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EPA **Project Summary**

# Proceedings: 1991 $SO_2$ Control Symposium

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**These proceedings document the 1991 $SO_2$ Control Symposium, held December 3-6, 1991, in Washington, DC. The symposium focused attention on recent improvements in conventional sulfur dioxide ($SO_2$) control technologies, emerging processes, and strategies for complying with the Clean Air Act Amendments (CAAA) of 1990. It provided an international forum for the exchange of technical and regulatory information on $SO_2$ control technology. More than 800 representatives of 20 countries from government, academia, flue gas desulfurization (FGD) process suppliers, equipment manufacturers, engineering firms, and utilities attended. In all, 50 U.S. utilities and 10 utilities in other countries were represented. In 11 technical sessions, speakers presented 111 technical papers on development, operation, and commercialization of wet and dry FGD, clean coal technologies, and combined sulfur oxide/nitrogen oxide ($SO_x/NO_x$) processes.**

***This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to highlight key topics of interest on $SO_2$ control that are fully documented in a separate report of the same title (see Project Report ordering information at back).***

## Introduction

The Symposium, jointly sponsored by the Electric Power Research Institute (EPRI), the Air and Energy Engineering Research Laboratory of the U.S. Environmental Protection Agency (AEERL/EPA), and the U.S. Department of Energy (DOE), is held periodically to transfer technical information and advance technology development application for control of sulfur dioxide ($SO_2$) emissions from fuel combustion.

The proceedings from this Symposium are five volumes, containing 111 presented papers covering 14 technical sessions:

| Session | Subject Area |
|---|---|
| I | Opening Remarks (EPRI, EPA, and DOE guest speakers) |
| 1 | Emission Allowance Panel Discussion |
| 2 | Clean Air Act Compliance Strategies |
| 3A | Wet FGD Process Improvements |
| 3B | Furnace Sorbent Injection |
| 4A | Wet FGD Design Improvements |
| 4B | Dry FGD Technologies |
| 5A | Wet FGD Full Scale Operations |
| 5B | Combined $SO_x/NO_x$ Technologies |
| 6A | Wet FGD Operating Issues |
| 6B | Clean Coal Demonstrations/ Emerging Technologies |

| | |
|---|---|
| 7 | Poster Session (papers on all aspects of $SO_2$ control) |
| 8A | Commercial FGD Designs |
| 8B | FGD By-Product Utilization |

These proceedings also contain opening remarks by the co-sponsors and comments by the three guest speakers. The guest speakers were Shelley Fidler - Assistant, Policy Subcommittee on Energy and Power, U.S. Congress; Jack S. Siegel - Deputy Assistant Secretary, Office of Coal Technology, U.S. DOE; and Michael Shapiro - Deputy Assistant Administrator, Office of Air and Radiation, U.S. EPA. Clean Air Act Compliance issues were discussed in a panel discussion on emission allowance trading and a session on compliance strategies for coal-fired boilers.

## Key Points

- To comply with Title IV of the CAAA in Phase I, wet limestone and lime FGD systems will dominate a very competitive scrubber market. By Phase II, a total of 40-50 GW of scrubbing will be in place.
- Additives are increasing wet FGD system performance to >95% $SO_2$ removal. Methodologies are being developed to evaluate an abundance of wet FGD design improvements.
- The $5 billion Clean Coal Technology Program has demonstrated and is continuing to demonstrate the commercial feasibility of technologies that have already reached proof-of-concept stage.
- In the area of dry FGD systems, furnace, economizer, and duct injection are low-capital-cost emerging technologies for retrofit of older coal-burning boilers. Newly developing simultaneous $SO_2/NO_x$ technologies expand the choices available to boiler operators and ease operational problems with a combined system.
- In addition to $SO_2$ control technologies, the symposium highlighted the many uncertainties surrounding compliance with the CAAA. These unresolved issues include EPA's pending decision on $NO_x$ regulation for Phase I Group 1 units under Title IV, visibility, a short-term ambient air standard for $SO_2$, air toxics, and air standards for $NO_x$ emissions in ozone nonattainment areas. Present operating issues include continuous emission monitoring systems, mist eliminator system problems, and acid mist emissions. Key regulatory uncertainties include accounting issues, taxation concerns, and planning questions. Several presenters encouraged active utility participation in the resolution of many of these issues.

## Opening Remarks

Since the previous $SO_2$ Control Symposium in May 1990, Congress passed the Clean Air Act Amendments of 1990. To comply with the CAAA, EPRI expects scrubbing of 12-15 GW of utility capacity in Phase I, a 40-50 GW scrubbing total by Phase II, and extensive coal switching in both phases.

Wet limestone and lime FGD systems are dominating the market in Phase I, and limestone forced oxidation systems are the most often selected technologies. Additives and enhanced designs are increasing performance to >95% $SO_2$ removal. Dry FGD systems are a niche market, and air toxics are becoming a factor in selecting scrubbers because of potential upcoming air toxics legislation.

Various unresolved issues will significantly impact how utilities control $SO_2$. These issues include EPA's pending decision on $NO_x$ regulation in Phase I, plume visibility, and a short-term ambient air standard for $SO_2$.

One year after passage of the CAAA, numerous questions relating to the role of 50 to 70% removal technologies, coal cleaning versus control technologies, and emerging technologies still remain unanswered. Many utilities have announced they may choose compliance strategies that rely on low-sulfur coal or fuel switching and may defer a decision on technology options until the tougher Phase II requirements in the year 2000.

## Clean Air Act Amendments

### *Overview*

Two featured luncheon speakers provided overviews of the Clean Air Act Amendments of 1990. Shelley Fidler, Assistant, Policy Subcommittee on Energy and Power, encouraged active participation by all in the industry in shaping CAAA implementation.

Michael Shapiro of EPA, characterized the CAAA as environmentally aggressive, the first use of a cap on total emissions, and a test of a novel market-based approach to allowance trading.

### *Emission Allowance Trading*

Utilities are reluctant to buy or sell emission allowances, according to EPRI, until the rules are clearer and the market is favorable. Although there are no trades yet, many utilities are planning to trade if appropriate.

Alice LeBlanc of the Environmental Defense Fund stated that the CAAA mandates tough environmental goals, introduces a market-based trading system, motivates innovation in the utility industry, and sets a key precedent for future legislation.

Craig Glazer, Chairman of the Ohio Public Utility Commission, suggests a proactive approach to promoting an active emission allowance trading market. He suggested that utilities follow a planning approach that includes listing all feasible plant options, ranking these by cost-effectiveness, inputting them to a production costing model, and then calculating revenue requirements for each option.

### *Compliance Strategies*

CAAA compliance strategies were discussed from a variety of perspectives, including the impact of scrubbing in Phase I, roles of scrubbing and emission allowance trading, methodologies for determining strategies, costs for use in these methodologies, and international impacts.

C.E. Fink of Consolidation Coal Company indicated that up to 50 % of total Phase I $SO_2$ reductions could be achieved with scrubbing and gave reasons why scrubbers are a low-cost compliance strategy.

Regarding the costs of various scrubbing technologies, a recently completed EPRI-sponsored project updated the costs of 26 FGD processes to 1990 dollars and also analyzed the technical merit and commercial status of currently available and emerging $SO_2$ control technologies.

### *Future Issues*

Several issues will impact the way electric utilities comply with the CAAA. These include air toxics, $NO_x$ emissions in ozone nonattainment areas, waste minimization, and water quality. Most of these will be the subject of legislation in the next few years.

The CAAA requires several detailed studies of the risks associated with fossil-fuel combustion. Based on these studies, EPA will determine whether further controls are needed. Ongoing studies by EPRI, DOE, and others will provide information to assist in this evaluation of air toxics.

### *New Developments in Wet FGD*

In the area of process improvements to wet FGD, increasing $SO_2$ removal efficiency was the focus of several presentations. In an attempt to dispel the negative connotation of using additives that is prevalent in the industry, R.E. Moser of EPRI

provided an overview of the current status of additive use in wet FGD systems and the functions they may perform in future designs.

The session on wet FGD design improvements emphasized both increasing $SO_2$ removal efficiency and reducing costs. Improvements in new as well as retrofit designs were discussed. EPRI is investigating a range of design options, including the use of trays and packing, additional liquid flow rate, and performance additives, for limestone and magnesium-enhanced lime systems to determine $SO_2$ collection capability and relative costs.

### *Wet FGD Operation*

Two presentations summarized wet FGD technology currently used in many operating plants. A. Saleem of General Electric Environmental Services covered the design and operation of single-train open spray tower FGD systems, and P. Rader of ABB Environmental Systems described the design of advanced limestone wet FGD systems in retrofit applications. While future operating issues include control of air toxics, present operating issues include continuous emission monitoring systems (CEMs), mist eliminator system problems, and acid mist emissions.

## Clean Coal Demonstrations/ Technologies

In 1986, the U.S. DOE initiated the Clean Coal Technology (CCT) Program to demonstrate the commercial feasibility of technologies that have already reached the proof-of-concept stage. Status reports on several CCT projects were presented later in the afternoon. R. Bolli of Ohio Edison presented current design features and recent test results from various Ohio Edison CCT projects.

Results from the Limestone Injection Multistage Burner (LIMB) extension testing at Edgewater were presented by T. Goots of B&W. LIMB combines furnace sorbent injection (FSI) of lime with humidification after the air heater and use of low-$NO_x$ burners to reduce both $SO_2$ and $NO_x$ emissions. FSI, in which sorbent injected in the furnace reacts with $SO_2$ and is removed by particulate controls, can achieve moderate $SO_2$ reduction (approximately 50%) at a cost per ton of sulfur removed claimed to be lower than for wet FGD.

## Dry FGD Technologies

Dry FGD processes include FSI, duct injection, and spray drying (dry scrubbing). Some of these technologies can significantly reduce capital costs, compared to conventional wet scrubbing. Dry processes can be divided into two categories: high- and low-temperature processes.

### *High-Temperature Processes*

Two utility-scale generating unit applications of FSI with low $NO_x$ burners (LIMB) were presented. One of these, LIMB, located at Ohio Edison's Edgewater Station, is discussed in the section on Clean Coal Technologies. The second, an EPA-sponsored LIMB installation at the 180-MW Yorktown Unit 2 of Virginia Power Company, was reviewed by J. P. Clark of ABB Combustion Engineering Systems. Clark detailed plans for an 8-month test scheduled for 1992.

### *Low-Temperature Processes*

The Limestone Emission Control (LEC) process removes $SO_2$ using a moving bed of quarry-sized limestone, as covered by M.E. Prudich of Ohio University. DOE's duct injection technology program , funded through the Pittsburgh Energy Technology Center, will result in a duct injection design handbook.

The EPA-developed advanced silicate (ADVACATE) technology is a lime-based, duct injection process, in which silica-containing ash is reacted with lime at modest temperature to remove $SO_2$. EPA's C. Sedman outlined recent ADVACATE process optimization in a pilot plant and reported plans for a 10-MW field evaluation at TVA's spray dryer/ESP pilot plant at the Shawnee Test Facility in 1992.

## Combined $SO_2/NO_x$ Technologies

EPRI has evaluated the potential for developing combined $SO_2/NO_x$ technologies to provide attractive alternatives to conventional wet FGD and selective catalytic reduction (SCR). For new plants, the NOXSO, Copper Oxide, Zinc Oxide, and SNOX processes were rated equivalent or preferable to wet FGD/SCR.

Various combined $SO_2/NO_x$ processes were also discussed. Pilot-scale results of a furnace urea/sorbent slurry injection technology were reviewed by EPA's B. K. Gullett. This EPA-sponsored project demonstrated the successful combination of Ca-based sorbent injection and selective non-catalytic reduction (SNCR) technologies in a slurry process. D. Helfritch of R-C Environmental Services & Technologies presented results of subscale tests for use in a proof-of-concept demonstration of an integrated dry injection process consisting of combustion modification using low $NO_x$ burners, dry injection of hydrated lime at the economizer, dry injection of sodium bicarbonate at the air heater exit for additional $SO_2$ and $NO_x$ removal, and flue gas humidification for ESP conditioning.

## Conclusion

To comply with the CAAA in Phase I, wet limestone and lime FGD systems will dominate a very competitive scrubber market. By Phase II, a total of 40-50 GW of scrubbing will be in place.

The 1991 EPRI/EPA/DOE $SO_2$ Control Symposium presented many improvements in $SO_2$ control technology that will help utilities cost-effectively attain these levels of scrubbing. Additives are increasing wet FGD system performance to >95% $SO_2$ removal. The $5 billion CCT Program has demonstrated and is continuing to demonstrate the commercial feasibility of technologies that have already reached proof-of-concept stage.

In the area of dry FGD systems, furnace, economizer, and duct injection are low-capital-cost emerging technologies for retrofit of older coal-burning boilers. Dry technologies like EPA's ADVACATE, currently undergoing larger scale demonstration, show promise for >90% $SO_2$ removal. Newly developing simultaneous $SO_2/NO_x$ technologies expand the choices available to boiler operators and ease operational problems with a combined system.

In addition to $SO_2$ control technologies, the symposium highlighted the many uncertainties surrounding CAAA compliance. Various unresolved issues will significantly impact how utilities control $SO_2$. These issues include EPA's pending decision on $NO_x$ regulation in Phase I, visibility, a short-term ambient air standard for $SO_2$, air toxics, $NO_x$ emissions in ozone nonattainment areas, waste minimization, and water quality. Present operating issues include CEMs, mist eliminator system problems, and acid mist emissions. Key regulatory uncertainties include accounting issues, taxation concerns, and planning questions. Several presenters encouraged active participation in the resolution of many of these issues.



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*The complete report, entitled "Proceedings: 1991 $SO_2$ Control Symposium, Volumes 1, 2, 3, 4, and 5," (Order No. PB93-196095/AS; Cost: $52.00; subject to change) will be available only from:*

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