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Project Summary

Recent Developments in SO_2 and NO_x Abatement Technology for Stationary Sources in Japan

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This report is a compilation of information on the current status of abatement technology used to control major air pollutants (including SO_2, NO_x, and particulates) in Japan. It focuses on flue gas desulfurization (FGD), combustion modification (CM), and selective catalytic reduction (SCR) of NO_x. Information in this report was gathered from utility company representatives and FGD, CM, and SCR process developers, as well as from the author's research in this field. Current air pollution regulations in Japan, related problems, operational parameters of commercial FGD and SCR plants, FGD and SCR economics, and the author's evaluation of the processes also are described.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, 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

To attain stringent Japanese ambient air quality standards of 0.04 ppm (daily average) for SO_2 and 0.04-0.06 ppm (daily average) for NO_2, the emission regulations have been tightened, requiring further SO_2 and NO_x abatement. In 1984, the total number of FGD plants in Japan reached 1,400, with a total capacity of 130 x 10^6 Nm^3/h (42,000 MW equivalent). About 62% (total capacity) of the FGD plants use a wet lime/limestone process. Another 28% use sodium scrubbing. About 8% (total capacity) of the FGD plants use processes that produce sulfuric acid, elemental sulfur, or ammonium sulfate by-products.

Nitrogen Oxides

For NO_x abatement, extensive combustion modifications (CMs)—including flue gas recirculation (FGR), staged combustion, and use of low-NO_x burners—have been applied to numerous combustion facilities. The NO_x concentrations in utility boiler flue gases have been lowered to 150-300 ppm for coal-fired boilers, 80-130 ppm for oil-fired boilers, and 40-60 ppm for gas-fired boilers. For additional NO_x abatement, about 160 selective catalytic reduction (SCR) plants have been constructed. Total SCR capacity reached 90 x 10^6 Nm^3/h (29,000 MW) equivalent by the end of 1984; of this capacity, 24,000 MW was applied to utility boilers. About 60% of the SCR plants are used with oil-fired utility boilers, 21% are used with coal-fired boilers, and 19% for gas-fired boilers.

Sulfur Dioxide/Nitrogen Oxides

In 1983 and 1984, 14 coal-fired utility boilers either began operation or were scheduled to go into operation. All of these boilers use FGD to remove about 85-98% of SO_2 and produce a by-product gypsum. Thirteen boilers use combustion modification and SCR to remove 68-85% of NO_x. The emission concentrations produced by these 14 coal-fired boilers are 30-100 ppm SO_2 and 20-200 ppm NO_x with 20-100 mg/Nm^3 of dust. All FGD and SCR plants for coal-fired boilers have been operated with over 99% reliability.

Results

Due to these air pollution control efforts, ambient SO_2 concentrations in Japan have been lowered to meet the stringent standard in virtually all regions of the country including large industrial areas. The ambient NO_2 concentrations have been decreasing since 1983 in spite of the rapid increase in the number of automobiles. Japan's NO_2 concentrations have met the stringent standard in most regions, even in large cities. Photochemical smog has been reduced as a result of the abatement of NO_x and hydrocarbons. Virtually no acid rain has been experienced due to effective SO_2 and NO_x abatement and Japan's topography.

Economics

The cost of both FGD and SCR has been lowered, due mainly to technology improvements. The investment cost for limestone-gypsum process FGD plants for coal-fired boilers has been lowered from about 30,000 yen/kW in 1979-1980 to about 20,000 yen/kW in 1983-1984. The power consumption of FGD processes was also reduced from 2.0-2.5% to 1.4-2.1%. The annualized cost of the wet limestone gypsum process is currently about 1.5 yen/kWh including 7 years depreciation and 10% interest.

The investment cost of SCR for utility boilers in yen/kW is 5,000-7,000 for coal-, 4,000-5,000 for oil-, and about 2,500 for gas-firing. The annualized SCR cost in yen/kWh including 7 years depreciation and 10% interest is 0.5-0.6 for coal-, 0.2-0.3 for oil-, and about 0.15 for gas-firing.

The cost of generating power by coal combustion—including the cost for ash disposal, SCR, and FGD—is lower than that for burning low sulfur oil, although both fuels produce a similar quality flue gas. Several large combined-cycle power plants (700-1,000 MW) that burn natural gas (either existing or planned) use SCR to remove 80-85% of NO_x.

Conclusions

SCR is simple and easy to operate but is much more costly than combustion modification. FGD and combustion modification may be used to prevent acid rain, and SCR can be used when further NO_x abatement is needed.

Selective noncatalytic reduction (thermal $DeNO_x$) has been used commercially but has not become popular in Japan because of its low efficiency and high ammonia leakage. Many other NO_x removal and simultaneous SO_2/NO_x removal processes have been tested and are used commercially in small plants. Most of these processes are not used at large plants because of their high cost or by-product disposal problems.

Although Japan has succeeded in controlling SO_2 and NO_x emissions to a considerable extent, additional research is underway to improve the cost effectiveness of emission control technology.

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The complete report, entitled "Recent Developments in SO_2 and NO_x Abatement Technology for Stationary Sources in Japan," (Order No. PB 86-110 186/AS; Cost: $22.95, subject to change) will be available only from:
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