TECHNOLOGY BRIEF

UCC DRY SORBENT INJECTION SYSTEM

Enhanced In-Line Mill Technology Saves Utilities Millions

Coal-fired power plants are being driven by the EPA to assess various technologies and capabilities for enhanced SO_3 removal. Since 2005, United Conveyor Corporation-Dry Sorbent Injection has conducted numerous Dry Sorbent Injection (DSI) tests to demonstrate SO_3 removal performance versus trona particle size. The test described in this technology brief confirms that low SO_3 stack emissions are achievable with dry sorbent injection technology. A key discovery is that milling technology, specifically in-line pneumatic milling systems, provides the only way to achieve very low SO_3 stack emissions when injecting trona. Additionally, results show that a fine milled particle size can reduce sorbent usage by half.

Dry Sorbent Injection Test Overview

The DSI test compared SO_3 removal performance of as-delivered unmilled trona, in-line coarse milled trona and in-line fine milled trona. DSI is an economical and effective technology that injects selected sorbents into the flue gas to control SO_2, SO_3, mercury and other acid gases. When trona is the appropriate sorbent choice, in-line milling decreases trona usage by increasing surface area per ton injected to enhance reactivity and improve dispersion throughout the flue gas.

The test had three primary objectives:

1. Verify known removal performance of as-delivered unmilled trona and UCC fine milled trona
2. Determine the SO_3 removal performance of in-line coarse-milled trona
3. Use the SO_3 removal curves to compare the life cycle sorbent costs of each approach

Implementation and System Configuration

Trona injection was performed with one positive pressure pneumatic conveying system splitting into eight injection lances located downstream of the air preheaters and upstream of the electrostatic precipitator (ESP) – a common configuration for injection systems. The United Conveyor Corporation (UCC) splitter system was designed to ensure ±10 percent sorbent distribution across each injection lance, and was verified to achieve this performance during laboratory testing. The lance placement was determined using computational fluid dynamics (CFD) modeling. The patent-pending UCC in-line mill system, was used to mill the trona. The UCC in-line mill system operates with the positive pressure pneumatic conveying system and utilizes only the conveying air stream in the milling process. The mill size reduction is adjustable, and was reduced by design during some test runs, intentionally increasing the sorbent particle size to closely match competing mill performance and corresponding SO_3 removal rates.

The median trona particle sizes evaluated:

- As-delivered unmilled trona: 30-40 microns
- Coarse milled trona: 16-18 microns
- UCC fine milled trona: 12-14 microns

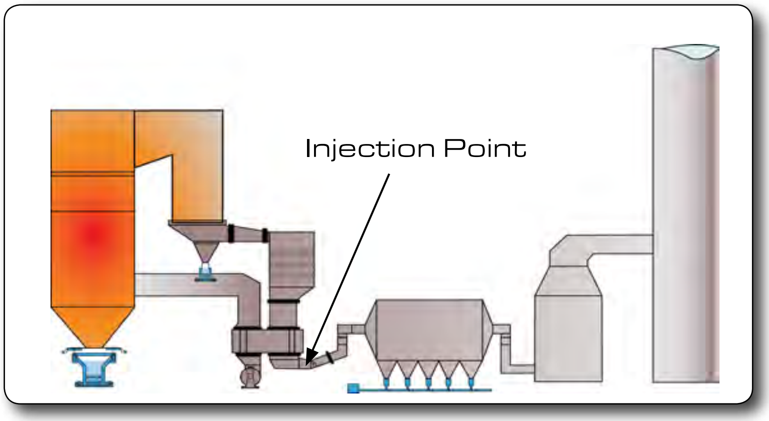
Plant Operation

The UCC test was performed at a plant with a 700MW unit with the following environmental controls:

- Selective catalytic reduction (SCR) system for nitrogen oxide (NOx) removal
- Cold side ESP for particulate removal
- Wet flue gas desulfurization (FGD) for SO_2 control

The baseline for the plant SO_3 concentration levels were:

- The boiler and SCR converting approximately 2 to 2.5 percent total SO_2 to SO_3
- ESP outlet SO_3 concentration in the range of 28-33ppm without DSI injection



Sampling Methodology and Testing Tools

SO_3 concentration was measured by both a dew point monitor and controlled condensate testing (EPA Method 8A). All testing samples were taken between the ESP and FGD. The dew point monitor provided continuous monitoring of the flue gas dew point which was converted to an approximate SO_3 concentration. SO_3 concentrations calculated indirectly from dew point compared conservatively to SO_3 concentrations determined by EPA Method 8A.

Note: SO_3 concentrations well below 5ppm were measured using interval and event sampling techniques. However, UCC acknowledges that at concentrations well below 5ppm, the measurement tolerance of current technology and test methods may not provide the accuracy necessary to consistently validate emission limits due to testing tolerance bands exceeding absolute measurements.

As-delivered unmilled, coarse milled and fine milled trona samples were taken passively by a pitot tube placed in the center of the conveying stream. This sampling method was validated by taking 100 percent material samples at multiple injection lance sites concurrent with the pitot tube samples. All samples were analyzed using a Beckman Coulter laser analyzer.

Test Results and Analysis

The test results showed:

- Predictable SO_3 removal performance curves for each particle size measured/tested
- Smaller particle size allows lower SO_3 removal while significantly lowering trona usage
- Fine milled trona is projected to save $4.5 million and $2 million over five years compared with as-deliver unmilled trona and coarse milled trona respectively

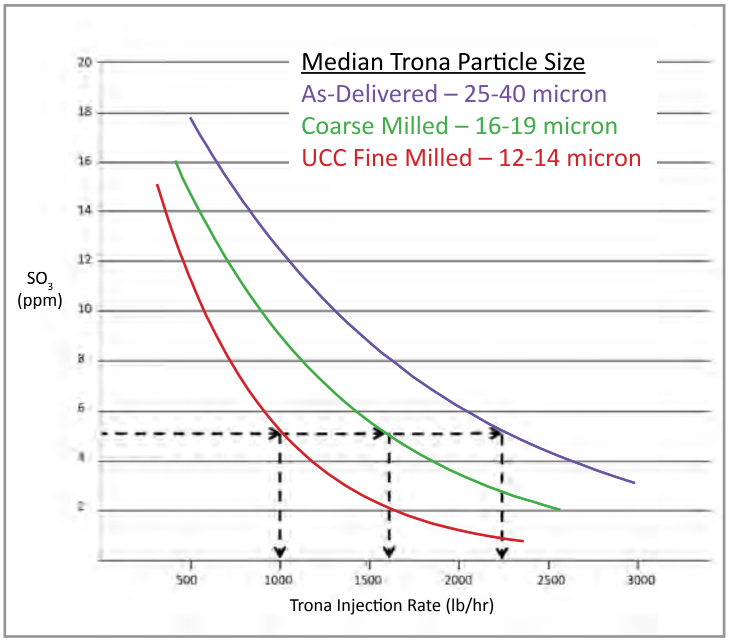
Proven Return on Investment

Figure 1 shows a comparison of the annual trona costs and five year aggregated savings associated with achieving 5ppm SO_3 concentrations at the ESP outlet using as-delivered unmilled, coarse milled (competitive mills) and UCC fine milled trona. The annual trona cost comparison assumes a capacity factor of 90 percent for a mid- to large-sized power plant and a price of $180/ton for as-delivered unmilled trona.

Figure 1 - **Cost Comparison to Achieve <5ppm SO_3**

Sorbent (Trona)	Particle Size (median)	Injection Rate (lb/hr)	Annual Sorbent Costs	5-Year Sorbent Savings
As-delivered Trona	25 - 40 micron	2,300	$1,631,988	n/a
Coarse Milled	16 - 19 micron	1,600	$1,135,296	$2,483,100
UCC Fine Milled	12 - 14 micron	1,000	$ 709,560	$4,464,000

Figure 2 - **Milled Trona Injection Rate vs. Outlet SO_3 Concentration**



Note: Typically less than 5ppm is necessary to avoid a visible SO_3 Plume

Conclusion

DSI systems are low capital cost and suitable for retrofit into units with SCRs and/or wet scrubbers. UCC DSI technology delivers effective SO_3 control and is capable of achieving SO_3 emission limits well below 5ppm as a result of in-line milling technology producing sorbent particle size of 12 to 14 micron. This small particle size will reduce sorbent usage up to 50%. Industry leading UCC DSI technology provides the coal-fired power industry the most efficient and economical method to meet current and future SO_3 emission limits and regulations.