Use Dry Sorbent Injection to Comply with Air Emissions Regulations

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Outline

- Regulations
  - Boiler MACT
    - HCl
  - Utility MACT
    - HCl
  - CSAPR (Cross State Air Pollution Rule)
    - SO_2
- Dry Injection of Trona or Sodium Bicarbonate
- HCl and SO_2 Removal Performance
- Summary

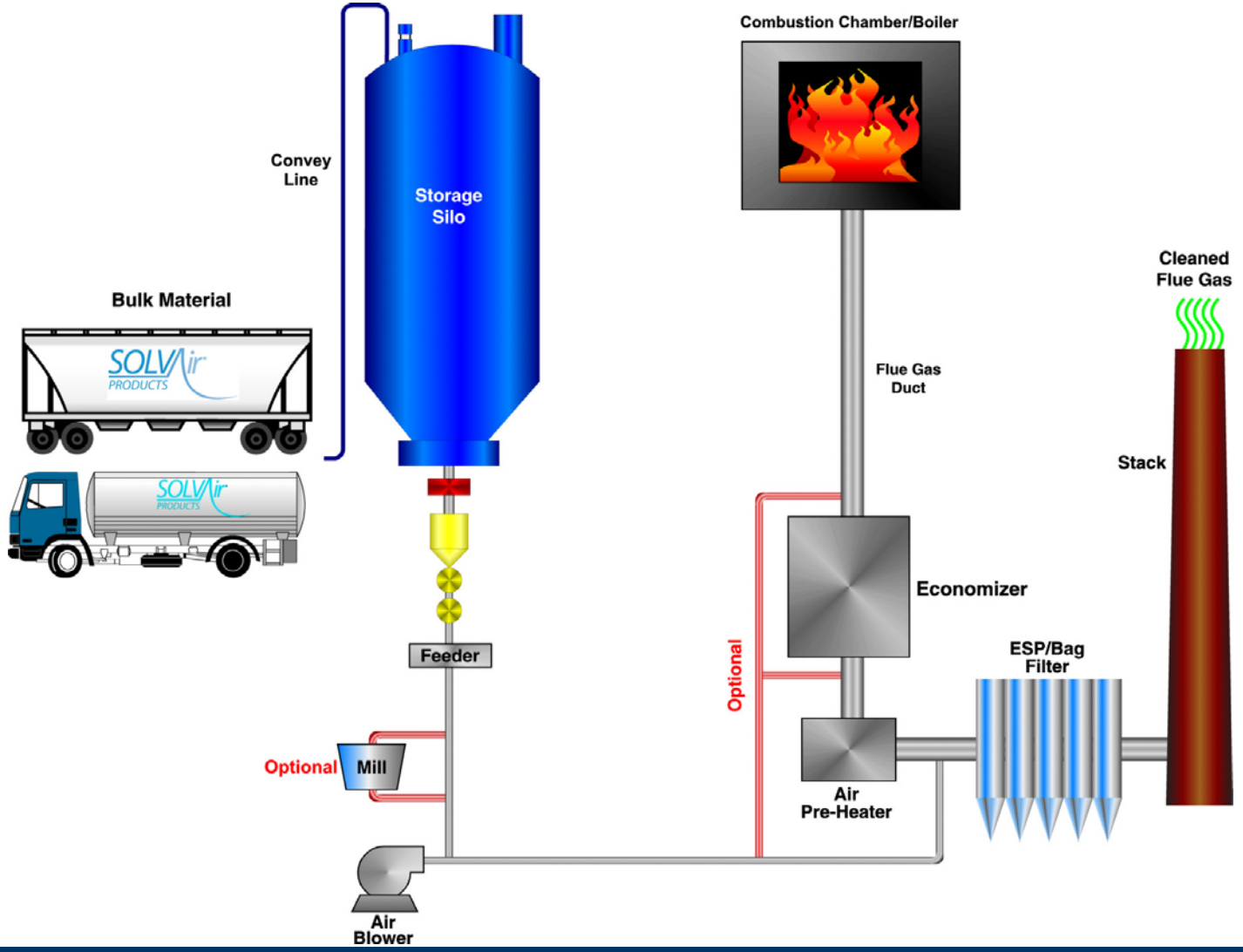
Boiler MACT - HCl Limits

Fuel Type	HCl Limit (lb/MMBtu)
Solid Fuel	0.022
Liquid Fuel	0.0012
Gas	0.0017

Utility MACT – HCl Limits

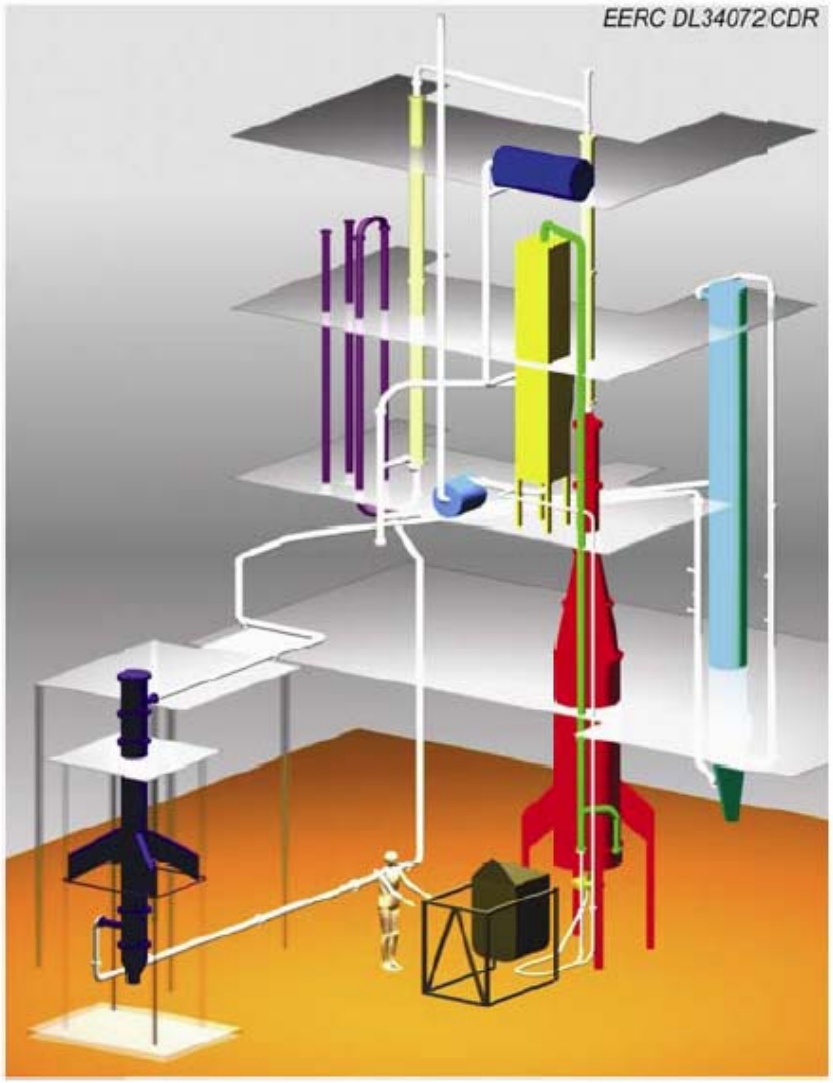
Fuel	Existing Boilers (lb/MMBtu)	New Boilers (lb/MWh)
Coal	0.002	0.0004
IGCC	0.0005	0.002
Solid Oil Derived Fuel	0.005	0.0004

Example of a Utility DSI System



Test at EERC, University of North Dakota

- A pilot plant
- Central Appalachian Coal (CAPP)
- Two PM control devices
  - ESP
  - Bag house
- Four sodium sorbents and one hydrated lime
- Flue gas duct diameter: 6”. The small duct size results in almost perfect mixing between sorbent and flue gas, and consequently much better HCl and SO_2 mitigation performance than with utility boilers.



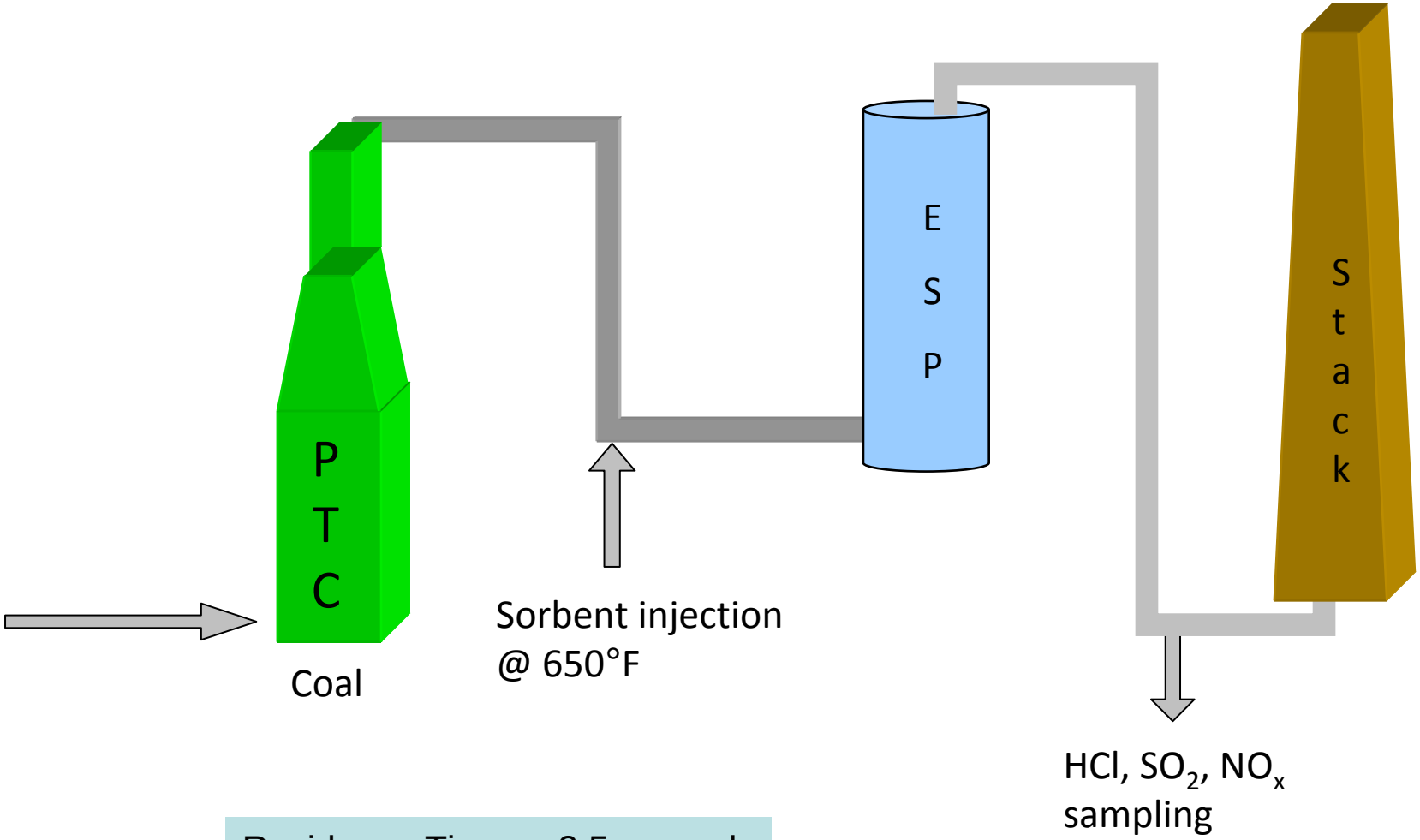
CAPP Coal Analysis

Proximate Analysis, as received,%	Sample 1	Sample 2
Moisture	2.79	2.64
Volatile Matter	33.76	33.24
Fixed Carbon	52.16	52.26
Ash	11.29	11.85
Ultimate Analysis, as received, %		
Hydrogen	5.04	5.05
Carbon	71.63	72.63
Nitrogen	1.22	1.22
Sulfur (%)	0.78	0.78
Oxygen (Ind)	10.05	8.48
Ash	11.28	11.85
Heat Value, Btu/lb	11,496	
Chlorine, µg/g	954–970	

Sorbents

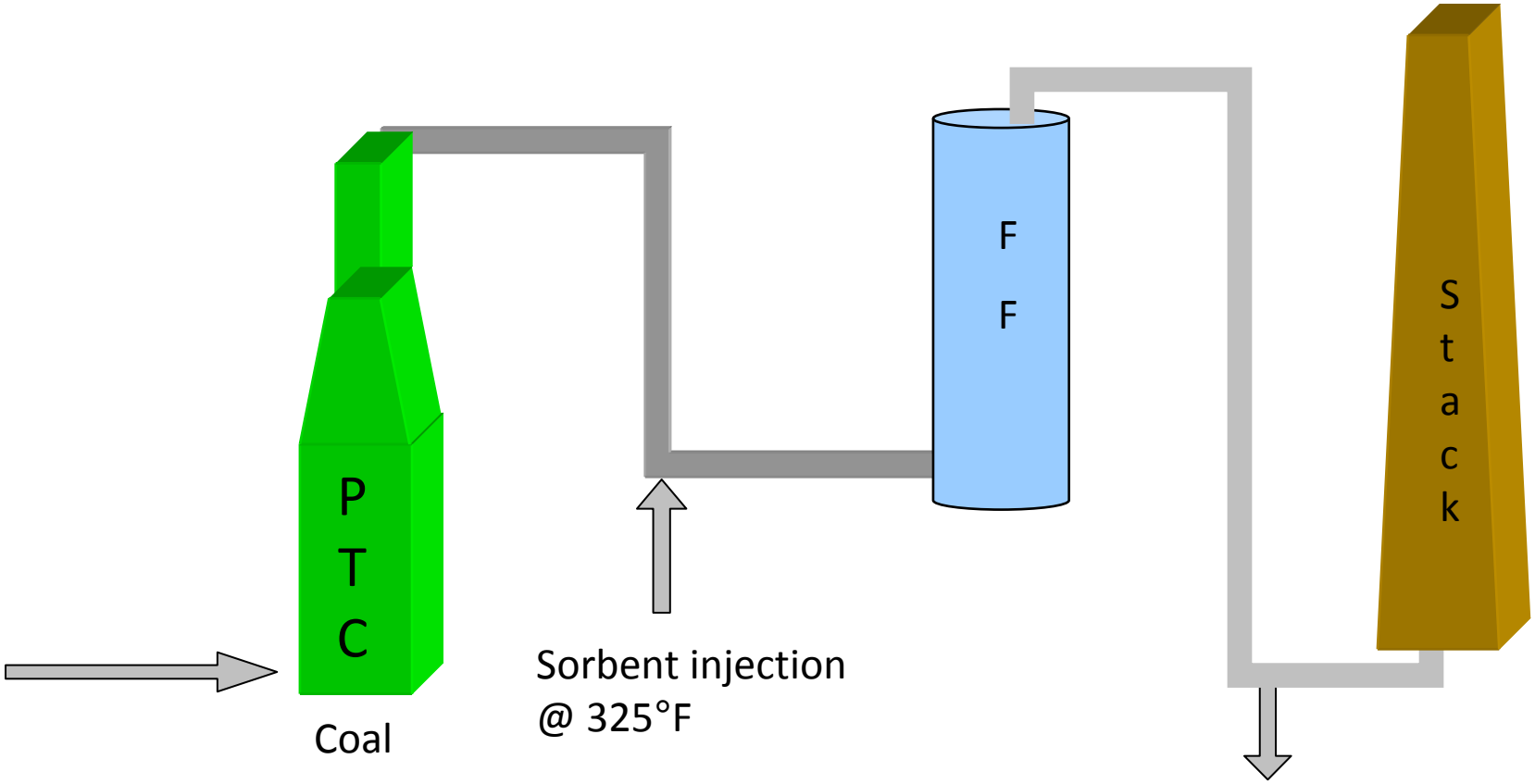
- **Trona (S200)**
  - d_{50}: 30 µm , d_{90}: 120 µm
- **Milled Trona (S250)**
  - d_{50}: 15 µm, d_{90}: 60 µm
- **Milled Sodium Bicarbonate (S350)**
  - d_{50}: 12 µm, d_{90}: 40 µm
- **Finely Milled Sodium Bicarbonate (S450)**
  - d_{50}: 7 µm ,d_{90}: 17 µm
- **Hydrated Lime**
  - d_{90}: 45 µm, purity: 96.8%

Injection Upstream of ESP



Residence Time: ~ 2.5 seconds

Injection Upstream of Baghouse

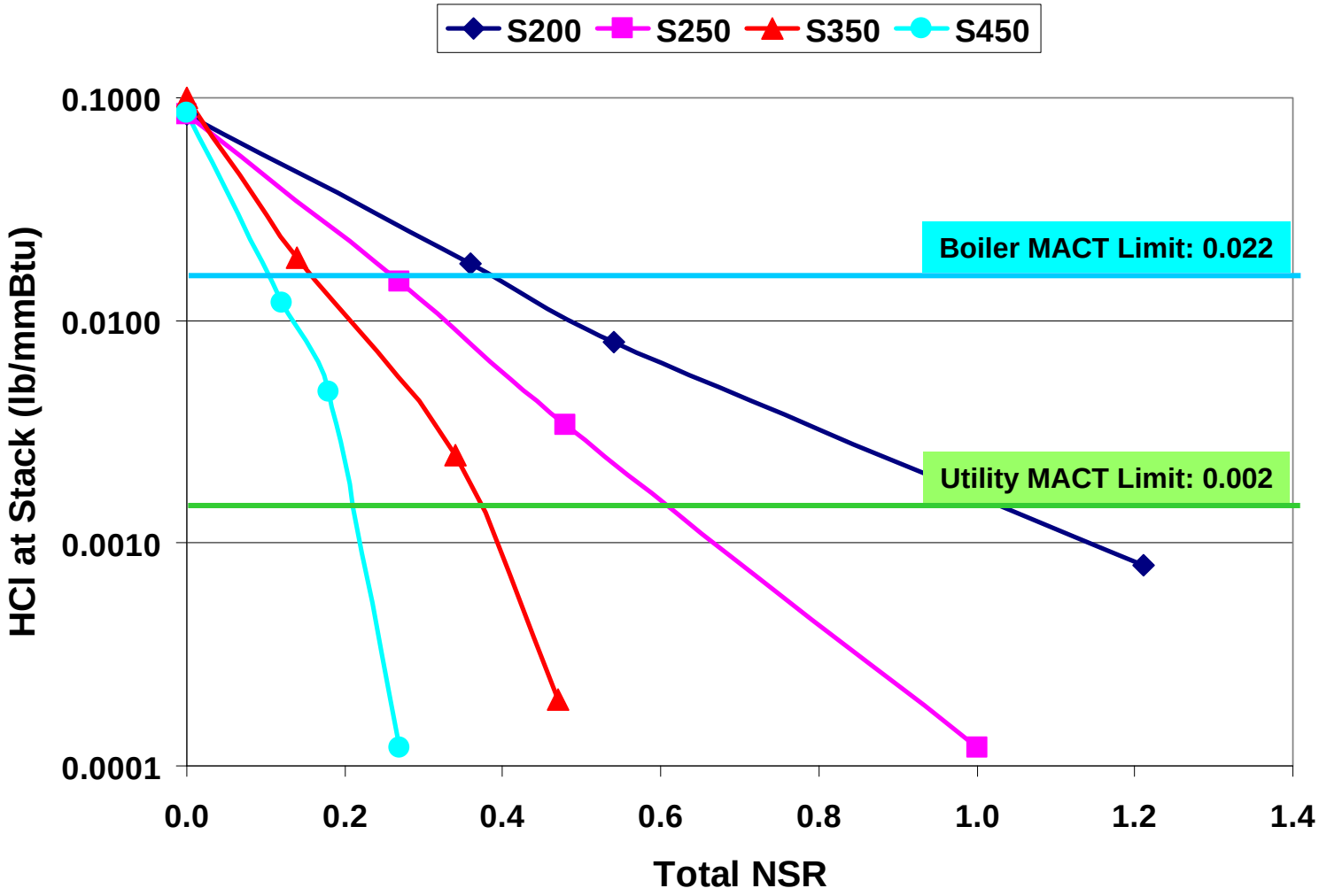


- Residence Time in duct: ~ 1 second
- Baghouse was cleaned before each run

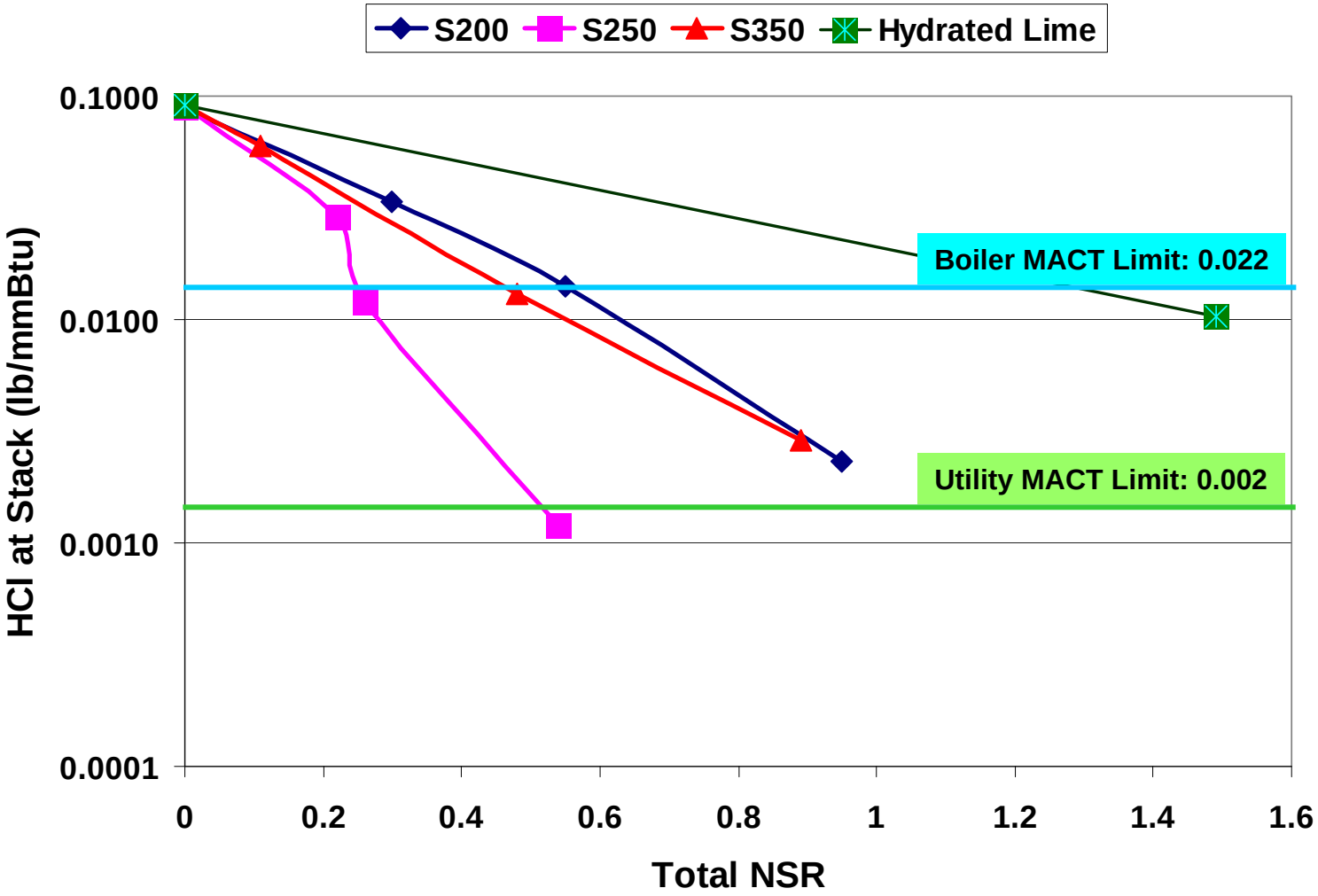
Sorbent Performance

HCl Removal

HCl Removal with Sorbent Injected at ESP Inlet



HCl Removal with Sorbent Injected at Baghouse Inlet

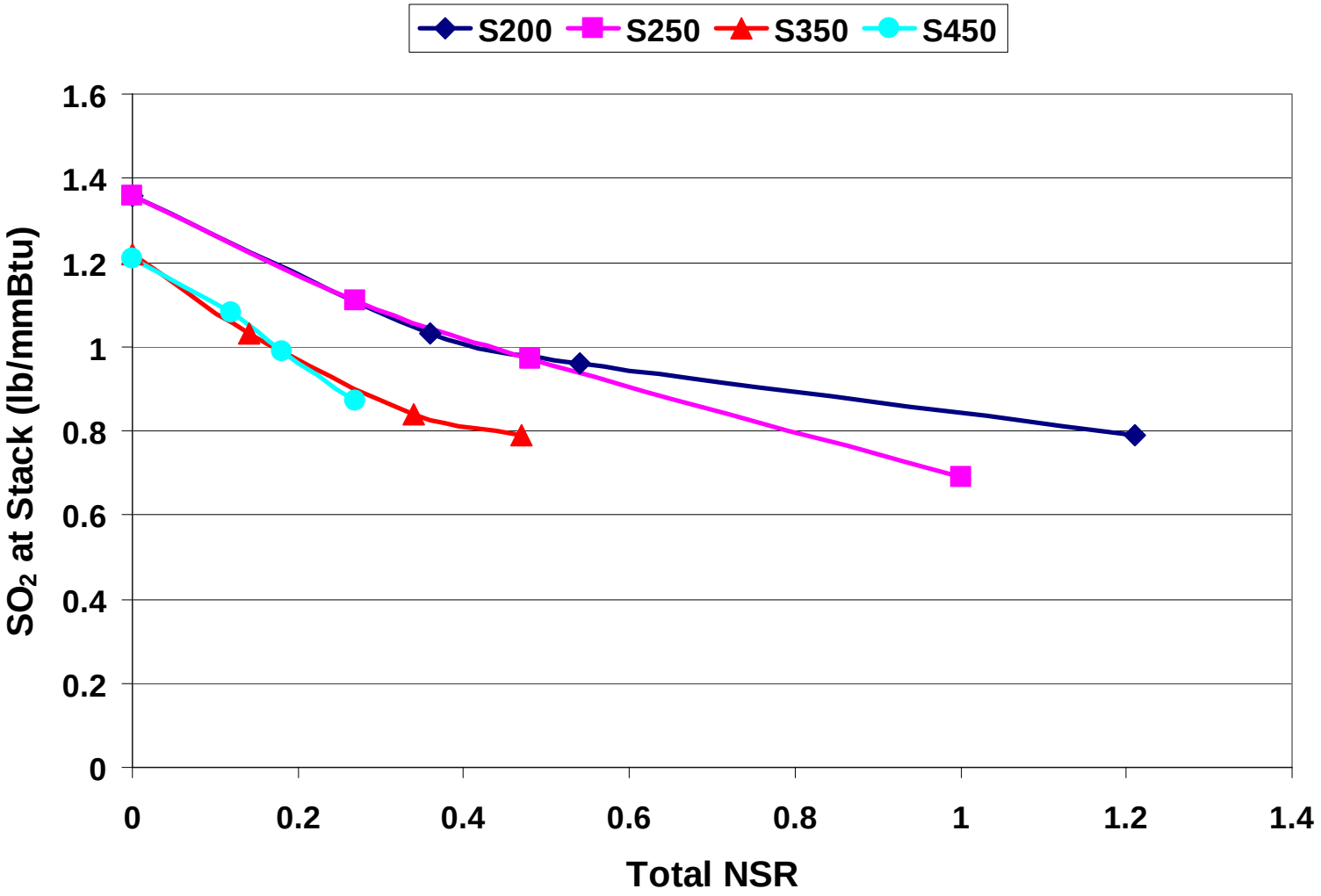


Sorbent Performance

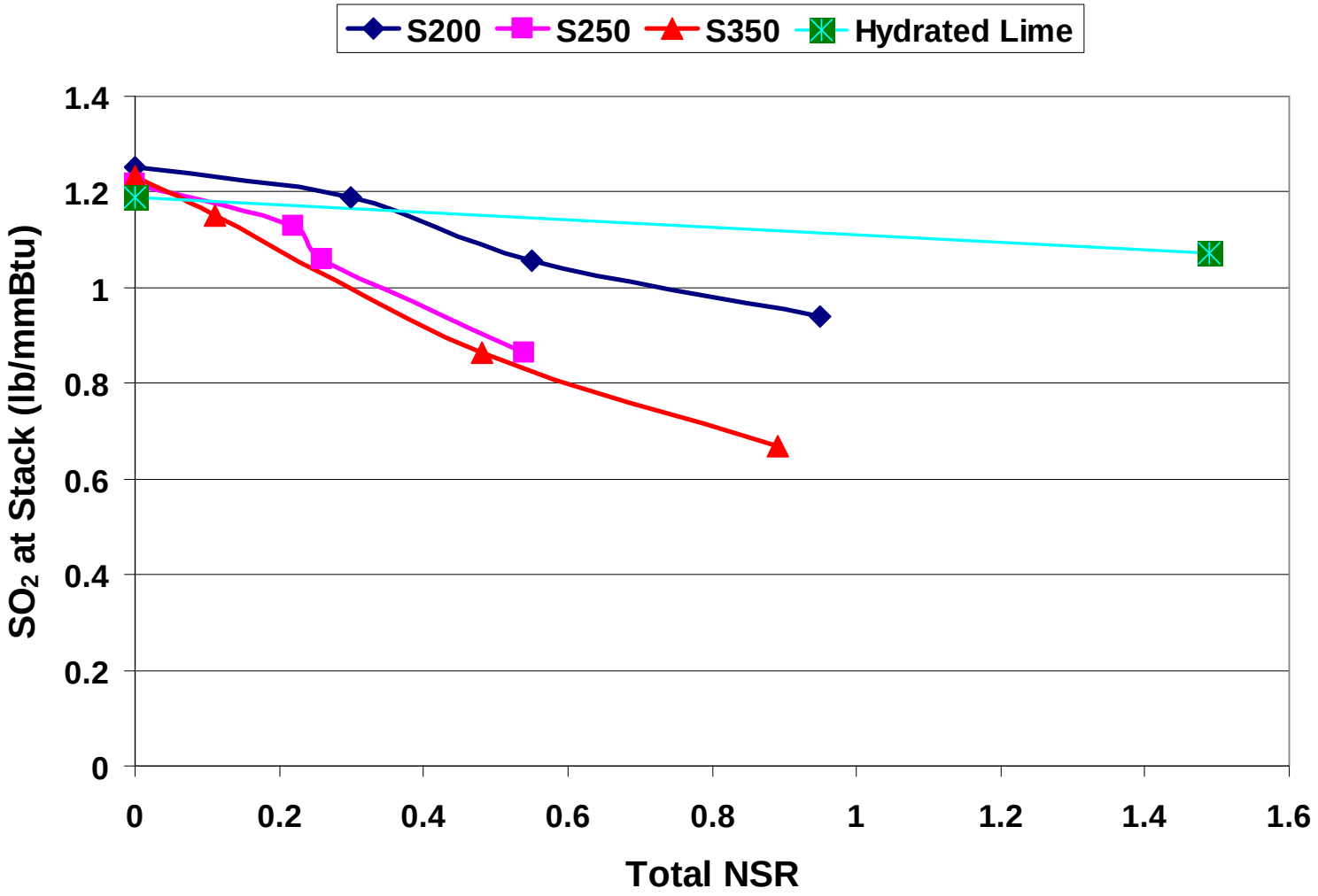
Some SO_2 is unavoidably removed coincident with the removal of HCl. Higher reactivity rates of HCl than SO_2 would suggest lower levels of SO_2 removal.

If higher SO_2 removal is also desired, more sorbent needs to be injected.

SO_2 Removal with Sorbent Injected at ESP Inlet



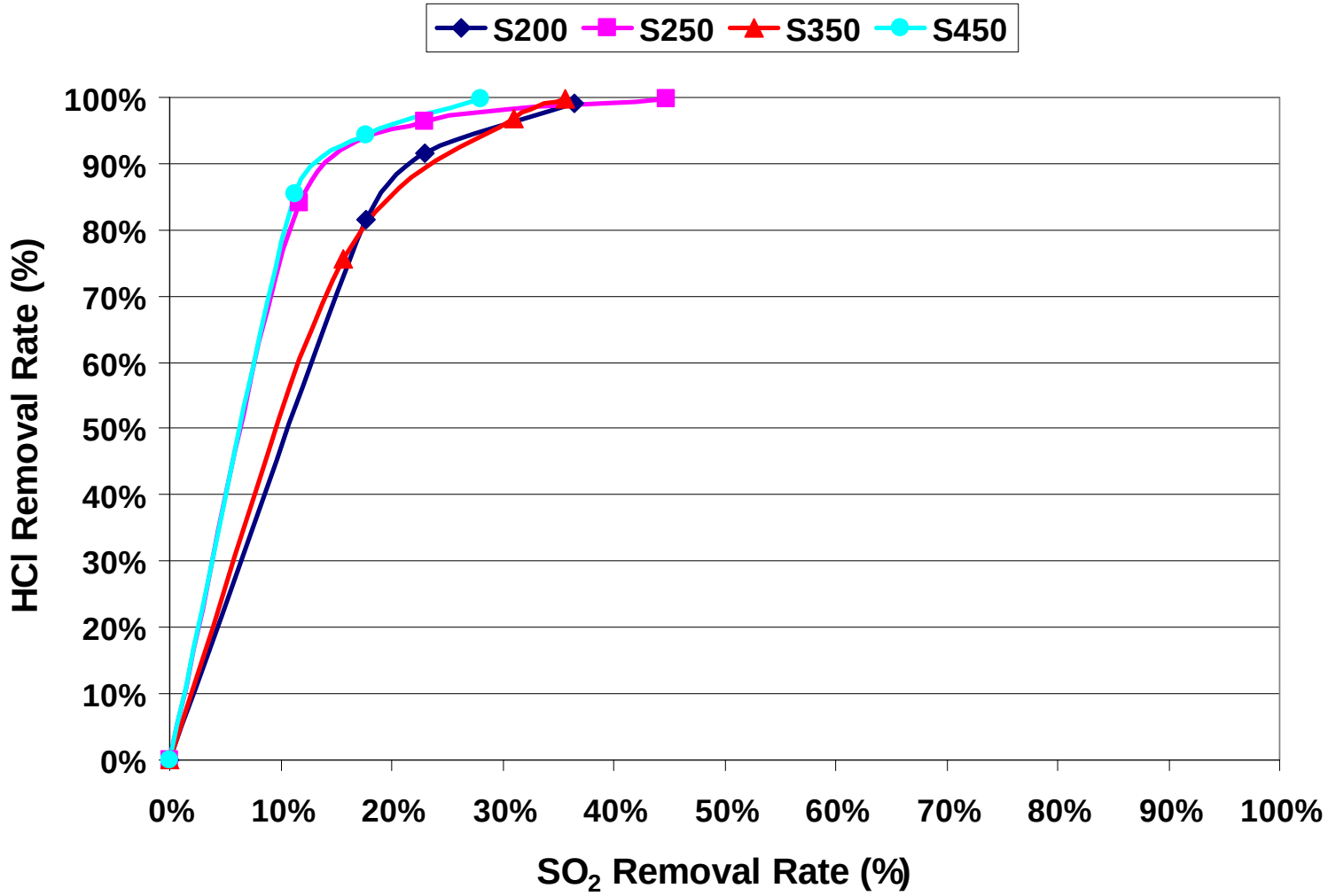
SO_2 Removal with Sorbent Injected at Baghouse Inlet



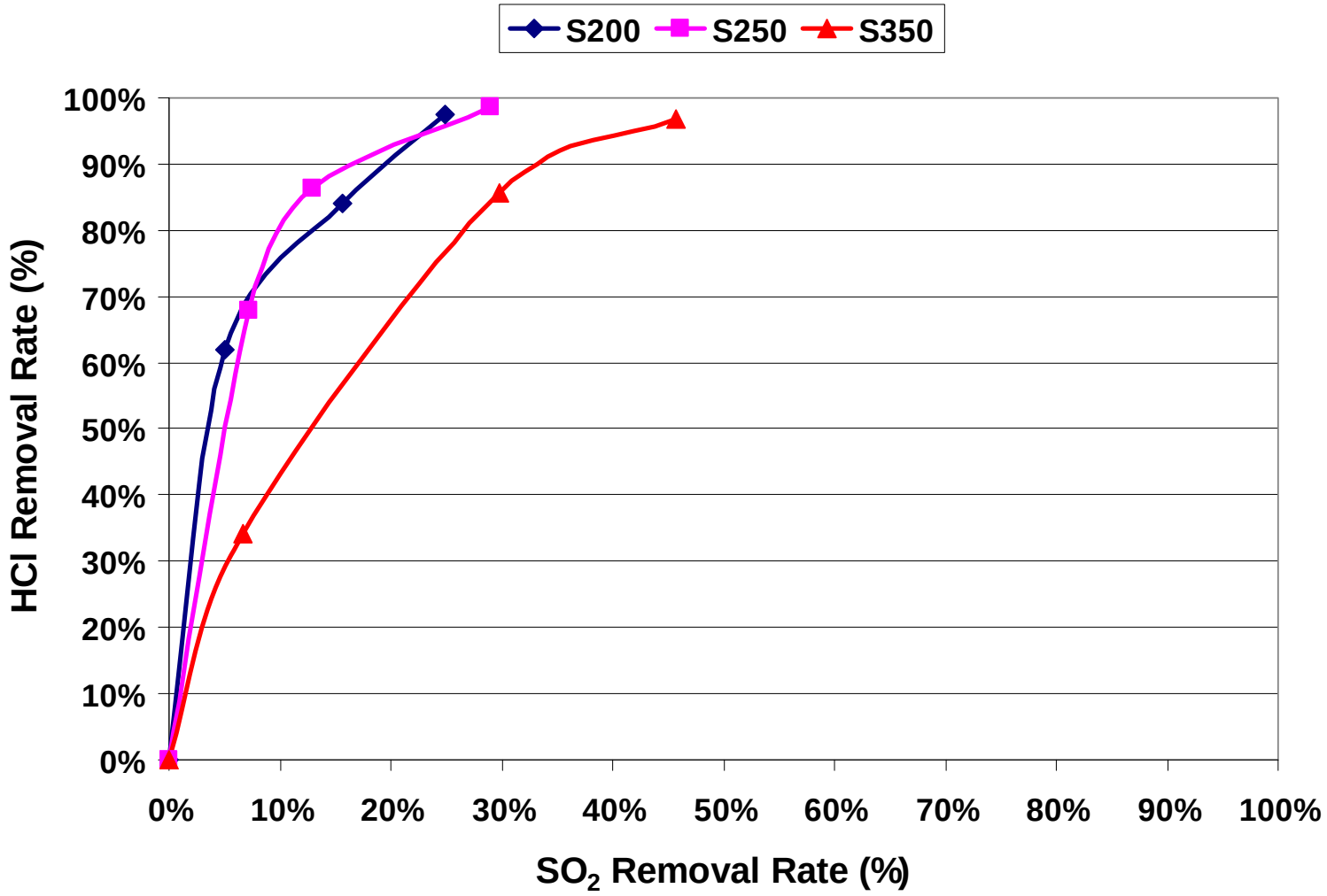
Sorbent Performance

Combined HCl and SO_2 results

HCl Removal vs. SO_2 Removal - ESP



HCl Removal vs. SO_2 Removal - Baghouse



Summary

- **Dry Injection of trona or sodium bicarbonate is a cost effective way to mitigate HCl, SO_2 and SO_3.**
  - **Low capital cost.**
  - **Compatible with ESP and Baghouses.**
- **Able to achieve high removal rates for HCl (>99%) and SO_2 (>90%)**
  - Able to meet the HCl limits in the proposed Utility MACT (0.002 lb/MMBtu) and Boiler MACT (0.022 lb/MMBtu)
- **Effective over a wide temperature range (275 ^{0}F – 1500 ^{0}F)**
- **Has been implemented at many coal-fired power plants in the United States and waste incinerators in Europe .**

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