Advances in Mercury Control Technology for Industrial Sources

July 9, 2008

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Presentation Outline

- **MACT History – Activated Carbon**
- **Factors Controlling Mercury Emissions**
- **Case Study**
- **Activated Carbon Supply**

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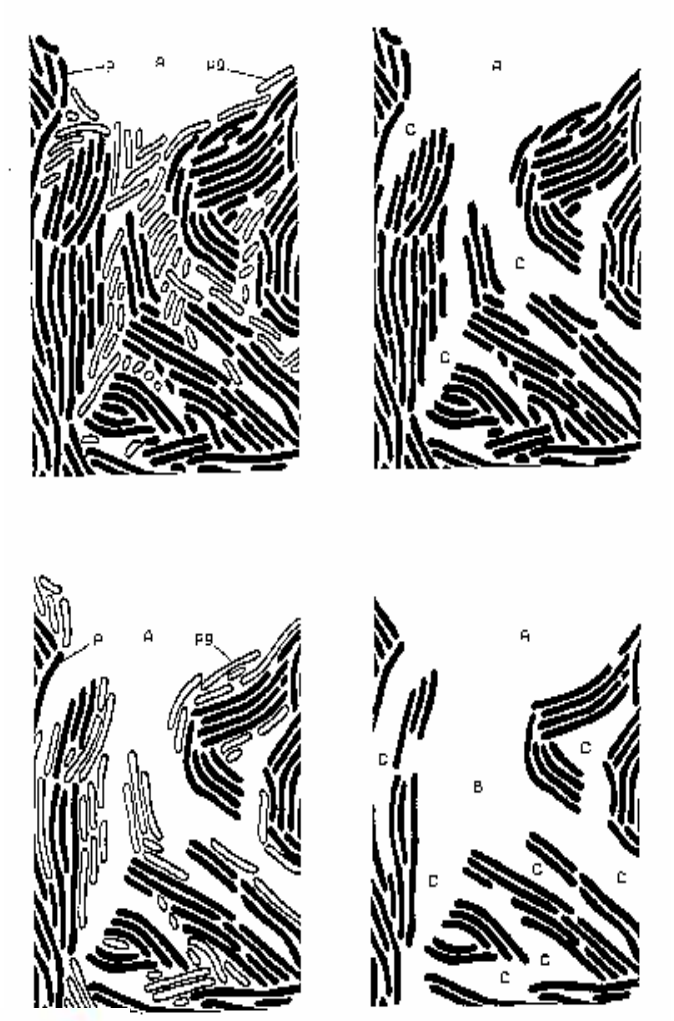
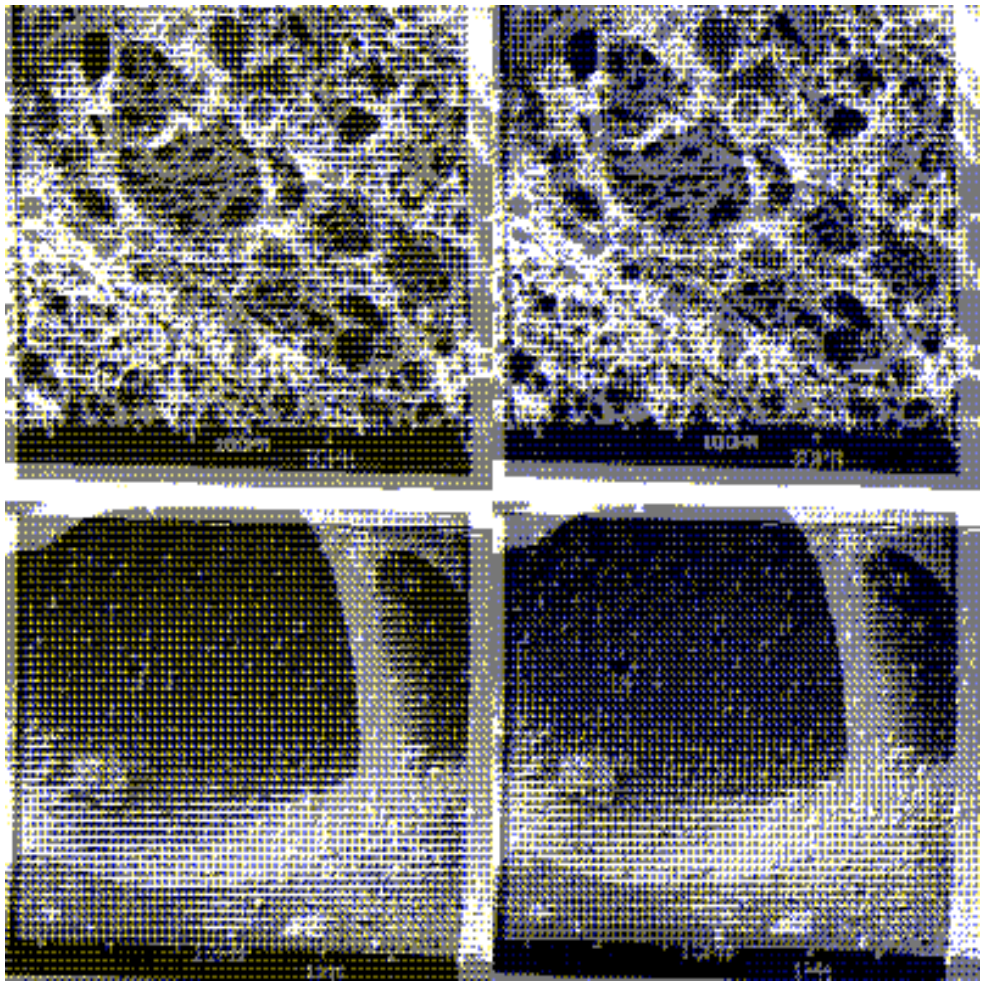
What is Activated Carbon?





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MACT Overview

	NESHAP						
	MWC MACT	HWC MACT	Foundry MACT	2° Al Smelter MACT	Portland Cement MACT	Boiler MACT	Coal-Fired Electic Utilities (no MACT)
Regulation Issued	1995	2001	2003	2003	2006	**VACATED**	**VACATED**
Hg	✓	✓	✓			✓	✓
Dioxins / Furans	✓	✓		✓	✓		

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Original Boiler MACT

- **BACT for Existing Sources**
  - **Large Units: heat input > 10 mmbtu/hour**

Non-mercury metallic HAP	**Fabric Filter**
Mercury	**Fabric Filter**
Inorganic HAP	**Scrubbers**
Organic HAP	**none identified**

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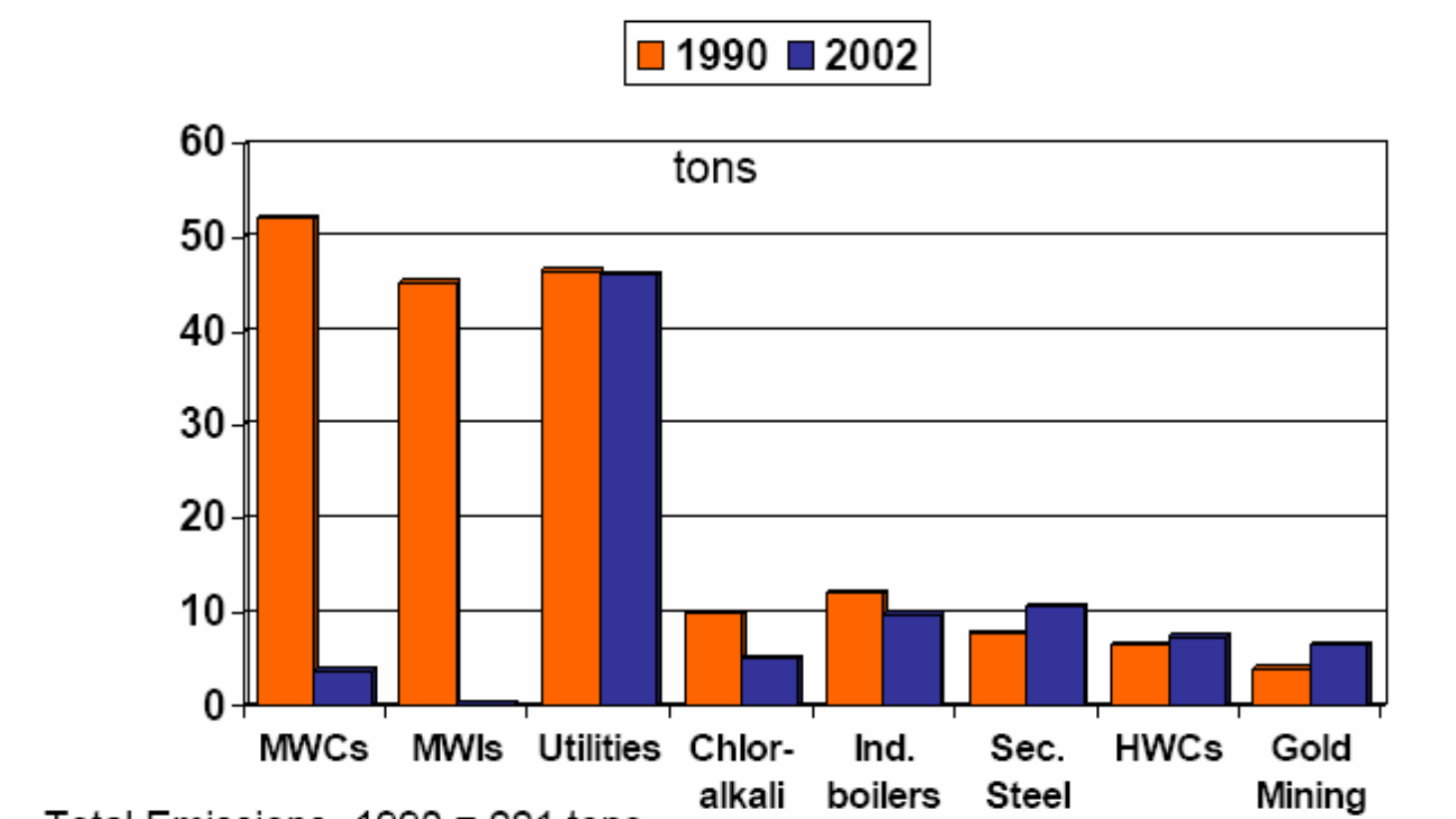
Estimated Hg Emissions by Source



Total Emissions -1990 = 221 tons
Total Emissions - 2002 = 119 tons

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Plant Dynamics Affecting Hg Capture

- Coal Type
- Configuration of APCD
- Boiler efficiency – unburned carbon (UBC) in fly ash

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Key Factors Affecting Hg Capture

Coal Burned in Industrial Boilers

Coal Type	Hg ppm	Cl ppm	S Wt. %	Ash Wt. %	HHV BTU/lb
Bitum.	0.11 (0.04 - 0.28)	1033 (48 – 2730)	1.69 (0.55 – 4.1)	11.1 (5.4 – 27.3)	13,203 (8646 – 14014)
Sub-Bit.	0.07 (0.02 – 0.14)	158 (51 – 1143)	0.5 (0.22 – 1.16)	8.0 (4.7 – 26.7)	12,005 (8606 – 13168)
Lignite	>0.11	188 (133 – 233)	1.30 0.8 – 1.42	19.4 12.2 – 24.6	10,028 (9487 – 10702)

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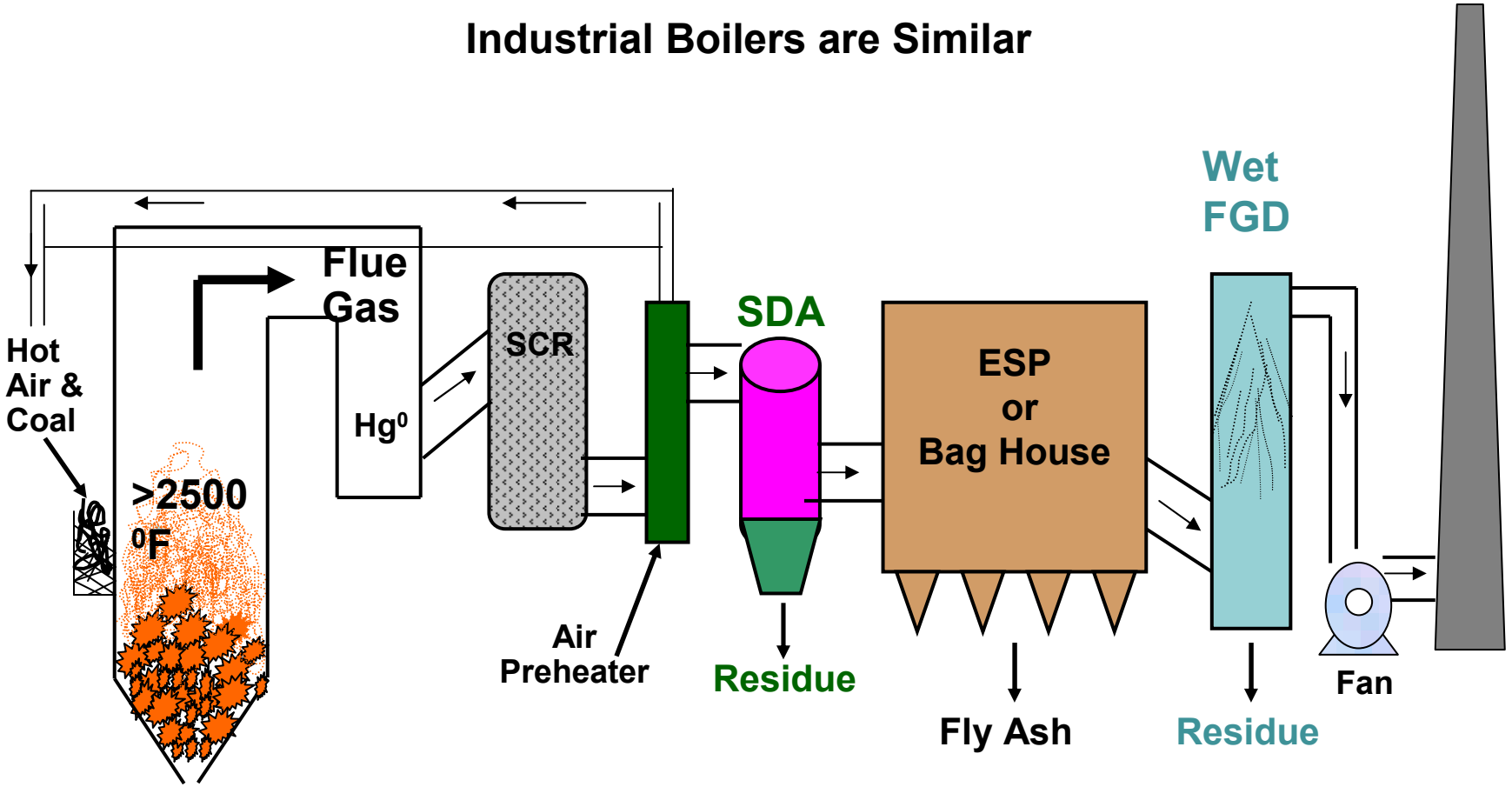
Coal data reported on dry basis. About 15% of units use coal blends.

"Control of Mercury Emissions from Coal Fired Electric Utility Boilers: An Update", U.S. Environmental Protection Agency, Office of Research and Development, Research Triangle Park, NC, February 18, 2005.

Possible APCD in a Coal Fired Utility Plant

Industrial Boilers are Similar



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APCD Affect on Hg Capture

- **CS-ESP**
  - **poor Hg capture (<5%) with PRB or lignite**
  - **about 30% removal with bituminous coals**

- **Fabric Filter**
  - **up to 90% mercury capture with bituminous coals**
  - **low Hg capture with lignite or PRB coals**

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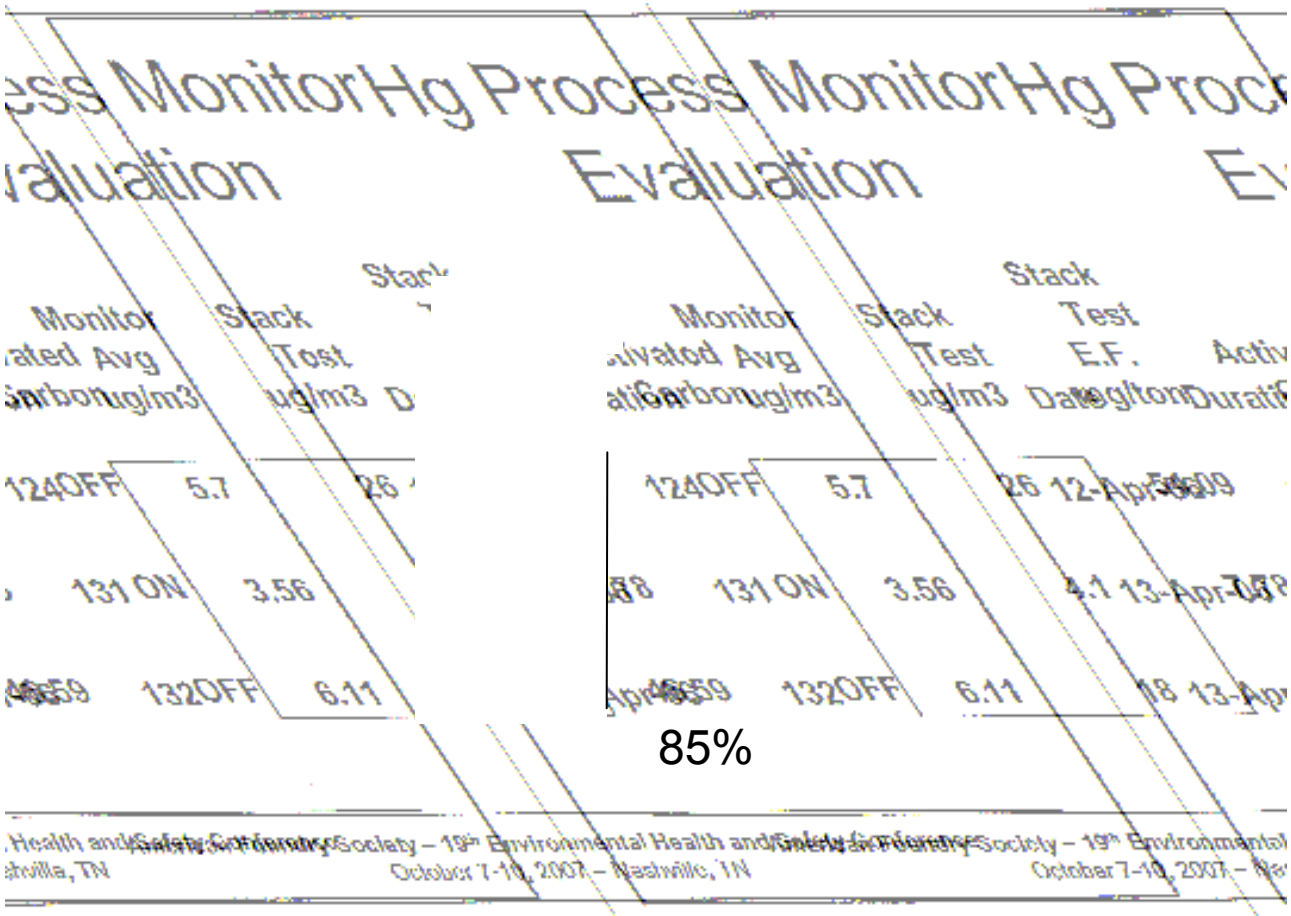
Case Study: MACT – Iron Foundry

- MACT Regulations, passed in 2003, require reduction in Hg emissions through mandatory elimination of Hg switches in scrap feed.
- NJDEP Enacted their own emission-based Hg reduction stds. Allowing no more than 35 mg/metric ton of scrap or 75% reduction. Passed in 4/07, compliance by 1/10.
- Other states expected to follow.
- Expected PAC usage ~120,000 lbs/yr per facility

MACT – Iron Foundry



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Compliance with Activated Carbon
Utility vs Typical Industrial Boiler

- **Utility**
- Salem Harbor, MA
- Generation nameplate ~ 90 Megawatts
- Steam Production ~ 600,000 lb per hour
- Air flow rate ~ 300,000 acfm
- Burn ~ 270,000 tons/year eastern bituminous coal
- **University**
- Located in Northeast US operating 4 Boilers
- Boiler Size averages 125 mmBTU/hour
- Steam Production annual average is 200,000 lb per hour
- Air flow rate ~ 100,000 acfm
- Burn ~ 75,000 tons/year eastern bituminous coal

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Compliance with Activated Carbon Utility vs Typical Industrial Boiler

Location	Coal	Equipment	Carbon Grade	Carbon Rate (lb/MMacf)	% Removal	Annual Carbon Estimate (lbs)
Salem Harbor	Est Bit	C-ESP	Darco-Hg	10	80-90	1,500,000
University	Est Bit	Fabric Filter	Darco-Hg	~1-3	80-90	150,000 – 500,000

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Compliance Cost Comparison

	Air Flow	Capital Expense	Annual Carbon Expense
	(acfm)	($)	($)
Electric Utility	1,200,000	$1,250,000	$2,000,000
MWC	175,000	$1,250,000	$100,000
Iron Foundry	250,000	$1,250,000	$100,000
Industrial Boiler	500,000	$1,250,000	$300,000

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Activated Carbon Market

- **What's important going forward?**
  - **Specifications**
  - **Performance Guarantees**
  - **Product Offerings**
  - **Demand and Supply**

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Activated Carbon Specifications

- EPRI Initiative
  - Molasses, Iodine Number, BET (N2) Surface Area, Methylene Blue, BWC, Tannin Number, Phenol Number & others
- Different Carbon Base = Different Test.
- Industry needs a standardized test

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Performance Guarantees

- **Individual AC companies may or may not offer**
- **Site specific – many variables including APCD and coal type consistency**
- **Adsorptive Tests to Characterize Activated Carbon**
  - Hg Loading Capacity and Kinetics
    - Norit Americas has developed a Hg adsorption test in order to begin specifying its flue gas mercury removal products on a new CEM-based analysis.
    - Our future goal is to ensure that every lot of carbon meets expected mercury removal requirements for a standardized flue gas.

New Products - Surface Modifications

- Low Rank Fuels (DARCO Hg-LH)
- Concrete Compatible (DARCO Hg-CC)
- SO_3 Resistant Carbon (Darco E-26)
  - Moderate SO_3 Coal and SO_3 Conditioning Applications
- Others in development

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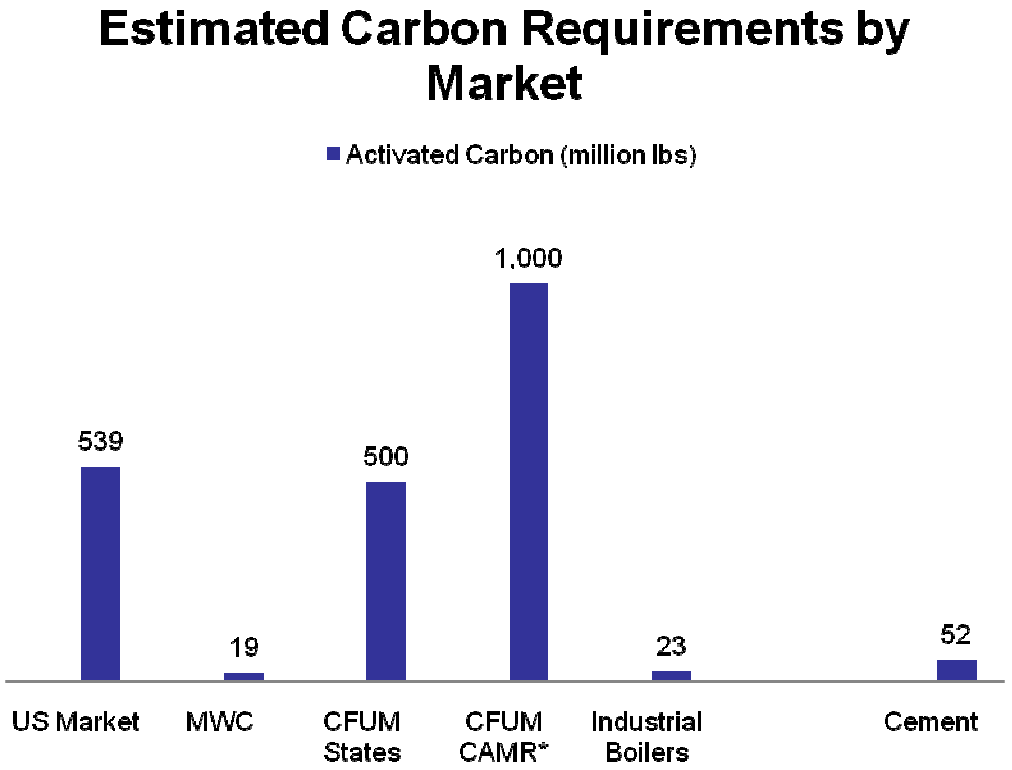
Activated Carbon Demand



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* Assumes no new technology, better estimate is 500-800mm additional lbs with Federal MACT Rule

Activated Carbon Supply

Norit's Supply for Future Demand

- Plant capacity is being added to meet demand
- Current powder capacity: 120 million pounds
- Permitting for 150 million additional pounds at current facilities
- Stage 2: expand to new locations
- Typical lead time for additional capacity is 12-18 months

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Expansion Update

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