



**FLY ASH
LEGISLATIVE
UPDATE & FACTORS
EFFECTING SUPPLY**

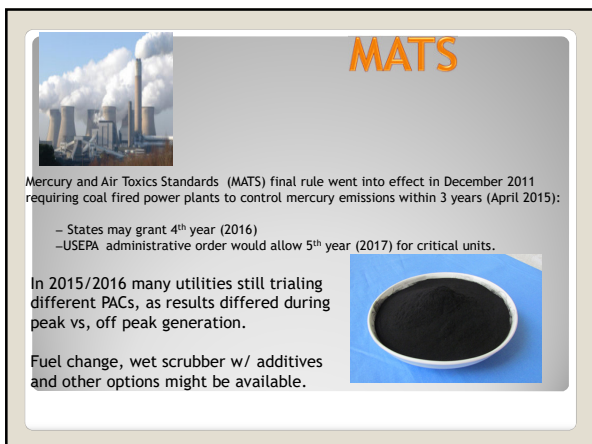
MCC June 2017

The slide features a collage of images: hands holding a pile of grey fly ash, a white fly ash separator, a pile of yellow fly ash, and a cross-section of a porous material. A small '80' logo is also visible.

EPA Regulations

- Coal ash regulatory bill pass by congress on December 10th. Haz/Non Haz.
- Included as part of a major water infrastructure bill. (Water infrastructure improvement for the nation act)
- President Obama signed the bill.
- Regulation is back to the state level.
- Scott Pruitt (OK attorney general) appointed to head the EPA.

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MATS

Mercury and Air Toxics Standards (MATS) final rule went into effect in December 2011 requiring coal fired power plants to control mercury emissions within 3 years (April 2015):

- States may grant 4th year (2016)
- USEPA administrative order would allow 5th year (2017) for critical units.

In 2015/2016 many utilities still trialing different PACs, as results differed during peak vs, off peak generation.

Fuel change, wet scrubber w/ additives and other options might be available.

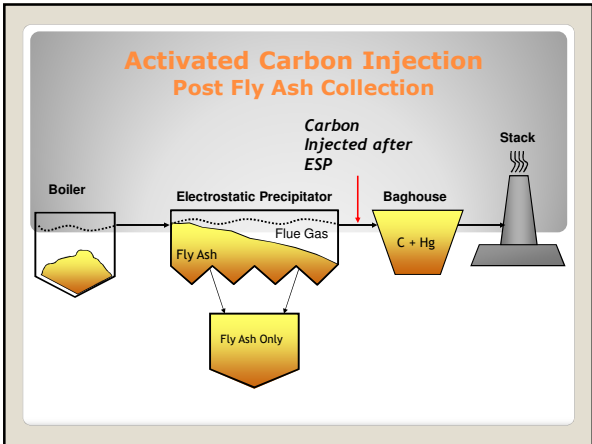


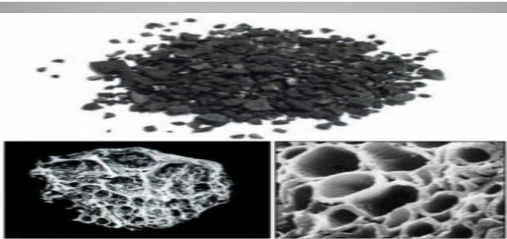
- **Dry Sorbent Injection (Trona)** 40-75% reduction in SO₂: Lime, hydrated lime, Sodium bi-carbonate
- **Powdered Activated Carbon (PAC)** 90% mercury removal

Dry Sorbent Injection Technologies

- PAC creating many air issues in the fly ash market, which creates a tight supply chain.
- Many in the specifying agencies and ready mix/related industry do not understand PAC.
- Will create entrained air issues, effect dependent on PAC utilized.
- Does not effect specification at DOT.

Powdered Activated Carbon





**Injected Activated Carbon
Designed to capture Mercury**

Sorbent Vendors

Top players vying for this \$10 billion /year market

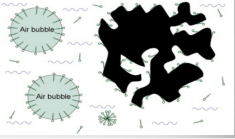
Mercury Control:

- Cabot (Norit) – DARCO-Hg family of sorbents
- Calgon – Flue PAC family of sorbents
- ADA carbon Solution: Power PAC, Fast Pac
- Albemarle: B-PAC, C-PAC, H-PAC,
- BASF – Mercury Sorbent HX – Brominated mineral sorbent
- Novinda: Amended Silicates
- EM2C: Additive & PAC
- ADA ES: coal additive, engineering solutions and consulting
- Others: Shaw, Nalco (scrubber additives)

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- Carbon adsorbs AEAs → ↑Carbon = ↑AEA Adsorption
- PAC – small amount, big impact (300 – 400 m²/g)
- Native Unburned Carbon – Big amount, small impact (2 – 6 m²/g)
- LOI is not proving meaningful information anymore

ADSORPTION... is the best option




LOI → Adsorption


K.H. Pedersen, A.S. Jensen, M.S. Singh-Rasmussen, K. Dan Johansen

- Widely used by the industry
- Fly Ash + water (+cement)
- Add a drop of AEA
- Agitate
 - Blender or
 - Shaken, not stirred
- Stable foam... no? repeat
- Record amount of drops needed to achieve a stable foam
 - Subjective
 - Poor repeatability

Foam Index



**QA/QC Is Critical!
LOI is Irrelevant.**



Foam Index/Windows/Carbon not mitigated.



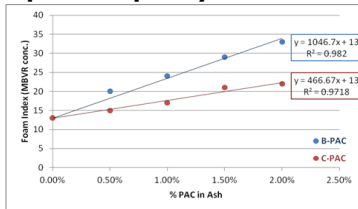
Foam Index/No Windows/Carbon mitigated



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PAC Adsorption Capacity varies.....

In this example, C-PAC is less adsorptive of MBVR than B-PAC.



The slope of the linear regression line indicates the foam index variability relative to changes in PAC % concentration in ash.

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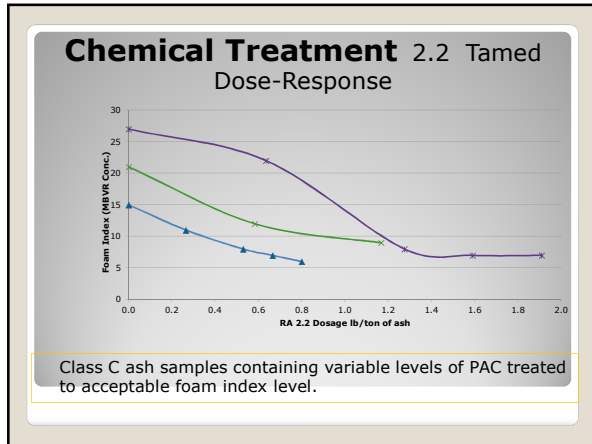
Activated carbon in concrete attracts the AEA hydrophobic end and prevent it from entraining air.

Air Bubble **Cement or fly ash**

Activated Carbon

Air Entrainment Agents (AEA's) prefer powdered activated carbon.

Chemical mitigation saturates the activated carbon surfaces with a sacrificial agent to prevent the adsorption of AEA's.



Beneficiated ash with chemical treatment

Sample Description	Control	C-Ash		C-Ash with PAC	
	Cement	No PAC	Untreated	Treated	
Foam Index (conc MBVR)		3	18	5	
AEA dosage (oz/cw)	1.2	1.4	4.2	1.7	
Air Content (6%±1%)	7.0%	7.0%	6.25%	5.75%	
Bulk Density, lb/ft ³	144.8	145.6	147.2	148.0	
Slump, inches (6±1)	6.25	6.0	6.25	5.75	
3 day, psi	2814	2858	3039	2907	
7 day, psi	3433	3689	3592	3918	
28 day, psi	4594	4802	4764	4908	

Ash treatment restored the AEA dosage to same level expected with ash containing NO activated carbon.

Adsorption isotherm breakthrough

- Fly ash + known concentration of standard surfactant (150 ppm),
- Measure final concentration
- Fly ash + water
- Add small amount of surfactant
- Measure
- Is there any surfactant in solution... no?
- Repeat until surfactant is detected in solution
- Record amount of surfactant needed to detect surfactant in solution

Adsorption Isotherm/Breakthrough
Using Fluorescence as detection method

- **Newton:** Ammonia, PAC and Trona
- **Jeffrey's and Tecumseh:** PAC
- **N. Omaha:** PAC
- **Nebraska City:** PAC, Trona.
- **Edwards Station:** PAC
- **Approximately 2 million tons treated!**

Plants in Service Meeting current Regulations.

- 2015-2016 was a perfect storm of negative impacts to supply.
- Persistent low natural gas supply.
- Coal plant shutdowns due to regulation during peak demand.
- Mild weather in key parts of the country.

Annual average capacity factor of selected electricity generating technologies (2005-15)

Year	Coal steam generators (%)	Natural gas combined-cycle generators (%)
2005	~70	~35
2006	~70	~35
2007	~70	~35
2008	~70	~35
2009	~70	~35
2010	~70	~35
2011	~70	~35
2012	~70	~35
2013	~70	~35
2014	~70	~35
2015	54.6	56.3

Current fly ash supply picture.

- Final 2015 share of power generation:
- Coal 33.2%- Natural gas 32.7%
- 2016 EIA forecast for 2016:
- Coal 32%- Natural gas 33%

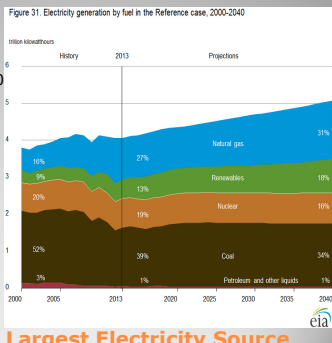
U.S. monthly net electric power generation (Jan 2014-Oct 2015)

Coal Is Down But Not OUT!

- Lower capacity plants: Under 200MW
- Older plants avg. 54 years.
- Units without SO2 controls
- Plants not planning installing SO2 controls.

What Plants Are Being Retired?

- U.S. government forecasts show coal will remain largest energy resource for electricity generation at least through 2040
- Coal's **share** of electricity generation continues to decline, but **volume** of generation remains stable
- Worst case scenario, 1 Billion tons still to be produced.
- 3% increase in coal use in 2017.
- 1-3% increase in 2018.



Coal Will Remain Largest Electricity Source

SOURCE: U.S. Energy Information Administration, Annual Energy Outlook 2015



- ACAA estimates 1.4BI has been disposed of in ponds and landfills since 1974.
- Specifications do not prohibit reclaimed ash.

Beneficiation and Reclamation

- High Sulfur coal, More class F ash?

Dependent on installation of scrubbers
New sources of ash?

- Blended ash C/F
May require mods to state and industry specs.

- Storage needed

Future opportunities







A business card for Benjamin J. Franklin, Director of Technical Services. The card is light gray with a white border and a drop shadow. It lists contact information: Mobile: 314-974-5095, Email: bfranklin@headwaters.com, and website: www.flyash.com. The word "THANKS" is printed in large, bold, yellow letters at the bottom center.

- Benjamin J. Franklin
- Director of Technical Services
- Mobile: 314-974-5095
- Email: bfranklin@headwaters.com
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THANKS
