

# MACT Strategies – Compliance Strategies with Hydrated Lime

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**ADA Environmental Solutions** creates and delivers cutting edge technical and chemical solutions to reduce emissions from coal-fired power plants, Portland cement kilns and industrial boilers, helping customers meet environmental goals while balancing their business needs.

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# The Compliance Challenge

## ■ Integrated Decisions

- Multiple regulations. Decisions on one pollutant may affect options for others
- Long-range, multi-plant CapEx decisions

## ■ Tight Timeframes

- Implementation by 2014 for MACT and Transport Rule
- Many capital decisions must be made 2 to 3 years before implementation

## ■ Limited Resources

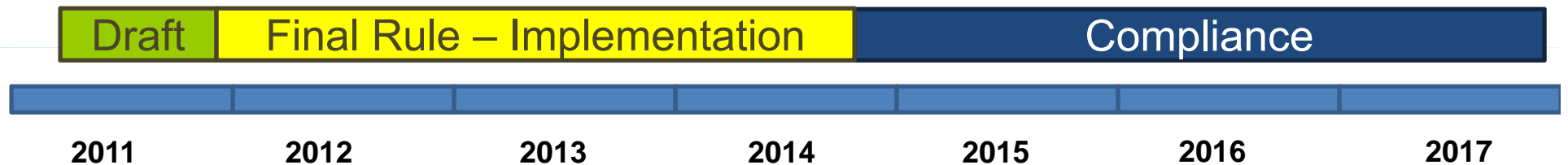
- Testing Services, Engineering and Construction Services, APC Equipment, Chemicals

# MACT and CATR

- The Air Toxics Rule (Draft March 16, 2011)
  - Combines MACT and NSPS
  - Requires Maximum Achievable Control Technology (MACT)
    - Mercury
    - Total PM: surrogate for non-mercury metal HAPS. Limits on individual metals or total metal acceptable
    - HCl: surrogate for acid gases HAPS.  
SO<sub>2</sub> allowed for scrubbed units
    - Organic HAPS: Work Practice Standards
  - NSPS: for PM, SO<sub>2</sub>, NO<sub>x</sub>
- Clean Air Transport Rule (CATR) (Draft July 6, 2010)
  - Reduce SO<sub>2</sub> and NO<sub>x</sub> in 31 states and D.C.

# Timeline for U.S. EPA Regulations Impacting the Power Industry

## Toxics Rule



## CATR

### Clean Water Act

- 316b Implementation
- Effluent Guidelines

### Coal Combustion Residuals Implementation

# MACT/Toxics Rule

Coal Subcategory	Total PM lb/MMBtu	HCl lb/MMBtu	Mercury lb/TBtu
> 8300 Btu/lb			
Existing	0.03	0.0020	1.0
New <sup>2</sup>	0.005	~0.00003	~0.012
<8300 Btu/lb			
Existing	0.03	0.0020	4.0 <sup>1</sup>
New <sup>2</sup>	0.005	~0.00003	~4.0

<sup>1</sup>Beyond-the-floor limit, based on assumption that ACI can be used

<sup>2</sup>Fuel input limits for new plants estimated from lb/MWhr output basis

## New Source Performance Standards:

SO<sub>2</sub> : 1.0 lb/MWh

NOx:

- 1) combined NOx+CO of 1.2 (lb NOX + lb CO)/MWh; or
- 2) NOx limit of 0.7 lb/MWhr.

# Toxics Rule Emissions Limits

Fuel	Assumed Properties		Emission at Proposed Existing Boiler Limit		
	Coal Cl µg/g dry	Coal Hg µg/g dry	Total PM <sup>1</sup> gr/dscf	HCl <sup>1</sup> ppmvd	Mercury <sup>1</sup> µg/dscm
Bituminous	1000	0.10	0.017	1.7 (> 90%)	1.3 (80-90%)
Subbit	25	0.10	0.026	2.7 (~ 10%)	2.0 (80 – 90%)
Lignite	50	0.10	0.030	3.0 (~ 60%)	9.3 (~ 60%)

<sup>1</sup>Concentrations at 3% O<sub>2</sub>

# CATR States for SO<sub>2</sub>

- Plants in CATR states more likely to be FGD candidates
  - Group 1: 15 states (stricter controls in 2014):
    - Georgia, Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin.
  - Group 2: 13 States/DC (same controls in 2014):
    - Alabama, Connecticut, Delaware, District of Columbia, Florida, Kansas, Louisiana, Maryland, Massachusetts, Minnesota, Nebraska, New Jersey, and South Carolina.

# Hydrated Lime and Compliance

- Mercury (Hg):
  - Activated carbon injection (ACI) is effective at controlling Hg *if SO<sub>3</sub> levels are relatively low*
  - ✓ Hydrated lime can effectively be used to protect AC
- Total particulate matter and non-Hg metals
  - ✓ Hydrated lime can reduce condensable PM fraction
  - ✓ Hydrated lime effective for some volatile metals (e.g. Se)
- Acid Gases (HCl):
  - ✓ Hydrated lime effective for HCl trim control
- SO<sub>2</sub>
  - ☒ Hydrated lime not as effective for SO<sub>2</sub> control at typical operating temperatures

# Compliance Strategies Using Lime

- Unit Characterization of High Risk for retirement
  - Unscrubbed: *New CapEx must be justified compared to other options*
  - Bituminous-fired: *SO<sub>2</sub> and HCl limits may be difficult to achieve without FGD*
  - Older (Built prior to 1970), Smaller (< ~ 300MW)
- Lime injection is far less capital intensive than Wet or Dry FGD and is a valid consideration of extending the life of reliable generating assets
- DSI can be installed and commissioned prior to the compliance dates

# Need for Reliable APC Equipment

- **No exceptions** for startup, shutdown, or malfunctions (SSM)
  - 30-day averaging period still required high reliability
- Potential for multiple pollutant violation for DSI malfunction (HCl, Hg, condensable PM)
  - PAC left unprotected in high-S flue gas, H<sub>2</sub>SO<sub>4</sub> blinds PAC to Hg control
  - Immediate impact to HCl and condensable PM
- Compliance assurance demands APC reliability

# System Design & Operational Challenges

- Motive air source for most pneumatic systems is compressed ambient air.
  - Most systems use a regenerative or positive displacement blower.
  - Compression inefficiencies result in heat being added to the motive air.
- Carbonate formation is inevitable.
- Traditional systems fail because of carbonate scaling and system occlusion.

# System Design & Operational Challenges

- Moisture:
  - Ambient air
  - by product of the carbonate reaction.
- Presence of moisture further complicates conveyance system performance.
  - $\text{Ca}(\text{OH})_2$  will absorb water and alter handling characteristics ( $\uparrow$  density).
  - $\uparrow$  related abrasion & agglomeration issues.
- These effects seem additive to promote component scaling, material accumulation, and eventual system failure.

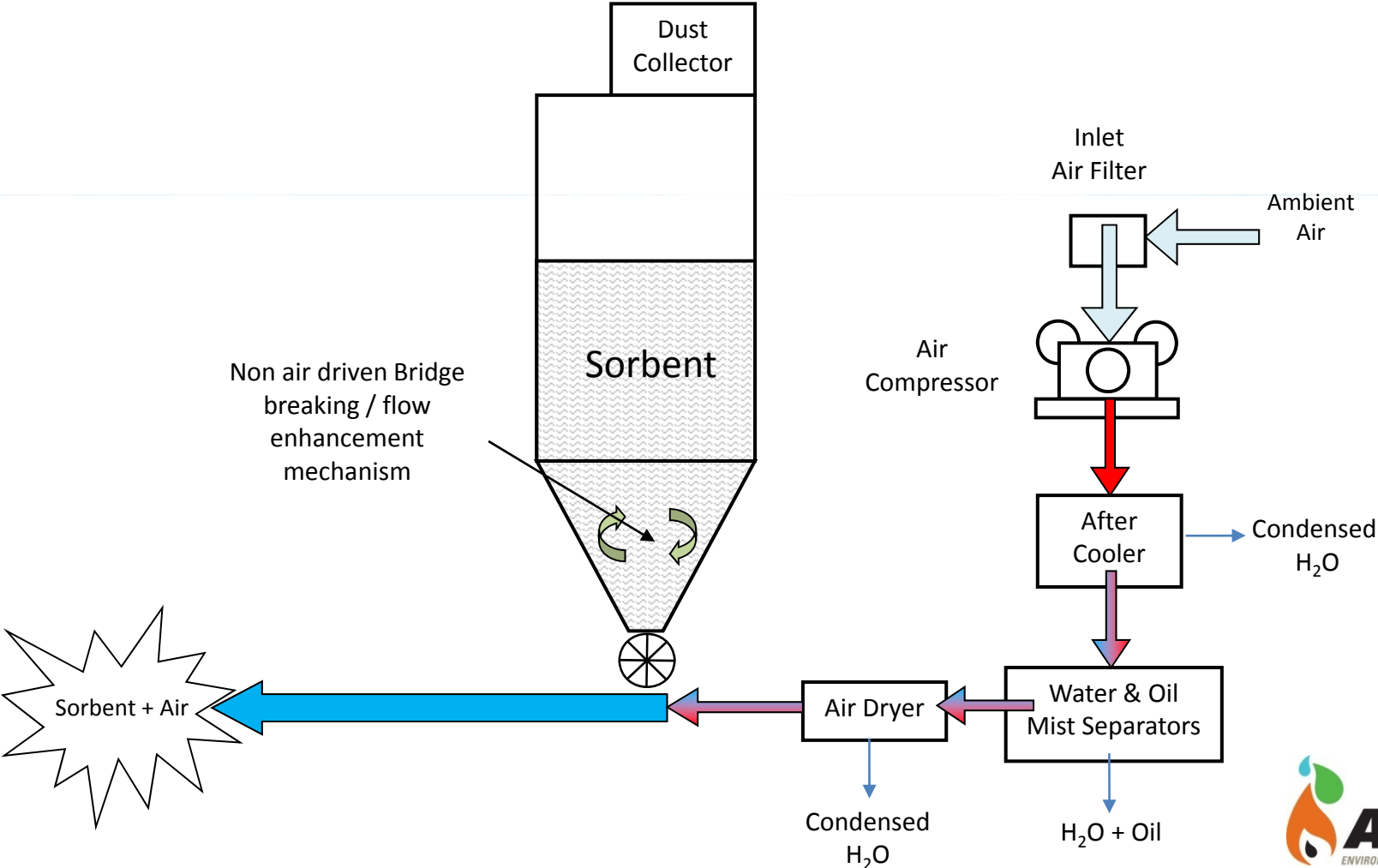
# System Design & Operational Challenges

- System design which promotes the targeted chemistry and limits by-product chemistry.
- CO<sub>2</sub> is part of the ambient air but we can moderate its impact by reducing heat input.
- Transport and Distribution considerations.
  - *In duct sorbent distribution affects chemical and physical abilities of the sorbent to react.*
  - ↓ velocities facilitate distribution and ultimately reagent utilization.

# Enhanced Hydrate Delivery System Design

- CO<sub>2</sub> & heat are issues with previous approach.
  - Scale prevention should include temperature and moisture control of the entire conveyance system.
- Three primary design criteria:
  1. low conveyance air temperatures
  2. low conveyance air moisture levels. and
  3. appropriate conveyance velocities.
- The ADA design philosophy can be summarized as: *'keep it cool, keep it dry, keep it slow<sup>TM</sup>.'*

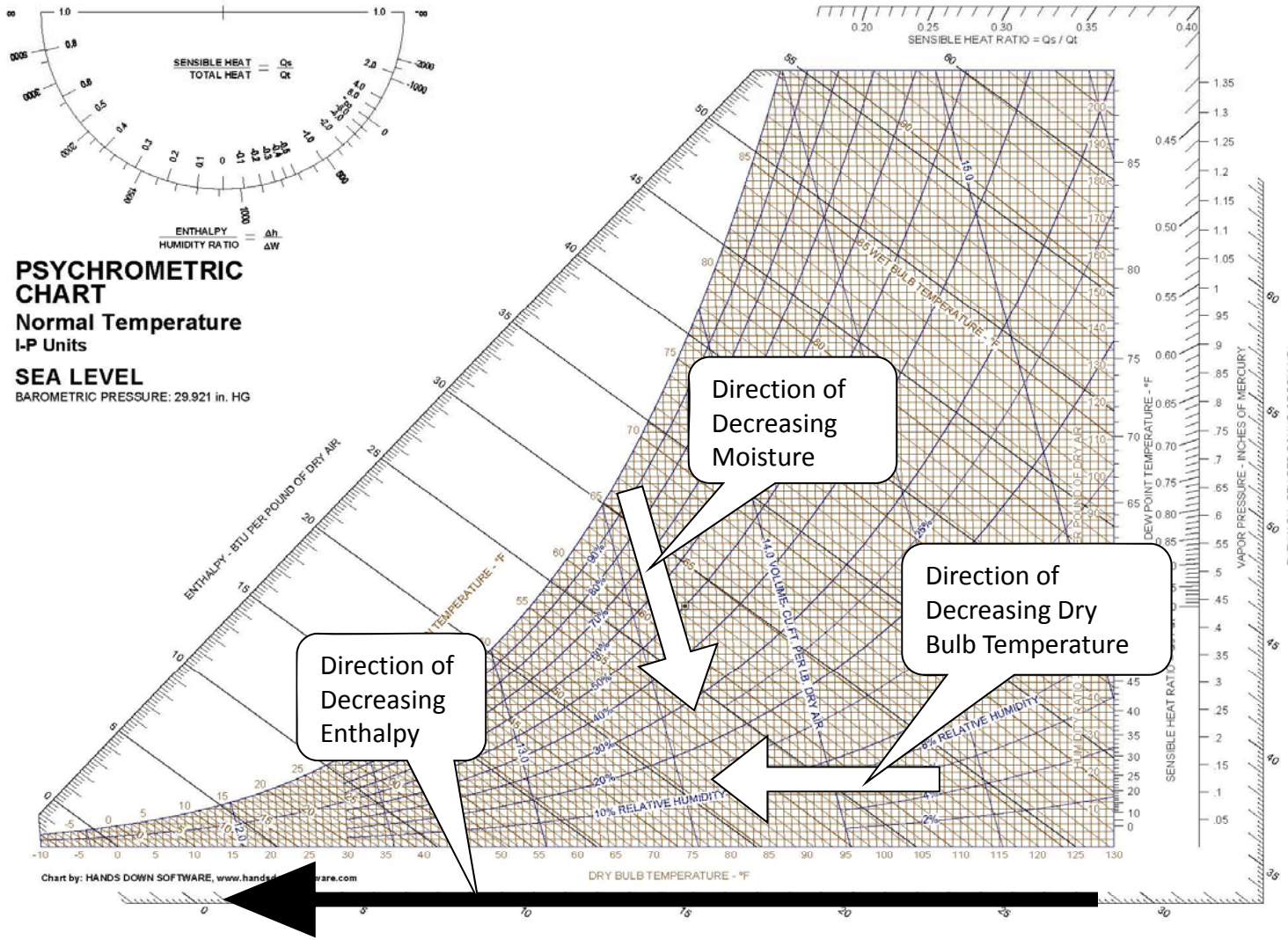
# Enhanced Hydrate Delivery System Design



# Enhanced Hydrate Delivery System Design

- Using cool dry expanded compressed air has some distinct advantages:
  - Constant volume.
  - Since alkaline sorbents are hygroscopic, air moisture content is principal to overall system performance and for enduring operation.
- Related to air dryness & moisture content is the ability of the dry air to be an insulator
  - Since the compressed air system provides dryer air, it has less ability to carry & transfer heat to its surroundings
  - Consequently the air cannot transfer heat to the hydrate further facilitating scale prevention.

# Enhanced Hydrate Delivery System Design



# Enhanced Hydrate Delivery System Design

- Dry compressed air is supplied to the air supply side at the metering point.
- Near the manifold, the compressed air expands to the design pressure of the dilute phase pneumatic conveyance system
  - The precisely metered air is allowed to expand adiabatically.
  - This expansion achieves a net cooling effect which further facilitates reducing system temperature.

# Enhanced Hydrate Delivery System Design



- Conveying at slower velocities material tends to move the material with the bulk air flow.
- Slow velocities help prevent excessive material impingement and abrasion erosion of system components.
  - Soft powder plug detection and removal.
- To allow continued & reliable operation at lower velocities, ADA developed a manifold which allows material to follow conveyance air and assure the designed distribution is maintained.

# Enhanced Hydrate Delivery System Design

- Enhancing system reliability
  - Avoid the ‘bad’ carbonate species.
  - Lower conveying temperatures.
  - Maintain slower conveying velocities to minimize material self-heating, impingement, and turbulence.

# Wrap-up

- Hydrated lime injection can play a prominent role in the compliance strategies for a subset of existing EGUs
- Equipment availability and reliability are paramount in compliance initiative
- Enhanced system reliability is possible by understanding the chemistry and designing system that address the unique chemical challenges.

*You can buy hardware, you need to work for compliance*

# Thank You

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