Understanding Hydrated Lime Properties In Acid Gas Control

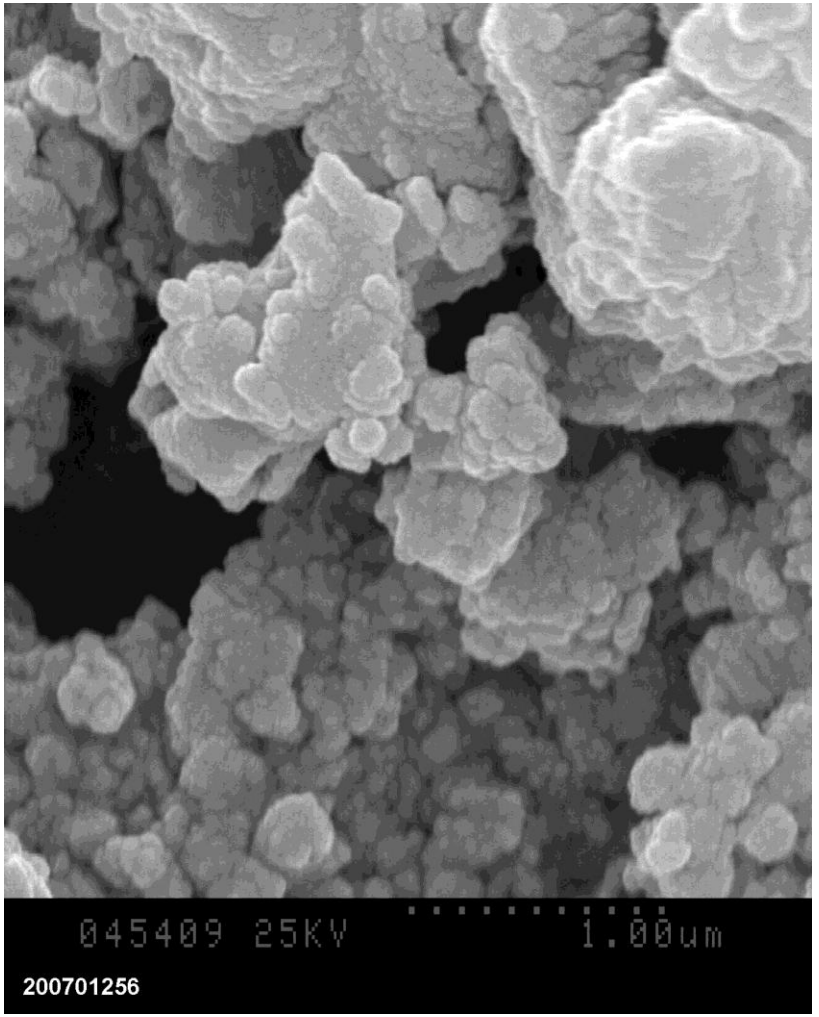
Mike Tate

McIlvaine Company Hot Topic Hour

June 21, 2012

Understanding Sorbent Properties

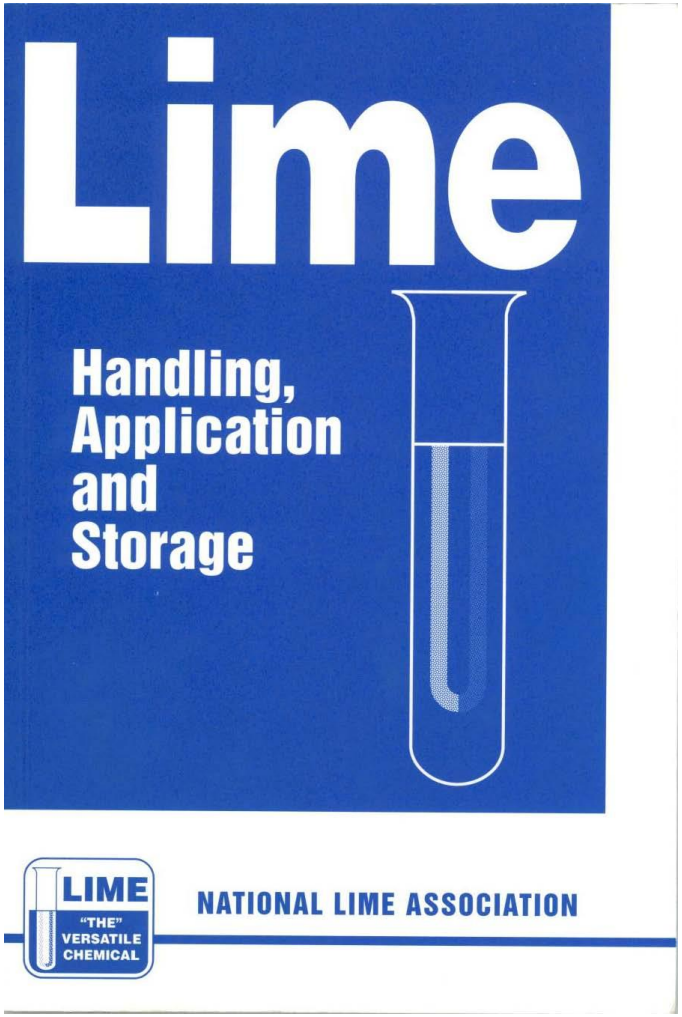
- Material Handling
- Chemistry
- Reactivity
- Effect on Particulate Removal
- Reaction Products



Material Handling

Material Handling Characteristics

- **Silo Design**
  - Density (25 – 35 lbs/ft^3)
  - Cone Angle
  - Flowability
    - Flow Aids
    - Rotary Feeder
- **Pneumatic Conveying**
  - Air Temperature Effect
  - Moisture Level
  - Piping design



Chemistry

Chemical Composition

- Mining location can influence the chemistry of the sorbent.
- Levels of calcium and magnesium compounds are important. (90% min.)
- Higher purity – Better?

Reactivity

Sorbent Reactivity

- Normalized Stochiometric Ratio
- Fineness/Surface Area
- Temperature
- Residence Time

Sorbent Molecular Weight Analysis

Sorbent	Chemical Formula	Moles to Capture 1 Mole SO_2	Molecular Weight
Hydrated Lime	$Ca(OH)_2$	1	74
Trona	$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$	.67	151
Sodium Bicarbonate	$NaHCO_3$	2	168

Example: Trona Reactions

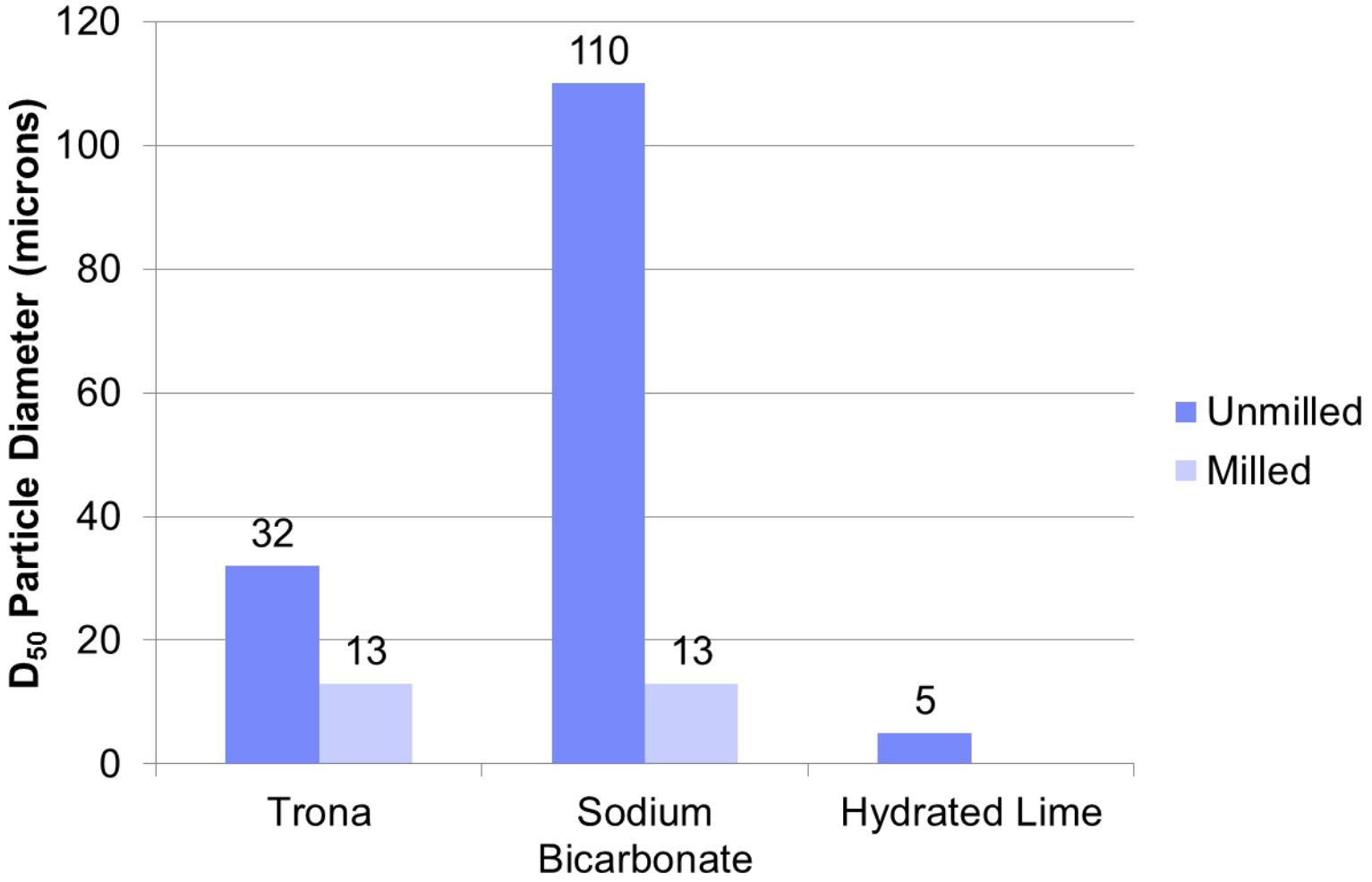
Primary Reaction - $2(Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O)(s) + heat \rightarrow 3Na_2CO_3\ (s) + 5H_2O\ (g) + CO_2\ (g)$

Secondary Reaction - $Na_2CO_3 + SO_2 \rightarrow Na_2SO_3 + CO_2$

NSR – Ratio of Moles Not Weight

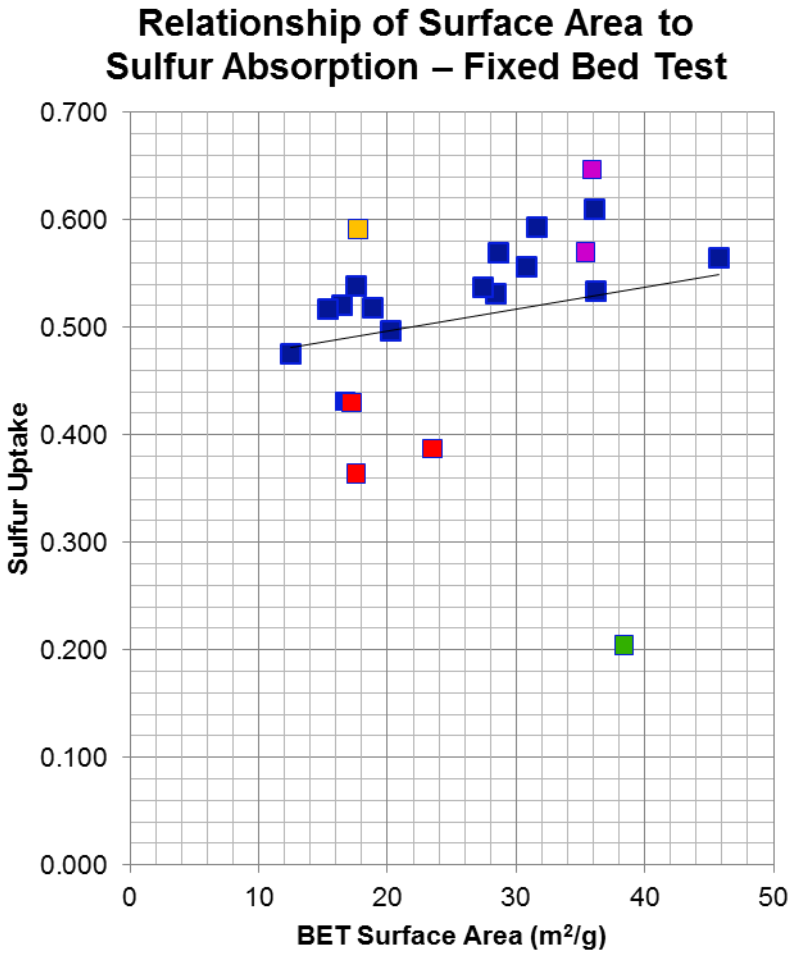
Normalized Stoichiometric Ratio	Theoretical Ratio By Weight of Sorbent to SO_2 for Complete Capture		
	Hydrated Lime	Trona	Sodium Bicarbonate
1.0	1.16	2.35	2.63
1.5	1.73	3.53	3.94
2.0	2.31	4.71	5.25

Sorbent Particle Size



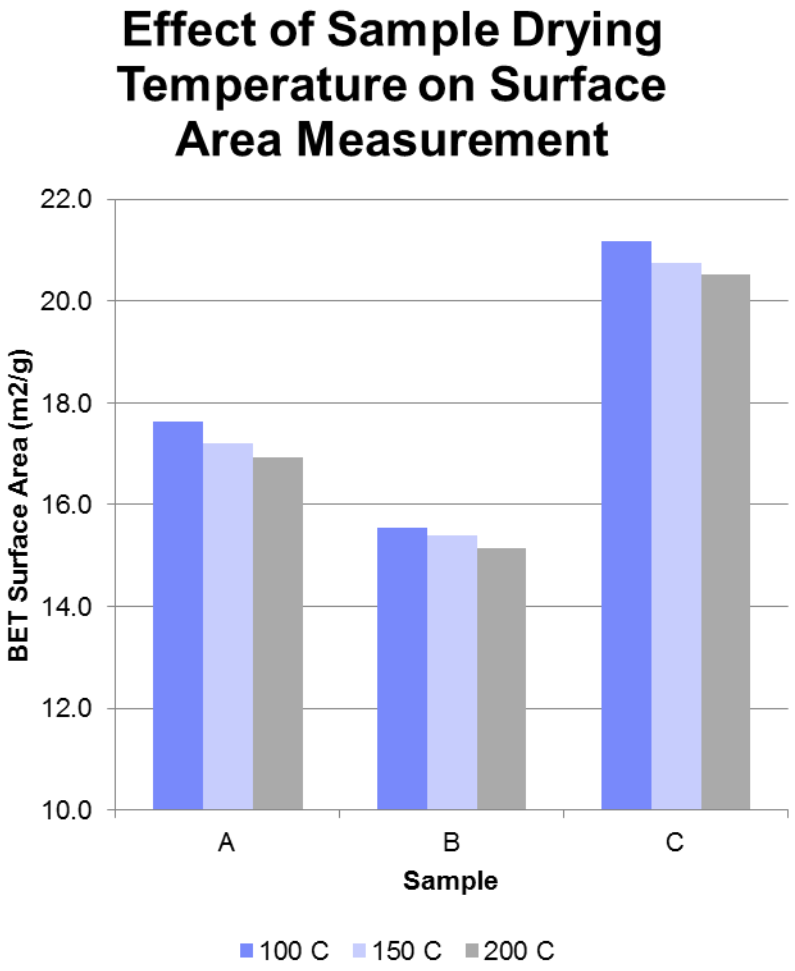
Sorbent Surface Area

- As surface area increases, sulfur removal increases?
- A dynamic variable
  - Temperature Effects
  - Pore plugging



Surface Area Measurement

- No standards currently exist for sample preparation.
- Begun working on standards for sample preparation in ASTM
- Temperature and length of time for sample preparation can influence results
- Vacuum preparation may also be a factor



Temperature Effects

- Flue gas contains multiple components that could potentially react with the sorbent.
- These components react with the sorbent in different temperature windows.
- Downstream effects of the sorbent and the reaction products must be considered.
- Trade-offs to get the targeted level of removals must be evaluated on a site by site basis.

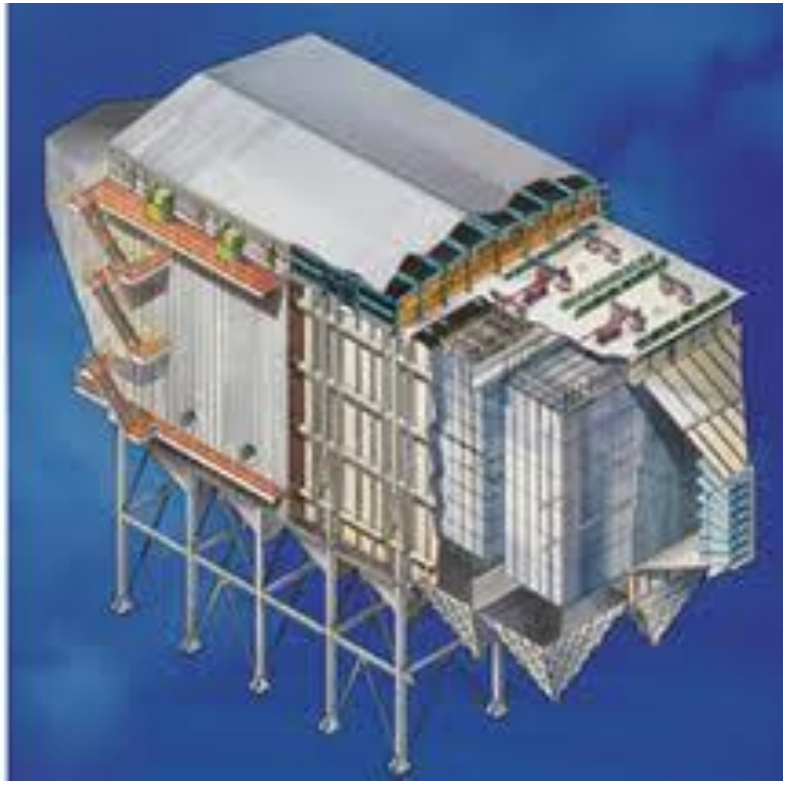
Residence Time Impact

- Longer times of exposure benefit all sorbents.
- Temperature profile of exposure time is important.

Particulate Removal

Particulate Removal Considerations

- ***Baghouse***
  - Provides greater exposure of the sorbent to flue gas which can improve removal efficiencies
- ***Electrostatic Precipitator***
  - Increased solids concentration can be problematic for ESP performance
  - Lime injection can increase resistivity. Humidification can improve collection performance.



Reaction Products

Effect On Fly Ash

- Spent sorbent can be a significant portion of the fly ash collected
- Soluble salts can limit beneficial use
- Solubility of metals in ash could be impacted

Summary

Summary

- There are a wide range of characteristics that can influence the performance of sorbents
- Differences in flue gas composition and process characteristics between boilers point to the need for testing to define performance
- The impact of reaction products should be considered when looking at the viability of different sorbent options

Questions?