THE McILVAINE COMPANY

MISSISSIPPI LIME™

Discovering what's possible with calcium™

Meeting Regulatory Needs with Hydrated Lime

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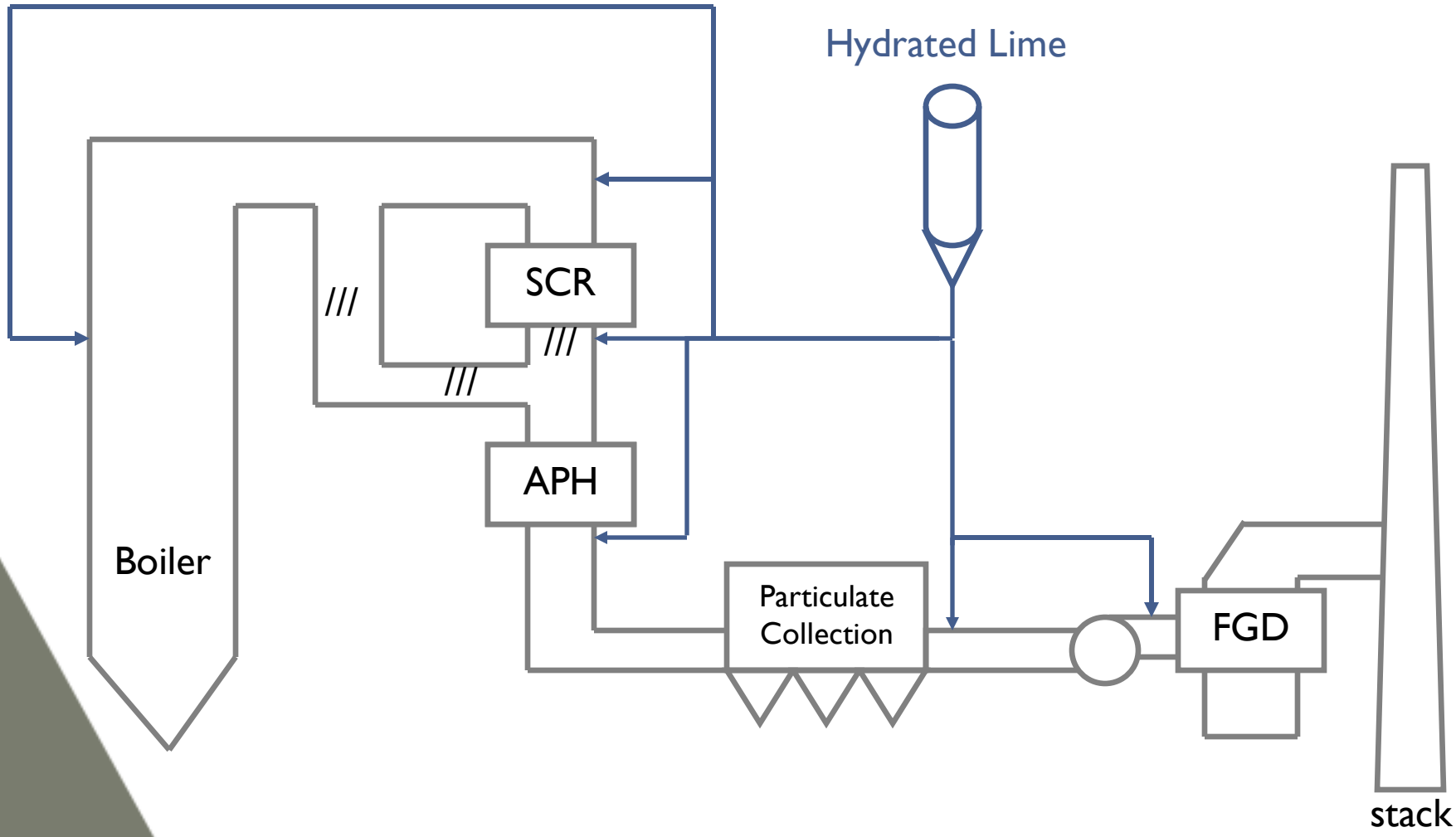
Regulatory Reasons for Acid Gas Mitigation

- Pre-MACT
  - Offset additional SO_3 generated from SCR installation
  - Control blue plume at stack from Wet FGD addition
    - Appearance
    - Local concerns
- Future
  - Consent decree on acidic gases
    - Specified amount at the stack
      - Limitations of Method 8A
  - Particulate
    - 0.030 lb/MM Btu (filterable)
  - HCl as acid gas surrogate
    - 0.002 lb/mmBTU
    - Protection of PAC for Hg control
  - Consistency and OST of mitigation system will be critical

Questions to Answer

- Are you buying tons or moles of sorbent?
  - Forecast annual usage in *tons* for comparison of sorbents
- Where are you and where do you have to get with pollutants?
  - Potential side benefits of acid gas mitigation
  - Hydrated lime effective for SO_3 and HCl at a wide temperature range
- What will your injection system look like?
  - Expectations on Operations and Maintenance
  - Hydrated lime systems with good design principles are in place and working well in the industry
- Implications of sorbent choice
  - Supply
  - Solid, multi-location supply base
  - Logistics
  - Availability via truck or rail; low working capital and short lead time
  - Ash
  - No leaching issues

Injection Location Options for Hydrated Lime



Acid Gas Emission Control – Baghouse Shawnee

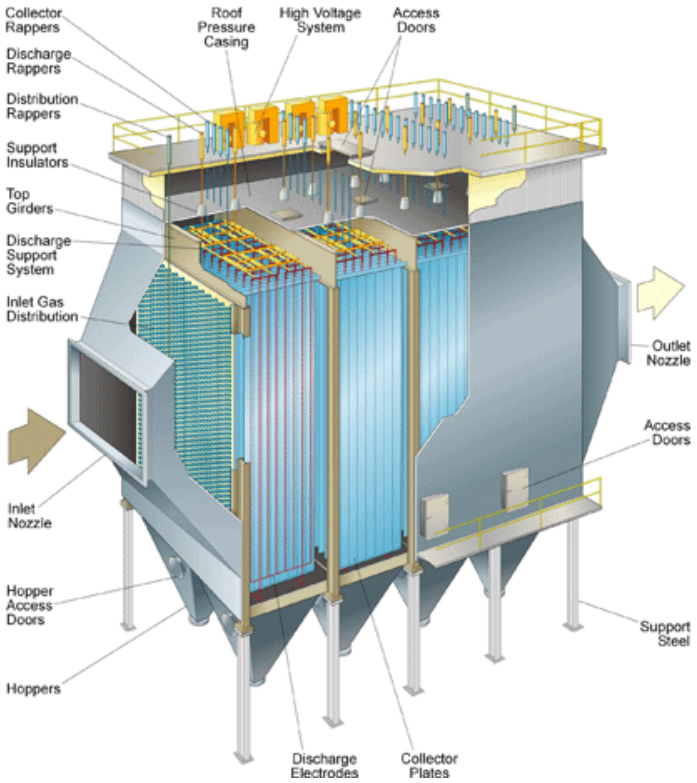
DSI Program targeting HCl emissions to meet 2015 MATS

- Baghouse seasoning is essential for test program *(yellow vs green)*
- HCl limits easily met with low hydrate requirements
  - Lower limit of feeder capability for consistency
- Results of follow-up study also optimistic

Hydrate Injection Rate	HCl (lb/MMBTU)	HF (lb/MMBTU)	H_2SO_4 (ppmvd)
0 lb/hr - Baseline	0.0030	0.0045	1.3
600 lb/hr (in flight)	0.0016	0.0046	**0.46**
1,000 lb/hr (in flight)	0.0016	0.0043	**0.42**
350 lb/hr	**0.0005**	**0.0006**	**0.37**
350 lb/hr	**0.0007**	**0.0007**	**0.35**
300 lb/hr	**0.0008**	**0.0006**	**0.35**

SO_3 Control with Hydrate ESPs

- SO_3 conditions ESP
- Ash resistivity
  - Sodium reduces; Calcium increases
- Strategy for Unit-specific issues
  - Distribution of particulate in duct
  - Balance hydrate feed and SO_3 levels
    - Important to maintain ESP conditioning
    - ~3ppm SO_3
  - Short Residence time in front of ESP
    - Manage with split injection



Courtesy B&W

Lodge Cottrell presentation from 2011 APC conference
– Reinholdenvironmental.com library section

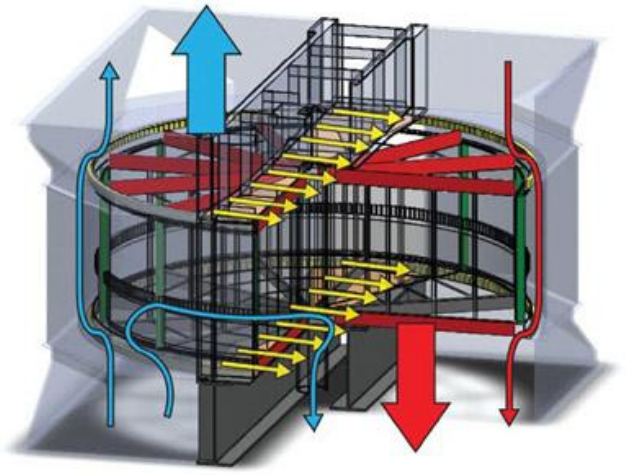
Typical SO_3 Removal Rates - ESP systems

- Residence time effects
  - Short (<2 sec) will require more sorbent
- Injection system efficiencies
  - Flue gas coverage
  - Feed system

Removal Rate Examples Using Hydrated Lime

Plant	*lb hydrate: lb SO_3*	Treated Stack
550 MW	3.9 : 1	<1.5 ppm
1300 MW	3.9 : 1	3 ppm
700 MW	3.5 : 1	3.5 ppm
>500 MW	1.9 : 1 3.8 : 1	<6 ppm <2 ppm
>500 MW	2.5 : 1 3.9 : 1	4 ppm <2 ppm

Hydrate Prior to Air Preheater



Courtesy BreenES

Hot side injection offers additional benefits:

- Better utilization of sorbent
  - Longer reaction time
- APH operation
  - Eliminate ABS buildup from ammonia slip
  - Flexibility on SCR operation
- Lower heat rate
  - Reduce acid dew point through APH

Neutralization of SO_3 by hydrate will occur at pre-APH temperatures

- Sodium sorbents:
  - Byproducts and intermediates can form without temperature and concentration control
- Calcium sorbents
  - No issues with reaction byproducts or intermediates
  - Multiple trials of Pre-APH since '09
  - Utility – Pre-APH since 2010
    - No issues reported

Pre-SCR Injection with Hydrated Lime for SO_3

- Potential benefits
  - Residence time
  - Mixing/sorbent utilization
- Initial program
  - Unit <250MW
  - Bituminous coal
  - Injected over several days
- Observations
  - No operational issues during this limited test period
  - Noticeable reduction in hydrate required to achieve low SO_3 levels measured at APH outlet (vs injection at SCR outlet)
- Additional testing planned

Summary

Hydrated lime DSI is effective for acid gas mitigation

- Meeting HCl MATS Requirments
- ESP applications
- Pre-APH
  - Additional benefits of early SO_3 removal
- Interesting results with Pre-SCR injection

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