ANNUAL PROJECT REPORT
AS OF DECEMBER 2000

1. PROJECT SPONSOR:
CONSOL Energy Inc.
4000 Brownsville Road
South Park, PA 15129-9566

2. PROJECT MANAGER:
Duane C. McCoy
Sr. Engineering Consultant

TELEPHONE: 412-854-6520

3. OCDO GRANT NO. CDO/D-98-15

4. PROJECT UPDATE __ OR FINAL REPORT _X

5. PROJECT TITLE: Flue Gas SO_3 Reduction

6. PROJECT TERM: FROM: 10/12/99 **TO:** 11/12/00

7. BUDGET:

CO-SPONSORS NAME	**COST-SHARE**
OCDO	$ 73,180
CONSOL ENERGY Inc.	$151,787
	$
	$
	$
TOTAL PROJECT COST:	**$224,967**

I. ABSTRACT

8. OVERVIEW OF PROJECT & OBJECTIVES:
The first objective of this program is to determine a cost-effective method for the elimination of SO_3 from coal-fired boiler flue gas to allow efficient operation of selective catalytic and selective non-catalytic technologies for NOx removal. Another objective is to demonstrate improved boiler efficiencies resulting from the elimination of air preheater fouling caused by the reactions of flue gas SO_3. Each of these objectives will promote the use of high-sulfur Ohio coal in the State of Ohio, which has an electric power-generating system heavily invested in coal firing. Specifically, the conditions for the use of an inexpensive sorbent, such as limestone, dolomite, magnesium oxide, or magnesium hydroxide for absorption of SO_3 were investigated. The program was carried out in bench tests and in the CONSOL pilot-scale combustor.

9. WORK DONE AND CONCLUSIONS:

A bench-scale test unit was constructed to study the capture of SO_3 in simulated coal-fired flue gas using calcium and magnesium based sorbents. In addition to sorbent type, the unit was designed to study the effect of process variables including flue gas temperature, contact time, and composition. Tests were conducted using five sorbents: high-calcium quicklime, dolomitic quicklime, dolomitic limestone, high purity magnesium hydroxide (Fisher Scientific) and a by-product magnesium hydroxide (Dravo). The test unit operating temperatures were controlled over the range of 300 °C to 1000 °C (572 °F to 1832 °F) and contact times ranged from 0.5 minutes to 8 minutes. Under most test conditions, pulverized dolomitic limestone was far more reactive towards SO_3 capture per mole of Ca+Mg than the high-calcium quicklime, dolomitic quicklime, or high purity magnesium hydroxide from Fisher. However, when the Dravo by-product magnesium hydroxide was included in the test matrix, it proved to be the most active sorbent at temperatures up to 700 °C (1292 °F).

Based on the results of the bench-scale tests, a decision was made to conduct pilot-scale combustor tests using readily available low cost pulverized high-calcium limestone and pulverized dolomitic limestone sorbents. The tests were conducted in the CONSOL 0.5 MW_t pilot combustor unit. The results of these tests established the optimum temperature window for the sorbent injection and clearly showed that, under similar conditions, pulverized dolomitic limestone was a superior sorbent to pulverized limestone. The temperature window was 1093 °C to 1316 °C (2000 °F to 2400 °F). The maximum SO_3 removal achieved was 81% at a Ca+Mg:SO_3 mol ratio of 46:1 at about 1260 °C (2300 °F).

Based on the bench-scale and pilot combustor test results and additional information obtained from the literature, an economic evaluation was made comparing the costs of pulverized high-calcium limestone injection and dolomitic limestone injection with the use of commercially available magnesium hydroxide slurry injection for SO_3 control. This study showed that magnesium hydroxide slurry injection would be the most cost effective option with an estimated capital cost of about $0.82/kW and a SO_3 removal cost of $877/ton of SO_3 removed (basis: power station 600 MW (gross), 5 wt % S coal, 90% SO_3 removal). The study also showed that the use of by-product magnesium hydroxide slurry injection has the potential to further reduce the SO_3 removal costs.

10. PLANS FOR COMING YEAR:

The final report will be issued after comments on the draft report are received from OCDO. CONSOL is currently evaluating opportunities to conduct a large-scale demonstration of magnesium hydroxide slurry injection into a coal-fired boiler. The goal will be to determine if slurry injection can reduce flue gas SO_3 levels at temperatures above where ammonium bisulfate would form due to ammonia slip from boilers equipped with selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) NO_X controls. Alternatively, a demonstration that the use of magnesium hydroxide would limit air heater fouling or improve air heater cleaning operations would be equally desirable.

II. HIGHLIGHTS/ACCOMPLISHMENTS

11. A bench-scale test unit for comparing SO_3 sorbent reactivities was constructed and successfully tested. The bench-scale tests established the reactivity of five sorbents for SO_3 removal from a nitrogen/SO_3 gas stream. The sorbents were: high-calcium quicklime, dolomitic quicklime, dolomitic limestone, magnesium hydroxide from Fisher Scientific, and by-product magnesium hydroxide from Dravo. The by-product magnesium hydroxide and the dolomitic limestone generally showed the highest reactivities for SO_3 removal.

Low-cost pulverized high-calcium limestone and pulverized dolomitic limestone sorbents were tested in a 100lb/hr coal-fired pilot combustor. The tests established the optimum temperature window for sorbent injection and showed that pulverized dolomitic limestone was a superior sorbent to pulverized limestone.

Based on the bench-scale unit and pilot combustor data the economics of using pulverized limestone or pulverized dolomitic limestone were compared to the use of magnesium hydroxide slurry injection for controlling flue gas SO_3. The results showed that the use of magnesium hydroxide slurry injection would be the most economical control method.

A draft final report was written and forwarded to OCDO for review.

III. ARTICLES/PRESENTATIONS

12. Brandes, S. D.; Rosenhoover, W. A.; and DeVito, M. S. "The Development and Evaluation of a Cost-Effective Method For Reducing SO_3 From Coal-Fired Boiler Flue Gas", presented at the 17th Annual International Pittsburgh Coal Conference, Pittsburgh, PA, September 11-14, 2000.