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Project Summary

Interagency Flue Gas Desulfurization Evaluation

Final Report

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This report presents the results of a six-month study of flue gas desulfurization (FGD) technology conducted by an interagency team in 1977. The study was mandated by President Carter in his April 1977 National Energy Plan (NEP). The purpose of this study was to determine whether additional Federal funding would accelerate the commercialization and acceptance of FGD technology. This report concludes that FGD is the most viable short-term approach to meeting increased coal-use objectives of the NEP, and it identifies specific FGD research, development and demonstration priorities. This report also presents a background of FGD technology (as of 1977) and the methodology used in the study to select the most promising FGD processes and subsystems.

This Project Summary was developed by EPA's Industrial Environmental Research Laborabory in Research Triangle Park, N.C., to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Since the early 1970's, U.S. energy policy has focused on the goal of reducing the country's reliance on dwindling reserves of natural gas and costly supplies of foreign oil. This policy has gradually increased the use of coal as a primary energy source in the U.S., and the 1977 National Energy Plan was designed to accelerate this increase in coal utilization. The projected effect of the NEP was to raise total coal consumption in 1985 by about 20 percent over the 1985 base levels. The most dramatic increase will occur in the industrial sector, where coal use is expected to triple over the predicted 1985 base levels.

Because coal will continue to be burned directly in the near-term, this projected increase in coal utilization generates concern over emissions, particularly of sulfur dioxides, to the atmosphere. Projected utility and industrial SO_2 emissions, including baseline emissions for 1985 (without accelerated coal utilization) and projected emissions assuming implementation of the NEP are presented in Table 1. These emission estimates were constructed under two regulatory scenarios. The first, in compliance with current standards, assumed that:

1. All sources will be governed by present SO_2 emission regulations through 1985.
2. Full compliance with these regulations will be achieved by 1985.

Table 1. *Utility and Industrial SO_2 Emissions (Millions of Tons per Year)*

	1975 Actual	1985 Baseline	1985 President's Program	Percentage Change Over 1985 Baseline
Compliance with Current Standards[1]				
Industry	*10.8*	*12.4*	*15.9*	*+28%*
Utility	*18.6*	*20.2*	*18.2*	*(-10%)*
Total	*29.4*	*32.6*	*34.1*	*(+ 5%)*
Use of Best Available Control Technology (BACT)[2]				
Industry	*10.8*	*10.8*	*11.7*	*(+ 8%)*
Utility	*18.6*	*20.2*	*18.3*	*(- 9%)*
Total	*29.4*	*31.1*	*30.1*	*(- 3%)*

[1]Assumes full compliance with current standards by 1985: NSPS for new large boilers and SIP's for new small (10-25 MW) boilers. SIP's govern existing sources not subject to NSPS.

[2]Assumes BACT applied to all new utilities which begin operation after 1974 and to new industrial sources, after 1979.

Source: "Air Pollution Impacts of the Oil and Gas Replacement Program in the Utility and Industrial Sectors." Executive Office of the President. Energy Policy and Planning and the U.S. Environmental Protection Agency. June 20, 1977.

The second scenario, use of Best Available Control Technology (BACT), assumed that:

1. BACT will achieve 80% SO_2 emission reduction as a result of 90% removal efficiency with 90% availability of local coal.
2. BACT will be applied to all new utility sources after 1984, and all new industrial sources after 1979.
3. A revised New Source Performance Standard (NSPS) of 1.5 lb $SO_2/10^6$ Btu for small sources (10-25 MW) will be promulgated.
4. Existing sources regulated by State Implementation Plans (SIP's) will reach full compliance by 1985.

As of June 1977, there were a total of 119 FGD units, including 7,800 MW of FGD capacity which EPA considered operational, 12,600 MW under construction, and 30,000 MW planned. This was a total potential scrubbing capacity of roughly 51,000 MW out of a total coal-fired generating capacity of 275,000 MW. Despite the growing use of FGD systems, controversy still existed over several key issues such as reliability, cost, secondary pollutants, and the ability of vendors to meet expanded market demands.

Because of the controversy surrounding FGD technology, one of the specific elements included in the NEP was a "six-month review" to determine which, if any, FGD systems under development offered sufficient environmental, cost, and reliability advantages to merit an accelerated research, development, and demonstration (RD&D) program.

In response to the mandate for a review of FGD technology, an "Interagency Flue Gas Desulfurization Evaluation Study" was initiated to guide government RD&D and help accelerate the application of the technology. A draft report was produced in late 1977. Although a variety of circumstances have delayed publication of the final report, the methodology developed as part of this study is still useful in comparing and evaluating processes at the different stages of development. This study, which has been widely used in shaping government funding priorities for FGD research and development, also provides useful data and conclusions regarding the prospects of near-term progress in improving FGD efficiency, reliability, and costs.

The major conclusions of this study remain valid, even if some of the material is dated. In fact, the need to bring new FGD systems and processes on-stream is even more pressing today than it was in 1977. During the period from 1977 to 1979, several developments occurred that underscore the need for increased coal utilization over the short-term and continued progress in reducing emissions from coal combustion. These include the promulgation of more stringent NSPS for utility boilers, the disruption of foreign crude oil supplies, sharp increases in OPEC oil prices, the enactment of legislation prohibiting the use of oil and gas in many new utility and industrial facilities, and the growing uncertainty of nuclear energy.

A total of 138 processes, both national and international, were surveyed and then screened as to their potential for offering technological and/or economic advantages over the following six commercial and developing FGD processes:

- Lime/Limestone Wet Scrubbing
- Magnesia Slurry Scrubbing
- Wellman-Lord
- Sodium/Lime Double Alkali
- Citrate Buffered Absorption
- Rockwell International - Aqueous Carbonate Process

The process evaluators felt that the screening criteria provided an effective means of comparing FGD processes. However, some processes received high ratings even though they had limited acceptability due to some unique process characteristics. Also, some processes received low ratings due to their development status even though they were judged to have more potential than some of the processes with higher ratings so that engineering judgement was used as a screening criteria as well as evaluation criteria.

Recommendations

The most effective way to advance FGD technology would be through RD&D funding to find near-term solutions to problems faced by commercial and near-commercial processes. A secondary priority should be assigned to processes and process developments that provide longer-term benefits. The following recommendations were developed to meet both of these objectives.

Evaluation and use of magnesium as a mass transfer additive along with the use of organic and inorganic chemicals, such as adipic acid and sodium carbonate, is one of several methods for improvement of SO_2 removal from lime/limestone systems. Forced oxidation could reduce sludge disposal problems. Contactors could significantly reduce the cost and complexity of scrubbing, particularly the Chiyoda 121 system. Hardware improvements in instrumentation, mist eliminators, reheaters, and stack liners could greatly reduce recent FGD system failures.

Sulfur production with carbon instead of a reducing gas could significantly enhance FGD applicability due to its potential for reducing cost, complexity,

and secondary pollution. Moreover, RD&D efforts on the Rockwell International Molten Carbonate Regeneration System would demonstrate direct conversion of SO_2 to sulfur also without a reducing gas. Application of a low-Btu gas as a reductant in FGD systems could also eliminate this system's dependence on costly and scarce supplies of natural gas. Lastly, sulfur production in the calciner and sustained sulfuric acid production from a full-scale system, both aspects of magnesia slurry scrubbing, could enhance process applicability.

Limestone use in double-alkali systems as a regenerant can potentially improve operating costs because it is less expensive than lime as a raw material. Furthermore, methods for evaluating and testing regeneration of sodium sulfide by-products would further reduce raw material costs as well as eliminate disposal problems.

Studies of alternative or improved energy production technologies would be of great value to the industry. For instance, the Sorption/Steam Stripping concept has potential for more reliable, lower cost operation than some other regenerable systems. The Dowa Process appears to have significant advantages over current double-alkali FGD technology because it uses limestone as a regenerant and produces a marketable, quality gypsum by-product. The Integrated Cat-Ox system also shows cost advantages over current FGD technology at the 100 MW level. Finally, the Sulf-X process has potential as a SO_x/NO_x flue gas treatment process.

Conclusions

The results of this study showed that significant benefits can be derived by increasing Federal funds for FGD RD&D programs. Increased funding should also be used for research and development projects to improve both throwaway and regenerable systems that have been demonstrated on large-scale equipment. With adequate funding, process and subsystem evaluations of potential solutions to common FGD problems and new developments in FGD technology could be assessed and promulgated with greater economy, efficiency, and accuracy to the entire industry.

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The complete report, entitled "Interagency Flue Gas Desulfurization Evaluation: Final Report," (Order No. PB 81-152 043; Cost: $33.50, subject to change) will be available only from:
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