



**August 4, 2015**

**CIBO Conference  
Portland, ME**

**Sorbent Injection  
Information and  
Case Studies**

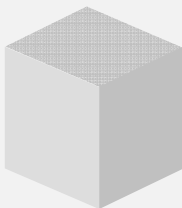
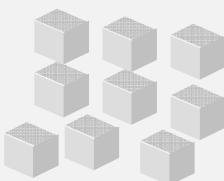
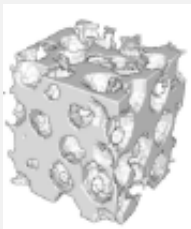

**Gerald Hunt  
Flue Gas Treatment Solutions Team  
Lhoist North America**

# Why is DSI Continuing to Gain Success?

- Improved Performance and Versatility
  - ✓ Improvements in DSI Technology and Associated Tools
    - Injection lances, distribution and mixing tools
    - Improved understanding/design around material handling; better system reliability
    - Improved understanding of flue gas considerations (temperature, other acids present, moisture)
    - Tools such as CFD modeling, reaction models
  - ✓ Improvements in Sorbents (calcium based)
    - Standard hydrates
      - “FGT grade” hydrates
    - Enhanced hydrates
      - Finer particles
      - High surface area/pore volume
        - Sorbacal® SP/SPS



# Lhoist Sorbent Information

Sorbent	Standard Hydrated Limes	FGT Grade Sorbocal® H	Sorbocal® SP	Sorbocal® SPS
Figure				<b>ACTIVATION</b> 
Typical Available $\text{Ca(OH)}_2$ - [%]	92 – 95	93	93	93
Typical Surface Area - [ $\text{m}^2/\text{g}$ ]	14 – 18	> 20	~40	~40
Typical Pore Volume - [ $\text{cm}^3/\text{g}$ ]	~0.07	0.08	~0.20	~0.20
Typical $D_{50}$ - [microns]	5 – 7	5 – 7	8 – 12	8 – 12

# Why Consider Enhanced Sorbents?

- Reduced sorbent consumption
- Achieve higher removal performance
- Potential operating cost savings
- Potential capital cost savings on equipment
  - ✓ Design based on enhanced hydrated lime
- Lower mass loading of calcium based “dust” on particulate control device and ash handling systems
  - ✓ Especially for ESP applications
- Fewer deliveries
- Less fly ash / spent sorbent disposal
- Different sorbents may behave differently, testing is important!
  - ✓ Also provides versatility for future needs and case study materials!



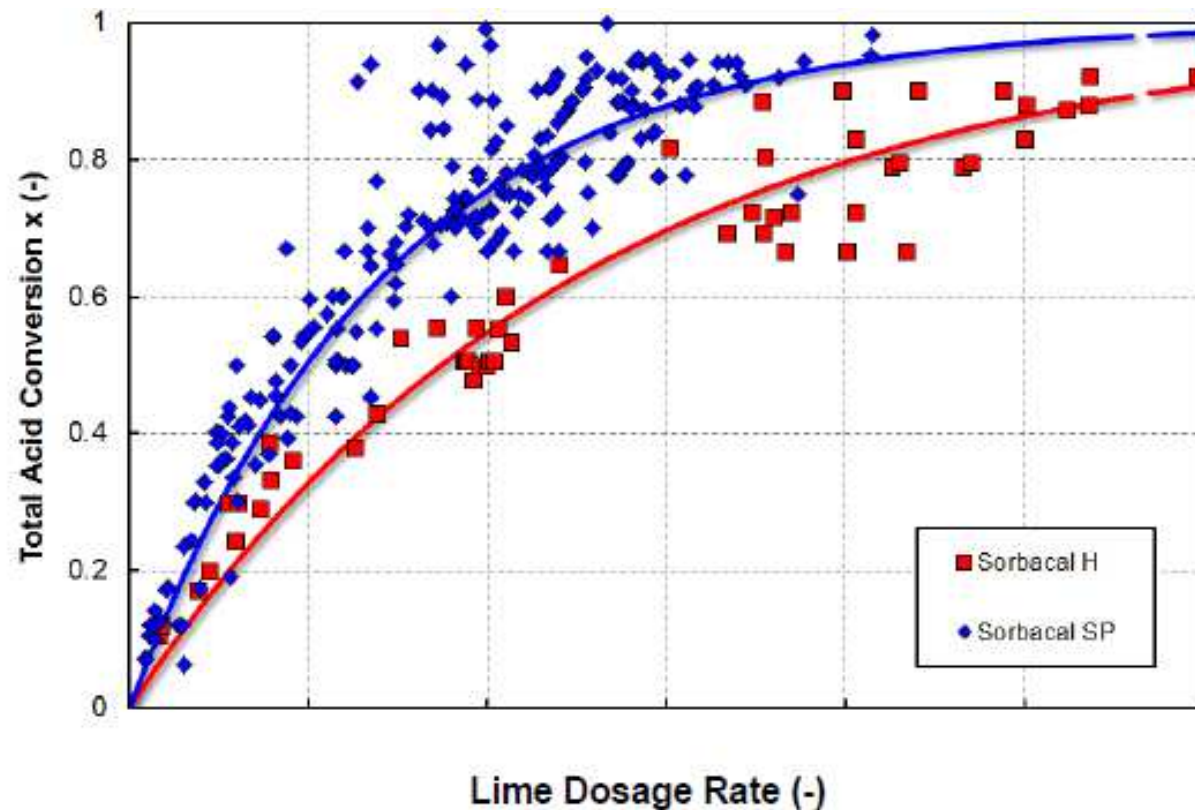
# Case Study Development – TRIALS!

- LNA has actively participated in 36 trials in the last 2 years

- ✓ Utility & Industrial
- ✓ BMACT, MATS, Permit
- ✓ HCl, SO<sub>3</sub>, SO<sub>2</sub>, and HF
- ✓ Trials important to confirm performance
  - Various injection configurations
  - Fuels
  - Sorbents
  - Changes in load/process
  - Site specific equipment needs

No.	Driver	Pollutant(s)	Sorbents	Application	LNA Scope		
					Sorbent	FTIRs	DSI
1	Consent	SO <sub>2</sub>	SP & SPS	Carbon Black	X		
2	IB MACT	HCl	H & SP	Pulp & Paper	X		
3	IB MACT	HCl	H & SP	Institution	X		
4	IB MACT	HCl	H	Misc	X		
5	Existing	HCl	H & SP	EGU	X	X	
6	MATS	HCl, SO <sub>2</sub>	SP	EGU	X		
7	Consent	HCl, SO <sub>2</sub>	SPS	EGU	X		
8	IB MACT	HCl	H & SP	Misc	X	X	
9	Permit	SO <sub>2</sub>	SPS	Steel	X		X
10	Permit	SO <sub>2</sub>	SPS	Steel	X		X
11	Consent	SO <sub>2</sub>	SPS	Carbon Black	X		
12	MATS	HCl & Hg	SPAC	EGU	X	X	X
13	Existing	SO <sub>2</sub>	SP	EGU	X	X	
14	Permit	HCl, HF, SO <sub>2</sub>	SPS	Tile	X	X	X
15	NAAQS	SO <sub>2</sub>	SP & SPS	Institution	X		
16	MATS	SO <sub>3</sub>	SP	EGU	X		
17		SO <sub>2</sub>	SPS	Pilot	X	X	
18	Consent	SO <sub>3</sub>	SP	EGU	X		
19	HISWI	HCl	SP	Medical Waste	X		
20	Permit	HCl, HF, SO <sub>2</sub>	SPS	Tile	X	X	X
21	IB MACT	HCl	SP	Glass	X		
22	Permit	SO <sub>2</sub>	LKD, Std HL & SPS	Lime	X	X	X
23	IB MACT	HCl	Std HL & SP	Misc	X	X	X
24	Consent	SO <sub>2</sub>	SPS	Cement	X		X
25	Consent	SO <sub>2</sub>	SLS45	Cement	X		
26	Consent	SO <sub>2</sub>	SPS	Cement	X		
27	IB MACT	HCl	SP	University	X		
28	Consent	SO <sub>2</sub>	H	Cement	X		X
29	Consent	SO <sub>2</sub>	SPS	Brick	X		
30	IB MACT	Hg	SPS10AC	Pulp & Paper	X		X
31	IB MACT	HCl	SP	Pulp & Paper	X		
32	Permit	SO <sub>2</sub>	SPS	Tile	X		
33	MATS	SO <sub>3</sub>	H	Utility	X		
34	Regional Haze	SO <sub>2</sub>	SPS	Utility	X	X	
35	NESHAP	HCl	SPS	Cement	X		
36	Permit	SO <sub>2</sub> , HCl, HF	SPS	Tile	X	X	

- Commercial Trial Library
  - ✓ Example: SO<sub>2</sub> removal in baghouse applications
  - ✓ Wide range of process conditions, applications
  - ✓ Sorbacal® SP twice as active as Sorbacal H (FGT type)



# DSI Case Studies

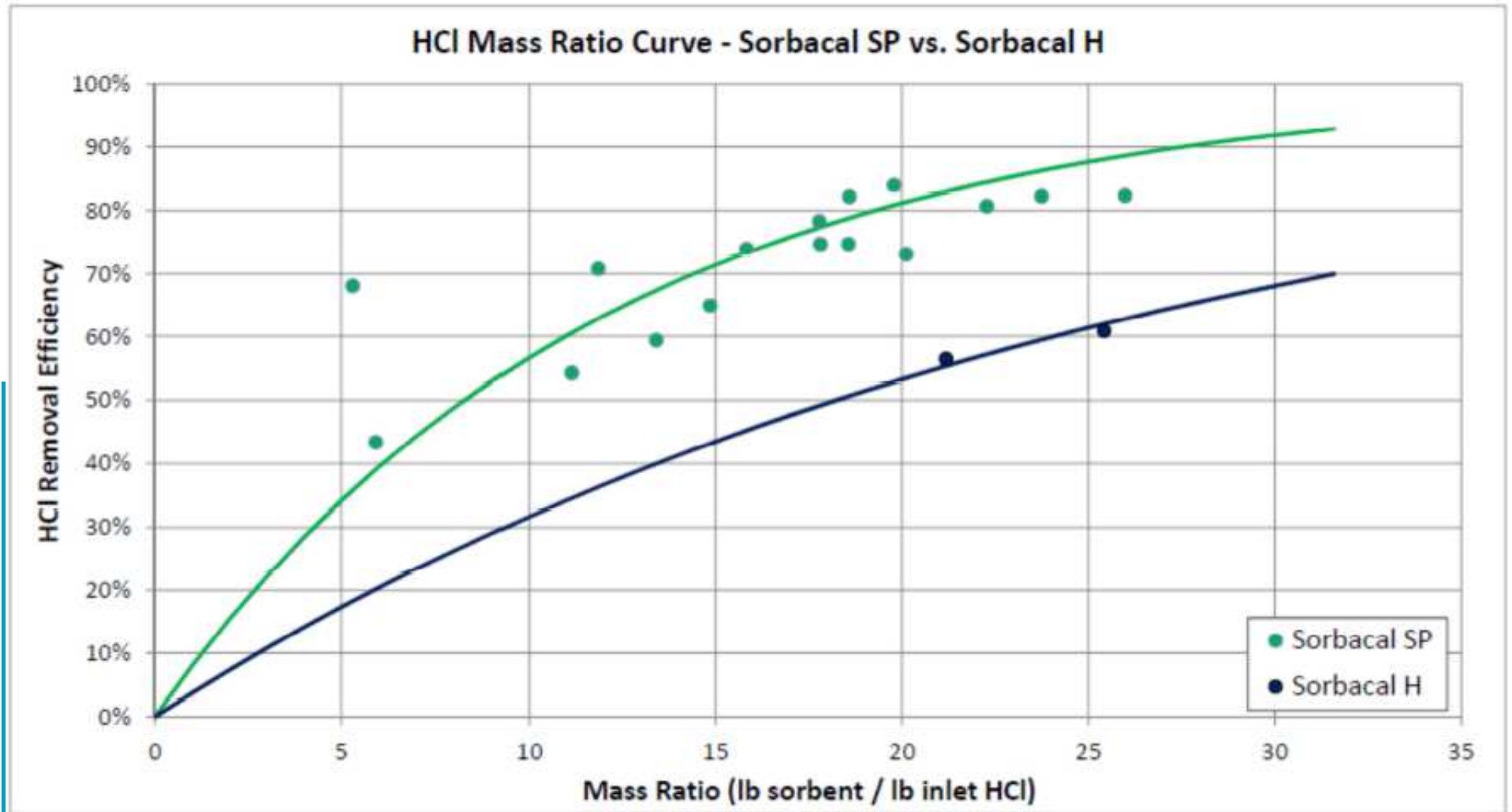


# Case Study – Pulp and Paper

- Application → Pulp & Paper
- Goal → ~ 65% HCl Removal Efficiency
- Why → Meet IB MACT HCl Limit of 0.022 lb/MMBtu
- Boiler → Air Heater → DSI → ID Fans → ESP
- Process Conditions
  - ✓ Flue gas flow rate ~400,000 ACFM
  - ✓ Flue gas moisture ~7-8% by volume
  - ✓ Baseline HCl concentration ~40 ppmv
  - ✓ Flue gas temperature at DSI location ~375 degrees F
- DSI → Eight (8) Injection Lances @ DSI Location
- Sorbent → Sorbacal® H & Sorbacal® SP
- Challenges → HCl Compliance w/ ESP



# Case Study – Pulp and Paper



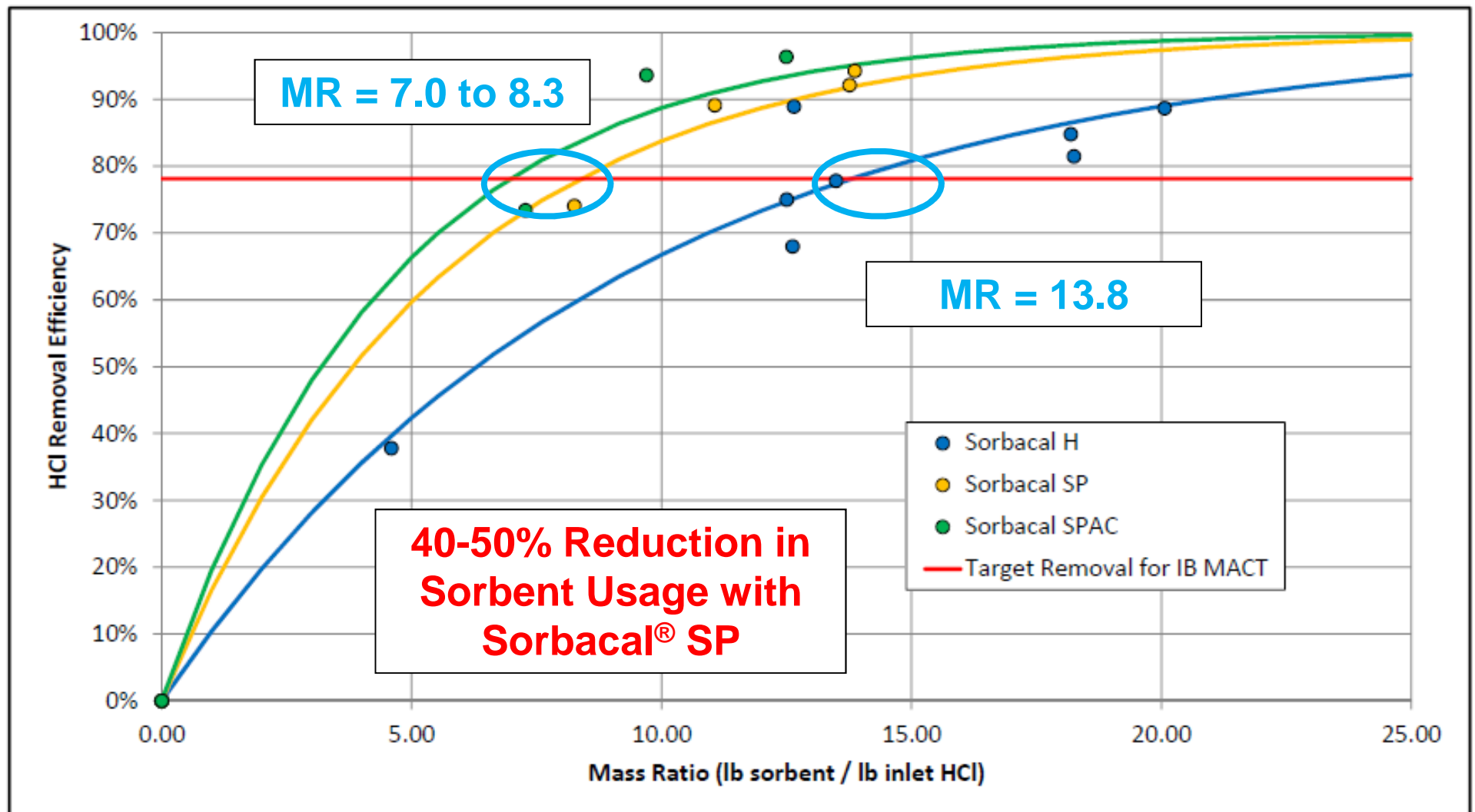
## Case Study – Industrial Multi-Pollutant



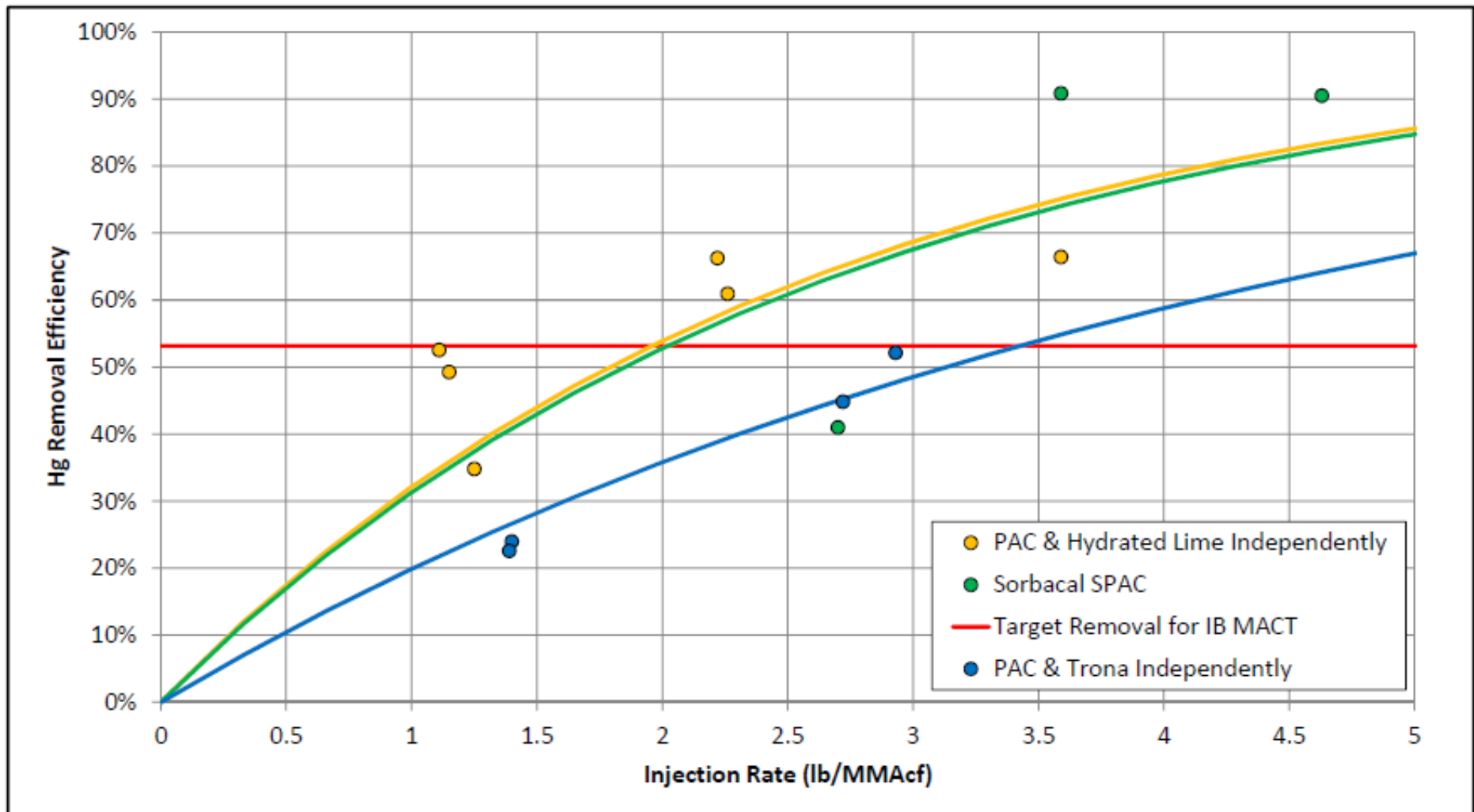
- Application → Industrial Facility w/ Existing DSI
- Goal → ~80% HCl & ~55% Hg Removal Efficiency
- Why → Meet Hg + HCl IB MACT Limits
- Boiler → Economizer → Multi-Clone → DSI → FF
- Process Conditions
  - ✓ Flue gas flow rate ~100,000 ACFM
  - ✓ Flue gas moisture ~6-6.5% by volume
  - ✓ Baseline concentrations ~0.1 lb/MMBtu HCl / 4-6 lb/TBtu Hg
  - ✓ Flue gas temperature at DSI location ~375-390 degrees F
- Sorbents → Sorbacal® SP / BPAC Blended Sorbent
- Challenges → Simultaneous HCl + Hg Compliance with Single Sorbent



# Results and Discussion – HCl Parametric Curve



# Results and Discussion – Hg Parametric Curve




## Case Study – Tile

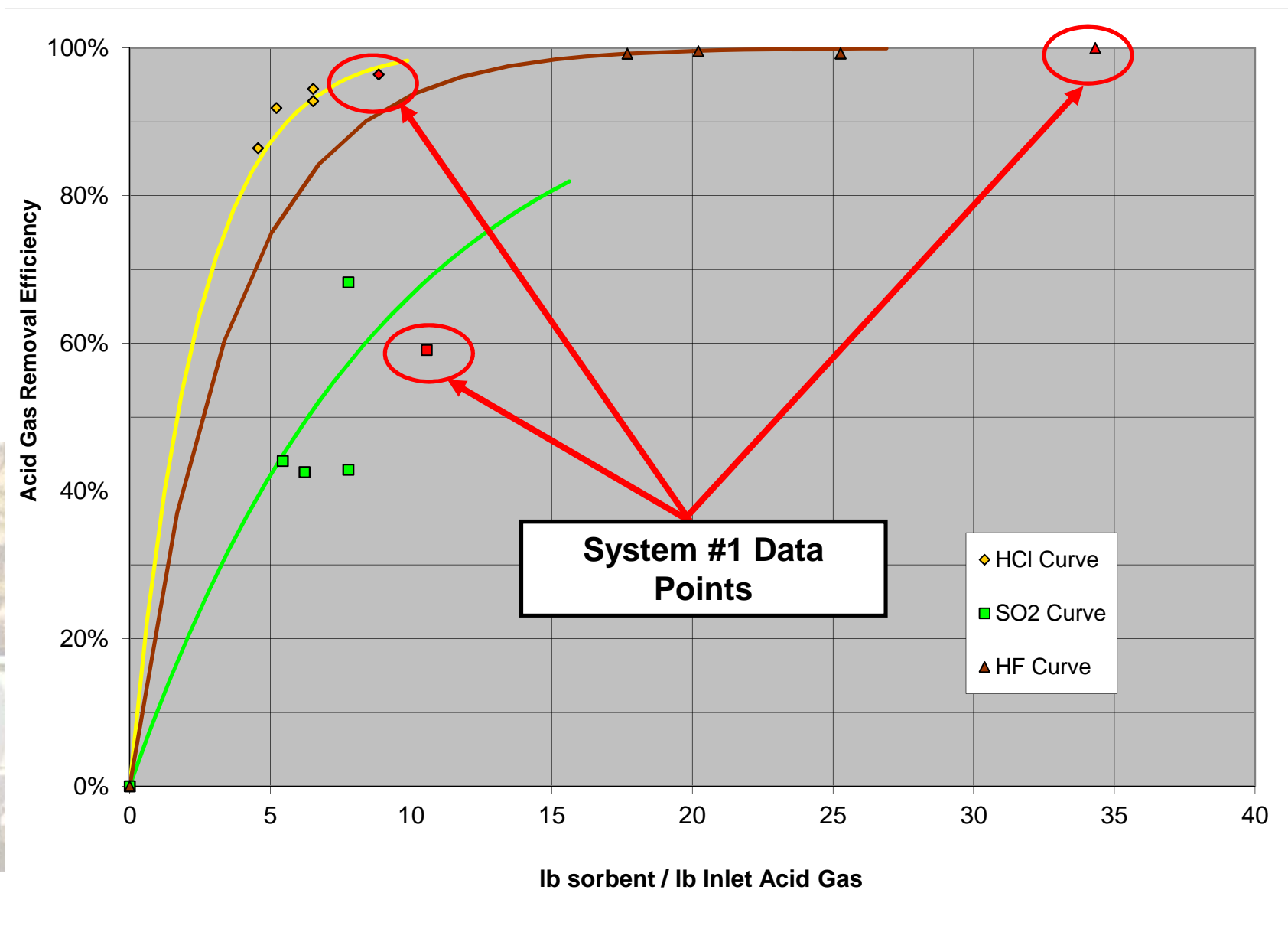
- Plant used sodium bicarbonate (SBC) and Sorbacal<sup>®</sup> SP
- SBC was used for SO<sub>2</sub> and HCl control but was not removing HF to permitted levels; 2<sup>nd</sup> system was installed to inject Sorbacal<sup>®</sup> SP for HF

System #1 Goal → 90% HCl, 85% HF & 60% SO<sub>2</sub> Reduction

System #2 Goal → 95% HCl & 65% HF Reduction

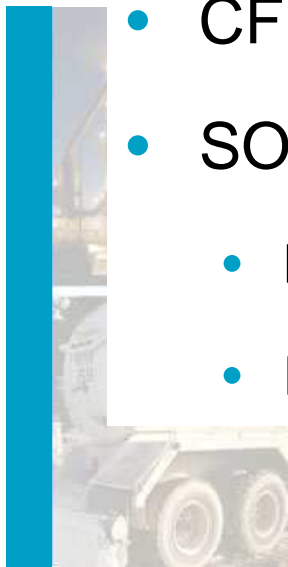
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- Residue could not pass TCLP (selenium and chromium)
    - classified as hazardous waste: \$550/ton to landfill
  - Sorbacal<sup>®</sup> SPS able to achieve SO<sub>2</sub>, HCl and HF limits and passed TCLP test; reduced landfill costs by \$480/ton
  - Continue to work with customer to optimize Sorbacal<sup>®</sup> SPS performance for all acid gases
    - ✓ Humidification, mixing, injection lances

# Case Study - Tile



## Other Applications of Interest

- PAC Protection
- Visible blue plume
- Corrosion protection
- Heat rate improvement / air heater protection
- CFB boiler w/ limestone → back end HCl control
- SO<sub>2</sub> removal on plants with existing FGD
  - Large Units for SO<sub>2</sub> trim
  - Replace slurry in FGD for high SO<sub>2</sub> removal efficiency



## Who is Lhoist?

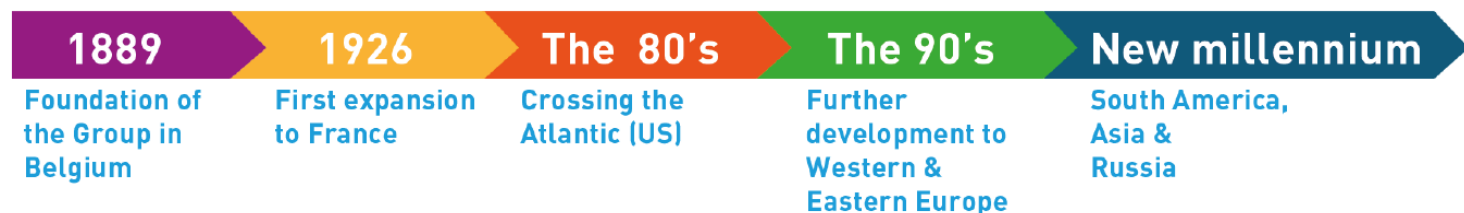
- A family owned company
  - ✓ Founded 1889
  - ✓ Belgium origin
- A Multinational
  - ✓ World's largest lime company
  - ✓ About 6,000 employees, 30 nationalities
  - ✓ Nearly 100 plants in 25 countries



### ■ Lhoist North America

- 24 Manufacturing plants, lime capacity ~ 6 million tpy
- ✓ 1 Corporate Research & Development (R&D) center
- ✓ 4 Application, Service and Development (ASD) centers
- ✓ 5 Fully Equipped Centralized Laboratories (CL)

## 125 YEARS OF EXPERTISE & INNOVATION



# Summary



Thank you!!

If you have any questions feel free to contact,

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