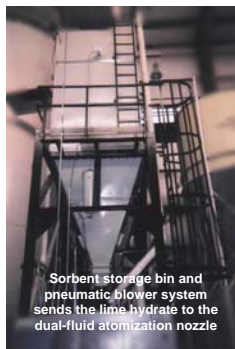


Benetech, Inc. Dry Sorbent Injection (DSI)

Benetech, Inc. personnel have commercial experience with dry sorbent injection with particular expertise in nahcolite duct injection with humidification supplementation. Currently, a market niche exists for a dry sorbent injection technology that uses inexpensive equipment. Benetech, Inc. is developing this type of technology which combines a sodium reagent with calcium alkali as the sorbents. This combination also mitigates the environmental impact of the reacted sorbents' disposal with a proprietary "encapsulation" technique.

Benetech is developing this new, low capital cost technology, commonly referred to as "dry sorbent injection" ("DSI"), for use at coal-burning power plants that operate only during peak electrical demand (swing units). This new DSI provides high pollution abatement performance, as well as, good utilization of chemical sorbents. Initial results indicate DSI will: reduce the quantity of chemical sorbents that are required to abate pollution; reduce the quantity of solid waste that is usually associated with chemical sorbents; and, provide coal users with an environmentally benign approach to dispose of the sodium and calcium sorbents after they react with new waste conditioning methods. All of these equate to savings for the coal user.

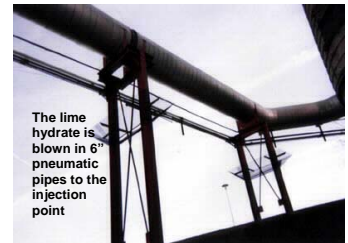
The technology injects the sorbents into the duct to react with the sulfur in the flue gas which was vaporized during the combustion of the coal. The flue gas emissions from the coal-fired boiler are humidified by fresh water in the air duct feeding the particulate collection device. An array of proprietary designed, water spray nozzles are linearly arranged to provide an evenly distributed, fine spray droplet pattern across the duct. The "dual-fluid atomization" nozzle injects water that contains sodium hydroxide as



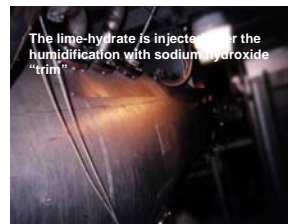
"trim" SO₂ absorbent.

The "dual-fluid atomization" nozzle-body assembly is arranged to also inject lime hydrate reagent. Surface wetting by the spray water droplet mist ensures effectiveness of the lime hydrate reagent surface in high-rate SO₂ mass transfer. The lime hydrate reagent controls the levelized, continuous SO₂ emissions, while the sodium hydroxide engages, or "trims", any SO₂ surges.

Benetech's advanced nozzle design optimizes the gasborne lime hydrate surface for improved SO₂ absorption by permitting fluidized dry lime to be fed from a tubular injector



surrounding the cylindrical humidification nozzle lance. The air-lime feed is swept uniformly into each side of the flat, fine-spray plume during its downstream expansion phase. The nozzle balances the air-lime feed with the air feed to the humidifying nozzle. Therefore, the surface wetting of dry particles is promoted while avoiding reduced reagent surface area caused by large droplet impingement.



All collected gas cleaning waste is intermixed in a pugmill with addition of water to yield a 70% solids "green" pozzolanic waste mass. The waste byproduct is aged in short (approximately 9 meters high) stacks for 4 to 6 days to improve bulk handling properties. Thereafter, the waste can be managed in a variety of ways. The lime addition in the fly ash may enhance the value of the waste byproduct for cement manufacturers. The material can be trucked to an abandoned underground coal mine site, where mine voids are packed using vertical bore holes to prevent

mine subsidence as well as block mine acid flow. It can be taken to a highway construction site for use in "pouring" of the sub-base or for providing sloped embankments. Finally, it is an excellent material for use at a reclamation site to construct a structural monolith (a.k.a. structural landfill). A new terrain profile can be built "from the ground up".

Benetech, Inc. successfully demonstrated commercial sodium sorbent injection for low and medium SO₂ emissions applications. Benetech, Inc. continues to provide installation and technical services at Wisconsin Electric Power Company, Port Washington, Wisconsin, U.S. and Hoechst Celanese, Inc., Spartanburg, South

Carolina, U.S. Currently, varieties of hydrated lime with sodium augmentation are under development at Benetech's Technical Center to create a "super-sorbent" technology to be marketed at electric power swing units in partnership with the Illinois Department of

Commerce and Community Affairs, Office of Coal Development and Marketing.

Cost of DSI at a low (20%) capacity factor 300 MW unit is represented below*:

Case	SO ₂ Removal (%)	Capital Cost (\$/KWe)	Total Control Cost (\$/ton SO ₂)
Wet FGD	90	150-280	1,150
Spray Dryer (Semi-Dry)	90	140-210	950
Dry Injection Technologies (U.S.)	40-60	70-120	1,000
Dry Injection Technologies (FRG:HSH)	Approx. 60	75	850
Multi-Stage (FRG:HSH) Preliminary Estimate	85-90	<120	800
Advanced Coolside	90	100	700
Benetech Dry Sorbent Injection	90	75	600

Note: Costs are expressed in constant 1990 U.S. Dollars.

*Adopted from Schwarzkopf, F. et al, "Commercial Application of Dry FGD Using High Surface Area Hydrated Lime", 1991 SO₂ Control Symposium, Washington DC.