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Project Summary

Boiler Design Criteria for Dry Sorbent SO_2 Control with Low-NO_x Burners: New Unit Applications

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A study to define the boiler modifications required to achieve 70% SO_2 removal with sorbent injection on a large tangentially fired utility boiler without supplemental spray drying was conducted under EPA sponsorship. This task was executed as a follow on to a recently completed broader evaluation of boiler design criteria for sorbent SO_2 control technology. A new 500 MWe utility boiler burning low-sulfur coal was considered to be modified to increase sorbent residence time and decrease gas quench rate to achieve 70% SO_2 removal in the boiler with atmospheric calcium hydrate prepared on-site. A second case was considered where no change was made to gas quench rate or sorbent residence time. The effects of adding a pulverizer to the sorbent preparation/injection system to permit production of a finer sorbent were determined. Capital costs, cost of electricity, and cost effectiveness per ton of SO_2 removed were developed and compared with the results of the earlier study.

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

The results of the initial study conducted under this contract, showed that the combination of limestone sorbent injection and a spray dryer offered significant cost advantages over conventional flue gas desulfurization in achieving 70% SO_2 removal on new tangentially fired utility boilers burning low-sulfur coal. This study was predicated on 50% SO_2 reduction in the boiler and the remaining reduction in the spray dryer.

This report gives results of additional work carried out under the same contract. The objective of the present study was to determine the relative costs of designing for New Source Performance Standards compliance (70% SO_2 removal) using only furnace sorbent injection on a new 500 MWe tangentially fired utility unit burning low-sulfur coal.

Results and Discussion

Process Description

A 500 MWe boiler of current design was selected as the baseline unit for the study. The low-sulfur coal (0.55% S) used in the initial study was also used for this study. The time.temperature characteristic through the critical 1232 to 871°C sulfation window was calculated to be 311°C/sec.

Atmospheric hydrated lime [$Ca(OH)_2$] was selected as the sorbent material for this study, based on its superior SO_2 removal performance relative to limestone. On-site hydration was assumed. The effect on process economics of incorporating a pulverizer to provide a finer sorbent product from the hydrating plant was determined.

Based on the calculated quench rate and selected sorbent, a 3.5:1 Ca/S molar ratio was selected to achieve 70% SO_2

removal. To increase residence time and reduce gas quench rate, open cavities were created in the convective pass by relocating the reheat surface to the rear pass area. Gas quench rate was reduced to 182°C/sec. Required sorbent stoichiometry was reduced to 3.1:1. Low temperature surfaces were rearranged with wider spaces to minimize erosion potential. Sootblowing capacity was increased.

As a trade-off study, the cost of achieving 70% SO_2 removal with minimal boiler modifications was determined. No significant modifications were made to the boiler. Gas quench rate remained at 311°C/sec. Sorbent stoichiometry was 3.5:1. Sootblower capacity was increased.

Process Economics

Capital and operating costs were developed for the cases described above, including the effect of adding a pulverizer to the sorbent preparation system. The costs were developed according to procedures outlined in the EPRI Technical Assessment Guide and are expressed in December 1985 dollars for a January 1986 start-up.

Extensive Boiler Modifications

For the extensively modified boiler design, incorporation of sorbent injection using $Ca(OH)_2$ to achieve 70% SO_2 reduction in the boiler cost $18.45/kW. First-year cost effectiveness of SO_2 removed was 574.32 $/ton (30-year levelized cost effectiveness was 1103.26 $/ton). First-year incremental cost of electricity was 1.66 mills/kW-hr (30-year levelized cost was 3.19 mills/kW-hr).

Adding a pulverizer to the sorbent preparation/injection system to achieve a finer sorbent product added 2.87 $/kW to the overall cost for either boiler design.

Minimal Boiler Modifications

Incorporation of sorbent injection to achieve 70% SO_2 removal on a new 500 MWe low-sulfur unit with minimal modifications (no cavities) resulted in a slightly lower capital cost (17.24 $/kW) than the unit with cavities, but a higher (poorer) first-year cost effectiveness of SO_2 removed (603.24 $/ton) (30-year levelized cost effectiveness was 1184.91 $/ton). First-year incremental cost of electricity was 1.74 mills/kW-hr (30-year levelized cost was 3.42 mills/kW-hr).

Initial Study Results

The cost of incorporating sorbent injection (limestone) plus a spray dryer to achieve 70% SO_2 reduction on a new 600 MWe low-sulfur unit was 44.10 $/kW. First-year cost effectiveness of SO_2 removed was 788.98 $/ton (30-year levelized cost effectiveness was 1287.90 $/ton). First-year incremental cost of electricity was 2.29 mills/kW-hr (30-year levelized cost was 3.73 mills/kW-hr).

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The complete report, entitled "Boiler Design Criteria for Dry Sorbent SO_2 Control with Low-NO_x Burners: New Unit Applications," (Order No. PB 87-139 952/AS; Cost: $11.95, subject to change) will be available only from:
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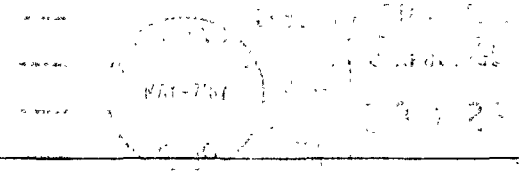

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