DRY HYDRATED LIME INJECTION FOR COAL-FIRED BOILER FLUE GAS DESULFURIZATION (FGD)

FOREWORD

When coal is oxidized (burned) as fuel, the elemental sulfur it contains is converted to SO₂. Some of this SO₂ is converted to SO₃ when oxygen leftover from the combustion process causes further oxidization in the boiler. A system equipped with a selective catalytic reducer (SCR) to reduce NOₓ emissions will convert additional SO₂ to SO₃. When SOₓ combines with moisture in flue gas, vapor-phase sulfuric acid is formed.¹

The presence of sulfuric acid in flue gas escaping into the atmosphere can form a visible plume and particulate emissions from the stack, corrode ducts, and damage downstream equipment.¹ SOₓ emissions are also known for their detrimental effects on human health and the environment, as they may cause smog, acid rain, and ozone depletion. Increased awareness of these problems has led to more legislation and increasingly tighter standards to regulate these harmful emissions.² The use of high-sulfur coal, while more economical, exacerbates these issues and requires more stringent emissions controls.¹

This paper describes a controlled method of mitigating SO₂ and SO₃ emissions by injecting powdered hydrated lime sorbent directly into a utility’s ductwork, typically between the air heater and particulate control device. Pilot scale testing has shown that hydrated lime reacts with SOₓ in flue gas to form synthetic gypsum, which is collected along with fly ash by the particulate control device.¹ This byproduct can be sold to gypsum wallboard plants worldwide.

EXAMPLE OF EMISSION CONTROL SYSTEM WITH DRY SORBENT INJECTION

DRY HYDRATED LIME SORBENT INJECTION OPERATING COST IMPACTS¹

<table>
<thead>
<tr>
<th>Capital Equipment Requirements</th>
<th>Storage silos; Pneumatic conveying system*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byproducts</td>
<td>Synthetic gypsum; Excess hydrated lime; Fly ash</td>
</tr>
<tr>
<td>Boiler Efficiency Impacts</td>
<td>None</td>
</tr>
<tr>
<td>SO₂ Allowance Impacts</td>
<td>None</td>
</tr>
<tr>
<td>NOₓ Removal Impacts</td>
<td>None</td>
</tr>
</tbody>
</table>

*See “Typical System Components” on page 3 for more information.
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DRY HYDRATED LIME SORBENT INJECTION SYSTEM – TECHNICAL SUMMARY

A. TYPICAL SYSTEM CONCEPT FOR COAL-FIRED POWER PLANTS

Nol-Tec Systems, Inc. designs and supplies systems that continuously transfer dry bulk hydrated lime from storage silos to injection ports on boiler flue gas ducts. Although system configurations vary with each application, a typical process includes four to six storage silos designed to hold five to ten days' worth of hydrated lime.

A fluidizing bin bottom is installed on each silo to prevent the stored hydrated lime from rat holing, bridging or arching. An air-activated butterfly valve is mounted below each fluidizing silo cone bottom, and an air-activated silo discharge system is located below each butterfly valve to serve as a refill device for the continuous loss-in-weight (LIW) feeder situated under each silo. The material is not exposed to any moving parts throughout the entire silo and silo discharge system, except for the butterfly valves used in refilling the LIW feeders.

The LIW feeders are designed to handle a continuous flow of hydrated lime. This example uses a nominal material feed rate of 4,000 lb/hr per duct. Each feeder is capable of holding a minimum of 45 ft³ of material, which minimizes the number of refills per hour. Minimizing the number of refills, in turn, maximizes the amount of time the feeders spend in gravimetric (LIW control) mode. Each feeder hopper is mounted on three load cells linked to the control system. Because three points define a plane, the load cells' signals are not corner-to-corner tuned, which makes the units easy to calibrate. A rotary valve operated by a variable frequency drive linked to the control system is mounted at the hopper discharge and serves as the material metering device. This valve discharges material through a small, vented chute directly into a blow-through rotary airlock running at a constant speed. The blow-through rotary airlock is the primary seal between the metering system and the pneumatic conveying line; the metering rotary valve is the secondary seal. Each feeder hopper is equipped with its own reverse jet pulse dust filter system, which traps nuisance dust generated during feeder refill and returns it to the process. The dust filter also facilitates air displacement in the hopper as material is metered out or replenished, as well as air leakage from the blow-through rotary airlock.

Dilute phase, positive pressure pneumatic conveying technology is used to transfer and inject metered hydrated lime throughout the system, and every precaution is taken to assure that the conveying lines do not become plugged with material. Each line is equipped with a dedicated positive displacement blower. These blower packages are connected to a common air dryer to ensure that the air used to convey material remains dry. As any variation in a blower's steady state operation could signal the need for conveying line maintenance, flow meters and variable frequency drive controls can be added to the blower packages. The conveying lines may be insulated to prevent condensation, and blowout ports can be provided to help locate and manage any issue that may arise.

The conveying lines terminate at convey line splitters that distribute hydrated lime to the duct injection lances. The line splitters are vertically oriented to achieve the best distribution possible. Nol-Tec Systems, Inc. has developed a method to analyze the status of each injection lance. Should a blockage occur, the injection lance is automatically purged.

Nol-Tec Systems, Inc. will supply control of all system components and provide more details about the control system in its engineering package.
B. TYPICAL DESIGN CRITERIA

- **Product:** Hydrated lime or any dry bulk sorbent material
- **Bulk Density:** 25-50 lb/ft³
- **Particle Size:** 325 Mesh
- **Moisture:** <1%
- **Temperature:** Ambient
- **Abrasiveness:** Mild
- **System Capacity:** As required based on plant’s flue gas flow rate
- **Convey Lines:** As required based on number of flue gas ducts

C. TYPICAL SYSTEM COMPONENTS

*Refer to process flow diagram on page 4 for corresponding numbers.*

1. Bulk truck unload line components
2. Silo end receivers
3. Guided radar continuous level indicators
4. Point level indicators
5. Dust collectors
6. Exhausters
7. Sign for delivery instructions
8. Storage silos
9. Fluidizing bin bottoms
10. Maintenance gates
11. Air-activated silo discharge systems
12. Gravity flexible connectors
13. Single cartridge dust filters
14. Load cell systems
15. Emergency high level indicators
16. Emergency low level indicators
17. Loss-in-weight feeders
18. Vent adapters
19. Airlock packages
20. Air drying systems
21. Blower packages
22. In-line thermal mass flow meters
23. Air line components from dryers and blowers to rotary airlocks
24. Conveying line components
25. Blowout ports
26. Knifegates with manual handwheel
27. Ball valves
28. Convey line distribution splitter assemblies
29. Knifegates with manual handwheel
30. Pressure transducers
31. Air-operated pinch valves
32. Conveying line components from distribution splitters to injection lances
33. Solenoid valves for injection lance cleaning
34. Injection lances
35. Rotary screw compressors
36. Compressed air dryer packages
37. Electrical Controls:
   a. Main PLC control panel
   b. HMI workstation for system control room
   c. Remote I/O panels for injection area
   d. Truck unloading operator panel
   e. Motor control center
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Silos

Silo Bin Vent

Truck Fill Line

Screeners
DRY HYDRATED LIME INJECTION FOR
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Modular Control Room

Desiccant Dryers

PD Blower Package
Refill System

Silo Aeration

Loss-In-Weight Feeder
Convey Lines from L-I-W to Splitters

Splitter Detail

Duct Injection Port

Splitter to Injection Ports
DRY HYDRATED LIME INJECTION FOR COAL-FIRED BOILER FLUE GAS DESULFURIZATION (FGD)

Sample HMI Control Screen

Sample Control Architecture

Hydrated Lime Control System
Control Panel 17 Slot Rack
1- 1756-L61 (2 M)
1- 1756-CN6
4- 1756-I/O (120VAC Input)
3- 1756-CN0 (120VAC Output)
1- 1756-P61 (Channel Isolated Input)
1- 1756-OF8 (6 Channel Isolated Output)
1- Allen-Bradley PLC-24VDC
1- Heifman Enclosure

Double Door w/ 100 Amp Disconnect
1- E-Stop / Reset & Stop PB
1- 5kVA Transformer
1- Soft-swat Duty UPS Backup for PLC/Panelview/Weigh Scales

Hydrated Lime Control System Motors
Power Required 3 Phase 460 VAC 100 Amp by Others
IEC starters location in Main Control Panel
1- Silo Exhaust Fan 5 HP [FVR]
2- Weigh Hopper Discharge RAL/12 HP [FVR] PowerFlex 70
2- Blow Thru RAL 1 HP [FVR]
2- Pressure Blow w/ 10 HP [FVR]

See page 10 for full contact information.
FOR MORE INFORMATION, PLEASE CONTACT:

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With thanks to Mr. Bryan Williams – System Engineer-Chemical, Fossil Fuel Division of the Tennessee Valley Authority

REFERENCES
