Lhoist North America
Lhoist Group

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PC MACT – Low Cost HCl Control Option

March 30, 2011

Topics of Discussion

- Lhoist and Lhoist North America
  - Our Company
  - Our Focus
- Summary of PC MACT Regulations
- Focus on HCl
  - Control Options
  - Experience
  - US Testing
- Questions

Who We Are

- Lhoist and Lhoist North America
  - Lhoist Group is a family business headquartered in Brussels, Belgium
  - Lhoist has been in business for more than 115 years and is the **Largest** producer of **Calcium Products** in the world
    - ✓ More than 80 plants in 17 countries

  - Lhoist North America (LNA)
    - ✓ Began as Chemical Lime Company in 1966
    - ✓ Franklin Industrial Minerals
    - ✓ Plants and terminals throughout the US (mainly sunbelt)
    - ✓ Suppliers of high quality chemical grade products including **Limestone, Quicklime, Slurry,** and **Hydrate (Sorbacal®)**

Focus on Emission Control

- Lhoist and LNA have been focused on the emission control areas for many years
  - In Europe, Lhoist has developed **Emission Control Solutions** into the municipal solid waste, waste to energy, chemical, glass, and **Cement** industries
  - In the US, LNA has a **FGT Solutions Team** focused on emission control applications, and have much experience in the utility industry with controlling SO_2, as well as SO_3, and other acid gases
  - Ability to perform **Dry Sorbent Injection** (DSI) demonstrations utilizing our injection equipment, FTIR for emissions monitoring, and high quality **Sorbacal®** products

- Final MACT Emission Limits:

MACT Emission Limits for Portland Cement Plants

Source type	*Pollutant*	*Emission limit*
Existing kilns at major or area sources	Particulate matter	0.04 lb/ton of clinker
	Dioxins/furans	0.2 ng/dscm (TEQ)[1,2]
	Mercury	55 lb/MM tons of clinker
	Total hydrocarbons	24 ppmvd[2,3] measured as propane
New kilns at major or area sources	Particulate matter	0.01 lb/ton of clinker
	Dioxins/furans	0.2 ng/dscm (TEQ)[1,2]
	Mercury	21 lb/MM tons of clinker
	Total hydrocarbons	24 ppmvd[2,3] measured as propane
Existing kilns at major sources	HCl	3 ppmvd[2]
New kilns at major sources	HCl[4]	3 ppmvd[2]
Existing clinker coolers at major or area sources	Particulate matter	0.04 lb/ton of clinker
New clinker coolers at major or area sources	Particulate matter	0.01 lb/ton of clinker
Existing or new raw material dryers at major or areas sources	Total hydrocarbons	24 ppmvd[3,5] measured as propane
Existing or new raw material dryers at major sources	Opacity	10%
Existing or new raw material mills at major or area sources	Opacity	10%

CEMS = continuous emissions monitoring system; HCl = hydrochloric acid; MACT = maximum achievable control technology; ppmvd = parts per million by volume, dry basis; TEQ = toxicity equivalent.

[1]If the average temperature at the inlet to the first particulate matter control device (fabric filter or electrostatic precipitator) during the dioxins/furans performance test is ≤400°F, this limit is changed to 0.4 ng/dscm (TEQ).

[2]Corrected to 7% oxygen.

[3]Any source subject to the 24-ppmvd total hydrocarbon limit may elect to meet an alternative limit of 9 ppmvd for total organic HAPs. If the source demonstrates compliance with the total organic HAPs limit under the requirements of §63.1349, then the source's total hydrocarbon limit will be adjusted to equal the average total hydrocarbon emissions measured during the organic HAP compliance test.

[4]If the kiln does not have an HCl CEMS, the emission limit is zero.

[5]Corrected to 19% oxygen.

Source: Aspen Publishers, Inc.; adapted from 75 *FR* 55052.

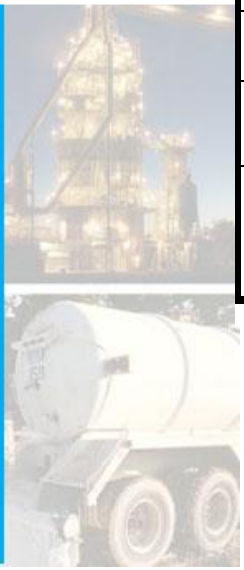
Current Control Technologies Present in the US

- Mercury
  - One kiln currently controls mercury using activated carbon injection and estimates they can achieve 85 percent control.
- THC
  - One kiln controls THC with a regenerative thermal oxidizer and achieves 98 percent removal of THC and CO combined.
- **PM**
  - All kilns have either ESPs or fabric filters to meet the 1999 NESHAP PM limit of 0.5 lb/ton clinker (0.3 lb/ton feed).
- **SO_2**
  - Five kilns have limestone wet scrubbers for SO_2control.
  - A few kilns have some type of lime injection system. These controls also reduce **HCl emissions** and (at least in the case of wet scrubbers) mercury emissions.
- NO_x
  - Five to fifteen kilns have selective non-catalytic reduction systems.

Projected Control Technologies to Meet PC MACT

Control Type	Pollutants Controlled	Maximum estimated control efficiency (percent)	Number of projected installations[c]
Lime injection	HCl	70	2
Limestone wet scrubber	Mercury HCl	Mercury – 80 HCl – 99.9	59-117
Activated Carbon Injection[a]	Mercury THC/Organic HAP	Mercury – 90 Organic HAP - 80	71-153
Regenerative Thermal Oxidizer[b]	THC	98	10-21
Membrane Bags added to existing Fabric Filter	PM	>99.9	6-28
Fabric Filter	PM	>99.9	0-2
Selective NonCatalytic Reduction	NOx	50-60	7

[a] Includes a second fabric filter for carbon capture
[b] May require a wet scrubber upstream for acid gas removal.
[c] Based on an estimated population of about 153 kilns. Many kilns may require multiple controls.



- Lime injection "maximum estimated control efficiency" based on standard hydrate
- Lime injection (often called Dry Sorbent Injection, or **DSI**) using enhanced hydrates could provide **>90%** control for **HCl Emissions**

Sorbacal® Product Development

- From a standard hydrate to a high performance hydrated lime
  - Type N: Standard hydrated lime
  - Sorbacal® H: First generation emission control hydrated lime
  - **Sorbacal® SP/SPS**: Next generation - high pore volume and high specific surface area hydrated lime

- The decisive parameters to enhance the gas/solid contact are **Pore Volume** and **Specific Surface Area** of the reagent

Range of Products

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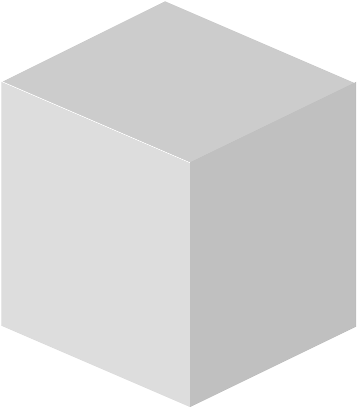
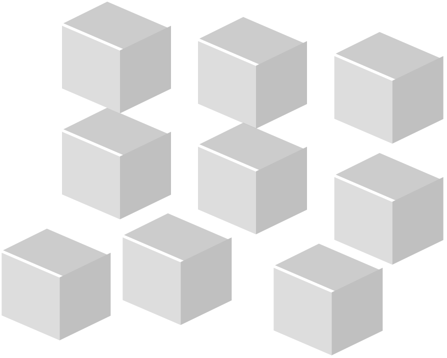
Standard Hydrate

- Physical characteristics
  - Surface 14 – 18 m²/g (BET)
- Reaction depending on temperature and humidity
- Disadvantage: Difficult to achieve high performance



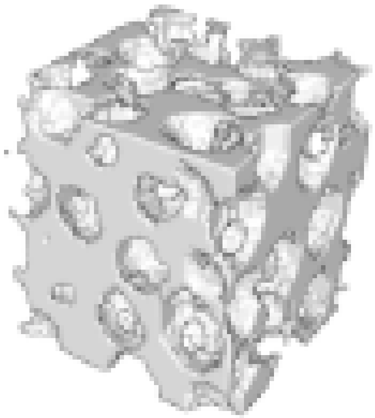
Sorbacal® H

- Physical characteristics
  - Finer particles and high surface area
  - **Surface > 20 m²/g (BET)**



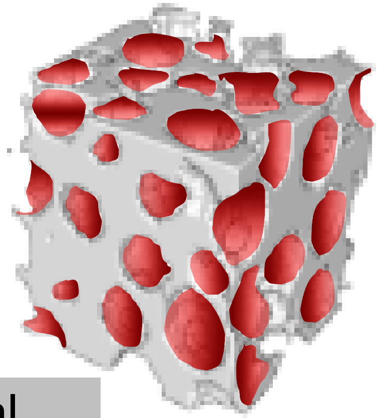
Sorbacal® SP and SPS

Sorbacal® SP



- Physical characteristics
  - High porosity
  - **Surface > 40 m²/g (BET)**
- High removal capacity through controlled influence of porosity (accessibility by acidic components)

Sorbacal® SPS



- Sorbacal® SP is activated before use to allow the gases to reach the porosities more easily

Important to Note: These products differ in Physical Structure (crystal form), but not in Chemistry (i.e. $Ca(OH)_2$-Content)

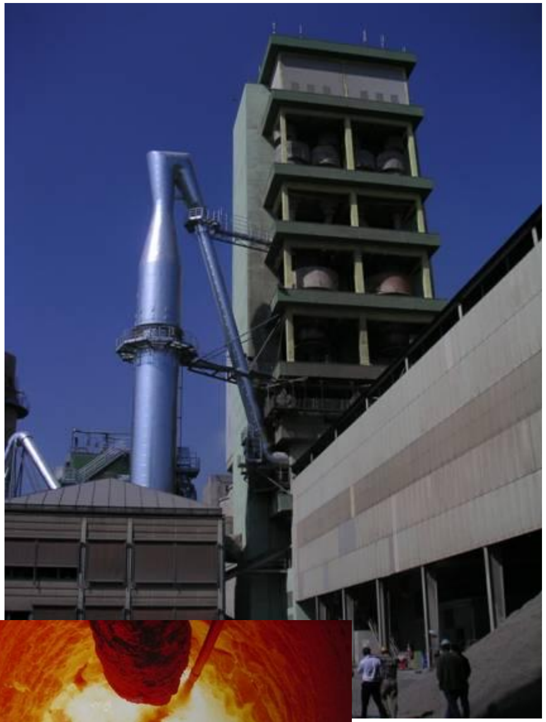
Demonstration and Commercial Use Experience

- Injection trials in Europe have led to commercial use of DSI technology with Sorbacal® products within the cement industry
  - For SO_2, HCl, HF
- Commercial installations in Europe & Asia have shown ability to achieve >90% SO_2 and > 99 % HCl removal with Sorbacal® SPS

Demonstration and Commercial Use Experience

- Case Studies/References available

Locations	
Beckum	Germany
Antoing	Belgium
Obourg	Belgium
Eclepens	Switzerland
Rochefort-sur-Nenon	France
Mardyck	France
Hope	United Kingdom
Saint-Laurent-du-Pont	France



- **These results have led LNA to begin laboratory and field demonstrations in the US**

Factors That Impact DSI Effectiveness

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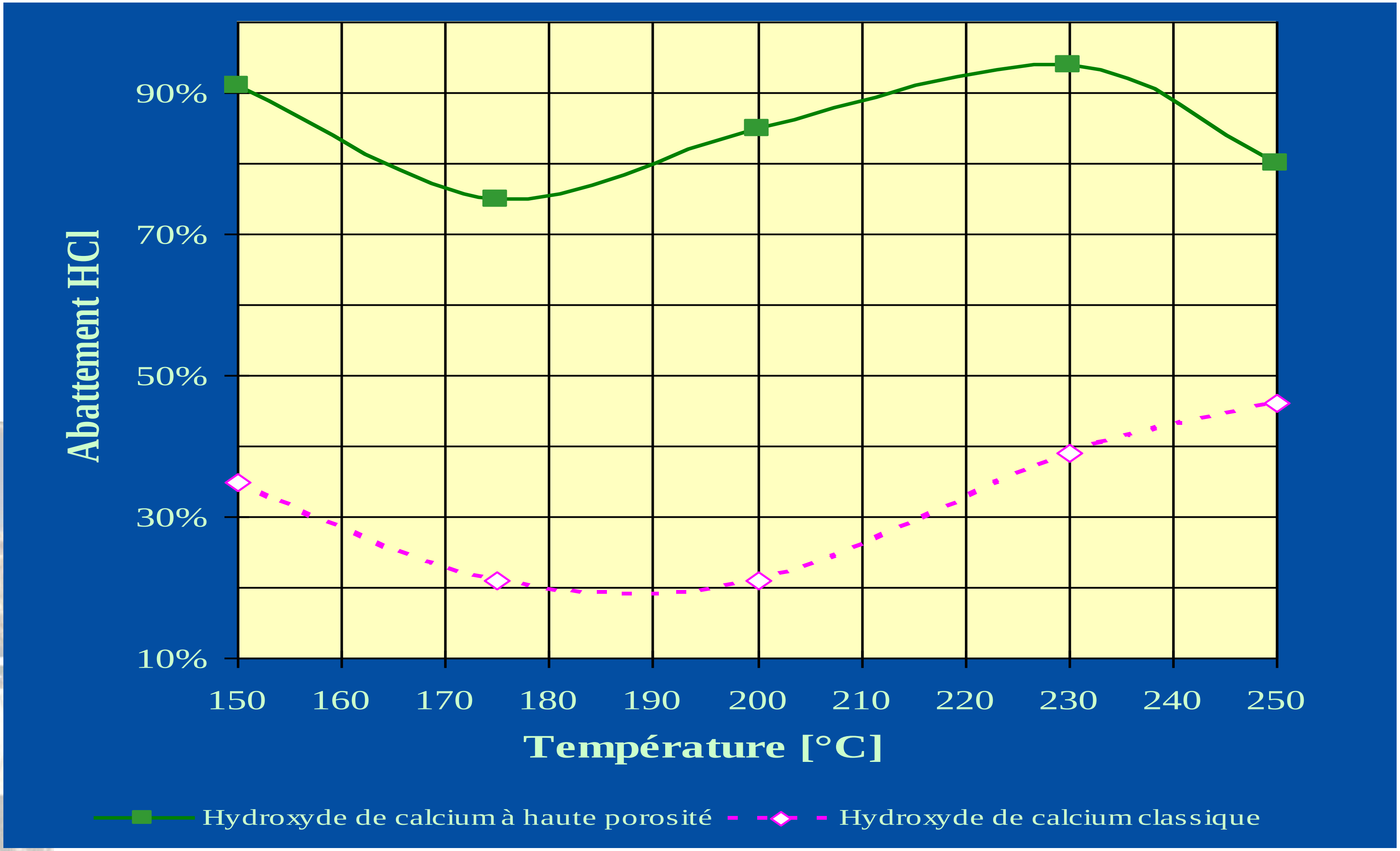
- Flue gas properties
  - Temperature
  - Moisture
  - Competing acid gases
  - CO_2 concentration

- Reagent properties
  - Particle surface area
  - Pore shape, size and volume
  - Particle size distribution

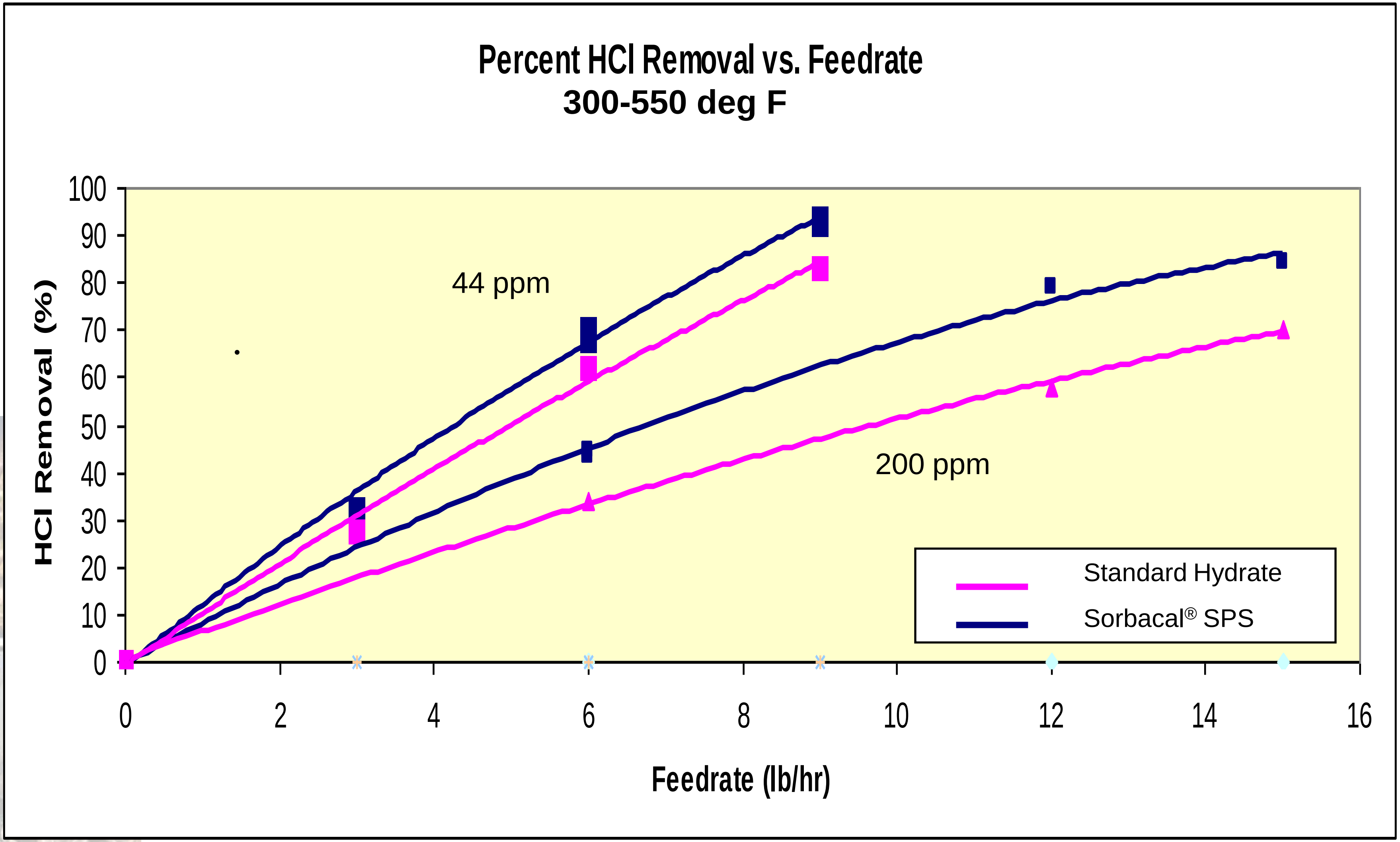
- System properties
  - Distribution of reagent injection
  - In-flight residence time
  - Particulate control device

HCl Removal Sorbacal® SPS vs. Standard Hydrated Lime



HCl : 1200 mg/Nm³ - H : 10 % - SR : 1,7 - CO_2 : 9 %

HCl Removal Sorbacal® SPS vs. Standard Hydrated Lime



Next Steps in US

- EPA Testing April 2011
  - Standard Hydrate and Sorbacal® SPS
  - Range of Injection Temperatures
  - Additional work on ESP vs. Baghouse performance
  - Develop understanding of competing acid gases

- Field Demonstrations
  - Cement
  - Paper
  - Utility

Questions?

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