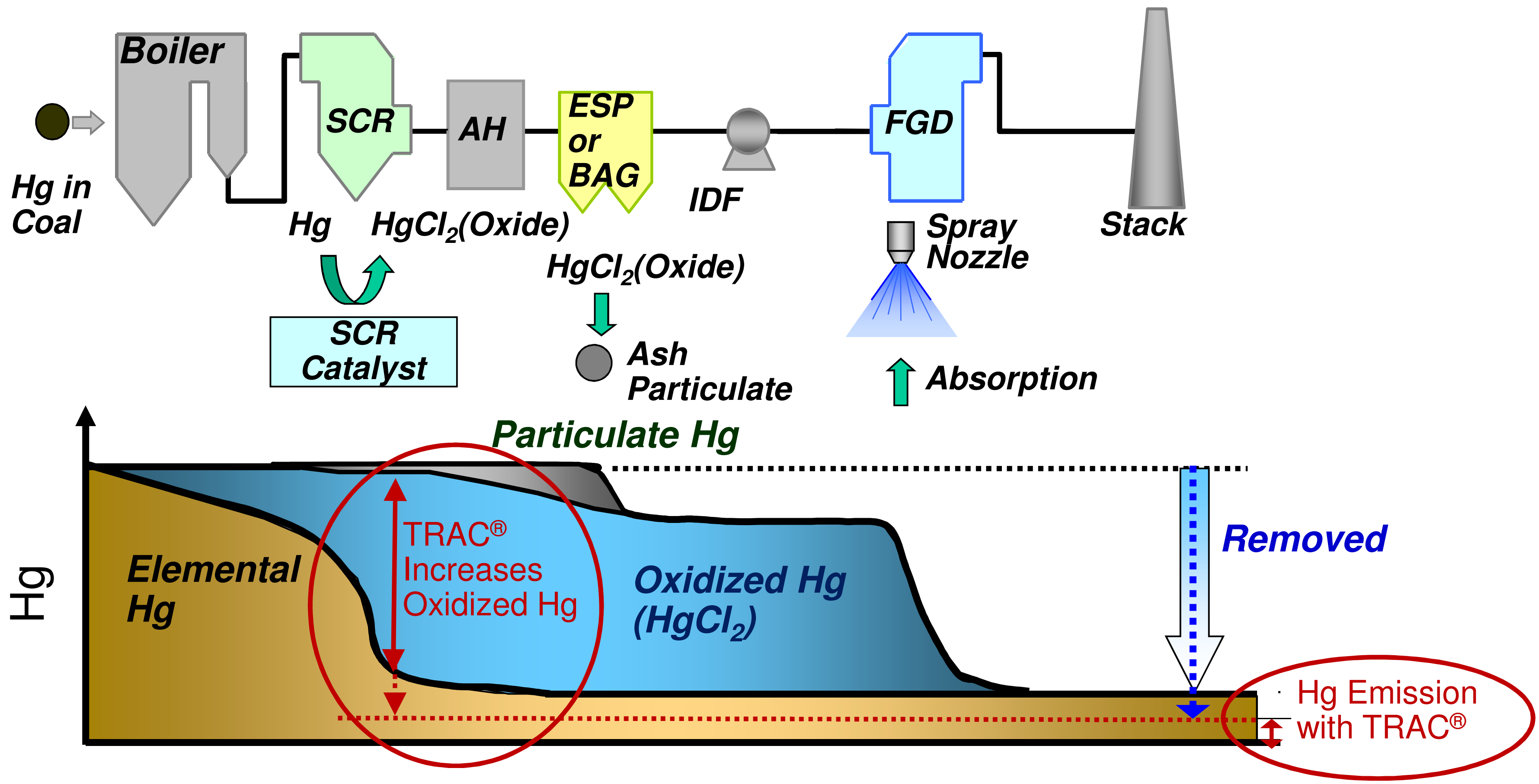
1st High Mercury Oxidation

2nd High DeNOx Performance

3rd Low SO_2 to SO_3 Oxidation



Process of Hg Removal by SCR + FGD



SCR Catalyst is a key component for mercury oxidation

Hitachi TRAC® Catalyst

R&D Testing

Pilot Test at MRC (Bituminous)

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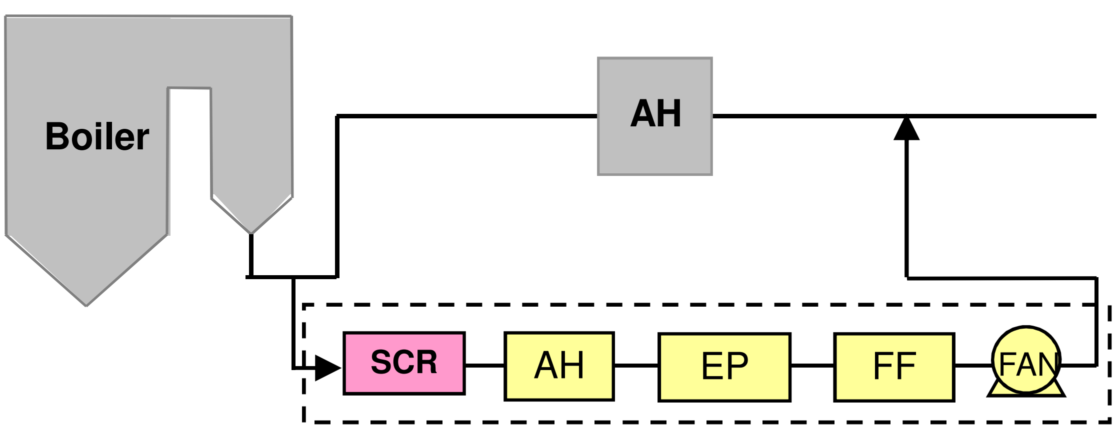
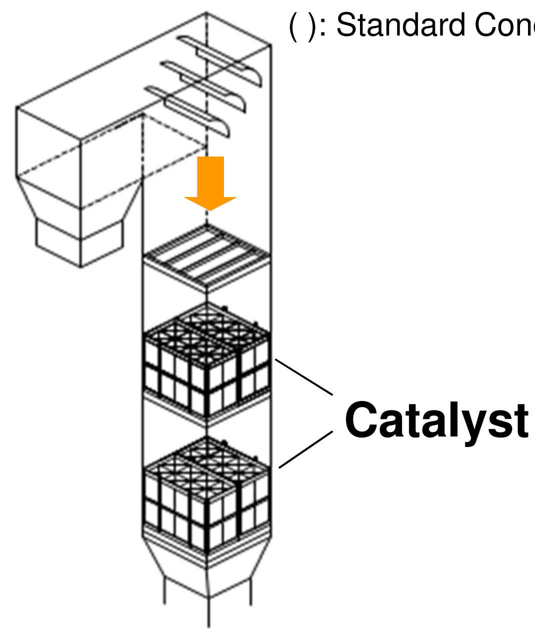
- MRC (Mercury Research Center)
- Host Unit - Gulf Power/Crist Unit5 (75MW)
- Coal - Low Sulfur Bituminous
- Slip Stream Reactor (SSR, 5MW equivalent)
  2 Layers SCR (cross section; 6.6' x 6.6')
- Parametric Testing of Hg Oxidation
  - Temperature
  - HCl
- Catalyst - TRAC® and Conventional Catalyst

Gas Flow Rate	**10,705 - 17,842 m^3N/h**
Temperature	**626 - 752 (698) F**
NOx	**180 - 230 ppm**
SO_2	**600 - 900 ppm**
HCl	**110 - 350 (130) ppm**
NOx Removal	**90 %**
Slip NH_3	**2 ppm**

( ): Standard Condition



Pilot Test Facility



SSR

Pilot Test at MRC (Bituminous)

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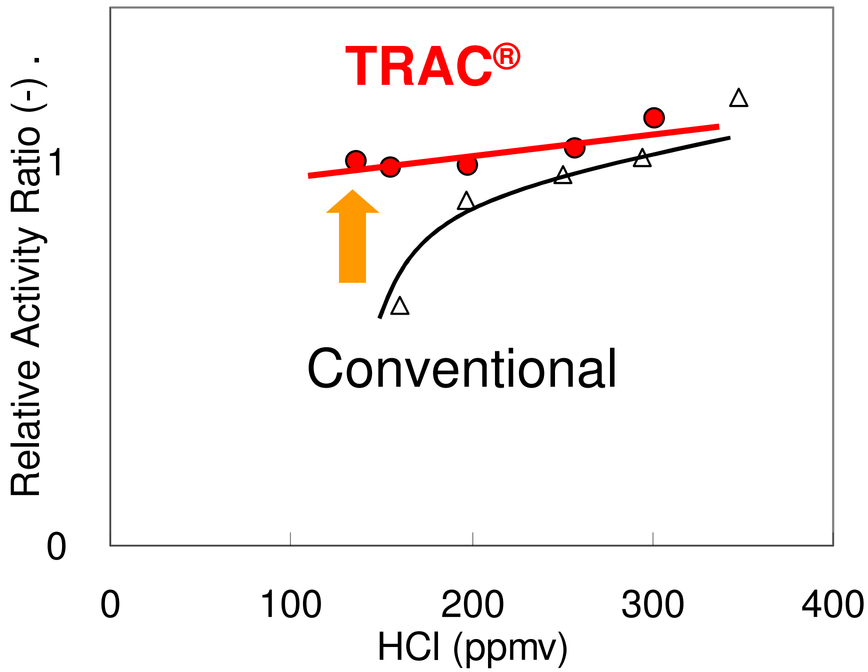
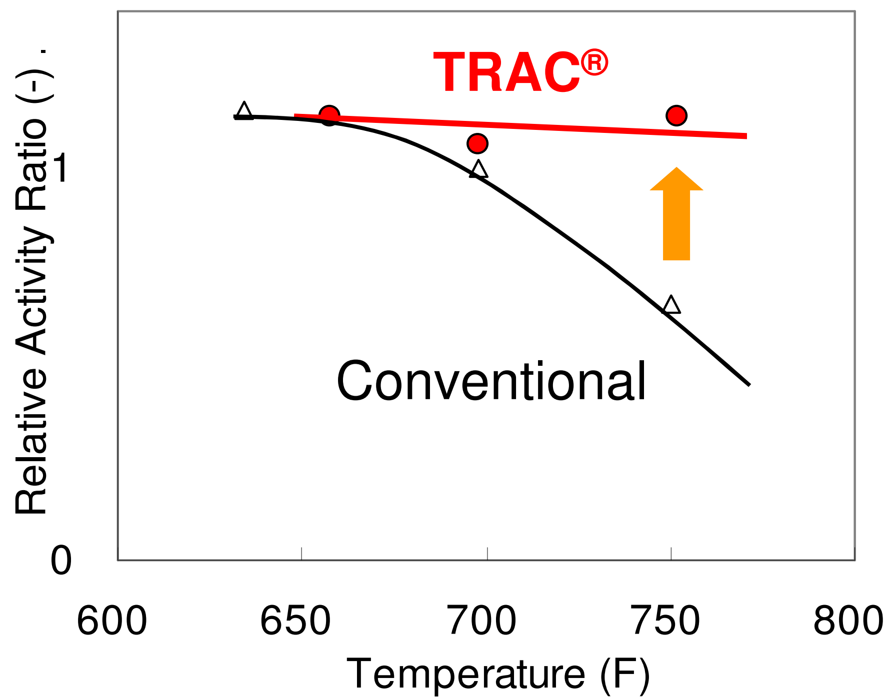
HCl Characteristics



Temperature Characteristics



TRAC® shows…

Higher Hg oxidation at lower HCl concentration

Higher Hg oxidation at higher temperature

Hitachi TRAC® Catalyst

Full Scale Application

Full Scale Application at PRB Plant

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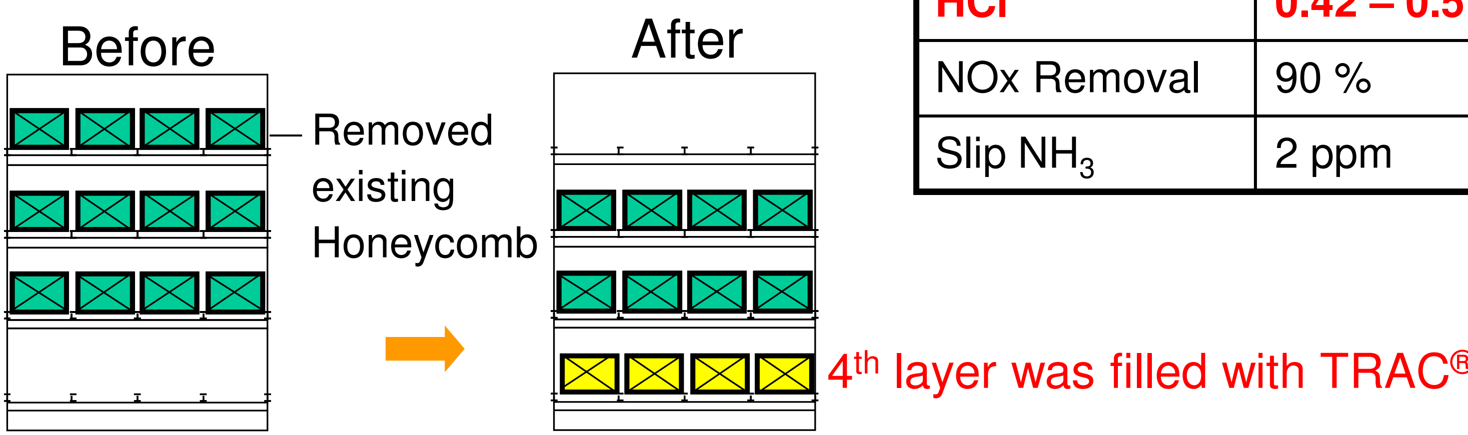
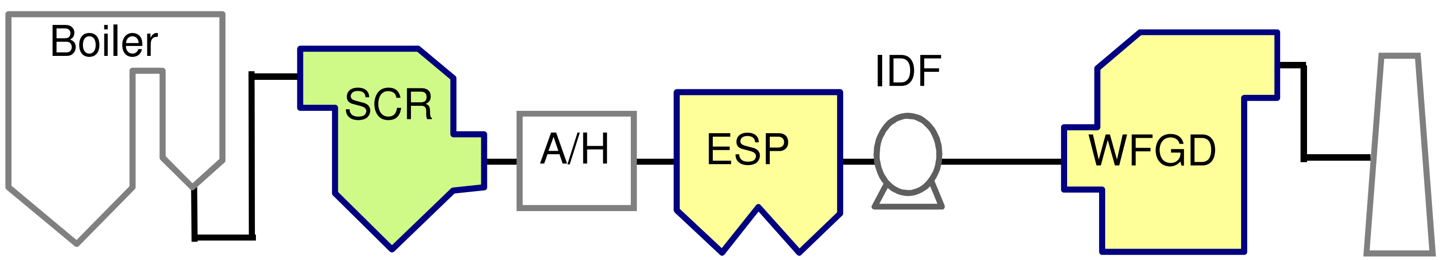
- Northern US Power Plant (640MW)
- Coal - PRB
- TRAC® Supplied in 2008 at 4th Layer

Gas Flow Rate	1,198,652 Nm^3/hr
Temperature	730 F
NOx	372 ppm
SO_2	478 ppm
HCl	**0.42 – 0.57 ppm**
NOx Removal	90 %
Slip NH_3	2 ppm



Hg Removal: **35%** → 70%



Full-Scale Result – Plant Miller

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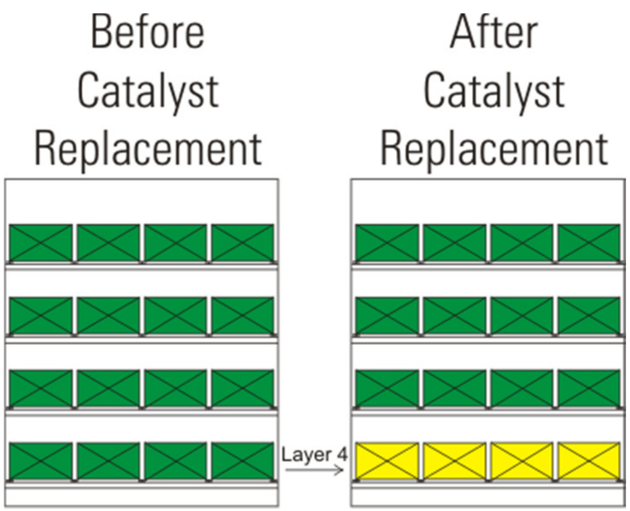
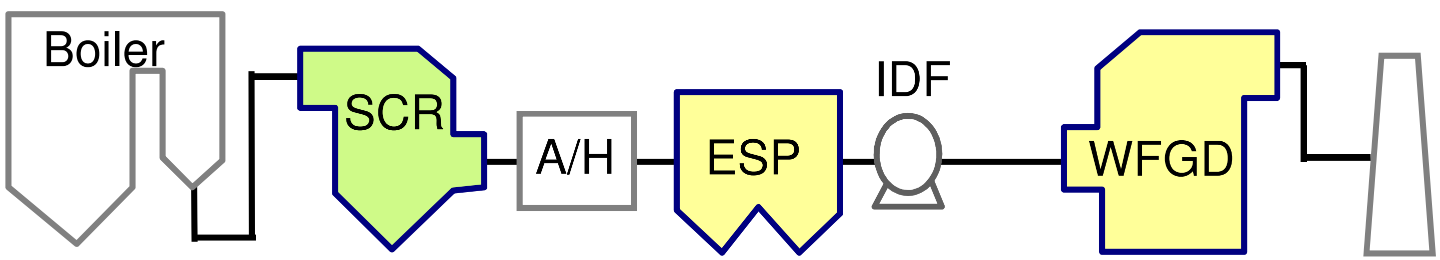
- Plant Miller Units 1 and 2 (720 MW)
- PRB Coal
- TRAC® Installed in spring 2011

Stack Gas Flow Rate	**3,397,200 m^3N/hr**
Temperature	**720 F**
NOx	**130-230 ppm**
SO_2	**125-325 ppm**
HCl	1-7 ppm
NOx Removal	**90 %**
Slip NH_3	**<2 ppm**



Hg Removal: **30%** Hg Removal: **60%**



Cost Impact of an Advanced Hg Oxidation Catalyst

High Sulfur Bituminous Fuel

TRAC® Mercury Removal Study

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Base Case 1 - ACI + ESP (No FF)

- Installation Cost of ACI System
- Operation (AC Consumption) Cost
- High Carbon Content in Ash – Impact on Ash Sales

Base Case 2 - ACI + FF

- Installation Cost of FF + SCI System
- ***Operation (AC Consumption) Cost***
- ***High Carbon Content in Ash – Impact on Ash Sales***

TRAC (With and Without FF)

- Slightly higher cost than Conventional Catalyst (10-15%)
- No Additional Operation Cost
- 3rd Layer Addition (Lower Layer - Most effective for Hg oxidation)

TRAC® Mercury Removal Study - Assumptions

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Conditions

1) Eastern Bituminous Fuel
2) Flue gas temperature at SCR Inlet = 775F
3) 90% of NOx removal with 2 ppm of slip NH_3
4) TRAC® Hg oxidation is at end of catalyst life condition

Assumptions

1) Required total Hg removal = 90%
2) HCl in flue gas =100ppmvd 3%O_2
3) Elemental Hg / Oxidized Hg at SCR inlet = 70/30
4) AC (Untreated) cost = $0.50 / lb
5) Oxidized mercury removal across FF/ESP, WFGD = 95%
6) Hg Oxidation across APH = 50% of remaining elemental Hg

Note: The following evaluation result for Eastern Bituminous are based on the conditions and assumptions shown above. If the conditions and/or assumptions change, the results shall be re-evaluated.

TRAC® Economics – Eastern Bituminous

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TRAC with ESP (no FF) **(for 550 MW unit)**	1 Layer of Non-TRAC® Addition	1 Layer of TRAC® Addition	3 Layers of TRAC® (margin?)
HG Oxidation(@ APH outlet), (%)	85	95	>97
Hg Remove w/o ACI(@ Stack), (%)	77	90	92
AC injection, # / MMACF	8	0	0
AC Cost / year	$3.34M	$0	$0
Differential Cost of TRAC / year	$0	$20,000	$60,000
Cost of using AC and/or TRAC over an eight (8) year period	$26,700,000	$160,000	$480,000

TRAC® Saves… $26,000,000 (Operating Cost)
ACI System Capital Cost (~$5M)

TRAC® Economics – Eastern Bituminous

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TRAC with FF (for 550 MW unit)	1 Layer of Non-TRAC® Addition	1 Layer of TRAC® Addition	3 Layers of TRAC® (margin?)
HG Oxidation(@ APH outlet), (%)	85	95	>97
Hg Remove w/o ACI(@ Stack), (%)	77	90	92
AC injection, # / MMACF	1.5	0	0
AC Cost / year	$630,000	$0	$0
Differential Cost of TRAC / year	$0	$20,000	$60,000
Cost of using AC and/or TRAC over an eight (8) year period	$5,040,000	$160,000	$480,000

TRAC® Saves… ***$4,800,000 (Operating Cost)***
FF System Capital Cost (~$35M)
ACI System Capital Cost (~$5M)

Cost Impact of an Advanced Hg Oxidation Catalyst

Low Sulfur PRB Fuel

TRAC® Economics – PRB Coal w/ ESP

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PRB Application (with ACI)

TRAC with ESP (for 650 MW unit)	3 Layers of Conventional catalyst	2 Layers of conventional and 1 Layer of TRAC®	3 Layers of TRAC®
Hg Oxidation(@ APH outlet), (%)	30	65	80
AC injection, # / MMACF	4.5	2.5	1.5
AC Cost (per year)	$3.39M	$1.88M	$1.13M
Differential Cost of TRAC / year	$0	$25,000	$75,000
Cost of using AC + TRAC over an eight year period	$27.12M	$15.24M	$9.64M

Notes: Assumes $0.75/lb for untreated AC
Additional cost of TRAC is 10-20%

TRAC® Saves

$17,000,000

TRAC® Economics – PRB Coal w/ FF

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PRB Application (with ACI)

TRAC with FF (for 650 MW unit)	3 Layers of Conventional catalyst	2 Layers of conventional and 1 Layer of TRAC®	3 Layers of TRAC®
Hg Oxidation(@ APH outlet), (%)	30	65	80
AC injection, # / MMACF	1.5	1.0	0.5
AC Cost (per year)	$1.13M	$0.75M	$0.38M
Differential Cost of TRAC / year	$0	$25,000	$75,000
Cost of using AC + TRAC over an eight year period	$9.04M	$6.2M	$3.64M

Notes: Assumes $0.75/lb for untreated AC
Additional cost of TRAC is 10-20%

TRAC® Saves

$5,400,000

TRAC® Record - Applications

Owner	Plant	Load (MW)	Coal	Supply	Country
A	Plant A	640	PRB	2008	US
B	Plant B	550	Bituminous	2010	EU
Southern Company	Miller Unit 1	735	PRB	2011	US
Southern Company	Miller Unit 2	735	PRB	2011	US
Southern Company	Barry Unit 5	773	Bituminous	2011	US
AEP	Mountaineer Unit1	1,300	Bituminous	2011	US
Southern Company	Bowen Unit 3	950	Bituminous	2011	US
AEP	Cardinal Unit 2	600	Bituminous	2012	US
C	Plant C	800	Bituminous	2012	EU
Southern Company	Hammond Unit 4	537	Bituminous	2012	US
Southern Company	Gaston Unit 5	910	Bituminous	2012	US
Southern Company	Bowen Unit 4	950	Bituminous	2012	US

Conclusion – Benefits of TRAC®

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- TRAC® has the potential to save Millions
  - In some cases, TRAC® can eliminate the need for installation of ACI or halogen injection.
  - In other cases, TRAC® effectively reduces operating costs by decreasing the amount of AC or halogens required for mercury control on both bituminous and PRB units.
  - By maintaining low SO2 to SO3 conversion, TRAC® can reduce the amount of sorbent injection required for SO3 mitigation.

Hg Oxidation Needs Considered for All Future Catalyst Replacements

Development Continues to…

Further Enhance TRAC® & CM Catalyst Performance

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