Acid Gas Removal with Trona
Focus on HCl Reduction

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Overview

• Natron\textsubscript{x} overview
• Trona Chemistry
• Trials Scenarios
  – Boiler 1
    • HF and HCl mitigation
  – Boiler 2
    • APH inlet vs. outlet
  – Boiler 3
    • Milled vs. Unmilled trona
• Conclusion /Questions
NatronX Overview

• NatronX Technologies, LLC is a partnership created by
  • FMC Corporation
  • Church & Dwight Co., Inc.
  • Tata Chemicals

• The Scope of the NatronX Technologies:
  – To develop, manufacture, market, sell and distribute sodium products for use in dry injection acid gas scrubbing processes
Trona Sorbent Reactions

Trona- (EnProve™ TR)

\[ 2 \text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O} + 3 \text{SO}_2 \rightarrow 3 \text{Na}_2\text{SO}_3 + 4 \text{CO}_2 + 5 \text{H}_2\text{O} \]

\[ \text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O} + 3 \text{HCl} \rightarrow 3 \text{NaCl} + 2 \text{CO}_2 + 4 \text{H}_2\text{O} \]

\[ \text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O} + 3 \text{HF} \rightarrow 3 \text{NaF} + 2 \text{CO}_2 + 4 \text{H}_2\text{O} \]

Stoichiometry

- 2.4 lbs of Trona neutralizes 1 lb of SO2 (g)
- 2.1 lbs of Trona neutralizes 1 lb of HCl (g)
- 3.8 lbs of Trona neutralizes 1 lb of HF (g)
Reaction Order

- Reaction Speed from fastest to slowest
  - Most reactive acid gas
  - Acid base reaction
  - Multi-step reaction

- HF
- HCl
- SO₂

F, Cl, Br, I

Most Reactive
Least Reactive
Trona Sorbent Reactions

\[
NSR = \left( \frac{\text{mmBtu}}{\text{hr}} \text{ heat input} \times \frac{\text{lbs}}{\text{mmBtu}} \text{ acid gas} \right) \times \left( \frac{\text{lbs}}{\text{hr}} \text{ Trona} \times \frac{226 \frac{\text{g}}{\text{mol}} \text{ trona}}{\text{mol} \text{ acid gas}} \times \frac{\text{mol} \text{ Trona theoretically reacted}}{\text{mol} \text{ acid gas theoretically reacted}} \right)
\]

- **NSR**
  - An adjusted ratio of showing the actual usage over theoretical usage of the reaction compared to ideal conditions
Trial Success Factors

• Sorbent Particle Size
• Residence time to Particulate collector
• Temperature of injection point
• Particulate collection equipment
  – Baghouse or ESP
• Material Distribution
• Material Handling
  – Moisture
  – Pre-calcination
Trona Milling

- Particle Size unmilled trona: D50 ~30 microns
- Particle Size milled trona: D50 ~22 microns
- Post Mill Temperature: 105°F
Sodium Alkali Typical Injection Locations

- Bottom Ash
- SCR
- Trona
- APH
- Trona
- Baghouse or ESP
- Trona
- Fly Ash
- FGD Wet Scrubber
Industrial Boiler Trial - Plant 1

- Size: 70 MW
- Fuel: Bituminous Coal
- Baseline HCl: 50 ppm
- Baseline SO$_2$: 500 ppm
- Particulate Collector: baghouse
- Injection points
  - Upstream of baghouse: 370-390°F
- Reduction Goal: 80% removal of HCl
Industrial Boiler Trial - Plant 1

Furnace → Econ → Baghouse → Stack

- Econ outlet 400°F
- Br AC injection
- trona injection
- FF outlet 375°F
- Stack temp 325°F
HCl reduction with Trona and Br-AC injection

- Unmilled Trona only
- 5 lb/hr Br AC
- 20 lb/hr
HF reduction with Trona and Br-AC injection

- Unmilled trona only
- 5 lb/hr Br-AC
- 20 lb/hr Br-AC

HF % Reduction vs. trona (lb/hr)
SO$_2$ reduction with Trona and Br-AC injection

- unmilled trona only
- 5 lb/hr Br-AC
- 20 lb/hr Br-AC
Plant 2 - Utility Boiler Trial

- Size: 240 MW
- Fuel: PRB
- Baseline HCl: 0.001 lb/mmBtu
- Baseline SO$_2$: 0.46 lb/mmBtu
- Particulate Collector: Cold-ESP
- Injection points
  - APH inlet: 750° F
  - APH outlet: 300° F
- Goal: MATS Compliance
HCl & SO$_2$ Removal Results
Milled Trona Injected at APH Inlet
HCl & SO₂ Removal Results
Milled Trona Injected at APH Outlet

% Removal vs. NSR

- SO₂ - APH Outlet
- HCl - APH Outlet
Plant 3 - Utility Boiler Trial

- Size: 90 MW
- Coal Type: PRB
- Baseline SO2: 0.53 lb/mmBtu
- Baseline HCl: 0.005 lb/mmBtu
- Injection point: APH inlet
- Injection temperature: 735° F
- Particulate Collector: ESP
Milled Trona HCl Reduction

![Graph showing the relationship between injection rate (lb/hr) and percent reduction of Milled Trona with HCl.]
Milled vs. Unmilled Trona for HCl reduction

Percent Reduction vs. NSR

- Milled trona
- Unmilled trona
Conclusions

- Dry Sorbent Injection with Trona is an effective solution for industrial and utility boiler emission control strategy.
- Trona has the ability to reduce HCl and HF by 90% or greater
- Temperature does effect the sorbent utilization efficiency
- Milling Trona will reduce the amount of sorbent required to achieve removal targets
Questions

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