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

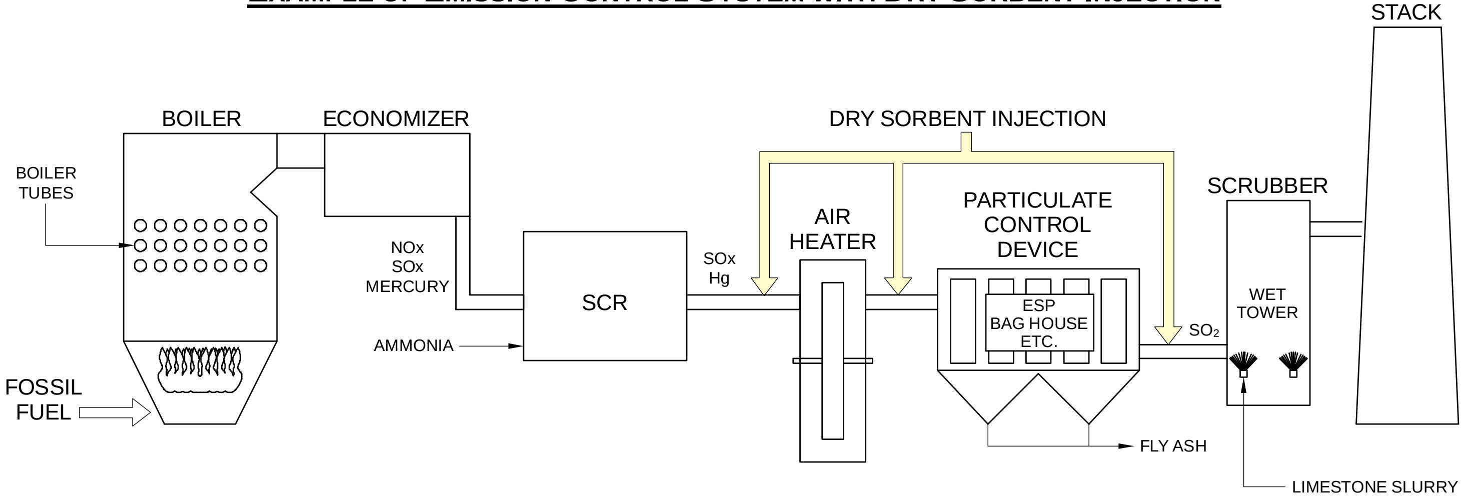
FOREWORD

When coal is oxidized (burned) as fuel, the elemental sulfur it contains is converted to SO_2. Some of this SO_2 is converted to SO_3 when oxygen leftover from the combustion process causes further oxidization in the boiler. A system equipped with a selective catalytic reducer (SCR) to reduce NO_X emissions will convert additional SO_2 to SO_3. When SO_X 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] SO_X 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 SO_2 and SO_3 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 SO_X 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 IMPACTS[1]	
Capital Equipment Requirements	Storage silos; Pneumatic conveying system*
Byproducts	Synthetic gypsum; Excess hydrated lime; Fly ash
Boiler Efficiency Impacts	None
SO_2 Allowance Impacts	None
NO_X Removal Impacts	None

See "Typical System Components" on page 3 for more information.

See page 10 for full contact 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 ft^3 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.

See page 10 for full contact information.

B. *Typical Design Criteria*

Product:	Hydrated lime or any dry bulk sorbent material
Bulk Density:	25-50 lb/ft^3
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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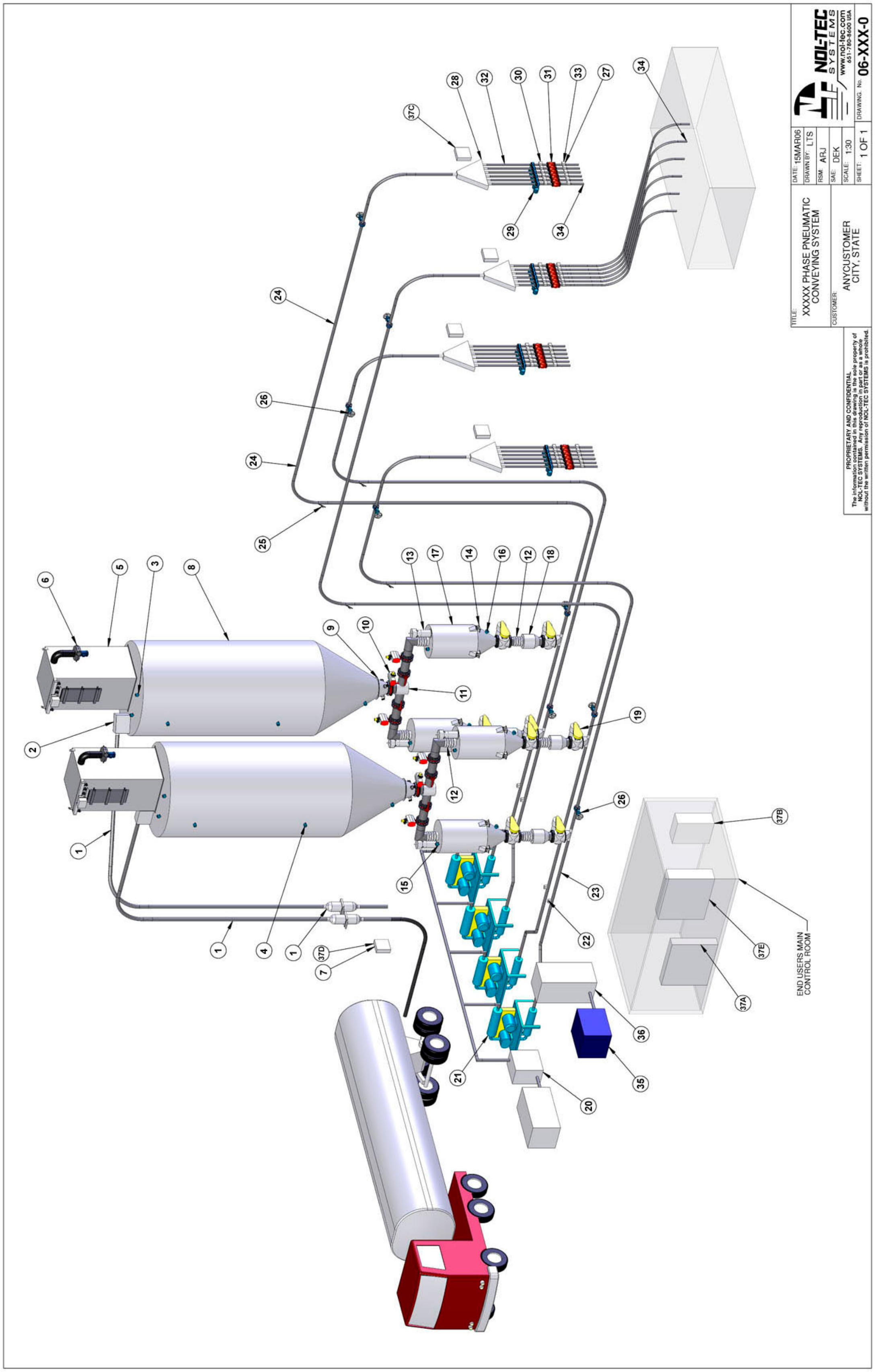
DRY HYDRATED LIME INJECTION FOR COAL-FIRED BOILER FLUE GAS DESULFURIZATION (FGD)



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Silos

Silo Bin Vent

Truck Fill Line Screeners

See page 10 for full contact information.

Modular Control Room

Desiccant Dryers

PD Blower Package

See page 10 for full contact information.

Refill System

Silo Aeration

Loss-In-Weight Feeder

See page 10 for full contact information.

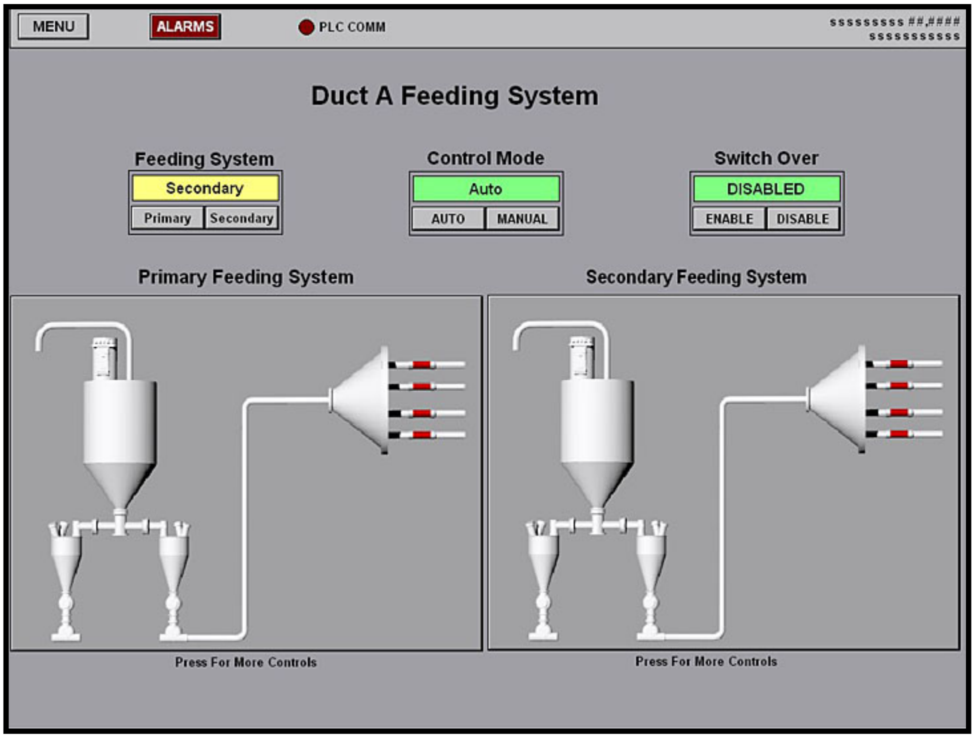
Convey Lines from L-I-W to Splitters

Splitter to Injection Ports

Splitter Detail

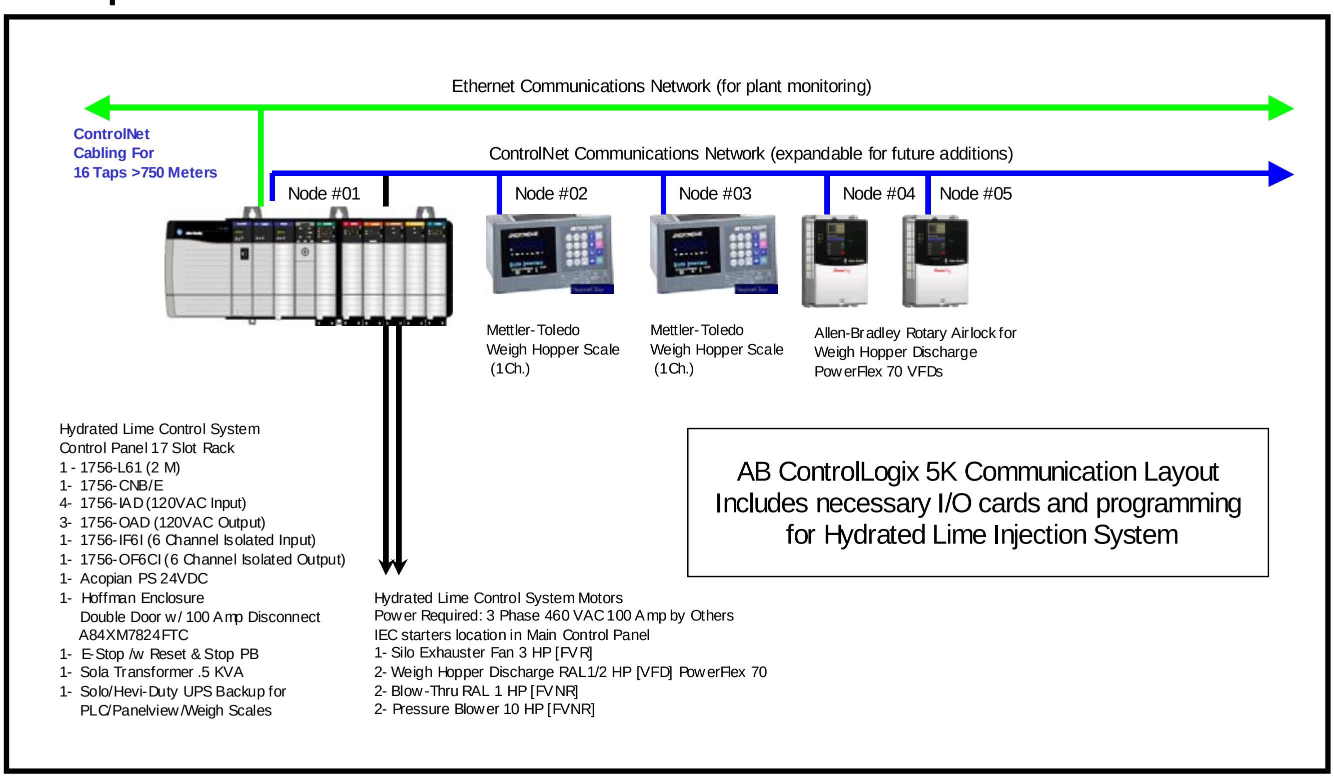
Duct Injection Port

See page 10 for full contact information.



Sample HMI Control Screen

Sample Control Architecture



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

REFERENCES

1. Gary M. Blythe, Richard G. Rhudy, Bill Aljoe, "Economic Comparison of SO_3 Control Options for Coal-Fired Power Plants," white paper, November 25, 2003.

2. R. K. Srivastava and W. Jozewicz, "Flue Gas Desulfurization: The State of the Art," *Journal of the Air & Waste Management Association*, vol. 51, p. 1676-1688, December 2001.