



# Dry Sorbent Injection for SO<sub>2</sub>, SO<sub>3</sub>, Hg and HCl



# SO<sub>2</sub>, SO<sub>3</sub>, Hg & HCl

## Dry Sorbent Injection

Utilities are actively evaluating various technologies and strategies to comply with EPA emissions regulations. Removal efficiency, capital and operating cost, plant life, outage requirements, scalability and impact on existing air pollution control (APC) equipment are typical considerations and trade-offs. Many plants have determined that Dry Sorbent Injection (DSI) delivers a simple, low cost solution to effective pollution control for their environmental fleet planning.

Since 2004, United Conveyor Corporation (UCC) has pioneered dry sorbent injection technology which injects selected sorbents into the flue gas to control SO<sub>2</sub>, SO<sub>3</sub>, mercury and HCl. UCC leads the industry in demonstration testing and is recognized as the technology leader that delivers system performance and confidence to our customers. Our experience removes the guesswork and we work closely with customers to deliver a reliable solution to each plant's specification.

### Multi-Pollutant Control Capability

Many plants are looking for a single, comprehensive solution for the removal of pollutants required by EPA MATS and CSAPR/CAIR regulations. Determining factors include complex chemistry, fluid dynamics, sorbent selection, injection location and interaction with existing APC equipment such as ACI systems, fuel additives and fabric filter / ESP collection. UCC has extensive experience with simultaneous SO<sub>2</sub>, SO<sub>3</sub>, HCl and Hg removal to deliver comprehensive compliance strategies in a timely and economical manner.



- HYDRATED LIME
- TRONA
- SODIUM BICARBONATE
- ACTIVATED CARBON
- OTHER MERCURY SORBENTS



### UCC Advantage

Our experience, technology and customer support set UCC apart from other suppliers. UCC ensures optimum plant performance through sophisticated predictive modeling for the injection grid design, on-site testing to validate sorbent type and injection rate, and proactive lab testing and evaluation of the effects on existing ash handling systems. UCC offers the expertise, confidence and single point accountability our customers expect in dry sorbent injection systems.

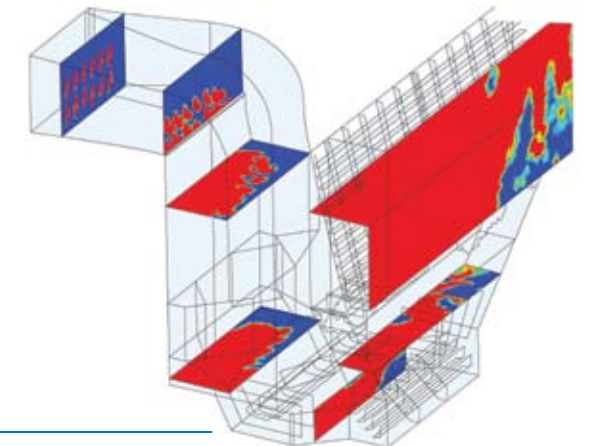
- **Performance-based turnkey solutions**
- **Over 25,000 hours of DSI demonstration testing**
- **VIPER™ mill technology delivers the highest removal efficiency and greatest cost savings**



### Innovation

UCC is committed to innovation and technology that deliver performance advantages in our dry sorbent injection systems. Continuing efforts focus on particle dispersion to improve removal efficiency, elimination of plugging and system design practices that drive operational reliability.

- **Splitters**  
The UCC design is optimized and tested for even sorbent distribution and high removal efficiency while minimizing the risk of plugging.
- **Injection Lances**  
The unique UCC design maximizes particle dispersion and eliminates plugging with no impact on pressure drop.
- **CFD Modeling**  
UCC specializes in Computational Fluid Dynamic (CFD) modeling of plant duct flows to predict and enhance sorbent distribution in flue gas, thereby maximizing performance and minimizing sorbent usage.



# Confidence

## On-Site Test and Demonstrations



Full-scale, on-site demonstration testing is used to validate the plant's compliance strategy and optimize the overall performance of the DSI system. Utilities understand the need to report compliance decisions to shareholders, and therefore require experienced planning, execution and professional reporting of demonstration tests.

Every boiler unit is unique and emissions are influenced by coal type, combustion conditions, ductwork, temperature and other APC equipment. During testing, modifications can be made to the injection grid, sorbent combinations and injection rates to maximize emissions removal. The ability to devise a meaningful, customized test plan and efficiently confirm emissions compliance is heavily influenced by prior experience.

### Preparation and Logistics

UCC process engineers are actively involved to ensure that demonstration testing goes smoothly and that the results directly support emission control strategy decisions.

- CFD modeling (computational fluid dynamics) of the particle dispersion can be used to predict and enhance performance and minimize sorbent usage prior to testing.
- Test matrices are developed that leverage UCC experience and data from previous tests. Conveying requirements are determined using UCC proprietary pneumatic programs.
- A comprehensive test plan is submitted to the plant in advance and serves as the "playbook" for execution.

### Execution

UCC demonstration equipment incorporates the latest injection and milling technology and is installed and operated with minimal disruption to the plant.

- The industry's most experienced field engineers are on-site for supervision, operation and troubleshooting.
- DSI process engineers are on-site to provide real-time data evaluation, consultation, and test plan adjustments as required to achieve best results.

### Data Evaluation and Reporting

The DSI process engineer consolidates and evaluates all the raw data from the COMS, CEMS, testing PLC and source testing.

- Removal results are compared to a database of previous site testing to confirm performance and improve results.
- A final test report is provided that summarizes the data and reviews it against the test objectives.
- UCC personnel are a continuous resource during plant/fleet emission control strategy evaluation and decision making.

- **NUMBER OF DEMONSTRATIONS 65+**
- **OVER 25,000 HOURS OF TESTING 25,000+**

When you need it done right,  
you can count on UCC



UCC has conducted over 65 full-scale demonstration tests and has over 25,000 hours of experience. This is the most hands-on, practical experience in the industry and provides clear differentiation in a crowded market. UCC test experience includes a strong technical understanding of SO<sub>2</sub>, SO<sub>3</sub>, HCl and Hg removal and any multi-pollutant combination.

Our fleet of mobile test equipment incorporates the latest injection and milling technology and is fully automated to generate reliable, high quality data. This unique capability provides the answers our customers need to make critical compliance decisions.



# Performance Advantage

## VIPER™ Mill Technology

The VIPER™ Mill is proven, reliable technology developed specifically for dry sorbent injection. The patented VIPER Mill operates in-line with the DSI system and delivers the smallest particle size, highest throughput and greatest cost savings in the industry. The result is 30-50% lower sorbent usage compared with as-delivered material.

- Designed for trona and sodium bicarbonate
- Capacity: 0.5 – 7 tons per hour
- Median particle size: 9-15 µm (trona), 15-19 µm (SBC)
- Reduced sorbent usage saves millions of dollars

## Skid Mounted Installation with Automated Cleaning

The VIPER Mill is equipped with an automated cleaning system to eliminate sorbent build-up. The 30-minute cleaning cycle ensures consistency in particle size while balancing horsepower, temperature rise and sorbent throughput. The VIPER Mill uses either a simple bypass system or redundant skid for uninterrupted DSI operation.

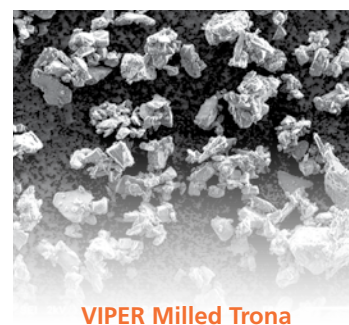
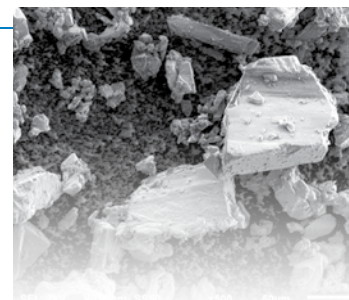
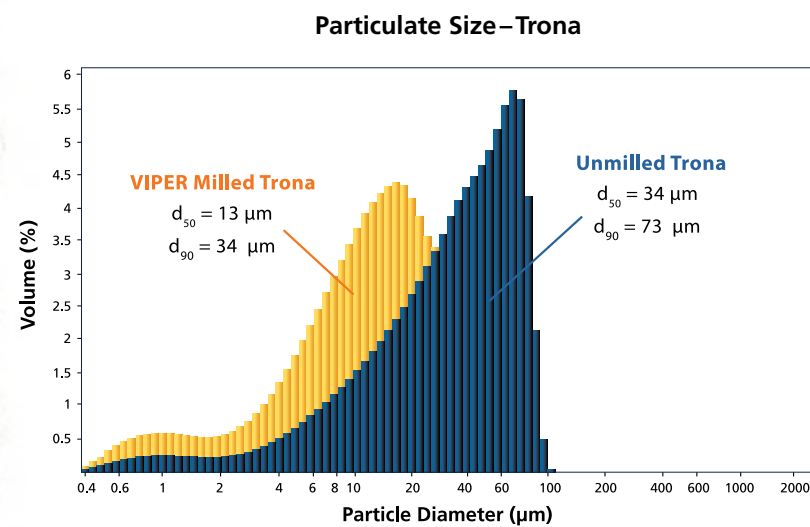
The VIPER Mill ships on a fully pre-piped and pre-wired skid for simple installation and lower installed cost.



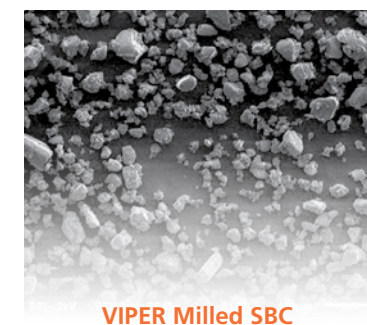
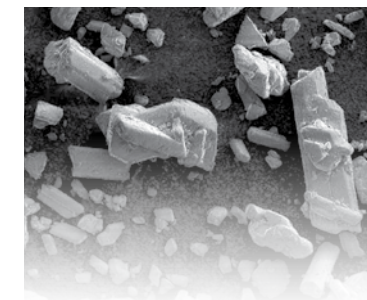
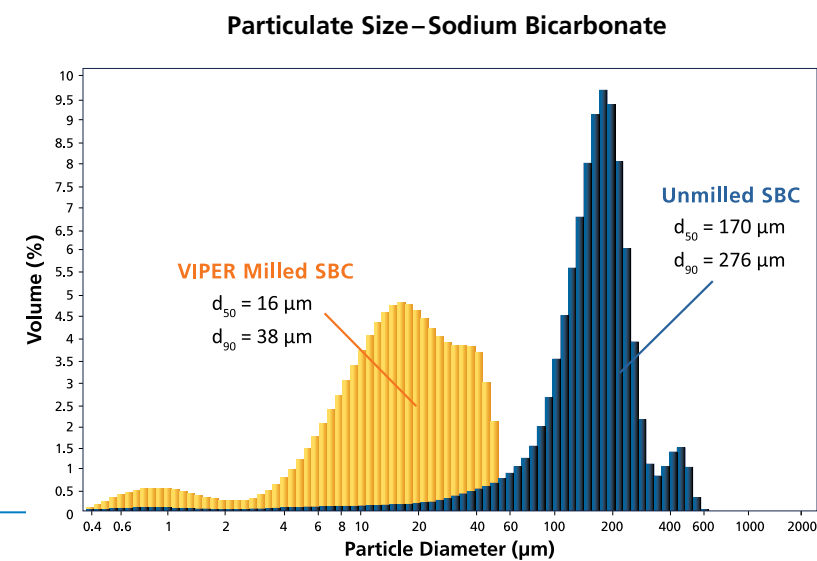
**7 TONS PER HOUR**  
**24/7 OPERATION**

The only mill developed specifically for DSI systems

### Trona



### Sodium Bicarbonate



# Dry Sorbent Injection

## Economic Advantage

### VIPER Mill – Smart Investment

The annual savings using VIPER Milling technology typically results in a payback period of less than one year. Integration of a single VIPER Mill can reduce sorbent costs by millions of dollars annually compared to other DSI systems.

In a typical SO<sub>3</sub> removal application, the VIPER Mill achieves aggressive ppm targets while saving nearly \$1 million per year compared with unmilled trona.

### SO<sub>3</sub> Economics

Unmilled vs. UCC Milled Trona

| Unit (MW) | SO <sub>3</sub> (ppm) | SO <sub>3</sub> Reduction (% Removal) | Unmilled (ton/hr) | VIPER Mill Fine Milled (ton/hr) | Annual Savings* |
|-----------|-----------------------|---------------------------------------|-------------------|---------------------------------|-----------------|
| 700       | 25                    | 90%                                   | 0.7               | 0.4                             | \$ 425,736      |
| 700       | 35                    | 90%                                   | 1.0               | 0.5                             | \$ 709,560      |
| 700       | 50                    | 90%                                   | 1.3               | 0.6                             | \$ 922,428      |



VIPER Mill technology saves utilities millions annually

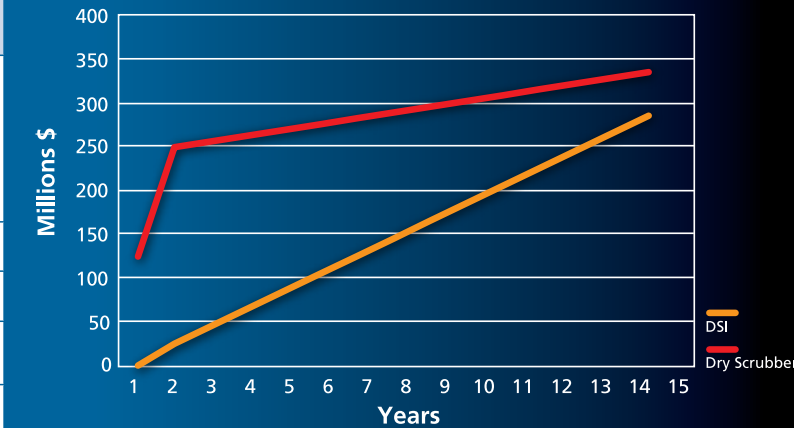
### DSI vs. Dry Scrubber

Dry sorbent injection is readily added to existing units and has a lower capital cost, yet higher operating cost, compared with dry scrubbers. An economic analysis comparing these solutions concludes that UCC's DSI system with VIPER Mill technology has a lower cash outlay and net present value beyond 15 years. Each plant has a unique footprint in terms of size, life expectancy, efficiency target and financial position and should consider all variables in their specific evaluation.

### 90% Removal – 600MW Unit with ESP/PRB Coal

|   | Dry Sorbent Injection  | Dry Scrubber   |
|---|--|--|
| <b>Efficiency Target</b>                    | 90% SO <sub>2</sub><br>90% HCl<br>90% Hg<br>removal with ESP and milled trona/activated carbon | 90% SO <sub>2</sub><br>90% HCl<br>90% Hg<br>removal with ESP |
| <b>Outage for Installation</b>              | None   | 1 month  |
| <b>Lead Time</b>                            | 12 months  | 2 years  |
| <b>System Costs (includes installation)</b> | \$25M  | \$250M   |
| <b>Operating Cost (w/ sorbent costs)</b>    | \$20M / yr.  | \$6.6M / yr.   |

### Cumulative Cash Outlay (NPV)



In a typical SO<sub>2</sub> removal application, the VIPER Mill can reduce sorbent usage by 30-50%. This delivers a \$3.0 million annual savings over unmilled trona for a typical 500-MW PRB unit at a 60 percent removal rate.

### SO<sub>2</sub> Economics

Eastern Bituminous Coal: Unmilled Trona vs. UCC Milled Trona

| Unit (MW) | Sulfur lb/mmbtu | SO <sub>2</sub> Reduction (% Removal) | Unmilled (ton/hr) | VIPER Mill Fine Milled (ton/hr) | Annual Savings* |
|-----------|-----------------|---------------------------------------|-------------------|---------------------------------|-----------------|
| 50        | 1.6             | 60%                                   | 2.4               | 1.7                             | \$ 993,384      |
| 100       | 1.6             | 60%                                   | 4.8               | 3.4                             | \$1,986,768     |
| 150       | 1.6             | 60%                                   | 7.2               | 5.1                             | \$2,980,152     |

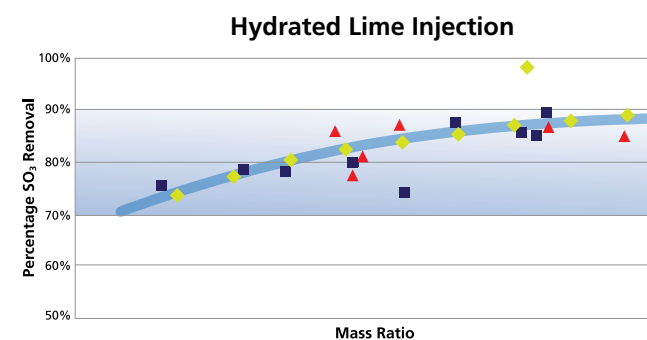
PRB: Unmilled Trona vs. UCC Milled Trona

| Unit (MW) | Sulfur lb/mmbtu | SO <sub>2</sub> Reduction (% Removal) | Unmilled (ton/hr) | VIPER Mill Fine Milled (ton/hr) | Annual Savings* |
|-----------|-----------------|---------------------------------------|-------------------|---------------------------------|-----------------|
| 100       | 0.8             | 60%                                   | 1.5               | 1.1                             | \$ 638,604      |
| 250       | 0.8             | 60%                                   | 3.8               | 2.7                             | \$1,617,797     |
| 500       | 0.8             | 60%                                   | 7.5               | 5.3                             | \$3,193,020     |

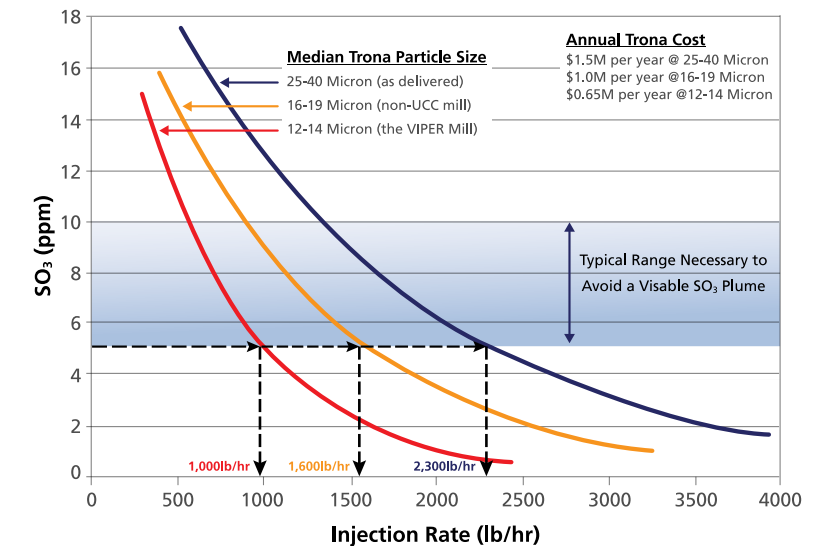
\* Based on Trona at \$180/ton

### SO<sub>3</sub> Removal with Cost Savings

DSI systems are suitable for retrofit into units with SCRs and/or wet scrubbers for effective SO<sub>3</sub> control. UCC has experience using hydrated lime and trona injection for SO<sub>3</sub> removal and has achieved SO<sub>3</sub> emission limits well below 5 ppm. Where trona is preferred, VIPER Milling technology will reduce sorbent usage by 50%.



### Milled Trona Injection Rate vs. Outlet SO<sub>3</sub> Concentration



# Confidence

## Service and After-Market Support

### Potential Impact to Existing Ash System

The addition of a DSI system introduces calcium or sodium-based by-products to the existing ash handling system. These by-products can alter the material characteristics of the existing fly ash, thereby affecting its flow properties and performance of existing hoppers and conveying pipes. In SO<sub>2</sub> applications, the additional solids load could exceed the design capacity of your existing system.

As the global leader in ash handling, UCC offers a comprehensive evaluation of your plant's current ash removal capacity. We will analyze the ash by-product and recommend any system changes to accommodate the increased load and altered material flow characteristics caused by the sorbent injection.

### Project Implementation and Knowledgeable Resources

UCC project management, field service and process engineering teams work hand-in-hand with customers to provide seamless execution of specification development, test and demonstration, design, erection and start-up, operation and maintenance training. UCC maintains a group of dedicated DSI process and field service engineers to work directly with customers during all phases of work, including after-market support.



UCC supports you for the life of your system

The UCC commitment to quality is backed by thousands of hours of development, testing and evaluation. United Conveyor Corporation has one of the world's most advanced research laboratories and conveyor test loops to simulate ash and reagent handling applications and validate design parameters. Our knowledge and experience in material behavior, product innovation and system development for challenging applications is unmatched in the industry.



UCC is committed to providing the highest level of service for as long as you own your system. Our field service engineers are available worldwide to assist with erection and start-up, operator training and maintenance.

#### • Replacement Parts

UCC offers the most readily available inventory of replacement parts to minimize downtime and reduce operating costs. Thousands of replacement parts are in stock and ready for next day shipment.

#### • Preventative Maintenance

This program is designed to keep your DSI system operating at peak efficiency, proactively prioritizing maintenance resources and minimizing the risk of unexpected downtime.

#### • Pre-outage and Outage Assistance

UCC inspection and advance planning ensures that parts are on-site before work begins, installed properly and tested, to deliver a smooth start-up.



## The UCC Commitment

As an industry innovator, we have long been at the forefront of ash handling technology. We recognize the importance of providing customers with the best equipment and latest technology that meet their demanding requirements and plant needs.

With our own advanced testing and technology lab, we are able to maintain control over the quality and delivery of our systems and equipment. The result is superior and predictable performance for our customers.

Our dedicated team of engineers, sales, service and in-house designers spans the globe covering six continents, assuring you that we can provide exceptional service whenever needed. This is our commitment to you.

## UCC Material Handling Solutions

### Fly Ash (Dilute, Medium and Dense Phase)

- Vacuum Systems
- Pressure Systems

### Bottom Ash (Wet and Dry)

- Hydraulic Systems
- Pneumatic Systems
- Mechanical Systems
- Vibratory Systems

### Mill Rejects

- Hydraulic System
- Pneumatic Systems

### Economizer Ash

- Hydraulic Systems
- Mechanical Systems
- Pneumatic Systems

### Dry Sorbent Injection

- Predictive (CFD) Modeling
- On-Site Testing and Demonstration
- Pneumatic Systems
- Installation

### Lime Handling

- Truck and Rail Unloading
- Pneumatic Systems

### System Components

- Crushers
- Mixer/Unloaders
- Gates/Valves
- Pipe/Fittings
- Filter/Separators
- Tanks/Vessels

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